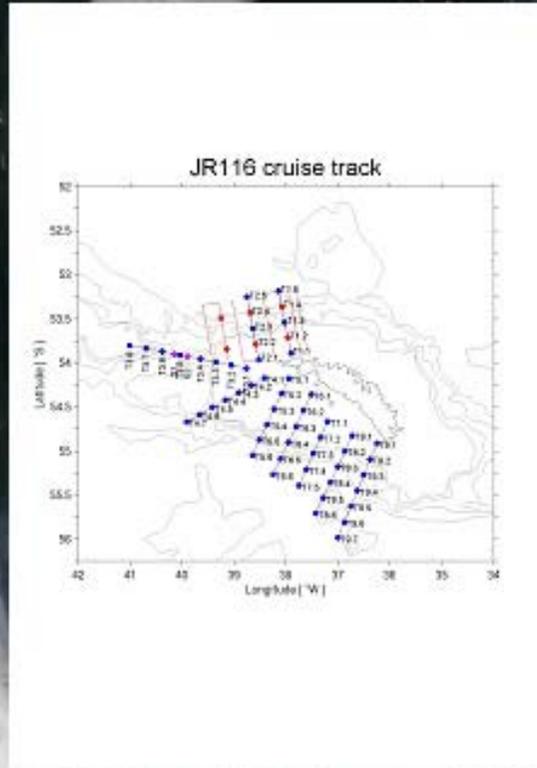


# JR116 Southern Shelf Structure & Production



**DYNAMOE CRUISE JR116: SEASON DEC 2004/ JAN 2005.....8**

A STUDY OF COMMUNITY STRUCTURE AND PRODUCTION ALONG THE SOUTHERN SHELF OF SOUTH GEORGIA AND LINKS WITH THE GEORGIA BASIN.....8  
PETER WARD & SALLY THORPE.....8  
BACKGROUND.....8  
CRUISE DESIGN.....9  
    *Specific questions include:*.....10  
CRUISE OUTLINE.....10

**CRUISE TRACK.....12**

SALLY THORPE.....12

**CRUISE NARRATIVE.....14**

PETER WARD.....14

**PHYSICAL OCEANOGRAPHY REPORT.....18**

SALLY THORPE, ZIGGY POZZI WALKER.....18  
1. CONDUCTIVITY-TEMPERATURE-DEPTH (CTD) PROFILING.....19  
    *Configuration and procedure*.....19  
    *Discrete salinity samples*.....20  
    *CTD Data Processing (Seasave)*.....20  
    *CTD Data Processing (Unix)*.....21  
    *CTD calibration*.....22  
    *Notes on specific casts*.....23  
    *Transmissometer*.....24  
2. NAVIGATION DATA.....25  
    1. Gyrocompass.....25  
    2. GLONASS.....25  
    3. Trimble 4000.....25  
    4. Ashtec ADU-2.....26  
    5. Doppler log.....27  
    6. Electromagnetic log.....27  
    7. Bestnav.....27  
    8. Swath bathymetry.....27  
    9. Year end.....27  
3. VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER (VMADCP).....28  
    *Instrument configuration*.....28  
    *Data Processing*.....28  
    *Calibration of the JR116 ADCP data*.....30  
    *ADCP SUMMARY*.....31  
4. OCEANLOGGER (UNDERWAY MEASUREMENTS).....32  
    *Data Processing*.....32  
    *Salinity calibration*.....32  
    *Problems*.....32  
    *Photo showing Oceanlogger screen at 2215 GMT 13 January 2005. Temperature axis ranges from 3.5—4.1 °C. Note the noisy sea temperature trace (magenta line)*.....33  
5. SIMRAD EA600 BATHYMETRIC ECHO SOUNDER.....34  
    *Data processing*.....34

6. EXPENDABLE BATHYTHERMOGRAPHS (XBTs).....	35
APPENDIX: CONFIGURATION REPORT FOR THE CTD SENSORS USED ON JR116 .....	37
CTD TABLE.....	40
<b>AFI 3/16 MOORING CRUISE REPORT JR 116/JR 118.....</b>	<b>43</b>
PETER ENDERLEIN & DOUG BONE .....	43
BACKGROUND, AIM AND METHODOLOGY:.....	43
RECOVERY AND REDEPLOYMENT DURING JR 116:.....	43
.....	43
<i>Table 1: List of events during recovery of both moorings (from the event log):</i> .....	44
<i>Table 2: List of events during redeployment of both moorings</i> .....	44
DATA VERIFICATION:.....	44
ADDITIONAL EVENTS AROUND THE MOORINGS:.....	45
<i>RMT 8 fishing</i> .....	45
<i>Acoustics for 6 hours</i> .....	46
<i>Swath Bathymetry</i> .....	46
WORK CARRIED OUT:.....	46
<i>WCP:</i> .....	46
<i>CTD:</i> .....	46
<i>ADCP:</i> .....	46
<i>NOVATEC beacons</i> .....	46
<i>ARGOS beacons</i> .....	46
<i>Releases</i> .....	46
INSTRUMENT SETTINGS (GENERAL):.....	46
<i>CTD</i> .....	46
<i>ADCP</i> .....	46
<i>WCP</i> .....	47
<b>MACRONUTRIENT ANALYSIS.....</b>	<b>48</b>
MICK WHITEHOUSE AND MIN GORDON.....	48
INTRODUCTION.....	48
JR116 AIMS.....	49
DATA COLLECTION AND ANALYTICAL METHODS.....	49
DATA ANALYSIS.....	49
TECHNICAL PROBLEMS ENCOUNTERED.....	50
REFERENCES.....	50
<b>PHYTOPLANKTON PRODUCTION.....</b>	<b>51</b>
REBECCA KORB, MIN GORDAN, IAIN CARRIE.....	51
INTRODUCTION.....	51
JR116 AIMS.....	51
DATA COLLECTION AND METHODS.....	51
RESULTS.....	52
<b>OPTICS RIG.....</b>	<b>53</b>
IAIN CARRIE, NATHAN CUNNINGHAM,, BEKI KORB.....	53
BACKGROUND.....	53
AIMS.....	53
METHOD.....	53

DATA COVERAGE.....	53
PRELIMINARY RESULTS.....	54
<i>Figure opt1</i> .....	54
PROBLEMS.....	54
<b>ACOUSTICS JR116: CRUISE REPORT.....</b>	<b>55</b>
CATHY GOSS, PETER ENDERLEIN, TONY NORTH AND GERAINT TARLING.....	55
INTRODUCTION.....	55
AIMS.....	55
METHODS/SYSTEM SPECIFICATION .....	56
<i>Software versions, hardware</i> .....	56
STRATEGIES FOR RUNNING SOUNDERS TOGETHER.....	56
<i>Sounder set-ups (all use external trigger in each case, and each needs to be logging)</i> ...56	
<i>Sounder set-ups for Western Core Box (all use external trigger in each case, and each needs to be logging)</i> .....	57
<i>Core box standard protocol</i> .....	57
IMPLICATIONS OF PING INTERVAL .....	58
<i>Distance between pings in metres</i> .....	58
<i>Widths of the seven-degree beam with depth</i> .....	58
FILE LOCATIONS.....	58
COMPRESSION WITH ECHOLOG.....	59
SETTINGS.....	59
DATA PROCESSING IN ECHOVIEW.....	60
CALIBRATION.....	60
<i>11/01/2005 00:44 Rosita Harbour</i> .....	60
DATA COVERAGE.....	61
<i>Oceanography transects</i> .....	61
<i>Western Core Box at South Georgia</i> .....	61
PROBLEMS ENCOUNTERED .....	62
<i>Interference</i> .....	62
<i>EK60 operation</i> .....	62
<i>Echoview operation</i> .....	62
FUTURE PLANS.....	62
<i>To Do List</i> .....	62
REFERENCES.....	62
TABLES AND FIGURES.....	63
APPENDIX 1: TABLE ACOUSTIC 1 .....	63
<i>EK60 settings at the start of the survey</i> .....	63
<i>Table Acou2 JR116 EK60 settings at the start of the survey and after calibration at Rosita Harbour</i> .....	65
APPENDIX 2: TRANSECT LOG.....	67
<b>ZOOPLANKTON.....</b>	<b>72</b>
SHREEVE, WARD, POND, HIRST.....	72
INTRODUCTION.....	72
FOOD QUALITY.....	72
PRELIMINARY RESULTS.....	72
NOTES ON BONGO NETS.....	72
KRILL.....	73

STABLE ISOTOPE TRACER EXPERIMENTS.....	73
<b>NET CATCHES AND KRILL BIOLOGY.....</b>	<b>74</b>
GERAINT TARLING, DOUG BONE , PETER ENDERLEIN, RACHAEL SHREEVE, .....	74
ANDREW HIRST & TONY NORTH.....	74
NET CATCHES.....	74
SUMMARY OF OPERATIONS AND CATCHES.....	74
LENGTH-FREQUENCY DISTRIBUTIONS.....	77
<i>Fig 1:Length-frequency distribution of all krill measured during JR116.....</i>	<i>77</i>
<i>Mysids: Antarctomysis maxima frequently occurred in RMT8 nets on shelf. Event 158 contained sufficient numbers to carry out a length-frequency distribution analysis. The analysis revealed that there were 3 modes in the population, with peaks at 15 mm, 30 mm and 38 mm.....</i>	<i>78</i>
<i>Fig 2: Length-frequency distribution of Antarctomysis maxima from event 158 (net 1). 78</i>	<i>78</i>
<b>KRILL SPAWNING STUDIES.....</b>	<b>79</b>
GERAINT TARLING, DOUG BONE , PETER ENDERLEIN, RACHAEL SHREEVE, .....	79
ANDREW HIRST & TONY NORTH.....	79
<b>AFI PROJECT CGS6/16.....</b>	<b>81</b>
<b>INDIVIDUAL BEHAVIOURAL RESPONSES OF KRILL TO STIMULI: AN APPROACH TO UNDERSTANDING SWARMING.....</b>	<b>81</b>
GERAINT TARLING (BAS) AND MAGNUS JOHNSON (SCCS, UNIVERSITY OF HULL).....	81
BACKGROUND.....	81
IMPLEMENTATION OF FIELD PLAN.....	82
<i>Table 1: RMT8 net catches from which krill were incubated and used for swimming experiments.....</i>	<i>83</i>
EXPERIMENTAL METHODS.....	83
<i>Figure 1: Fast Fourier Transform of the trace produced by a krill swimming while attached to a pendulum. The arrow highlights the easily visible peak at 3.12 Hz which directly corresponds to the pleopod beat rate of the animal.....</i>	<i>84</i>
<i>Figure 2: Typical example of krill swimming performance (sampling reduced from 100 Hz to 0.5 Hz for clarity) recorded on a PowerLab. 1 = Control krill, 2 = Estimated position of experimental animal due to ships movement, 3 = Raw data recorded for experimental animal, 4 = Movement of the krill after accounting for ship movement.....</i>	<i>85</i>
INFLUENCE OF PHYSIOLOGICAL CONDITION ON SWIMMING PERFORMANCE.....	85
INFLUENCE OF ENVIRONMENTAL FACTORS ON SWIMMING PERFORMANCE.....	86
LONG-TERM ACTIVITY PATTERNS.....	86
GROUND-TRUTHING TRANSDUCER PATTERNS.....	87
METADATA ANALYSIS.....	87
<i>Table 2: Distribution of maturity stages in the different protocols used for measuring swimming performance. Showing that swimming performance was measured in all the major maturity stages, although numbers of sub-adult females was relatively low.....</i>	<i>88</i>
<i>Fig.3: Distribution of moult stages amongst animals measured for swimming performance.....</i>	<i>88</i>
<i>Fig. 4: The length-frequency distribution and maturity stage of animals used in the swimming performance analysis.....</i>	<i>89</i>
PRELIMINARY RESULTS.....	90

<i>Fig. 5: The maximum angle of deflection resulting from the swimming performance of an animal compared to its underwater weight (calculated from Kils 1981); only data from measurements where the animal was sacrificed after observation was used [R2 = 0.4; P&lt;0.0001]</i> .....	90
<i>Fig. 6: The pleopod beat rate of different maturity stages</i> .....	92
<i>Fig. 7: Comparison of the signal to noise ratio between intermoult and pre/post moult animals</i> .....	93
<b>CTD TAGS.....</b>	<b>94</b>
L BOEHME.....	94
INTRODUCTION .....	94
METHODS .....	95
CALIBRATION .....	96
<i>Pressure</i> .....	96
<i>Temperature and Conductivity</i> .....	97
<b>VISUAL AND ACOUSTIC SURVEYS FOR CETACEANS.....</b>	<b>103</b>
RENÉ SWIFT AND DEBORAH SALMON.....	103
INTRODUCTION.....	103
AIMS.....	103
METHODS.....	104
<i>Visual surveys</i> .....	104
<i>Acoustic surveys</i> .....	104
RESULTS.....	105
PROBLEMS ENCOUNTERED.....	105
REFERENCES.....	105
<i>Table 1 Marine mammal sightings</i> .....	106
<i>Table 2: Fur Seal sightings</i> .....	106
<i>Figure 1. Cruise trackline and marine mammal sightings</i> .....	107
<i>Figure 2. Baleen whale sightings and cruise trackline around South Georgia</i> .....	107
<i>Figure 3. Odontocete sightings and cruise trackline around South Georgia</i> .....	108
<i>Figure 4. Fur seal sightings and cruise trackline around South Georgia</i> .....	108
<b>ETS CRUISE REPORT FOR JR116.....</b>	<b>109</b>
MARK PRESTON.....	109
EK60.....	109
XBT SYSTEM.....	109
CTD SYSEM.....	109
SWATH.....	109
ADCP.....	109
OCEANLOGGER.....	110
SSU.....	110
<b>ITS CRUISE REPORT.....</b>	<b>111</b>
JPRO.....	111
DATA LOGGING SYSTEMS .....	111
SCS .....	111
<i>SCS Event Log 1.3.Instruments</i> .....	111
<i>Ashtec ADU5 GPS</i> .....	111

<i>Trimble GPS</i> .....	112
<i>ADCP PC</i> .....	112
<i>Simrad EA600</i> .....	112
<i>Java Logging System</i> .....	112
<i>Perl Monitoring Programs</i> .....	112
<i>EM120 / Topas</i> .....	112
<i>EK60</i> .....	112
<i>1.8. Instrumentation Network</i> .....	113
<b>CODIS</b> .....	113
<b>WEB APPLICATIONS</b> .....	113
<i>MediaWiki</i> .....	113
<i>Bridge Science Log / Event Log</i> .....	114
<b>NETWORK HARDWARE</b> .....	114
<i>UPSes</i> .....	114
<b>SWITCHES</b> .....	115
<b>NETWARE / PCs</b> .....	115
<i>PC</i> .....	115
<i>EK60 Workstation 1</i> .....	115
<i>Surgery PC</i> .....	115
<b>UNIX SYSTEMS</b> .....	116
<i>JRUA</i> .....	116
<i>JRUI</i> .....	116
<b>DATA MANAGEMENT CRUISE REPORT.....</b>	<b>117</b>
NATHAN CUNNINGHAM.....	117
<i>SCS Streams for JR116</i> .....	117
HUBRIS (WEB BASED DATA LOGGING SYSTEM).....	118
<i>Keywords and Phrases</i> .....	118
<i>Design Features</i> .....	118
<i>Feature List</i> .....	119
<i>Summary</i> .....	119
<b>GEAR REPORT.....</b>	<b>120</b>
DOUG BONE, PETER ENDERLIN, NATHAN CUNNINGHAM .....	120
DOWN WIRE NET MONITOR.....	120
RMT SYSTEM.....	120
UOR.....	120
<i>NSHUTTLE, preferred setup. (e-mail to Chelsea)</i> .....	120
<i>Schematic of new UOR system</i> .....	122
<b>SCIENTIFIC STAFF.....</b>	<b>123</b>
<b>SHIPS CREW.....</b>	<b>123</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>124</b>
PETER WARD.....	124

# **DYNAMOE cruise JR116: season Dec 2004/ Jan 2005**

A study of community structure and production along the southern shelf of South Georgia and links with the Georgia Basin

Beki Korb, Sally Thorpe, Peter Ward, Jon Watkins & Mick Whitehouse

## **Background**

Two previous cruises undertaken around South Georgia during Q3 have focussed on two major and linked themes, namely quantifying production within, vs flux into the region and identifying key environmental features that promote production. One key finding is that primary production at South Georgia is mainly a local feature with little growth initiated upstream. SeaWiFS imagery and shipboard data have shown that phytoplankton blooms frequently occur downstream of the island, extending from the northwest coast to the Polar Front and then considerable distances to the east. Drifter releases and shipboard measurements have provided supporting evidence that productive waters move from the NW region of South Georgia's shelf/shelf break, cyclonically along the periphery of the Georgia Basin and then enter the Polar Front and are advected eastwards. The NW shelf is almost certainly a benthic source of iron to the generally HNLC conditions of the Southern Ocean while typical HNLC conditions can often be found upstream of the island. We have also demonstrated that strong links exist between mesozooplankton abundance and condition and differing phytoplankton regimes and it seems clear that the local production can often contribute greatly towards zooplankton standing stock. However in considering transport of krill and other zooplankton into the South Georgia region, pathways to the NW of the island are not obvious. Very few of the drifters released along the north coast during JR70 or along transects within the Scotia Sea during JR82 subsequently entered this area. Most released to the south of the SACCF were transported to the east of South Georgia without being drawn into the island's ambit. The only direct routes into the northwest from the areas lying to the east and south of the island appeared to be over the shelf, and yet the biological differences between regions suggested that this was not the main vector for much of the mesozooplankton.

SeaWiFS imagery has also supported the view that connections between east and west are limited but has also highlighted the importance of phytoplankton blooms on the island's southern shelf. A review of SeaWiFS data for the last 8 summer seasons indicates that the southern shelf is the most reliable source of chlorophyll around South Georgia with high levels evident in 29 out of 46 months. Indeed, there are at least two seasons (96/97 and 00/01) when the southern bloom contributed the vast majority of primary production to the system feeding into the Georgia Basin. It is likely that the southern shelf also provides a benthic source of iron to promote primary production but to date we have virtually no data on water flow in this region and no estimates of primary production rates.

To gain a balanced view of local production at South Georgia it has been agreed that this final Q3 cruise should be a survey of the island's productive southern shelf. We are proposing to undertake station-based measurements along a series of north-south transects situated over the southern shelf and extending across the shelf break. Additionally stations situated along transects radiating out from Willis Islands will be sampled to improve our view of advection at the western end of South Georgia and indicate the degree of connection between south-western and north-western shelf waters (Fig. 1). We also propose that transects are

acoustically surveyed during the hours of daylight to estimate the distribution of krill biomass. RMT 8 hauls will periodically be made to provide information on krill size frequency and to provide material for experimentation. The cruise in 2004/05 will probably represent the last opportunity to examine the pathways into and out of the region and questions of production and flux as they relate to South Georgia at this scale for the foreseeable future. Q4 science is going to focus on larger scale questions and will not explicitly deal with regional questions of this nature.

## **Cruise design**

The proposed cruise track should afford us better insight into physical processes on and off the southern South Georgia shelf with a view to a better understanding of on/off shelf transport and transfer to the WCB. The transects are aligned perpendicular to South Georgia's shelf and the expected flow. This will allow estimation of the geostrophic currents from CTD data and, together with the ADCP measurements, calculation of absolute flow rates. A nominal CTD station spacing of ~20 km is adequate to resolve larger-scale features and temperature and salinity measurements from the CTD will permit examination of water mass characteristics, giving further information on local currents. The UOR and ADCP data will allow resolution of the finer-scale features. On-shelf, the ADCP will be able to resolve water movement to full depth between stations.

A radial pattern of transects from the western end of South Georgia maintains the pattern of perpendicularity to expected flow. This gives a zonal transect between Shag Rocks and South Georgia (drifter data indicate that this passage is a transport route for waters south of South Georgia into the Georgia Basin) and two transects perpendicular to the westward flow in the Georgia Basin indicated by the drifters. This pattern also ensures that we should be able to identify any on-shelf transfer between the southern shelf and the WCB.

Earlier cruises (JR70, WOCE cruise A23) have shown that the SACCF is tied to the bathymetry of the eastern South Georgia shelf. Data (both SST and historical hydrographic data) indicate that south of South Georgia the SACCF may be closer to the southern shelf of South Georgia than previously thought (cf. Orsi et al, 1995). The extensions of the eastern-most transects of the proposed cruise track into the Scotia Sea will allow us to investigate this hypothesis. If the SACCF is close to the southern shelf of South Georgia then that would allow a fast-track transport route to the southern side of the island.

Extension of the northern transects into the Georgia Basin north of South Georgia will allow us to characterize the flow in this region, indicated by the drifters deployed in the past two cruises to be isolated from the main pathways of transport along the shelf.

The data collected will be extremely useful for future ocean circulation model refinements in the region by providing more data for validation, both in terms of water mass characteristics and velocity information, and also by running the swath system, bathymetry information.

In addition to physical observations we would routinely measure phytoplankton abundance, phytoplankton growth efficiency, physiological status using the FRRF, macronutrient availability and use, as well as assessing mesozooplankton abundance, composition and condition. Using SeaWiFS imagery we would also target areas of interest for more detailed primary production measurements.

### *Specific questions include:*

- 1) Estimation of mass transport within the surveyed region
- 2) The extent to which water upwells at the southern shelf-break (the shallows to the south of the Willis Islands and the submarine canyon to the west of Annenkov Island are of particular interest)
- 3) The spatial extent of the bloom and why it predominantly advects west and not east.
- 4) The impact of these southern productive waters on the region to the west of South Georgia and the Georgia Basin.
- 5) The spatial distribution of zooplankton including krill across the survey area and its relationships to mass transport and phytoplankton development.

### **Cruise outline**

The transect and station positions are given in Fig 1. Each of the 9 transects\* was ~80-120km long with stations spaced at approximately 20 km intervals. The exception was T9 at the eastern end of the southern shelf that was extended by some 20 km to cross the anticipated position of the SACCF and T3 running across from Willis Islands towards Shag Rocks. Station activities (1 near bottom CTD, 2 bongo nets, 1 shallow CTD and 1 optics rig cast to 200 m) and steaming between transects were estimated to take around 10.5-11 days. Additional acoustic surveying during daylight and RMT net hauls would add ~ 4 days to the total time. Other science tasks to be undertaken included surveying the Western Core Box (WCB) (4 days), uplifting and redeploying the 2 sets of moorings located with the WCB (1 day), echosounder calibration (0.5 day) and the dropping off of pax at Husvik. The ship also had to leave her cargo tender at Bird Island to assist RRS Shackleton unload cargo for the Bird Island rebuild and pick up one pax (Jaume Forcada). This latter was planned to be opportunistic and was highly weather dependent.

NB \* Originally the cruise was scheduled to be longer but due to the re-timetabling necessitated by JCRs inability to get into Rothera earlier in December, time was reduced by a week to 26/27 days to enable her to have another attempt later in January. This required a number of alterations from the original proposal in order to save time as follows:

- i) Rather than run each transect in daylight we adopted a rolling programme that meant we started transect activities as and when we arrived at the head of each transect. A casualty of this approach was our use of the UOR on the transects. With the many tasks that needed to be fitted in it was not possible to get the appropriate UOR people on watch to cover all possible eventualities. We also had concerns about the bathymetry on the south coast that is not as well known as that on the north coast. Rather than risk slowing the transects, or having to make abrupt alterations to the UOR flight path we decided that the ADCP and acoustics should take priority and run alone.
- ii) Rather than attempt to run the WCB as a separate exercise we realigned transects 1 and 2 to lie along the WCB acoustic lines (W2.2 and W3.2 respectively) and ran a mix of acoustics and station based work. We also reduced the number of stations on each to 5 by omitting the deep water ones to the north. The reconfigured survey is shown in Fig 1.

- iii) The number of RMT8 hauls budgeted for was reduced, although in fact there were very few targets to aim at over the southern shelf.

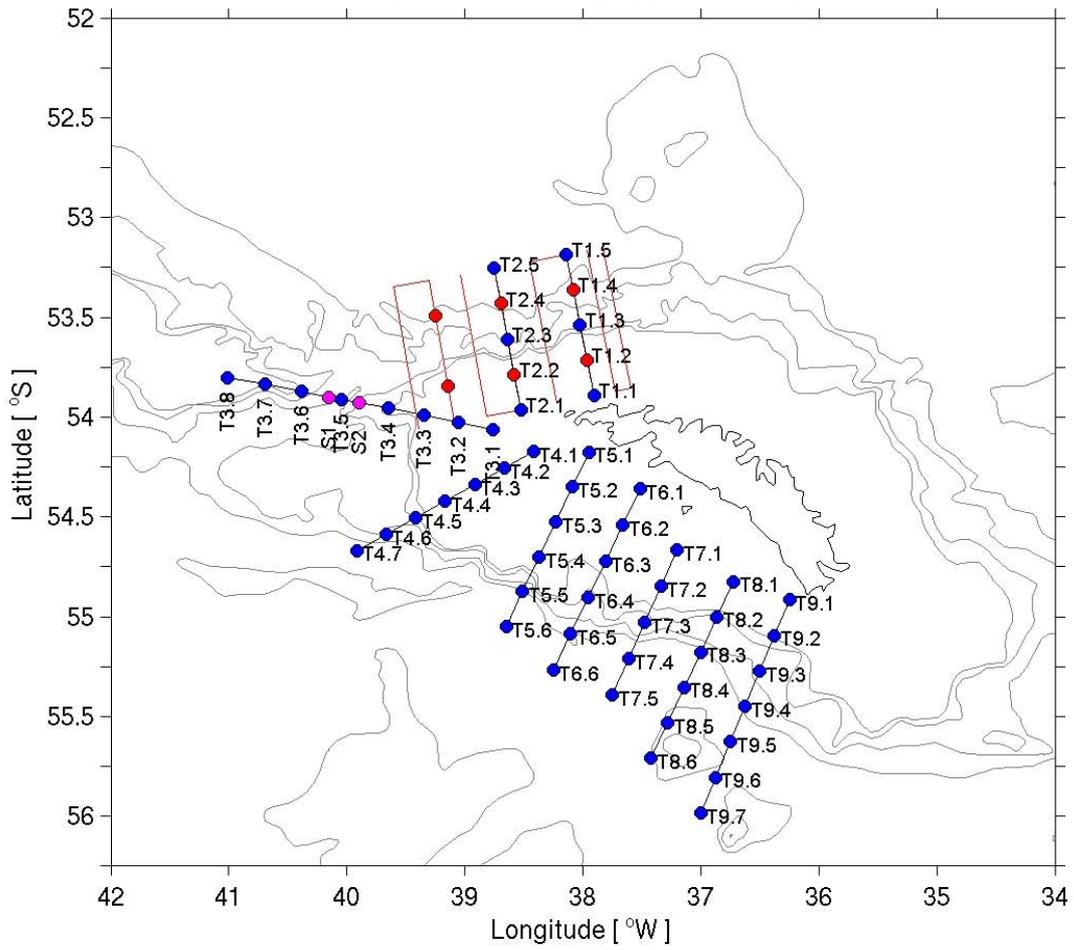
In all we estimated we would save some 4-5 days by approaching the survey in this way. In the event the weather was very kind to us and time losses for the revised programme were minimal.

Although JR116 was the cruise designation for the whole period we spent at sea, various modules were identified separately, thus core box acoustics (JR117) Moorings AFI 3-16 (JR118) and CGS 6/6 (JR119) were carried out within the main body of the cruise.

# **Cruise track**

Sally Thorpe

# JR116 cruise track



# Cruise narrative

Peter Ward

16<sup>th</sup> December

First of science party leave BAS via MOD and Lan Chile flights.

21<sup>st</sup> December

Remainder of scientific party arrive Port Stanley at 16:15 hrs local. Shore-side accommodation for the night.

22<sup>nd</sup> December

11:00 hrs scientific party arrive onboard JCR and begin mobilisation after lunch. Containers emptied and equipment distributed to the various labs and spaces by dinnertime. Work continues well into the evening.

23<sup>rd</sup> December

Safety brief at 0:800 hrs. Final preparation and fixing down of equipment continues through the morning. Depart FIPASS for Port William and Sparrow Cove where boat drills and emergency muster carried out. Head off to South Georgia around 14:30 hrs local. Pleasant roll and a following sea.

24<sup>th</sup> December

Science brief this morning followed by an emergency drill at 10:30hrs. Mobilisation continues in very reasonable weather. Shake-down station carried out at 14:00 hrs. Shallow CTD Bongos and the Optics Rig. All completed satisfactorily.

25<sup>th</sup> December

Continued progress in good weather. Relaxing Xmas lunch and buffet meal in the evening. Passing to the south of Shag Rocks during late afternoon with a few whales (Killers and a Right Whale) spotted by the bridge. ETA at first station pm tomorrow.

26<sup>th</sup> December

Travelled along the south coast of South Georgia this morning in calm conditions. Clear views of the 'foothills', although the peaks were shrouded in cloud. Remarkably little ice around considering how much was around last year, which should make things a lot easier. RMT8 haul in the morning successfully trialled the gear, as well as capturing krill and mysids and the first experiments were set up after lunch. Poor connection around the slip ring connector to the net monitor is presently being investigated. Onto transect at 12:30 pm just off Cape Disappointment, due off at 19:30 hrs this evening.

27<sup>th</sup> December

Stations commenced last night and continue through today. Weather generally grey and foggy although eminently workable. Silicate depletion over much of the area which is not quite what we were expecting (as ever the case). SeaWiFs composite from a couple of weeks ago indicated a very dense bloom over the southern shelf and around to the west. Pretty much what we had hoped for. However the next composite indicated that this had largely disappeared with surprising speed. Net catches providing young stages of *R. gigas* but dominated by *C. acutus* IVs and Vs and few ripe females. Appear to have missed the SACCF which we thought we might encounter near the outer station.

28<sup>th</sup> December

Transect 9 completed in the early hours and onto transect 8 around 05:30 hrs. Continues through the day. Outermost station in proximity of sea-mount associated with silicate rich water and different phytoplankton composition.

29<sup>th</sup> December

Transect 8 completed in the afternoon and relocated to transect 7. Fog continues throughout period.

30<sup>th</sup> December

A better day. A bit marginal at times for netting activities with a rather large swell surging down the side of the ship. RMT fished in the morning and caught....salps!  
Weather cleared in the afternoon and sun came out. South Georgia clearly visible by evening.

31<sup>st</sup> December

A spectacular sunrise as we continue down T6 in calmer conditions, although a large swell on the beam persists. Work transect until late afternoon when problems arise with power supply to bongo winch. Board replaced and we are in business again although tap gets smashed on way in but is quickly repaired. Turn in at normal time but woken just after midnight by phone call from UIC. This time there is a problem with the CTD winch control. Happy New Year!  
Elect to cross to inshore end of T5 and run up overnight with acoustics/ADCP.

1<sup>st</sup> January

Reach outer end of T5 at around 10:30 hrs. Renewed efforts by the shipside and Mark Preston finally sees the problem tracked down to a dodgy potentiometer on the control stick. On the road again at around midday. Run down T5 for rest of day.

2<sup>nd</sup> January

Krill fishing overnight but only a bag of mysids caught. Complete T5 around 10:30 hrs and head off towards T6.4 to complete the station work that the winch control problems caused us to miss.

3<sup>rd</sup> January

T6 completed overnight with a good catch of krill as well. Then steaming to T4 and station work following the acoustic /ADCP run. Ziggy has pulled muscles in his neck whilst shaking a salinity bottle!

4<sup>th</sup> January

T4 completed in flat calm conditions in late afternoon. Presently steaming T3 which has been realigned to incorporate the SHAGEX station positions. Good progress all round at present. Wonderfully calm evening as we transect out along T3. Groups of fur seals everywhere and a long, barely rippled swell, reflecting pastel hues as the sun goes down. ETA transect end around 03:00hrs tomorrow.

5<sup>th</sup> January

Station work commences in the early hours. Conditions deteriorating rapidly and a rather heavy swell starts to build. Concern at 3.5 that we might not get the Bongo sample due to

deteriorating weather. Thankfully things calm down sufficiently to allow one net but decide not to do optics rig. Weather starts to go down almost immediately and swell reduces by evening.

#### 6<sup>th</sup> January

Transect 3 completed by 06:00 hrs this morning. I believe we have broken the back of it and now only require samples from the WCB to meet the main project objectives. No decision yet about Bird Island and so we carry on with the core box survey W1.1 and W1.2 this time towing the undulator (in thick fog again!). Decide that the RMT samples from the core box should be preserved and not dealt with here on the ship. We are too few in number and trying to combine the transect stations with the core box stretches us unrealistically. 2/3 of the way down W1.2 we are requested to bring the undulator inboard. Valve on cooling water has 'gone' and up to 7-400 tonnes of seawater have entered the engine room depending on whom you believe. Everyone has to be up and ready to muster at a moments notice! Situation brought under control and we are back doing science by 20:00hrs.

#### 7<sup>th</sup> January

Stations completed overnight and onto transecting W2.1 and W2.2 at around 05:00hrs. A little more detail about the engine room flooding incident yesterday is beginning to emerge. Potentially very serious and we were particularly fortunate that there wasn't a big sea running, as we were effectively powerless during the period. Around 100 tonnes of water found its way in (official estimate). Station work started around 16:00 hrs.

#### 8<sup>th</sup> January

Slower progress overnight. Weather blowing up a bit and RMT at T2.4 cancelled. Remainder of station completed although only one bongo net taken. Strongish westerly at the moment. Fortunately things calm down through the day and complete station work around 15:00 hrs. Sprint up 3.1 before dark and complete around 20:00. Cross to 3.2 and start to work stations back down the transect.

#### 9<sup>th</sup> January

Complete as far as T1.3 by lunchtime in pretty thick fog. Station work taking longer than anticipated. Decide to cross over to deep mooring after lunch and lift in good visibility. Completed around 16:00 hrs and then run down to shallow mooring with clear views of north coast of South Georgia on the way. Shallow mooring inboard in thick fog around 1930 as it is starting to get dark. Good effort! Rest of evening dedicated to RMT8 fishing with a view to being back at northern end of 3.2 at 03:30 tomorrow to run the final day of acoustics.

#### 10<sup>th</sup> January

Clear day and low swell as acoustics run gets underway at 03:30 hrs. Continues throughout the day as we knock off 3.2 and 4.1 and 4.2. Conditions towards the end less than ideal in an increasing beam swell. Finish at inshore end around 18:45 hrs and head for Rosita Harbour to undertake the echosounder calibration overnight. Fisheries protection vessel 'Dorada' close by in early evening as we approach Bay of Isles.

#### 11<sup>th</sup> January

Is it to be Husvik or Bird Island. My guess having seen the surface charts for midnight last night would be Bird Island but not under ideal conditions. We shall see!

Bird Island it is with yesterdays swell having moderated considerably. Away from Rosita around 06:45 and along the north coast past right whales and teeming birdlife.

Anchor off BI in calm conditions around 10:15 hrs. Forward crane not working initially but once fixed cargo tender and boats away by 11:15 hrs. Base members to lunch. Depart around 15:00 hrs for deep mooring site in 40 kt winds. Only local winds though and once out to moorings it had calmed considerably. Successfully redeployed around 18:00 hrs. Shallow moorings redeployed next and then RMTs until its time to depart for Husvik in the early hours of tomorrow.

12<sup>th</sup> January

Steam through the early hours the 50-60 miles to Husvik. Arrive around 08:00 hours and drop Lars off to meet up with Martin Biuw and party, who were input by 'Dorada' a few days ago. Out onto the shelf around 09:00 hours to sample the two stations (1.1 and 1.2) we ran out of time for on the 9<sup>th</sup>. Short steep swell and 35-40 knots of wind which abated once we got clear of the island itself. Successfully sampled and so we now have a complete set. RMTs again tonight around the moorings sites and then up along transect ER635 and on to Stanley. ETA 08:00 hours Monday 17<sup>th</sup>.

13<sup>th</sup> January

Passage to shallow moorings site overnight. RMT after breakfast provides a 20 l bag of krill. Move off at 09:10 hrs to the start point for ER635. On track just after 13:00 hours and as we start to move offshore the clouds start to disappear and much of the Island appears in bright sunshine.

14<sup>th</sup> January

Complete ER635 section around 02:30 hrs. Ship making for Stanley running swath. Heading into a lumpy swell initially that restricts us to around 7knots. Settles down later. Packng, cleaning and cruise reports are the order of the day.

15<sup>th</sup> January

More of the same. Fog rolling in and out but calm seas for the most part. Cruise Dinner this evening which turned out to be a jolly affair. Doug, Cathy and Tony presented with cards and gifts. Quiz later on which was very entertaining hosted by Nathan and Lisa. Ship starts to lurch around in what transpires to be a pretty lumpy head sea. Not much sleep for many.

16<sup>th</sup> January

Calmed down over the course of the morning. Revised ETA has us in Port William for 08:00 hrs tomorrow. Thereafter to FIPASS at first available opportunity. Ship undergoes MCA audit upon arrival. Cruise personnel off ship at 10:00 hrs on Tuesday 18<sup>th</sup> with first flights out on 20<sup>th</sup> and then on 22<sup>nd</sup>

# Physical Oceanography Report

Sally Thorpe, Ziggy Pozzi Walker

This report contains details of the data collection and processing of the following data streams on JR116:

1. CTD operations
2. Navigational data
3. ADCP
4. Oceanlogger
5. Simrad EA600 bathymetry
6. XBT operations

## 1. Conductivity-Temperature-Depth (CTD) Profiling

A Conductivity-Temperature-Depth (CTD) unit was used on JR116 to vertically profile the water column. In total 102 CTD deployments were made, more than enough to call this a physics cruise!! At each station on Transects 1 to 9 of JR116 where the water depth exceeded 250 m, 2 deployments were made: one to full depth (10 m above the seafloor) and one to 120 m. These multiple deployments were made to ensure sufficient water samples for the needs of the physicists (deep samples for salinity calibration), nutrient chemists and primary production experiments (shallow samples); on future cruises it might be worth investigating borrowing the UKORS 24 bottle rosette to save the time spent on deploying the CTD twice at a station. At stations shallower than 250 m, one deployment was made to 10 m above the seafloor. In addition, we did a 1000 m cast at Western Core Box station W1.2N, two 200 m casts at the mooring recoveries and a 100 m cast for calibration of the EK60 in Rosita Harbour. Bottles were fired at standard depths on all but the moorings and EK60 CTDs; CTD depths and bottle firings are given in Table CTD1. Lat/lon information for each deployment is available from the JR116 event log. Comments on individual casts are included at the end of this report.

### *Configuration and procedure*

The BAS SeaBird (SBE) 911plus CTD was used for station-based profiling of the water column on JR116. 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 JR116, an altimeter, a fluorometer, a photosynthetically active radiation (PAR) sensor, an oxygen sensor and a transmissometer (see notes later on though) were also mounted to the system. In addition, the SBE35 deep ocean standards thermometer was fitted. Sensor serial numbers, calibration coefficients and the configuration of the CTD sensors are given in the Appendix. The CTD PC that logs the data is networked and synched to the ship's clock. The Seasave module of the Windows version of Seasoft was used to log the CTD data. Calibration data can be entered through the Configure menu on Seasave. Recording rate of the CTD data was set to 24 Hz.

The CTD package was deployed from the midship's 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. A fin was also attached to the frame to reduce rotation of the package underwater.

The general procedure was to power up the deck unit prior to deployment and commence logging, then lower the package to about 10 metres depth, where it was left to soak for 3 minutes. 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 "B", 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 depending on the purpose of the cast (see Table CTD1). The altimeter was used to detect the seafloor for the near-bottom CTDs. It gave correct readings throughout finding the seafloor at its maximum range of 100 m.

The SBE-35 high precision thermometer recorded a temperature each time a water sample was taken using the rosette. This temperature was the mean of 10 \* 1.1 seconds recording

cycles (therefore 11 seconds) of data. On two casts, only 11 temperatures were recorded by the SBE-35 despite 12 bottles being fired. We found no reason for this occurring.

### *Discrete salinity samples*

Discrete water sampling was conducted on the upcast of the CTD (except for the moorings CTDs and the CTD for the EK60 calibration—events 344, 347 and 352—when no bottles were fired). The winch was stopped at each desired bottle level, and a 15 second interval left before firing the Niskin. After closing the bottle, a 30 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. 11 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) before 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 bottleneck 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. The number of salinity samples per cast varied according to water depth from a maximum of 12 on the deeper stations to a minimum of four on the shallower stations. Duplicate salinity samples were taken where more than one bottle was fired at one depth. No salinity samples were taken from the duplicate shallow stations on the transects.

Once a crate of samples was full, the crate was moved into the *James Clark Ross's* Bio Lab, where the BAS Guildline Autosol model 8400B serial number 65763 was sited for JR116. The samples were left for a minimum of 24 hours to allow their temperatures to equalise with the laboratory temperature (around 21°C). The samples were then analysed on the 8400B, with measurements being made using Ocean Scientific standards P143 and P144 (K15 = 0.99989, & 0.99987 respectively). Two bottles of standard seawater were used per crate of salinity samples, one at the start and one at the end of the crate. The 8400B cell temperature was set to 24°C for the duration of JR116 and standardised to a dial reading of 534 at the start of the cruise. 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 JRUH for subsequent data processing. The salinometer performed well over JR116 giving stable readings.

### *CTD Data Processing (Seasave)*

BAS use the Seabird software called Seasoft-Win32 that includes several stand-alone programs for subsequent data processing. CTD data files were named within the SBE Seasave software as 116ctdNNN.dat, where NNN was the event number of the station in question. The Seasave software also writes out files 116ctdNNN.HDR containing the information inputted by the user prior to the cast (e.g. Ship, cruise, station, position), 116ctdNNN.BL that logs the bottle sequence number, position, date, time and beginning and ending scan numbers for each bottle file, and file 116ctdNNN.CON, a configuration file for the cast. Once logging was terminated, the SBE35 data were downloaded with the SeaTerm software to a file named 116ctdNNN.cap and the time in the software reset before switching off the deck unit. It was noticed that when resetting the time using the SeaTerm software, if

only the time was reset, the date would become incorrect. We therefore always entered the date as well as the time even if the date was correct. Likewise, to reset the date, the time had to be reset as well for the data change to come into effect. The .dat file was then converted to an ASCII format file (116ctdNNN.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 116ctdNNN.ros (containing the data for each scan associated with a bottle using the file 116ctdNNN.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 116ctdNNN.cnv was converted to 116ctdNNN\_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 ( $\alpha$ ) 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.

Note that the SBE Seasave software took a long time to start up before each CTD deployment (as did other software on the CTD PC). This was not solved on JR116.

### *CTD Data Processing (Unix)*

After correcting for cell thermal mass, all data relating to the CTD in question were transferred to the Unix system using Samba, where they were further processed using Matlab scripts provided by Dave Stevens from UEA as follows, where NNN represents the CTD event number:

116ctdpos: a unix script run outside Matlab that extracts latitude/longitude data at the bottom of the CTD cast. Outputs to 116ctdNNN.pos.

ctdcal\_jr116.m: reads in 116ctdNNN\_ctm.cnv file to Matlab, separating out each variable. Also reads in the CTD position from 116ctdNNN.pos. Outputs to 116ctdNNN.cal.

offpress\_jr116.m: applies a pressure offset if necessary to the CTD data. This is user-determined by examining the logged pressure when the CTD is on deck. Note that the inputted offset must be given as positive. Outputs to 116ctdNNN.wat.

spike.m: removes the larger spikes in the CTD datastreams. Outputs to 116ctdNNN.spk.

wake.m: removes wake effects in the data caused by the motion of the CTD package through the water column. This isn't too much of a problem with the BAS package and so the thresholds are set fairly low. Outputs to 116ctdNNN.wke.

spikemed.m: removes spikes in the fluorescence and transmissometer data. Outputs to 116ctdNNN.spm.

interpol.m: interpolates missing data in the CTD datastreams. Outputs to 116ctdNNN.int.

`makebot.m`: reads in the `116ctdNNN.ros` file, the `116ctdNNN.cap` file (SBE-35 data) and the `116ctdNNN.int` file to create a file with averaged data for each of the bottle firings. Saves to `116botNNN.1st` and `116botNNN.sbe`.

`addsal.m`: reads in the sample salinity data from the spreadsheet output and appends the data to `116botNNN.sal`.

`setsalflag.m`: sets salinity flag depending on the standard deviation of the data averaged to create the CTD bottle salinity data. Appends to `116botNNN.sal`.

`settempflag.m`: sets temperature flag depending on the standard deviation of the data averaged to create the CTD bottle temperature data. Appends to `116botNNN.sbe`.

`salplot.m`: plots the differences between the CTD and bottle salinities as a visual check. No output is generated.

`tempplot.m`: plots the differences between the CTD and SBE-35 temperatures as a visual check. No output is generated.

`salcal.m`: calculates conductivity offsets for both CTD sensors by considering only the non-flagged bottles. Appends to `116botNNN.sal`.

`tempcal.m`: calculates temperature offsets for both CTD sensors by considering only the non-flagged bottles. Appends to `116botNNN.sbe`.

`offsets_500m.m`: I didn't feel that the offsets generated by `salcal.m` and `tempcal.m` above were very useful as they quite often contained bottles in regions of high temperature/salinity gradients. Instead, I used `offsets_500m.m` to calculate offsets in both conductivity and temperature for bottles fired at depths of 500 m or more where the gradients in the water column are much reduced (following the methods of SOC). This script outputs to `jr116caldata.mat`. See below for more information on calibration of the sensors.

Although these next steps haven't yet been implemented on the JR116 data (nor have the scripts been modified for the JR116 data yet), this will be the sequence of events back at BAS, included here for future reference for onboard calibration of the CTD data...

`salcalapp.m`: this will apply the conductivity offset derived from the data in `jr116caldata.mat` to the CTD data and the bottle-averaged files. As described below, we are using the secondary sensor data.

`splitcast.m`: splits the cast into its downcast and upcast parts.

`ctd2db.m`: averages onto 2db levels.

Then any manual editing required on each cast can be performed.

### *CTD calibration*

To calibrate the primary and secondary conductivity and temperature sensors of the CTD, the sensor data were compared between sensors and with the salinity sample data and the SBE-35

high precision thermometer data. Matlab script offsets\_jr116.m gathered data from all bottles fired at or below 500 m (136 salinity samples and 143 temperature samples). Results are as follows, where C1, C2, T1, T2 represent the primary and secondary conductivity and temperature sensors respectively, botC1 and botC2 represent conductivities derived from the bottle salinities using the respective temperature sensors and T35 represents the SBE-35 data. Values given are mean  $\pm$  1 standard deviation.

T1–T2 =	$6.6370 \times 10^{-4} \pm 0.0017$
T1–T35 =	$6.3999 \times 10^{-4} \pm 0.0030$
T2–T35 =	$-2.3707 \times 10^{-5} \pm 0.0023$
C1–C2 =	$-0.0117 \pm 0.0016$
C1–botC1 =	$-0.0141 \pm 0.0011$
C2–botC2 =	$-0.0018 \pm 5.6918 \times 10^{-4}$

Clearly the CTD temperature sensors give consistent values that are in good agreement with the SBE-35 data. The secondary sensor is slightly better than the primary sensor and so we chose to use the secondary sensor to provide the temperature data for the JR116 CTDs.

In contrast, there is a large difference between the CTD conductivity sensors. The secondary sensor data are in good agreement with the bottle salinity values and so we use the secondary sensor to provide the conductivity data for the JR116 CTDs. Note that the primary sensor was also showing an offset of similar magnitude on JR115 (SOC Drake Passage repeat, Dec. 2004).

The duplicate values from the salinity samples have not been analysed yet although we did notice very good agreement between almost all pairs when running the samples on the Autosal. Please tune in later for the results...

#### *Notes on specific casts*

**099:** Accidentally restarted the CLAM (wire monitoring) PC by kicking the computer that's located under the CTD desk... Fortunately the system rebooted and remembered where it was when it was turned off.

**125:** Seabird alarm was triggered at about 3330 m on the downcast of the CTD. Data continued logging but noticed at the bottom of the cast that contact had been lost with the rosette so unable to fire bottles. Reconnected after a couple of attempts and worked fine on the upcast. However, the gantry then lost power at 14 m depth! It was the start of many a piece of equipment going wrong...

**139:** Only 11 datapoints in the 116ctd139.cap file. Don't know why; 12 bottles were fired.

**155:** Two bottles fired at 70 m meaning no water sample from 5 m was collected.

**263:** Only 11 datapoints in the 116ctd139.cap file. Don't know why; 12 bottles were fired.

**287:** Transmissometer replaced. CTD deployment likely to have been through the bilge water that was being pumped out following the engine room flood. Haven't checked to see if the data are anomalous.

**342:** CTD deployed to 128 m rather than 120 m. Just means that there will be some extra data.

### *Transmissometer*

The transmissometer mounted on the CTD failed between events 128 and 139. Unfortunately, this was not noticed until event 269. The unit was replaced before event 287. However, post-processing in SeaSave was carried out using the old transmissometer calibration values, as those for the replacement unit were not to hand. Anybody wishing to use the transmissometer data in future will need to reprocess the data with the correct calibration offsets.

## 2. Navigation Data

Navigational data were logged routinely into Pstar format on JR116 from 1443 GMT 23 December 2004 (jday 358) until 1200 GMT 17 January 2005 (jday 017). The four primary data streams 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 data streams were used regularly in processing other oceanographic datasets. In addition, we also processed data from the Doppler log, the Electromagnetic log and the EM120 swath bathymetry system.

The navigation data were processed twice daily using a set of Unix scripts detailed below. All but the Ashtech editing script and the final swath script are called by running `jr116_nav_go`.

### 1. 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 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. These are followed by `datpik` to force all the heading data to lie between 0 and 360 degrees. `psort` and `pcopym` are then called to remove duplicate times and ensure that time is monotonically increasing. The output file is called `116gyr[jday][a/p].raw`. The data are also appended to a master file called `116gyr01`.

### 2. 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. On earlier cruises, previous experimentation revealed disappointing performance from the instrument (accuracy approximately 15 m on JR47; see also analysis on JR67); we have not conducted any analysis of this sort on JR116. Data were logged routinely using `ggexec0`, but were not used in the processing of other data streams. Primary filenames, generated by the use of `datapup`, `pcopya` and `pheadr`, were of the form `116glo[jday][a/p].raw`. Some basic quality control is performed on this file using `datpik` within `ggexec0`, with the resulting data stored in `116glo[jday][a/p]._`

### 3. Trimble 4000

The Trimble data were processed using the unix script `gpsexec0`. This uses `datapup`, `pcopya` and `pheadr` in a similar manner to `gyroexec0` to retrieve the information from the RVS data stream and set the header information. 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 `116gps[jday][a/p].raw` and `116gps[jday][a/p]`, these being written before and after the `datpik` stage respectively. The processed data were then appended to a master file called `116gps01`.

#### 4. Ashtec ADU-2

The ship's gyrocompass is subject to an inherent error and can oscillate for several minutes after the ship makes a turn. Consequently, the Ashtec ADU-2 is used to correct errors in the gyrocompass heading before input of the data to the ADCP processing. The data were processed using the four unix scripts `ashexec0`, `ashexec1`, `ashexec2`, and `116ashedit.exec`. The first three are called within `jr116_nav_go`, the fourth is run independently after completion of `jr116_nav_go`.

`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 116ash[jday][a/p].raw.

`ashexec1` uses `pmerge` to merge in data from the master gyro file (116gyr01), 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 116ash[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°

atf 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.

`pavrg` - 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 calculated with `phisto` (above)

mrms outside the range 0 - 0.004

`pavrg` - 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 from `ashexec2` are 116ash[jday][a/p].edit and 116ash[jday][a/p].ave.

Finally, `116ashedit.exec` was used to manually remove obvious outliers from a-ghdg and interpolate any gaps in the data, producing the output file 116ash[jday][a/p].ave.dspk. Data were also appended to a master file called 116ash01.int.

The Ashtech lost its heading three times during JR116 which has impacts on the ADCP data. To find its heading again, the Ashtech has to be turned off and on again by ITS. On JR116 we had a useful warning display running on the SCS display monitor which turned red when the Ashtech lost its heading. Periods of heading loss on JR116 were:

003 05 0345—1049

008 05 1209—1539

014 05 1809—2035

These periods of data loss occurred either while we were on station or steaming back to Stanley so fortunately does not affect the ADCP data we collected on transects.

## 5. Doppler log

Data from the Doppler log were processed with `dopexec0`, called within `jr116_nav_go`. This script calls `datapup`, `pcopya` and `pheadr` as before to read in the raw data and output to a file named `116dop[jday][a/p].raw`. No further processing was done on these data during JR116.

## 6. Electromagnetic log

Data from the Electromagnetic log were processed with `emlexec0`, called within `jr116_nav_go`. As with `dopexec0`, the script calls `datapup`, `pcopya` and `pheadr` to read in the raw data, outputting to a file named `116eml[jday][a/p].raw`. Again, no further processing was done on these data during JR116.

## 7. Bestnav

Bestnav is a processed data stream that 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 JR116, the script `navexec0` was called within `jr116_nav_go` to read 12 hours of data at a time, and append them to a master file called `abnv1161`. 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 data file and despikes and smooths it (using `pmdian`, `pintrp`, `pfiltr`), outputting the data to `abnv1161.av`.

## 8. Swath bathymetry

The EM120 swath system was turned on wherever possible on JR116 when it was considered that it would not interfere with the EK60 acoustics data. The bathymetric data are passed on to Peter Morris and colleagues in GSD for proper processing. On JR116, some preliminary processing was carried out using `116swt` (run as part of `jr116_nav_go`) on a 12 hourly basis and `116swtpapall` at the end of the cruise. `116swt` reads in the raw data using `datapup`, `pcopya` and `pheadr` as before, outputting to `116swt[jday][a/p].raw` when there are data for that period. It then despikes the data using `pmdian` and `pedita` and outputs to `116swt[jday][a/p]`. `116swtpapall` uses `papend` to append the despiked swath data files then `pmerge` to merge in the navigation data from `abnv1161` and finally derives corrected depth using `parter`. The final output file is `swt116.al`.

## 9. Year end

The year changed from 2004 to 2005 whilst we were on JR116. Most nav execs either ask for the 2 digit year to be input or read it in from the `pexec` variable `YEAR` (set in `~pexec/pexec_setup`) which avoids any problems reading in the data from RVS. However, the execs that plot data have to be slightly modified to use `JDAY + 366` to form the lower and upper plot limits. Navigational execs that had to be modified in this way were `ashexec2` and `116ashedit.exec`.

### 3. 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 J116, 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 18 m, given the approximate transducer depth of 6 m. Note that on other cruises, the centre depth of the first bin has been set incorrectly to 14 m (see Brian King's notes in 116adpexec0). 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 JR116, in two modes (the ADCP was turned off between 2337 10 January and 1045 11 January 2005 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 JR116 data were collected and processed over the time period 1728 GMT 23 December 2004 (jday 358) to 1200 GMT 17 January 2005 (day 017). Ashtech heading, used in the ADCP data processing, was lost three times during the cruise:

003 05 0345—1049  
008 05 1209—1539  
014 05 1809—2035 (all times in GMT).

These periods of data loss occurred either while we were on station or steaming back to Stanley so fortunately do not affect the ADCP data we collected on transects.

A sequence of Unix scripts calling Pstar routines were used for the data processing, the first three of which are called within 116\_start\_adp\_go:

1) **Read data into PSTAR** 116adpexec0  
Data were read from the RVS Level C system into Pstar creating two output files 116adp [jday][a/p] and 116bot[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** 116adpexec0.1

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,

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

where the individual velocity measurements were given to an accuracy of 0.01%, and the environmental conditions were known to within  $\pm 35$  kPa pressure and  $\pm 0.5^\circ\text{C}$  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,

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

This correction term was applied to both the raw water and bottom tracked velocities measured on JR116.

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

$$1 - 0.00152 T \quad (3)$$

was also applied.

The output files created were 116adp[jday][a/p].t and 116bot[jday][a/p].t.

## 3) **Clock Correction**

116adpexec1

The VMADCP data stream was time stamped by the 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 entered into the 116\_start\_adp\_go script, and a correction applied to the data. This created the files 116adp[jday][a/p].corr, 116bot[jday][a/p].corr and clock[jday][a/p]. Note that to cope with the year end that occurred during JR116, 116adpexec1 was modified to use the pexec YEAR

variable minus 1 for the start date of the clock files to ensure compatibility with the data files from 1 Jan 2005 onwards. All clock corrections entered into `116_start_adp_go` after the new year also had to be adjusted and entered as `jday + 366` (2004 was a leap year).

**4) Gyrocompass error correction** 116adpexec2

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 `116adp[jday][a/p].true` and `116bot[jday][a/p].true`.

**5) Calibration** 116adpexec3

Two further corrections are applied to the VMADCP data:

- $A$  an inherent scaling factor associated with the VMADCP velocities
- $\phi$  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  $\phi = 0$  (misalignment angle) (a dummy calibration).

**6) Derivation of absolute velocities** 116adpexec4

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 `116adp[jday][a/p].abs` and `116bot[jday][a/p].abs`. These dummy absolute velocity files are needed in the calibration process but are rewritten with the calibrated data.

*Calibration of the JR116 ADCP data*

To calibrate the ADCP data, the bottom track data files were examined for periods of near constant speed and heading (by looking at variables *time heading bottomew bottomns depth* using `mList`). 'Near-constant' was defined as  $\pm 1^\circ$  in heading and  $\pm 0.2 \text{ m s}^{-1}$  in speed. Start and end datacycles of periods of more than 7 ensembles (14 minutes) were noted and input into the script `116adcp_calibration_exec`. This script calculates the misalignment angle ( $\phi$ ) and scale factor ( $A$ ) for each of the identified periods of time, as compared with GPS data for the same period of time. Averages are output to two tables: `cal_table` and `calibration.data`. Further details of the calculation of the misalignment angle and scale factor are given in the JR70 cruise report.

82 periods of at least 15 minutes (some were 45 minutes long) of data were identified from the JR116 bottom tracking ADCP files. The mean values of these time periods were averaged in Matlab using the script `jr116adp_calcaandphi.m`. The script transformed the phi values to lie in the range  $-180^\circ$  to  $180^\circ$  and excluded nine values that we had of

approximately  $178^\circ$ , and their associated values of  $A$ . The values of  $\phi$  and  $A$  derived from this script and applied to calibrate the JR116 data were:

$$\phi = -1.733, A = 1.0310.$$

These values are comparable to those derived on earlier cruises (e.g. JR94, Dec 2003:  $\phi = -1.6$ ,  $A = 1.030$ ; JR115, Dec 2004:  $\phi = -1.69$ ,  $A = 1.036$ ).

These derived values of  $\phi$  and  $A$  were inserted into `116adpexec3`. `116adpexec3` and `116adpexec4` were then rerun to produce calibrated water velocities relative to the ship and calibrated absolute velocities (with the same filenames as from the dummy calibration).

#### *ADCP SUMMARY*

The VMADCP performed well for the duration of the cruise. It is being replaced in the refit of the ship later this summer at which point it might be worth considering getting new software for running the ADCP as the current software is out-dated.

## 4. Oceanlogger (Underway Measurements)

Throughout JR116, 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 1423 GMT 23 December 2004 (jday 358) to 1115 GMT 16 January 2005 (jday 016) when the non-toxic seawater supply was switched off.

### *Data Processing*

Oceanlogger data were processed in 12 hour segments throughout the course of JR116. Three Unix scripts calling pstar software routines were used for this processing:

`116oclexec0`: Reads the oceanlogger data streams into a pstar format and merges in relative wind speed and direction from the anemometer data stream. Outputs to `116ocljday][a/p].raw`.

`116oclexec1`: Divides the data into ocean data and meteorological data files, writing meteorological data to a separate file. Calculates a raw salinity following despiking of the conductivity data. Output files are `116met[jday][a/p].raw` (containing the meteorological data) and `116ocljday][a/p]` (containing the oceanographic data).

`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 `116met[jday][a/p]`.

### *Salinity calibration*

During JR116, discrete salinity samples were taken from the ship's non-toxic supply, nominally at 6 hour intervals although it was actually more sporadic than that (so that a total of 42 samples were taken). 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*

We noticed on JR116 that the data from the temperature sensor on the thermosalinograph was often noisy with fluctuations of  $>0.2^{\circ}\text{C}$  (see photo below). This fault did not appear to be related to low flow rate. Mark Preston, the ETS support on board for JR116, was informed of the problem. Doug the Deck Engineer thinks that it is due to interference from the thrusters. However, the photo below was taken while we were steaming the ERS635 transect with the UOR (i.e. fairly constant speed and heading).



Photo showing Oceanlogger screen at 2215 GMT 13 January 2005. Temperature axis ranges from 3.5—4.1°C. Note the noisy sea temperature trace (magenta line).

## 5. Simrad EA600 Bathymetric Echo Sounder

The RRS *James Clark Ross* is equipped with a Simrad EA600 echo sounder, which was run virtually continuously to record ocean depth during cruise JR116 (it was turned off intermittently during the EK60 calibration that took place overnight on 10—11 January 2005). Data for the period 1523GMT 23 December 2004 (jday 358) to 1200GMT 17 January 2005 (jday 017) have been processed as described below.

### *Data processing*

EA600 data were logged by the SCS into the simulated level C data stream SIM500 and retrieved into twice-daily Pstar files using the script 116sim. This runs the Pstar routine datapup, taking the jday and am or pm as the requisite inputs. The EA600 data stream is uncorrected depth, i.e. bottom depth is calculated assuming a mean vertical sound velocity of  $1500 \text{ m s}^{-1}$ . Since the data are often very spiky, pmdian is run from within 116sim to replace each successive value with the median of a moving window of five adjacent data cycles. Finally, 116sim runs pedita on the uncorrected depths, since the EA500 data often features spurious zeroes; these were replaced with absent data markers. Two output files are produced from 116sim: 116sim[jday][a/p].raw and 116sim[jday][a/p], containing data from before and after the despiking respectively.

At the end of the cruise one final exec, 116simpapall, was run. This script appends all the cleaned 12 hourly simrad data files (papend), merges in navigation data from abnv1161 (pmerge) and derives corrected depth (pcarter). This creates one master file, sim116.al. No further processing, including manual despiking as has been carried out on earlier BAS cruises, was performed on the simrad data on JR116.

## 6. Expendable Bathythermographs (XBTs)

To supplement the CTD data collected on JR116 XBTs were deployed between CTD stations on transects 1 to 9 (approximately 20 km spacing), and also at 15 km resolution along a repeat of transect ERS635 across the North Georgia Rise.

Sippican T5 (1830 m maximum depth) and T7 (760 m maximum depth) probes were used. The XBT launcher was attached to the aftdeck on the port side for deployments during transects 1 to 9. The launcher was then swapped to the starboard side for deployments on the ERS635 transect to keep the XBT wire away from that of the UOR (being towed on that transect) with the prevailing wind conditions. A total of 45 T5 probes and 30 T7 probes were launched during JR116. Of these, three T5 probes and one T7 failed due to probe faults. A further four T5 and three T7 probes failed due to coming into contact with the UOR wire. This was resolved by delaying deployment of the XBT until the UOR was just coming up to the minimum depth of its undulation, near the surface. One T5 probe failed because of a bird strike on its wire and the data from one T7 probe were not collected due to a software fault (twice the software got confused with its numbering system and tried to overwrite existing files. It asks you whether you want to overwrite the existing files but if you say no, it won't give you another chance to save the data. To get around this, rename the older file outside the software and then allow the Sippican software to 'overwrite' the existing file – which doesn't exist any more). Considering these failures, the XBT deployments on JR116 had a success rate of 82.2% for T5 probes and 83.3% for T7 probes; excluding the UOR-associated failures, these rates increase to 91.1% and 93.3% respectively. See the JR116 event log for deployment positions of the XBTs.

XBTs were given time to acclimatise before deployment (generally at least 12 hours). 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 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 when it boots up but not subsequently after that, resulting in a small drift (< 1 minute) over the cruise period. Jeremy Robst has now set up K9 so that in future the PC clock should remain in synch with the ship clock. Position data are acquired across the network so that the software logs accurate 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 (JRUH) for processing. Three 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 116xbtNNN.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 116xbtNNN.edt was created.

3) `116xbtlist` - This uses `mlist` to write out an ascii version of `116xbtNNN.edt` to 116xbtNNN.edt.txt.

## Appendix: Configuration report for the CTD sensors used on JR116

Date: 01/17/2005

ASCII file: D:\data\Jr116\jr116.CON

Configuration report for SBE 911/917 plus CTD

-----

Frequency channels suppressed : 0  
Voltage words suppressed : 0  
Computer interface : RS-232C  
Scans to average : 1  
Surface PAR voltage added : No  
NMEA position data added : No  
Scan time added : No

### 1) Frequency, Temperature

Serial number : 4302  
Calibrated on : 2 March 04  
G : 4.37260000e-003  
H : 6.41632000e-004  
I : 2.16042000e-005  
J : 1.73786000e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

### 2) Frequency, Conductivity

Serial number : 42875  
Calibrated on : 17 March 04  
G : -1.05506000e+001  
H : 1.46804000e+000  
I : -5.25852000e-003  
J : 5.11651000e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

### 3) Frequency, Pressure, Digiquartz with TC

Serial number : 09P35716-0771(93686)  
Calibrated on : 15 April 04  
C1 : -4.785925e+004  
C2 : -3.416160e-001  
C3 : 1.442400e-002

D1 : 3.781000e-002  
D2 : 0.000000e+000  
T1 : 3.011158e+001  
T2 : -3.924450e-004  
T3 : 4.201770e-006  
T4 : 2.250320e-009  
T5 : 0.000000e+000  
Slope : 1.00000000  
Offset : 0.00000  
AD590M : 1.284610e-002  
AD590B : -8.492756e+000

#### 4) Frequency, Temperature, 2

Serial number : 32191  
Calibrated on : 2 March 04  
G : 4.31969000e-003  
H : 6.38784000e-004  
I : 2.26921000e-005  
J : 2.13675000e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

#### 5) Frequency, Conductivity, 2

Serial number : 41912  
Calibrated on : 17 March 04  
G : -4.15895000e+000  
H : 5.35728000e-001  
I : -5.18624000e-004  
J : 5.00904000e-005  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

#### 6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor

Serial number : 7274  
Calibrated on : 24th March 04  
M : 1.00000000  
B : 0.00000000  
Calibration constant : 3831000000.00000000  
Multiplier : 1.00000000  
Offset : -0.03798000

#### 7) A/D voltage 1, Free

#### 8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 88216  
Calibrated on : 21 June 04  
VB : 0.387000  
V1 : 2.014200  
Vacetone : 0.396800  
Scale factor : 1.000000  
Slope : 1.000000  
Offset : 0.000000

9) A/D voltage 3, Free

10) A/D voltage 4, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : CST-527DR  
Calibrated on : 1 July 04  
M : 21.1770  
B : -1.2710  
Path length : 0.250

11) A/D voltage 5, Free

12) A/D voltage 6, Altimeter

Serial number : 2130.27001  
Calibrated on :  
Scale factor : 15.000  
Offset : 0.000

13) A/D voltage 7, Oxygen, SBE 43

Serial number : 0620  
Calibrated on : 21 March 04  
Soc : 4.0500e-001  
Boc : 0.0000  
Offset : -0.5123  
Tcor : 0.0006  
Pcor : 1.35e-004  
Tau : 0.0

## CTD Table

Shallow CTDs to 120 m depth with bottles fired at 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120 m:

Event	Station												
11	9.7	31	9.4	64	8.5	95	7.5	128	6.6	178	6.4	246	3.7
17	9.6	39	9.3	70	8.4	102	7.4	133	6.5	200	4.7	253	3.6
24	9.5	45	9.2	76	8.3	109	7.3	142	5.6	206	4.6	260	3.5
		51	9.1	83	8.2	116	7.2	149	5.5	212	4.5	266	3.4
		57	8.6	90	8.1	122	7.1	155	5.4	218	4.4	272	3.3

Event	Station	Event	Station
298	2.5	342	1.3
303	2.4/W2.2N		
309	2.3		
328	1.5		
335	1.4/W3.2N		

## Other CTDs

Event	Station	CTD depth	Bottle 1	2	3	4	5	6	7	8	9	10	11	12
2		Test	200	200	200	200	150	150	150	100	100	100	50	20 5
8		9.7	3587	3587	3000	2000	1000	500	200	180	160	140	50	2020
14		9.6	3542	3542	3000	2000	1000	500	200	180	160	140	50	2020
21		9.5	3436	3436	3000	2000	1000	500	200	180	160	140	50	2020
28		9.4	3070	3070	3000	2000	1000	500	200	180	160	140	50	2020
35		9.3	1765	1765	1765	1765	1000	500	200	180	160	140	50	2020
42		9.2	244	244	244	244	244	244	200	180	160	140	50	2020
48		9.1	186	186	186	186	186	186	186	180	160	140	50	2020
54		8.6	2513	2513	2513	2000	1000	500	200	180	160	140	50	2020
61		8.5	2643	2643	2643	2000	1000	500	200	180	160	140	50	2020

67	8.4	3231	3231	3000	2000	1000	500	200	180	160	140	50	2020
73	8.3	2673	2673	2673	2000	1000	500	200	180	160	140	50	2020
80	8.2	218	218	218	218	218	218	200	180	160	140	50	2020
87	8.1	139	139	139	139	139	139	139	139	139	139	50	2020
92	7.5	3705	3705	3000	2000	1000	500	200	180	160	140	50	2020
99	7.4	2908	2908	2908	2000	1000	500	200	180	160	140	50	2020
106	7.3	1419	1419	1419	1419	1000	500	200	180	160	140	50	2020
113	7.2	221	221	221	221	221	221	200	180	160	140	50	2020
119	7.1	211	211	211	211	211	211	200	180	160	140	50	2020
125	6.6	3751	3721	3000	2000	1000	500	200	180	160	140	50	2020
131	6.5	3417	3417	3000	2000	1000	500	200	180	160	140	50	2020
139	5.6	3840	3840	3000	2000	1000	500	200	180	160	140	50	2020
146	5.5	2514	2514	2514	2000	1000	500	200	180	160	140	50	2020
152	5.4	226	226	226	226	226	226	200	180	160	140	50	2020
159	5.3	160	160	140	120	100	80	60	50	40	30	20	10 5
165	5.2	186	160	140	120	100	80	60	50	40	30	20	10 5
170	5.1	151	140	120	100	80	70	60	50	40	30	20	10 5
175	6.4	1361	1361	1361	1361	1000	500	200	180	160	140	50	2020
181	6.3	222	160	140	120	100	80	60	50	40	30	20	10 5
187	6.2	224	160	140	120	100	80	60	50	40	30	20	10 5
192	6.1	228	160	140	120	100	80	60	50	40	30	20	10 5
197	4.7	3313	3313	3000	2000	1000	500	200	180	160	140	50	2020
203	4.6	2864	2864	2864	2000	1000	500	200	180	160	140	50	2020
209	4.5	1620	1620	1620	1620	1000	500	200	180	160	140	50	2020
215	4.4	270	270	270	270	270	270	200	180	160	140	50	2020
222	4.3	232	160	140	120	100	80	60	50	40	30	20	10 5
227	4.2	239	160	140	120	100	80	60	50	40	30	20	10 5
233	4.1	199	160	140	120	100	80	60	50	40	30	20	10 5
238	3.8	126	120	100	90	80	70	60	50	40	30	20	10 5
243	3.7	352	352	352	352	352	352	200	180	160	140	50	2020
250	3.6/ShagEx	481	481	481	481	481	481	200	180	160	140	50	2020
257	S1/ShagEx	1254	1254	1254	1254	1000	500	200	180	160	140	50	2020
258	3.5/ShagEx	2077	2077	2077	2000	1000	500	200	180	160	140	50	2020

261	S2/ShagEx	1224	1224	1224	1224	1000	500	200	180	160	140	50	2020
263	3.4/ShagEx	457	457	457	457	457	457	200	180	160	140	50	2020
269	3.3	436	436	436	436	436	436	200	180	160	140	50	2020
275	3.2	196	160	140	120	100	80	60	50	40	30	20	10 5
280	3.1	197	160	140	120	100	80	60	50	40	30	20	10 5
287	W1.2S	281	281	200	150	100	80	60	50	40	30	20	10 5
292	W1.2N	1000	1000	800	600	400	200	150	125	100	80	60	4020
295	2.5	3739	3739	3000	2000	1000	500	200	180	160	140	50	2020
301	2.4/W2.2N	3433	3433	3000	2000	1000	500	200	180	160	140	50	2020
306	2.3	2117	2117	2117	2000	1000	500	200	180	160	140	50	2020
314	2.2/W2.2S	204	160	140	120	100	80	60	50	40	30	20	10 5
320	2.1	145	140	120	100	80	70	60	50	40	30	20	10 5
325	1.5	3658	3658	3000	2000	1000	500	200	180	160	140	50	2020
332	1.4/W3.2N	2606	2606	2606	2000	1000	500	200	180	160	140	50	2020
339	1.3	1711	1711	1711	1711	1000	500	200	180	160	140	50	2020
344	Deep mooring	200											
347	Shallow mooring	200											
352	EK60 cal	100	100										
359	1.1	137	120	100	90	80	70	60	50	40	30	20	10 5
365	1.2/W3.2S	123	123	100	90	80	70	60	50	40	30	20	10 5

# AFI 3/16 mooring cruise report *JR 116/JR 118*

Peter Enderlein & Doug Bone

## Background, Aim and Methodology:

The background, aim and methodology of the AFI 3/16 project: **Moorings to investigate intra-annual variability in krill abundance and water-mass physical characteristics of South Georgia** is described in detail in the JR 82 cruise report

## Recovery and Redeployment During JR 116:

The deep water mooring recovery started at 17:29 GMT of Jan 09<sup>th</sup> with a CTD to 200m, 2 cables from the dropping position followed by EK 60 acoustics on the dropping point of the mooring for 1/2 hour from 17:54 to 18:25 GMT. The weather was ok (force 3-4), with some fog and a visibility of around 300m. The releases were first activated at 18:35 and a positive response “hook released” was received. After just 2 min at 18:37 the mooring appeared at the surface. Thereafter the whole mooring was recovered without any problems and at 19:25 the whole mooring was on deck.

We relocated straight away to the shallow water mooring position, just 17 m away. The shallow water mooring recovery started at 21:07 GMT with a CTD to 200m, again 2 cables away from the original dropping position followed by EK 60 acoustics on the original dropping point for ½ hour from 21:35 to 22:05 GMT. The mooring was released at 22:16 GMT and surfaced just 2 min later. At 22:37 the mooring was successfully recovered without any problems.

After RMT fishing around the shallow mooring position and the calibration at Rosita Harbor the deep mooring was redeployment at **53.5245S & 37.9357W, on 11.01.2005 at 21:22 GMT.**

After relocating to the shallow site the shallow water mooring was successfully redeployed at **53.7984S & 37.9357W on 11.01.2005 at 23:50 GMT.**

Both deployment took place as described in the second deployment report in JR96 with the changes described in the JR100 mooring cruise report: To control the release of the weights, they were lowered over the stern with the starboard Effer crane on a strop and a sacrificial rope attached to the weights was threaded through two deck eyes. The weights were then lowered down until the sacrificial rope took up the weight. Then the strop was taken off. At the release point the rope was cut on top of a piece of wood between the eyebolts using an Axe

.

*Table 1: List of events during recovery of both moorings (from the event log):*

Date/Time	Event	Lat	Long	Comment
<b>Deep Mooring</b>				
09/01/2005 17:29	344	-53.5142	-37.8487	CTD Deployed
09/01/2005 17:35		-53.5142	-37.8486	CTD @ 200m
09/01/2005 17:46		-53.5142	-37.8488	CTD Recovered, relocating to mooring position
09/01/2005 17:54		-53.5117	-37.8499	commence acoustics for 30 mins
09/01/2005 18:25		-53.5122	-37.8496	relocating 300m down current
09/01/2005 18:33		-53.5139	-37.8484	hydrophone deployed
09/01/2005 18:35	345	-53.5139	-37.8485	mooring released
09/01/2005 18:37		-53.5139	-37.8484	buoy surfaced
09/01/2005 18:44		-53.5128	-37.8497	mooring grapnelled
09/01/2005 18:45		-53.5127	-37.85	messenger attached, moving ahead for recovery to deck
09/01/2005 19:20		-53.51	-37.8639	acoustic released recovered
09/01/2005 19:21		-53.51	-37.8643	recovering buoy
09/01/2005 19:25		-53.51	-37.865	buoy recovered
<b>Shallow Mooring</b>				
09/01/2005 21:07	347	-53.7974	-37.936	CTD Deployed
09/01/2005 21:15		-53.7973	-37.936	CTD @ 200m
09/01/2005 21:23		-53.7972	-37.9359	CTD Recovered
09/01/2005 21:35		-53.7947	-37.9389	vsl relocated to mooring position for acoustics
09/01/2005 22:05		-53.7949	-37.9386	acoustics complete - moving astern ready to release buoy
09/01/2005 22:14	348	-53.7959	-37.9355	Vsl on Full Dp Deploying Hydrophone
09/01/2005 22:16		-53.7959	-37.9354	buoy released
09/01/2005 22:19		-53.7957	-37.9359	buoy surfaced and sighted
09/01/2005 22:37		-53.7942	-37.9404	buoy recovered

*Table 2: List of events during redeployment of both moorings*

Date/Time	Event	Lat	Long	Comment
<b>Deep Mooring</b>				
11/01/2005 20:45		-53.5416	-37.8543	vsl slowing for mooring deployment
11/01/2005 21:00		-53.5091	-37.8515	on station for mooring deployment
11/01/2005 21:22	355	-53.5245	-37.8427	Buoy deployed
11/01/2005 21:56		-53.5087	-37.8516	sinker weight released
<b>Shallow Mooring</b>				
11/01/2005 23:35		-53.7991	-37.935	vsl slowing for mooring deployment
11/01/2005 23:43		-53.7991	-37.9351	on station for mooring deployment
11/01/2005 23:50	356	-53.7984	-37.9357	Buoy deployed
12/01/2005 00:00		-53.7947	-37.9389	sinker weight released

## Data verification:

5 instruments have worked perfectly fine. The WCP seems to have worked well, they produced a proper file and our initial check and a check by Ryan Saunders in St. Andrus showed that they gathered useful data. The only problem was that the ADCP on the shallow mooring has not worked at all. We assume that the computer problem during the set up of the instrument must have caused the problem, the instrument seems to be physical fine and also the electronics worked perfectly fine when we “talk” to the instrument.

## Additional events around the moorings:

### RMT 8 fishing

4 RMT hauls were carried out in the vicinity of the moorings. 2 deployments were carried out at the deep mooring during night time, covering the depth zones: 500-300m, 300-200m, 200-100m, 100-10m. The ADCP is situated around 200m. A day and a nighttime deployment was carried out at the shallow mooring. The nighttime haul covered the depth zones 285-200m, 200-10m. The daytime haul did not unfortunately cover these same depth zones because of a miscommunication between operators – the realised haul was: Net 1 10-250m; Net 2 250-10m. All catches were analysed semi-quantitatively and preserved.

349	-53.79627 -37.91969	09/01/05 23:41	09/01/05 23:46	285 -200 m	10/01/05 23:46	10/01/05 00:30	200 -10 m	Semi-quantitative	Yes	Yes
369	-53.51853 -37.77307	13/01/05 00:03	13/01/05 00:17	490 -300 m	13/01/05 00:17	13/01/05 00:25	292 -195	Semi-quantitative	No	Yes
370	-53.48895 -37.85311	13/01/05 01:11	13/01/05 01:18	200 -100 m	13/01/05 01:18	13/01/05 01:26	100 -5m	Semi-quantitative	No	Yes
371	-53.79284 -37.94523	13/01/05 11:00	13/01/05 11:32	19 -248 m	13/01/05 11:32	13/01/05 12:02	248 -4m	Semi-quantitative	Yes	Yes

349	09/01/05 23:41	Semi-quantitative	Net 1: 240ml Net 2: 3959 ml	<b>Net 1: (in ½ sample)</b> – 15 krill, 1 <i>Crangon</i> , 14 <i>E. triacantha</i> , 12 <i>Antarctomysis maxima</i> , 1 other mysid, 7 cf. <i>Orchomene</i> , 81 <i>Themisto</i> , 182 <i>Thysanoessa</i> , >500 <i>Rhincalanus gigas</i> , ~5 <i>Pareuchaeta</i> , 1 Polychaet worm, 2 Petropods <b>Net 2: (200 ml sample)</b> – 171 krill, 186 <i>Thysanoessa</i> , 67 <i>Themisto</i>	Net 1: ½ catch preserved Net 2: 500ml preserved
369	13/01/05 00:03	Semi-quantitative	Net 1: 170ml Net 2: 140ml	<b>Net 1: (whole sample)</b> 1 <i>Sergia</i> sp., 1 krill, 3 siphonophores, 3 myctophids, several cluepoid fish larvae, 3 small octopod, 1 large octopod, 1 <i>Periphylla periphylla</i> , 37 <i>Themisto</i> , 10 <i>Paradania boeckii</i> , 55 <i>E. triacantha</i> , 2 winged pteropods, 2 giant ostracods, >100 chaetognaths, 10 <i>Primno macropa</i> , 5 cf <i>Cyphocaris</i> , 26 red pteropods, >200 <i>Thysanoessa</i> <b>Net 2: (whole sample)</b> - 29 <i>E. triacantha</i> , 43 <i>Themisto</i> , 1 Myctophid, 1 larval fish (clupeoid), >500 <i>Euchaeta</i> , >500 <i>Rhincalanus gigas</i> , 12 red pteropods, >250 <i>Thysanoessa</i> , ~50 chaetognaths, 5 siphonophores, 1 <i>Vibilia</i> , 5 <i>Primno macropa</i>	Yes
370	13/01/05 01:11	Semi-quantitative	Net 1: 300ml Net 2: 100ml	<b>Net 1: (whole sample)</b> – 14 <i>Tomopteris</i> , 6 krill, 2 myctophids, 1 squid, 8 <i>E. triacantha</i> ; (1/8 subsample) – 200 adult <i>Thysanoessa</i> (many larval <i>Thysanoessa</i> besides), 202 <i>Themisto</i> , 3 <i>Primno macropa</i> <b>Net 2: (whole sample)</b> – 128 <i>Themisto</i> , 1 <i>Hyperia macrocephala</i> , 3 <i>E. superba</i> , 1 myctophid, 1 <i>Calycopsis</i> , 1 siphonophore, 4 <i>Primno macropa</i> , 2 <i>Vibilia</i> , 28 <i>E. triacantha</i> , 1 <i>Tomopteris</i> , 127 <i>Thysanoessa</i>	Yes

37 1	13/01/0 5 11:00	Semi- quantitative		<b>Net 1:</b> 26 litres of krill <b>Net 2:</b> (1/10 sample)- 78 krill, 244 <i>Themisto</i> , 55 <i>Thysanoessa</i> , 2 <i>E. triacantha</i> , 3 <i>Primno macropa</i>	1/10 subsample of Net 2 preserved
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### *Acoustics for 6 hours*

From 05:27:00 on the 13/01/2005 @ -53.79478S -37.93849W we were able to sit on station at shallow mooring site, conducting acoustics (EK60) for over 5 hours, until 10:53:00 @ -53.79298S -37.94476W when the ship was moving off station.

### *Swath Bathymetry*

during JR116 we were running several times over the two moorings positions in good weather conditions, having the EK120 swath running. These data should help us to produce a more detailed underwater map of the two moorings positions.

## **Work carried out:**

### *WCP:*

- Data download

### *CTD:*

- Data download

### *ADCP:*

- Data download

### *NOVATEC beacons*

- Checked, no work necessary

### *ARGOS beacons*

- Checked, no work necessary

### *Releases*

- Checked, no work necessary

## **Instrument settings (general):**

### *CTD*

#### *shallow:*

start time: 11.01.2005

sample interval: 240 sec.

#### *deep:*

start time: 11.01.2005

sample interval: 240 sec.

### *ADCP*

#### *Shallow:*

Start time: 11.01.2005

Duration: 210 days

Sample interval: 5 min

Pings in interval: 7

*Deep:*

Start time: 11.01.2005

Duration: 210 days

Sample interval: 5 min

Pings in interval: 7

*WCP*

*Shallow:*

start time: 11.01.2005

burst\_resolution = 1

ping\_length = 600

lockout\_range = 0

gain = 1

max\_range = 200

burst\_multiplier = 120

burst\_count = 18

bin\_size = 8

*Deep:*

start time: 11.01.2005

burst\_resolution = 1

ping\_length = 600

lockout\_range = 0

gain = 1

max\_range = 200

burst\_multiplier = 120

burst\_count = 18

bin\_size = 8

# Macronutrient Analysis

Mick Whitehouse and Min Gordon

## Introduction

In the *Discovery Reports* Hardy and Gunther (1935) hypothesised that nutrients, upwelled at the southern shelf-break of South Georgia, initiated primary production that was subsequently carried around the island and which in turn sustained grazing zooplankton in the island's lee. Later, having realised that the island's system tended to maintain high macronutrient concentrations, Hardy (1967) suggested that perhaps the upwelling of "another material" was key. This material was/is most likely to be iron.

Currently, although we regard the mega phytoplankton blooms of South Georgia to be a downstream phenomenon (Korb et al. 2004), the downstream applies as much to the Scotia Ridge and shelf areas as to the island itself. We presume that the ocean's interaction with the island's shelf transports sedimentary iron to the euphotic zone. During Q3 our primary interest has been the balance between production local to South Georgia and that transported into the system, and although much of our effort in the field has focused on the area to the north of the island, SeaWiFS imagery has allowed us to monitor the entire system. While we have identified important controls on primary production to the north of the island, blooms that appear to originate in the waters on the southern shelf have until now not been investigated.

Drifter buoy trajectories have confirmed the current flow indicated by earlier models such as FRAM. Generally speaking, water approaching South Georgia from the west and south is diverted either to the west or east of the island prior to converging to the west of the island and traveling cyclonically around the Georgia Basin. Thus the megablooms frequently evident throughout the Georgia Basin may be initiated on the southern or the northern shelf (or both).

SeaWiFS data is available for the last 8 seasons. Viewing the monthly summer (October-March) compilations the southern shelf appears to be a more reliable source of chlorophyll with high levels evident in 29 out of 46 months. Shelf blooms to the north are less well defined with more interactions with off-shelf waters (SACCF, MEB, NWGR), and high levels are evident during 20 months in both shelf and off-shelf waters. There are at least two seasons (JR17, JR57) when the southern bloom appeared to contribute the majority of phytoplankton to the system feeding into the Georgia Basin.

The southern shelf bloom is frequently sited towards the western end of the shelf reaching from the western shelf-break to the vicinity of Annenkov Island. Furthermore it appears to predominantly feed chlorophyll-laden waters to the west of the island, ie. presuming shelf water moves around the eastern end of the island it rarely seems to contain high concentrations of chlorophyll. Also there's a tendency for the southern bloom to get underway earlier in the season compared with that to the north.

When assessing phytoplankton dynamics macronutrient depletion may provide a useful proxy when controls such as grazing have reduced phytoplankton standing stocks. Generally speaking, depletions of 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 when micronutrients such as iron are not available. Also the ratio of macronutrient use may indicate the prevalent type of growing phytoplankton.

## **JR116 aims**

During cruise JR116 nutrient concentrations (measured contemporaneously with phytoplankton standing stock and growth rates along with physical oceanography and satellite imagery) were monitored to address the following questions:

1. What was the spatial and temporal extent of the southern shelf bloom and how did it compare with that to the north of the island?
2. Were specific sites along the shelf and shelf-break of greater importance with regards to upwelling of nutrients and initiation of primary production?
3. With ADCP measurements, can we predict where the southern shelf waters (and their phytoplankton) are transported?
4. What is the likely contribution of these productive southern waters to the region to the west of South Georgia and the Georgia Basin downstream?

## **Data collection and analytical methods**

Water bottle sub-samples for macronutrient analysis were collected at all stations and along all major transects. The use of two twelve-bottle CTD casts at each station allowed a reasonably detailed water column profile assessment. Standard depths for nutrient analysis were nominally 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180 and 200 m. Along the nine major transects, the four transect pairs within the Western Core Box, and transect ER635 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  $\mu\text{m}$ ), and the filtrate was analysed colorimetrically for dissolved nitrate+nitrite ( $\text{NO}_3+\text{NO}_2\text{-N}$ ), nitrite ( $\text{NO}_2\text{-N}$ ), ammonium ( $\text{NH}_4\text{-N}$ ), silicic acid ( $\text{Si(OH)}_4\text{-Si}$ ) and phosphate ( $\text{PO}_4\text{-P}$ ) 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. Nitrite measurements were abandoned early in the cruise due to technical difficulties.

## **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 require the application of time-lags to individual chemistry lines. Additionally the data will need to be examined alongside the physical and biological oceanographic data to enable a reasonable assessment of nutrient dynamics. Therefore a preliminary assessment of the data is not practical. However, a cursory glance at the raw data indicated widespread depletion of surface nutrients throughout the survey area. This was especially so for silicic acid and was most striking over the southern shelf areas. Nitrate and phosphate depletion was more marked to the north of the island and sub-surface ammonium appeared plentiful. A full evaluation of the data should be completed during summer 2005.

## Technical problems encountered

We had several problems with the segmented-flow analytical equipment during this cruise that were due primarily to its age. The most serious problem was with one of the analyser's peristaltic pumps – the drive mechanism for the entire system. Both of the analyser's pumps are >25 years old and the wear and tear on components such as tube beds and rollers is now severe. As obsolete instruments these pumps would be prohibitively expensive to get serviced and to get new components fabricated for them and so we should invest in new equipment for the Q4 programme. The knock-on effect of using a new set of pumps is that the entire system will require updating to accommodate instruments that will have different flow capacities and physical dimensions. This rebuild should be accomplished in the next financial year if we are to have a working system in place for the first Q4 cruise. Additionally, the logging PC is years out of date and should be replaced with a tower system and flat screen that will suffer less interference than the present system does from the analyser's nearby power transformers and regulators. The new PC should be purchased at a later date.

## References

- Hardy A (1967) Great waters: a voyage of natural history to study whales, plankton and the waters of the Southern Ocean in the old Royal Research Ship Discovery, with the results brought up to date by the findings of the R.R.S. Discovery II, Collins.
- Hardy AC, Gunther ER (1935) The plankton of the South Georgia whaling grounds and adjacent waters, 1926-1927. *Discovery Reports*. 11: 1-456.
- Korb RE, Whitehouse MJ, Ward P (2004) SeaWiFS in the southern ocean: spatial and temporal variability in phytoplankton biomass around South Georgia. *Deep Sea Research Part II*, 51: 99-116.
- Whitehouse MJ (1997) Automated seawater nutrient chemistry. British Antarctic Survey, Cambridge, 14 pp.
- Whitehouse MJ, Preston M (1997) A flexible computer-based technique for the analysis of data from a sea-going nutrient autoanalyser. *Analytica chimica Acta* 345: 197-20.

# Phytoplankton Production

Rebecca Korb, Min Gordan, Iain Carrie

## Introduction

Primary production at South Georgia is mainly a local feature with little growth initiated upstream. In particular, the region to the northwest of South Georgia supports intense ( $>5 \text{ mg m}^{-3}$ ) blooms that can be both spatially and temporally extensive. In contrast to the generally iron-deplete Southern Ocean, it is likely that water downstream of South Georgia (i.e. the northwest region) is iron replete through upwelling and/or island run-off. Remotely sensed Chl *a* images show that extensive blooms may also occur on the islands southwestern shelf. Whilst South Georgia's northwestern bloom and its links to secondary production have been extensively studied by BAS, many questions remain regarding transport of water into the region. The southern shelf is also likely to provide a benthic source of iron to promote primary production but to date we have little data on water flow in this region and no estimates of primary production rates.

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, transport of southern and northern shelf water) 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 FRRF will also provide information on photosynthetic efficiency, which may be related to iron concentrations in the water column and/or light regimes. 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 between the southern and northern shelves of South Georgia.

## JR116 aims

During cruise JR116, 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 biological, 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 Georgia Basin).
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, 2 CTD casts were deployed; a shallow CTD for collection of chlorophyll *a*, primary production and nutrient samples and a deeper CTD (to near bottom) for physical measurements. On the shallow CTD water was collected at 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 and 120 m. Occasionally, when bottom depths were shallow, only one CTD cast was deployed. During daylight hours, PAR profiles were obtained from the deep CTD cast and used to estimate water depths for primary production. Fluorescence and PAR data from the shallow CTD cast will be examined back at Cambridge.

Chlorophyll *a* was measured at all hydrographic station. Size fractionated chlorophyll *a*, from a standard depth of 20 m, was also measured at every station at. 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  $-20^{\circ}\text{C}$  and stored until it was convenient to extract and analyse then on the ship.

Primary production was measured whenever possible whilst R. Korb was on shift. This resulted in only 29 stations being sampled for primary production. A number of PI curves rates were also measured on the phtotosynthetron, although the overall numbers of these experiments were low due to time constraints and lack of personnel to carry out 14C work.

The FRRF was deployed on an optics rig at most stations and connected to the ships underway seawater supply during transects. It was not possible to calibrate the instrument at sea or carry out blanks as we did not have a cuvette suitable for this work. Instead, bucket blanks, with DI water and filtered seawater were performed at all gain settings for the light and dark chambers.

At station 1.3, water samples were taken from the 5m CTD bottle and from the 100  $\mu\text{m}$  bongo net. The water was added to filtered seawater containing  $f/2$  and cultures were placed in the incubator on the aft deck. On the 15<sup>th</sup> Jan, the cultures were removed to the cold room and on the 16<sup>th</sup> they were removed to the fridge in the rad. lab. The cultures will be returned to the CCAP in Oban for the potential isolation of new phytoplankton species into culture.

## Results

Chlorophyll *a* concentrations are not known at present as the chl. *a* standard used to calibrate the Turner fluorometer is yet to be analysed on a spectrophotometer. However from MODIS it was evident that at the time of the cruise we had already missed the height of the bloom and surface chlorophyll *a* concentrations were approximately  $1 \text{ mg m}^{-3}$ .

Primary production rates were moderate and uniform around the southern shelf with values generally  $< 0.75 \text{ g C m}^{-2} \text{ d}^{-1}$ . Full analysis and verification of the primary production and FRRF data sets will be undertaken on our return to Cambridge.

# Optics Rig

Iain Carrie, Nathan Cunningham,, Beki Korb

## Background

Remote sensing systems such as the Sea-viewing Wide Field of view Sensor (SeaWiFS) and the more recent Moderate Resolution Imaging Spectroradiometer (MODIS) provide accuracy in their ocean colour products within the limits set at the onset of deployment in open ocean “case one” waters (chlorophyll dominated). However in coastal “case two” waters where ocean colour is dependant on a number of other constituents such as Coloured Dissolved Organic Matter (CDOM) and Suspended Particulate Material (SPM), standard SeaWiFS algorithms for atmospheric correction and Chlor-a often fail drastically.

## Aims

The primary aim is the characterisation of water type around South Georgia both on and off shelf, through profile and sampling of optically significant components within the water column. These data will be used to model the water column and provide possible Water Leaving Radiance ( $L_w$ ) values that can be compared to SeaWiFS and MODIS match up data.

## Method

$L_w$  values are proportional to the backscatter component over the absorption of the water column ( $bb/a$ ).

Three instruments were deployed to profile the water column using a custom built stainless steel instrument cage. The instruments deployed were a SeaBird 19plus CTD, a Hobilabs Hydroscat-2 and a Wetlabs AC9+.

The Hobi Labs Hydroscat-2 provides elastic backscattering values at 470nm and 676nm and fluorescence values. The AC9 measures absorption ( $a$ ) and attenuation ( $c$ ) at nine wavelengths hence providing us with values for scattering ( $b$ ) as  $c=a+b$ . The CTD provides a temperature/depth profile that can be used additionally to temperature correct the other two instruments.

The absorption of CDOM at 440nm was measured using a custom made instrument. Seawater samples from 5m were filtered using Gellman 0.2micron membrane filters and placed in a 10cm pathlength cuvette and placed in a 405nm beam. The voltage output was compared to a milliQ water sample blank and the attenuation/absorption from CDOM at 440nm calculated. 2L of the same 5m samples was passed through preweighed 47mm Whatman GFF filters which were then frozen for further analysis of SPM content in the future.

All data will be used to model light levels in the water column using Hydrolight (radiance transfer modelling tool).

## Data Coverage

Profiles and 5m samples were taken on every transect station. The standard depth of profile was 200m, which was reduced in water shallower than this figure.

## Preliminary Results

The abundance of fog and poor atmospheric conditions casts serious doubt on numerous satellite matchups. J date 365 yielded the only obvious possible sea/satellite matchup (fig opti1)

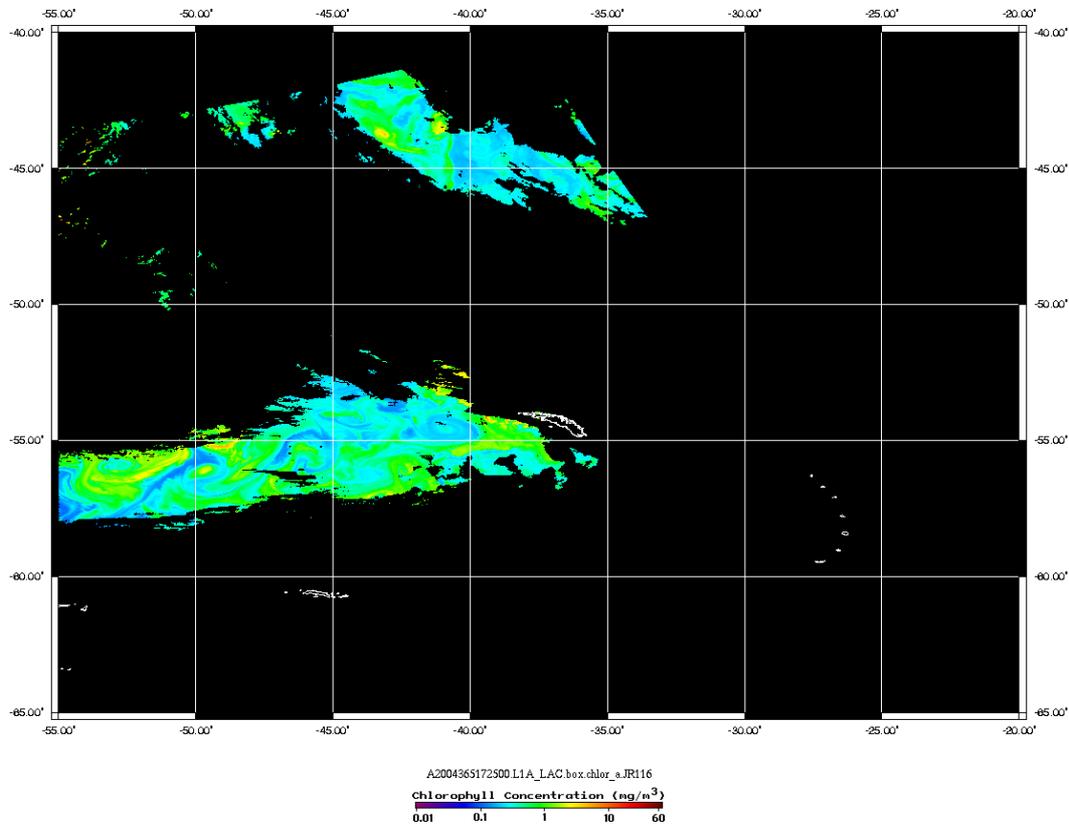


Figure opti1

## Problems

A number of small problems concerning power supply and battery charging on all instruments were encountered in the early stages. New connectors and the following of correct protocol reduced these problems. As mentioned previously fog and cloud hindered possible satellite match ups and nighttime stations reduced this number further.

# Acoustics JR116: Cruise Report

Cathy Goss, Peter Enderlein, Tony North and Geraint Tarling

## Introduction

JR116 on *RRS James Clark Ross*, has been predominantly an oceanographic cruise concentrating on a series of stations spaced out along 9 transects covering the south and west continental shelf of South Georgia and the immediate offshore area. The survey transects were each run at 10 knots twice: firstly without stopping, to provide continuous ADCP data, and secondly stopping for CTDs, Bongo nets, an Optical Rig and occasional RMT8 nets for krill. Acoustic data were logged from the Simrad EK60 fishery sounder (EK), operating at 38, 120 and 200 kHz, from the Simrad EA600 Bridge sounder (EA), which operated at 12 kHz and from the Simrad EM120 swath bathymetry system (EM) also operating at 12 kHz.

In shallow water (< 1000m) all three systems were run together without compromising the rate of data collection. However in deep water, the time taken for the swath system to complete a cycle of pings from the sounder to seabed and back and the further time to process the series of returning echoes could mean that there was up to 15 seconds between pings. At 10 knots the distance between ping centres would be 77m, sufficient for an average krill swarm to be missed completely. Both the continuous or discontinuous runs of each transect ran through day and night, thus neither run was preferable for acoustic survey of the biota that may migrate above the transducers at night. However there was time allowed between the stations for fishing of acoustic targets using RMT8 nets, thus it was decided to use these periods to give preference to EK data collection and the continuous runs preference to swath data collection. At worst the ping interval for all sounders was reduced to 1 every 15 seconds at the deepest part of the first transect run.

Stations spaced along each transect were worked on a return run giving short sections for acoustic cover of the same line. These were run using the EK and EA only in order to give more frequent EK pings, the longest interval being 6 seconds. The EA showed a broad band of interference when run simultaneously with the EM so the short sections also provided an opportunity to collect better 12kHz water-column data for comparison with the EK

The 9 acoustic transects were followed by a standard survey for krill in the Western Core Box using established acoustic methods. The survey carried out at South Georgia over an area north of Bird Island was the fifth repeat in a series of combined oceanographic/acoustic surveys in the austral summer. Eight transects were run in the Western Core Box area.

## Aims

- Collection of acoustic data on all transects, fishing searches and net sampling during the cruise.
- Provision of acoustic data to accompany visits to two mooring sites, described elsewhere in the cruise report – JR119.
- Acoustic survey in the Western Core Box at South Georgia. The objective of these surveys is to provide an acoustic stock assessment of krill at three different seasons for five years.
- An assessment of the utility of the EA600 bathymetric sounder to obtain water column data at 12kHz to enhance the EK60 fishery sounder data collection at 38, 120 and 200 kHz.

- Obtain bathymetric data from the EM120 swath system as widely as possible within the working area, without compromising other acoustic data collection.
- Calibration of the EK60 and the EA600 at an appropriate site.
- Back up and post process acoustic data.

## Methods/system specification

### *Software versions, hardware*

Simrad ER60 v 2.0.0

Sonardata Echolog 60 v 3.25.02

Sonardata Echoview v 3.25.02 – live viewing v. 3.20.87 – post-processing

HASP Dongle BAS1 is licensed for base, bathymetry, analysis export, school detection module, virtual echogram module, and for live viewing.

The Echosounder pc AP10 and the neighbouring EK60 workstation 2 pc are integrated into the ship's LAN, and ER60 .raw data files were logged to a Sun workstation jrua, using a samba connection, which is backed up at regular intervals and supported by hardware backup in the event of a machine failure. Echolog was run on workstation 2 and the compressed .ek6 files stored locally to improve speed of loading data into Echoview.

## Strategies for running sounders together

*Sounder set-ups (all use external trigger in each case, and each needs to be logging)*

	SSU groups required	EM mode	EA mode	EK mode
Outbound 10kts	EM&EA EK	Calculated Active	Transmit Passive	Timed (700ms) or calculated
Return 10kts	EA EK	OFF	Calculated Active	Timed (700ms)

*Sounder set-ups for Western Core Box (all use external trigger in each case, and each needs to be logging)*

**Starting at north end**

	SSU groups	EM120 (swath)	EA600 (bridge)	EK60 (fish)
Changing to set-up for day time acoustic/UOR transects 10kts	EM&EA EK (No change)	Switch Off Pinging and Logging  Switch back on when water <1000m Check SSU Timed 1700ms	Ask Bridge to switch to Active Change SSU: Timed 1700ms  While EM on then ask bridge to switch to Passive and change SSU to Transmit	Timed (800ms) (Total interval 2.5 secs at all times)
Night time (or off day-transect)	EM&EA EK	On Calculated Active	Transmit Passive	Calculated or timed 800ms

**Starting at south end**

	SSU groups	EM120 (swath)	EA600 (bridge)	EK60 (fish)
Day time acoustic/UOR transects 10kts	EM&EA EK	On for first transect while water <1000m Timed 1700ms  Else off	While EM on then Passive and Transmit  Else Active and Timed 1700ms	Timed (800ms) (Total interval 2.5 secs at all times)
Night time (or off day-transect)	EM&EA EK	Calculated Active	Transmit Passive	Calculated or timed 800ms

**Core box standard protocol**

- Build up to speed 1 mile before station to launch UOR
- Start transect at least 30 minutes after dawn
- 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
- Travel 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

## Implications of ping interval

The following tables make clear the implications of distances travelled between pings at different ping intervals:

### *Distance between pings in metres*

Interval: seconds	distance at 10 knots	depth at which pings overlap	Distance at 3 knots	Depth at which pings overlap
1	5.14	42.06	1.54	12.62
2	10.29	84.11	3.09	25.23
2.5	12.86	105.14	3.86	31.54
5	25.72	210.28	7.72	63.08
10	51.44	420.55	15.43	126.17
15	77.17	630.83	23.15	189.25

### *Widths of the seven-degree beam with depth*

Depth	Width	Depth	Width	Depth	Width	Depth	Width	Depth	Width	Depth	Width
<b>5</b>	0.61	<b>55</b>	6.73	<b>105</b>	12.84	<b>155</b>	18.96	<b>205</b>	25.08	<b>255</b>	31.19
<b>10</b>	1.22	<b>60</b>	7.34	<b>110</b>	13.46	<b>160</b>	19.57	<b>210</b>	25.69	<b>260</b>	31.80
<b>15</b>	1.83	<b>65</b>	7.95	<b>115</b>	14.07	<b>165</b>	20.18	<b>215</b>	26.30	<b>265</b>	32.42
<b>20</b>	2.45	<b>70</b>	8.56	<b>120</b>	14.68	<b>170</b>	20.80	<b>220</b>	26.91	<b>270</b>	33.03
<b>25</b>	3.06	<b>75</b>	9.17	<b>125</b>	15.29	<b>175</b>	21.41	<b>225</b>	27.52	<b>275</b>	33.64
<b>30</b>	3.67	<b>80</b>	9.79	<b>130</b>	15.90	<b>180</b>	22.02	<b>230</b>	28.13	<b>280</b>	34.25
<b>35</b>	4.28	<b>85</b>	10.40	<b>135</b>	16.51	<b>185</b>	22.63	<b>235</b>	28.75	<b>285</b>	34.86
<b>40</b>	4.89	<b>90</b>	11.01	<b>140</b>	17.13	<b>190</b>	23.24	<b>240</b>	29.36	<b>290</b>	35.47
<b>45</b>	5.50	<b>95</b>	11.62	<b>145</b>	17.74	<b>195</b>	23.85	<b>245</b>	29.97	<b>295</b>	36.09
<b>50</b>	6.12	<b>100</b>	12.23	<b>150</b>	18.35	<b>200</b>	24.47	<b>250</b>	30.58	<b>300</b>	36.70

## File locations

Initial settings following JR100 and revised settings after calibration appear in Tables Acou1 and Acou2. Full calibration results are available in 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\echoview3\Live Viewing Templates\EK60-60-EK6.EV on workstation 2. With the current version of Echoview it was most important *not* to save this template regularly or virtual variables were multiplied by the number of times the file had been saved

All transect details during the cruise were recorded on a transect log located on the ship's intranet, which automatically entered lat and long for each time entered. Oceanographic survey transects were divided up whenever there was a break for a CTD station or for fishing, and numbered 1.1.2, 1.2.3, to 1.n.n+/-\*1 as needed on transect 1, to indicate the sections between stations 1.1 and 1.2, 1.2 and 1.3 and so on.

## Compression with Echolog

Echolog allows for a variety of data compression strategies. Averaging samples below the sounder detected bottom plus an offset could give unwanted results 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 is 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 – 9999m, this could be from 10m to 250m for krill studies since the first 10m is normally deleted at processing stage, and deeper data are not used.
- 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
- 

Echozip also uses the settings; 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.

## Settings

EK60 settings are shown in Tables acou1 and acou2; they are listed for the start of the cruise (derived from JR100), 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.

## Data processing in Echoview

Initial settings for Echoview were based on salinity and temperature recorded at the time of JR100. This yielded sound velocity of 1457 and absorption coefficients: 38 kHz – 10.132dB/km; 120 kHz – 27.280 dB/km; 200 kHz – 40.552 dB/km.

For post processing, an ev file was set up with standard virtual variables that were created following the JR70 example, using pre-calibration settings (Acou1), and a krill delta Sv range of 2-12dB. These have been documented in Anon (2000), and are also described in Echoview help ‘about virtual variables’ (Higginbottom et al, 2000).

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

- Save the first .ev file to the Templates folder in the same directory as the version of Echoview.exe being used for the processing. *Save regularly throughout processing steps*
- Select new data files according times on transect log
- Review surface noise line and integration stop line (seabed or 250m whichever is deeper)
- Mark bad data: start and end, false bottom, interference, drop-out, missed pings
- Export integrated data from two versions of *mask 120s-c* echogram: gridded by 1 nautical mile by 250m and 500m by 250m.
- Variables exported include NASC, Sv, end distance, 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.

## Calibration

11/01/2005 00:44 Rosita Harbour

Before calibration all discharges were stopped, and the EA500, EM120 and ADCP turned off.

Line lengths had been measured in metres for previous calibrations to set the sphere at 25m, additional calculations were added to put a sphere in front of the EA:

	38	120/200	12
Port forward	41.93	39.98 (-1.95)	40.326(-1.6)(f.100)
Port Aft	43.85	46.13 (+2.28)	42.284 (-1.6)
Starboard	37.25	37.25 (0)	39.030 (+1.8)

0036h GMT CTD event 352 was carried out. The average temperature (2.215516) and salinity (33.57917) for 6-25m and the resulting sound speed (1457.55) were entered into the EK60. The water depth started at 194m, but varied slightly as the ship moved in the tidal current. The sea state was reasonably calm but ruffled by the wind, but the ship on DP remained very stable throughout the calibration.

Each of the Single target detection menus was adjusted to favour the appearance of the sphere as a single target, i.e. weaker targets needed to be excluded. Thus the min acceptable echolength was 0.8 and the min threshold was –50.

38 kHz calibration completed at 0220h

120 kHz calibration completed approximately 0330h  
(EA active but on low power, 200W)

200 kHz calibration was hampered when the sphere did not appear in the lower two quadrants of the calibration plot, except at the centre of the plot, (although it did appear in the EA single target window) but the rms value was acceptable.

200 kHz calibration completed approximately 0420h

The 12kHz sphere was put in place at 0430h, using new knots and pulling in 1.6m on the port aft (no new knots were added to this line). The sphere was visible at the bottom edge of the 38 kHz beam. As a rough approximation, using distances from the plan of the transducers provided by the ship, 0.9m was let out at the starboard reel, and around 2m at each of the port reels. A faint mark was visible just above 30m in the echogram view; the mark could be made to appear and disappear by systematic adjustments with the target adjuster. Each line was adjusted in and out in turn to arrive at the maximum echo, and then the sequence was repeated 3-4 times. In theory this would bring the sphere closer and closer to the centre of the beam with each iteration. The best position was seen at 0519h GMT at 29m. No adjustments to any settings on the EA600 were possible on the instructions of the ships officers.

12kHz calibration completed at 0532h GMT.

The recorded 200 kHz calibration should be sent to Simrad with a request to find out the cause of the non-appearance of the sphere in the lower part of the calibration window.

## **Data coverage**

### *Oceanography transects*

These were covered using the three sounder systems according to the strategy laid out above  
*Western Core Box at South Georgia*

Eight transects were run in the Western Core Box, one was cut short owing to a flood in the engine room.

- Two 43 mile transects completed each day for 2 days.
- At night two oceanographic transects were run. These had been realigned to match up to two of the core box transects. The deep CTDs necessitated an extra half day to complete these
- On the final day the last 3 transects were completed, by starting at dawn and continuing until dusk, this was possible because the last three transects are comparatively close together

## Problems encountered

### *Interference*

A variety of interference types were seen on this survey. The most potentially damaging were short spikes of very high intensity, source unknown (positive dB range), but these were comparatively rare also easy to identify (by increasing the threshold of a resampled variable until only they remained visible and then lining these up with a raw variable where they were delineated and designated as bad data). When switching between modes it happened on occasion that the EA was not switched to external trigger when it was turned to active mode (i.e. not controlled by the SSU) – this generated a regular diagonal line of strong spikes

### *EK60 operation*

The EK60 sounder was run using ER60 software (v.2.0.0) that suffered regular crashes, experienced before on JR96, but different from the crashes that were noted on JR100 with the older EK60 software. The ER software typically shut down following a change in the operation of the SSU (Simrad Synchronisation Unit), but not always. When a message referring to ComContainer.exe was received, this usually meant that the program could be simply restarted providing the first few pings were run without the ‘ingoing trigger’ box selected on the ping control menu (i.e. without initial input from the SSU).

### *Echoview operation*

On several occasions Echoview crashed from live viewing and during processing with ‘Abnormal program termination’ and other notices for no apparent reason. Sonardata have confirmed that this is most likely to be caused by a heavy workload on the workstation.

## Future Plans

### *To Do List*

- Compare specification of EK60 pc to that recommended on Sonardata’s website in order to avoid crashes
- Obtain new version of Echoview that does not have the live viewing ‘copy’ bug
- The recorded 200 kHz calibration should be sent to Simrad with a request to find out the cause of the non-appearance of the sphere in the lower part of the calibration window

## References

Anon (2000) Report of the CCAMLR 2000 Synoptic Survey B0 Workshop held at La Jolla, California, July 2000. SC-CCAMLR ---

Higginbottom, I.R., Pauly, T.J. and Heatley, D.C. (2000) Virtual echograms for visualisation and post-processing of multi-frequency echosounder data. Proceedings of the Fifth European Conference on Underwater Acoustics, ECUA 2000 (Ed M.E. Zakharia) 1497-1502.

## Tables and Figures

### TABLE ACOU1 EK60 SETTINGS AT THE START OF THE SURVEY,

### TABLE ACOU2 EK60 SETTINGS AT THE START OF THE SURVEY, AND AFTER THE CALIBRATION

#### Appendix 1:. Table acoustic 1

##### *EK60 settings at the start of the survey*

JR116 EK60 settings - recorded under menu items from EK500  
changes from JR100 in bold

	<b>EK60</b>	<b>ER60 v2.0.0</b>	<b>Menu location</b>
	start	start	
	11/03/2004	25/12/2004	
/OPERATION MENU/Ping Mode	Ext Trig	Ext Trig	OPC
/OPERATION MENU/Ping Interval		<b>Maximum</b>	OPC
<i>Salinity</i>		<b>34</b>	IE
<i>Temperature</i>		<b>2</b>	IE
<i>Sound Velocity</i>	1457 m/s	1457 m/s	IE
Transceiver-1 Menu/Mode	Active	Active	ON
Transceiver-1 Menu/Transducer Type	ES38	ES38	ON
Transceiver-1 Menu/Transducer Depth	0.00 m	0.00 m	ON
Transceiver-1 Menu/Absorption Coef.	10.05 dBkm	<b>10.132 dBkm</b>	IE
Transceiver-1 Menu/Pulse Length	1.024ms	1.024ms	ON
<i>Transceiver-1 Menu/sample interval</i>	0.1865m	<b>256µs</b>	ON
Transceiver-1 Menu/Bandwidth	2425Hz	2425Hz	ON
Transceiver-1 Menu/Max. Power	2000 W	2000 W	ON
Transceiver-1 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	IST
Transceiver-1 Menu/Sv Transd. Gain	24.19 dB	<b>24.18 dB</b>	IST
<i>Transceiver-1 Menu/Sa correction</i>	-0.07 dB	<b>-0.61 dB</b>	IST
Transceiver-1 Menu/Angle Sens.Along	22.00	22.00	IST
Transceiver-1 Menu/Angle Sens.Athw.	22.00	22.00	IST
Transceiver-1 Menu/3 dB Beamw.Along	7.02°	7.02°	IST
Transceiver-1 Menu/3 dB Beamw.Athw.	6.94°	<b>7.06°</b>	IST
Transceiver-1 Menu/Alongship Offset	0.07°	<b>-0.06°</b>	IST
Transceiver-1 Menu/Athw.ship Offset	0.03°	<b>0.01°</b>	IST
Transceiver-1 Menu/Frequency	38 kHz	38 kHz	IST
Transceiver-2 Menu/Mode	Active	Active	ON
Transceiver-2 Menu/Transducer Type	ES120-7	ES120-7	ON
Transceiver-2 Menu/Transducer Depth	0.00 m	0.00 m	ON
Transceiver-2 Menu/Absorption Coef.	27.21 dBkm	<b>27.28 dBkm</b>	IE
Transceiver-2 Menu/Pulse Length	1.024ms	1.024ms	ON
<i>Transceiver-2 Menu/sample interval</i>	0.1865m	<b>256µs</b>	ON
Transceiver-2 Menu/Bandwidth	3026 Hz	3026 Hz	ON
Transceiver-2 Menu/Max. Power	1000 W	<b>500 W</b>	ON
Transceiver-2 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	IST

Transceiver-2 Menu/Sv Transd. Gain	22.43 dB	<b>21.25 dB</b>	IST	
<i>Transceiver-2 Menu/Sa correction</i>	-0.42 dB	-0.42 dB	IST	
Transceiver-2 Menu/Angle Sens.Along	21.00	21.00	IST	
Transceiver-2 Menu/Angle Sens.Athw.	21.00	21.00	IST	
Transceiver-2 Menu/3 dB Beamw.Along	7.92°	<b>7.54°</b>	IST	
Transceiver-2 Menu/3 dB Beamw.Athw.	7.78°	<b>7.53°</b>	IST	
Transceiver-2 Menu/Alongship Offset	0.05°	<b>-0.02°</b>	IST	
Transceiver-2 Menu/Athw.ship Offset	0.15°	<b>-0.11°</b>	IST	
Transceiver-2 Menu/Frequency	120 kHz	120 kHz	IST	
Transceiver-3 Menu/Mode	Active	Active	ON	
Transceiver-3 Menu/Transducer Type	ES200-7	ES200-7	ON	
Transceiver-3 Menu/Transducer Depth		0.00 m	0.00 m	ON
Transceiver-3 Menu/Absorption Coef.	40.45 dBkm	<b>40.552 dBkm</b>	IE	
Transceiver-3 Menu/Pulse Length	1.024ms	1.024ms	ON	
<i>Transceiver-3 Menu/sample interval</i>	0.1865m	<b>256µs</b>	ON	
Transceiver-3 Menu/Bandwidth	3088 Hz	3088 Hz	ON	
Transceiver-3 Menu/Max. Power	320 W	<b>300 W</b>	ON	
Transceiver-3 Menu/2-Way Beam Angle	-19.60 dB	-19.60 dB	IST	
Transceiver-3 Menu/Sv Transd. Gain	26.30 dB	<b>23.79 dB</b>	IST	
<i>Transceiver-2 Menu/Sa correction</i>	0.00 dB	<b>-0.33 dB</b>	IST	
Transceiver-3 Menu/Angle Sens.Along	23.00	23.00	IST	
Transceiver-3 Menu/Angle Sens.Athw.	23.00	23.00	IST	
Transceiver-3 Menu/3 dB Beamw.Along	8.00°	<b>6.66°</b>	IST	
Transceiver-3 Menu/3 dB Beamw.Athw.	7.90°	<b>6.83°</b>	IST	
Transceiver-3 Menu/Alongship Offset	0.00°	<b>-0.22°</b>	IST	
Transceiver-3 Menu/Athw.ship Offset	0.00°	<b>-0.11°</b>	IST	
Transceiver-3 Menu/Frequency	200 kHz	200 kHz	IST	

Single Target detection settings – all frequencies

Min threshold		-70
Min echolength	0.8	0.8
Max echolength	1.3	<b>1.2</b>
Max phase deviation	2.0	<b>4.0</b>
Max gain comp (dB)	1.0	<b>5.0</b>

IST = Install transceiver; Select; Transducer parameters

IE = Install Environment

OPC = Operation; Ping Control

ON = Operation; Normal

EA 600 24.12.2004 svel 1500 sal 35 temp 10degC

	With EK	With EM & EK	
Transceiver Menu/Mode	Active	Passive	ON
Transceiver Menu/Transducer Type	GPT 12kHz 0090720346a0 12-16/60		ON
Transceiver Menu/Transducer Depth	0.00 m		ON
Transceiver Menu/Absorption Coef.	1280 dBkm		IE
Transceiver Menu/Pulse Length	4.096 ms		ON
Transceiver Menu/sample interval	0.7680m		ON
Transceiver Menu/Bandwidth	657 Hz		ON
Transceiver Menu/Max. Power	1000 W		ON
Transceiver Menu/2-Way Beam Angle	-13.90 dB		IST
Transceiver Menu/Sv Transd. Gain	18.5 dB		IST
Transceiver Menu/Sa correction	-0.00 dB		IST

Transceiver Menu/Angle Sens.Along	0	IST
Transceiver Menu/Angle Sens.Athw.	0	IST
Transceiver Menu/3 dB Beamw.Along	15.4°	IST
Transceiver Menu/3 dB Beamw.Athw.	15.4°	IST
Transceiver Menu/Alongship Offset	0.00°	IST
Transceiver Menu/Athw.ship Offset	0.00°	IST
Transceiver Menu/Frequency	12 kHz	IST

Ping filter on, ping rate max display 20log TVG -50 (backstep min -60)

**Table Acou2 JR116 EK60 settings at the start of the survey and after calibration at Rosita Harbour**

Software	ER60 v2.0.0		Menu location
	start	Post calibration	
	25/12/2004	11/01/2005	
/OPERATION MENU/Ping Mode	Ext Trig	Ext Trig	OPC
/OPERATION MENU/Ping Interval	Maximum	Maximum	OPC
<i>Salinity</i>	34	33.58	IE (33)
<i>Temperature</i>	2	2.2	IE (2)
<i>Sound Velocity</i>	1457 m/s	1457.56 m/s	IE (1457)
Transceiver-1 Menu/Mode	Active	Active	ON
Transceiver-1 Menu/Transducer Type	ES38	ES38	ON
Transceiver-1 Menu/Transducer Depth	0.00 m	0.00 m	ON
Transceiver-1 Menu/Absorption Coef.	10.132 dBkm	10.03	IE
Transceiver-1 Menu/Pulse Length	1.024ms	1.024ms	ON
<i>Transceiver-1 Menu/sample interval</i>	256µs	256µs	ON
Transceiver-1 Menu/Bandwidth	2425Hz	2425Hz	ON
Transceiver-1 Menu/Max. Power	2000 W	2000 W	ON
Transceiver-1 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	IST
Transceiver-1 Menu/Sv Transd. Gain	24.18 dB	24.14 dB	IST
<i>Transceiver-1 Menu/Sa correction</i>	-0.61 dB	-0.58 dB	IST
Transceiver-1 Menu/Angle Sens.Along	22.00	22.00	IST
Transceiver-1 Menu/Angle Sens.Athw.	22.00	22.00	IST
Transceiver-1 Menu/3 dB Beamw.Along	7.02°	7.11°	IST
Transceiver-1 Menu/3 dB Beamw.Athw.	7.06°	7.08°	IST
Transceiver-1 Menu/Alongship Offset	-0.06°	-0.05°	IST
Transceiver-1 Menu/Athw.ship Offset	0.01°	0.02°	IST
Transceiver-1 Menu/Frequency	38 kHz	38 kHz	IST
Transceiver-2 Menu/Mode	Active	Active	ON
Transceiver-2 Menu/Transducer Type	ES120-7	ES120-7	ON
Transceiver-2 Menu/Transducer Depth	0.00 m	0.00 m	ON
Transceiver-2 Menu/Absorption Coef.	27.28 dBkm	26.92	IE
Transceiver-2 Menu/Pulse Length	1.024ms	1.024ms	ON
<i>Transceiver-2 Menu/sample interval</i>	256µs	256µs	ON
Transceiver-2 Menu/Bandwidth	3026 Hz	3026 Hz	ON
Transceiver-2 Menu/Max. Power	500 W	500 W	ON
Transceiver-2 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	IST
Transceiver-2 Menu/Sv Transd. Gain	21.25 dB	20.23	IST
<i>Transceiver-2 Menu/Sa correction</i>	-0.42 dB	-0.45	IST
Transceiver-2 Menu/Angle Sens.Along	21.00	21.00	IST
Transceiver-2 Menu/Angle Sens.Athw.	21.00	21.00	IST
Transceiver-2 Menu/3 dB Beamw.Along	7.54°	7.89°	IST

Transceiver-2 Menu/3 dB Beamw.Athw.	7.53°	7.98°	IST
Transceiver-2 Menu/Alongship Offset	-0.02°	0.05°	IST
Transceiver-2 Menu/Athw.ship Offset	-0.11°	-0.23°	IST
Transceiver-2 Menu/Frequency	120 kHz	120 kHz	IST
Transceiver-3 Menu/Mode	Active	Active	ON
Transceiver-3 Menu/Transducer Type	ES200-7	ES200-7	ON
Transceiver-3 Menu/Transducer Depth	0.00 m	0.00 m	ON
Transceiver-3 Menu/Absorption Coef.	40.552 dBkm	40.10	IE
Transceiver-3 Menu/Pulse Length	1.024ms	1.024ms	ON
<i>Transceiver-3 Menu/sample interval</i>	256µs	256µs	ON
Transceiver-3 Menu/Bandwidth	3088 Hz	3088 Hz	ON
Transceiver-3 Menu/Max. Power	300 W	300 W	ON
Transceiver-3 Menu/2-Way Beam Angle	-19.60 dB	-19.60 dB	IST
Transceiver-3 Menu/Sv Transd. Gain	23.79 dB	22.68 dB	IST
<i>Transceiver-2 Menu/Sa correction</i>	-0.33 dB	-0.32 dB	IST
Transceiver-3 Menu/Angle Sens.Along	23.00	23.00	IST
Transceiver-3 Menu/Angle Sens.Athw.	23.00	23.00	IST
Transceiver-3 Menu/3 dB Beamw.Along	6.66°	7.18°	IST
Transceiver-3 Menu/3 dB Beamw.Athw.	6.83°	6.17°	IST
Transceiver-3 Menu/Alongship Offset	-0.22°	-0.13°	IST
Transceiver-3 Menu/Athw.ship Offset	-0.11°	-0.02°	IST
Transceiver-3 Menu/Frequency	200 kHz	200 kHz	IST

Single Target detection settings – all frequencies

Min threshold	-80
Min echolength	0.8
Max echolength	1.2
Max phase deviation	4.0
Max gain comp (dB)	5.0

IST = Install transceiver; Select; Transducer parameters

IE = Install Environment

OPC = Operation; Ping Control

ON = Operation; Normal

## Appendix 2: Transect log

Time	Transect Name	Latitude	Longitude	Water Depth	Comment
13/01/2005 15:59	ER635	-53.7134	-36.79616	176.02	Start of transect
13/01/2005 12:15		-53.76238	-38.02356	296.99	Leaving mooring buoy site heading for ER635
13/01/2005 05:20	3.2	-53.79669	-37.94053	322.41	end at shallow mooring site
13/01/2005 02:31	3.2	-53.40092	-38.05842	2519.82	Night transect with swath from offshore to inshore mooring site start
10/01/2005 21:48	W4.2S	-53.859	-37.67476	248.22	End of transect (relocated west due to ice)
10/01/2005 21:08	4.2	-53.7599	-37.62625	274.27	Coming off transect because of ice
10/01/2005 17:09	W4.2N	-53.14882	-37.83237		Transect Start
10/01/2005 16:22	4.1N	-53.17194	-37.96125		Transect End
10/01/2005 11:57	W4.1S	-53.76238	-38.02356	296.99	Start
10/01/2005 11:05	W3.2S	-53.88957	-37.90618	146.02	End
10/01/2005 09:43	W3.2	-53.66785	-37.96516	134.64	Detour for bergs
10/01/2005 06:48	3.2	-53.18601	-38.14067	3716.02	Start
10/01/2005 05:50	3.2	-53.1966	-38.1362	3345.74	end night run from shallow mooring site to 3.2.N
10/01/2005 00:55	3.2	-53.79052	-37.96132	318.25	start night run from shallow mooring site to 3.2.N
09/01/2005 20:59	deep mooring to shallow mooring	-53.79817	-37.93457	8.25	end
09/01/2005 19:30	deep mooring to shallow mooring	-53.51059	-37.86524	1362.3	start (approx)
09/01/2005 17:14	1.3 to deep mooring	-53.51155	-37.84005	0	end
09/01/2005 16:32	1.3 to deep mooring	-53.54159	-38.02064	1692.28	start
09/01/2005 13:24	1.4.3	-53.53776	-38.02379	1739.73	end at 1.3
09/01/2005 12:03	T1.4.3	-53.36374	-38.08572	2604.81	Start
09/01/2005 06:38	1.5.4	-53.40743	-38.06086	2524.76	end start RMT
09/01/2005 05:18	1.5.4	-53.19393	-38.15425	3688.32	Start 10 knots
09/01/2005 01:06	deadhead 3.1 to 3.2	-53.18913	-38.14097	3590.67	end of transect W.3.2.N
08/01/2005 23:47	3.1 to 3.2 deadhead	-53.17544	-38.47517	3778.82	start swath
08/01/2005 23:24	W3.1	-53.22017	-38.44955	3767.66	end of transect W.3.1.N
08/01/2005 19:02	W3.1S	-53.9228	-38.22269	103.8	Start
08/01/2005 10:25	2.3.2	-53.61015	-38.64279	2183.97	Start
08/01/2005 07:13	T2.4.3	-53.60921	-38.63934	2106.05	End
08/01/2005 00:43	W2.2	-53.48659	-38.655	3804.54	too windy for RMT returning to station 2.4 for possible station work
07/01/2005 23:20	W2.2 swath run	-53.26819	-38.74674	0	Start

07/01/2005 18:42	W2.2	-53.25435	-38.75035	3793.74	end of transect W2.2
07/01/2005 14:09	W2.2 S	-53.95991	-38.52859	150.98	start of transect W2.2 S
07/01/2005 12:59	W2.1 S	-53.99725	-38.81782	195.01	end of transect W2.1
07/01/2005 10:43	W2.1	-53.64527	-38.92775	1728.55	Small detour avoiding iceberg
07/01/2005 08:30	W2.1N	-53.28432	-39.03958	3724.11	Start 10 knots
07/01/2005 06:35	W1.2N-W2.1N	-53.49284	-39.25668	3153.46	12knots
07/01/2005 03:20	W1.2	-53.54586	-39.21668	3324.76	end of between station section
07/01/2005 01:52	W1.2	-53.78427	-39.18417	332.97	start of stretch between core stations from end first rmt to start of second
06/01/2005 22:49	W1.2	-53.84684	-39.14672	294.55	transect end at stn W1.2S
06/01/2005 22:30	W1.2	-53.7925	-39.1583	329.26	short stretch of transect back to stn W1.2S (+swath)
06/01/2005 19:40	W1.2	-53.73873	-39.17601	395.37	transect interrupted owing to technical problem
06/01/2005 17:02	W1.2	-53.31307	-39.30486	4003.79	Start
06/01/2005 15:44	W1.1	-53.34568	-39.60247	3681.55	End
06/01/2005 11:20	W1.1	-54.05378	-39.39187	416.19	Start
06/01/2005 08:59	3.1W1.1	-54.05624	-38.76427	200.27	Began from 3.1 towards W1.1
06/01/2005 06:04	3.2.1	-54.02422	-39.05513	204.57	Start of transect
06/01/2005 04:35	3.3.2	-54.0276	-39.05627	211.05	end of transect
06/01/2005 03:27	3.3.2	-53.99161	-39.35391	464.68	Start of transect
06/01/2005 01:21	3.4.3	-53.99194	-39.34861	434.16	end of transect
06/01/2005 00:11	3.4.3	-53.95389	-39.64233	477.83	Start of transect
05/01/2005 19:52	3.5.4	-53.92797	-39.89243	1240.13	end of transect
05/01/2005 19:15	3.5.4	-53.91165	-40.04673	2118.88	Start 3.5 to 3.4
05/01/2005 16:38	3.6.5	-53.91511	-40.05054	2810.53	end of transect
05/01/2005 16:10	3.6.5	-53.89853	-40.15617	1267.28	resume transect after CTD
05/01/2005 14:57	3.6.5	-53.90086	-40.16019	1297.81	break in transect for S1
05/01/2005 14:04	3.6.5	-53.90086	-40.16019	1297.81	Start
05/01/2005 11:30	3.7.6	-53.87136	-40.38256	500.25	End
05/01/2005 10:18	3.7.6	-53.83391	-40.69267	366.6	Start
05/01/2005 08:10	3.8.7	-40.78905	-40.69645	369.05	End
05/01/2005 07:01	3.8.7	-53.80233	-41.0095	133.49	Start
05/01/2005 05:12	3	-53.80202	-41.01196	134.12	End of transect on shag rocks shelf
04/01/2005 21:03	3	-53.80202	-41.01196	134.12	Start at 3.1 to 3.8
04/01/2005 21:02	4.1 to 3.1	-54.06276	-38.7528	202.2	End
04/01/2005 19:43	4.1.3.1	-54.16307	-38.44281	224.84	Start 4.1 to 3.1

04/01/2005 17:42	4.2.1	-54.16947	-38.41641	216.58	End
04/01/2005 16:40	4.2.1	-54.25349	-38.66958	251.7	Start
04/01/2005 14:30	4.3.2	-54.25043	-38.66481	0	End of transect
04/01/2005 13:26	4.3.2	-54.33428	-38.91829	245.29	Start 4.3 to 4.2
04/01/2005 11:15	4.4.3	-54.33603	-38.9158	245.88	end
04/01/2005 10:17	4.4.3	-54.4065	-39.16233	292.44	Start
04/01/2005 07:38	4.5.4	-54.43112	-39.2021	243.19	End
04/01/2005 06:35	4.5.4	-54.4898	-39.41727	1640.28	Start 4.5 to 4.4
04/01/2005 03:48	4.6.5	-54.50245	-39.41542	1651.18	end of transect
04/01/2005 02:50	4.6.5	-54.57612	-39.64782	2892.66	Start 4.6 to 4.5
03/01/2005 23:09	4.7.6	-54.5812	-39.66588	2788.62	end of transect
03/01/2005 22:05	4.7.6	-54.66018	-39.91549	3608.09	Start of transect
03/01/2005 17:54	4	-54.66709	-39.91544	3365.9	End of transect offshore
03/01/2005 11:39	4	-54.66709	-39.91544	3365.9	start 4.1 to 4.7
03/01/2005 07:25	6.1.4.1	-54.35687	-37.52808	184	Start of transect between 6.1 and 4.1
03/01/2005 05:31	6.2.1	-54.3619	-37.51185	247.08	end of transect
03/01/2005 04:16	6.2.1	-54.53983	-37.66199	235.42	Start of transect
03/01/2005 01:37	6.3.2	-54.53832	-37.65342	233.59	end of transect
03/01/2005 00:25	6.3.2	-54.71358	-37.80459	233.56	Start of transect
03/01/2005 00:25	6.3.2	-54.71358	-37.80459	233.56	Start of transect
02/01/2005 22:31	6.4.3	-54.72216	-37.80861	228.68	end of transect
02/01/2005 21:30	6.4.3	-54.87171	-37.93331	1072.12	Start of transect
02/01/2005 18:29	5.1.6.4	-54.90145	-37.95107	1365.7	end of transect
02/01/2005 13:32	5.1.6.4	-54.02884	-39.03386	171.27	Start from 5.1 to 6.4
02/01/2005 11:52	5.2.1	-54.17424	-37.9416	162.57	End
02/01/2005 10:34	5.2.1	-54.33806	-38.08426	193.32	Approx start time
02/01/2005 09:00	5.3.2	-54.35015	-38.08986	195.55	End
02/01/2005 07:47	5.3.2	-54.52233	-38.23512	170.78	Start
02/01/2005 04:33	5.4.3	-54.55011	-38.25099	164.4	broken off transect for fishing
02/01/2005 03:32	5.4.3	-54.70225	-38.36877	239.82	start run back from 5.4 to 5.3 10 knots
02/01/2005 01:26	5.5.4	-54.70005	-38.36315	235.17	end of transect
02/01/2005 00:16	5.5.4	-54.8725	-38.51229	2558.2	
01/01/2005 20:46	5.6.5	-54.87405	-38.50956	2542.25	end of transect
01/01/2005 19:31	5.6.5	-55.05205	-38.62622	3915.89	Start of transect

01/01/2005 13:12	5	-55.05322	-38.64913	3922.82	end T5
01/01/2005 06:53	5	-54.17405	-37.94875	161.03	Start of transect
01/01/2005 03:18	6.3.5.1	-54.90374	-37.95139	1406.25	problems with both gantries - transecting on 351.5deg course to inshore end transect 5
01/01/2005 02:00	6.4.3	-54.90374	-37.95139	1406.25	station work stopped due to winch problems searching for krill
31/12/2004 23:22	6.5.4	-54.90251	-37.95694	1407	end of transect
31/12/2004 22:08	6.5.4	-55.0905	-38.08981	3565.32	Start 6.5 to 6.4
31/12/2004 16:07	6.6.5	-55.08492	-38.10363	3473.37	Arrived 6.5
31/12/2004 14:55	6.6.5	-55.25831	-38.24051	3812.56	Approximate start time
31/12/2004 09:51	6	-55.26018	-38.24554	3835m	End of transect offshore
31/12/2004 03:54	6	-54.35809	-37.51522	234.08	Start of transect
31/12/2004 03:50	7.1.6.1	-54.35186	-37.50304	217.62	end of transect
31/12/2004 00:56	7.1.6.1	-54.66343	-37.19891	193.74	start of deadhead
30/12/2004 22:48	7.2.1	-54.66716	-37.19987	188.59	end of transect
30/12/2004 21:31	7.2.1	-54.84351	-37.33784	229.65	Start of transect
30/12/2004 19:14	7.3.2	-54.84755	-37.33815	229.78	end of transect
30/12/2004 18:00	7.3.2	-55.02979	-37.47323	1430.12	start of transect
30/12/2004 14:58	7.4.3	-55.03223	-37.47055	1526.5	end of transect
30/12/2004 14:15	7.4.3	-54.84348	-37.33812	229.35	transect resumed after RMT (overlap)
30/12/2004 13:14	7.4.3	-55.08706	-37.51879	1902.27	interruption for RMT
30/12/2004 12:23	7.4.3	-55.19787	-37.58957	2955.81	start of transect 7.4 to 7.3
30/12/2004 08:13	7.5.4	-54.84755	-37.33815	229.78	Arriving Stn 7.4 end of transect
30/12/2004 06:42	7.5.4	-55.41994	-37.71894	3739.6	transect section 7.5 to 7.4 begun at 10 knots
30/12/2004 02:13	7	-55.385	-37.74459	3788.4	End of transect offshore
29/12/2004 21:31	7	-54.6655	-37.197	196	start at inshore end EM&EA + EK
29/12/2004 19:25	8.1.7.1	-54.82277	-36.72244	146.01	dead head between transect 8 and transect7 EA&EM EK
29/12/2004 17:22	8.2.1	-54.82285	-36.71602	~ 150m	end of transect
29/12/2004 16:21	8.2.1	-54.97501	-36.83498	206.98	Start about 1 mile from 8.2 avoiding bergs
29/12/2004 11:05	8.3.2	-55.0442	-36.86959	805.96	Easterly detour avoiding bergs and new station 1 mile inshore (N) of old station
29/12/2004 10:06	8.3.2	-55.17554	-37.00364	2920.27	Started from 8.3 towards 8.2
29/12/2004 06:10	8.4.3	-55.17657	-37.00215	2569.28	end of transect
29/12/2004 04:50	8.4.3	-55.35442	-37.14132	3288.19	transect section 8.4 to 8.3 begun at 10 knots
29/12/2004 00:49	8.5.4	-55.35846	-37.13793	3291.18	end of transect
28/12/2004 23:39	8.5.4	-55.52772	-37.23599	2660.83	Start 8.5 to 8.4

28/12/2004 19:51	8.6.5	-55.52815	-37.28003	3748.14	end of transect
28/12/2004 18:35	8.6.5	-55.70497	-37.41834	3295.92	Start 8.6 to 8.5
28/12/2004 14:32	8	-55.70832	-37.42425	2534.64	end of transect
28/12/2004 09:38	8	-54.97142	-36.85784	229.67	Detour west around bergs
28/12/2004 08:37	8	-54.91465	-36.27122	168.05	Started T8 at 8.1 @ 10kts
28/12/2004 06:49	9.1.8.1	-54.91465	-36.27122	168.05	dead head from transect 9 to transect 8 inshore end
28/12/2004 04:39	9.2.1	-54.91619	-36.25022	183.29	end of transect
28/12/2004 03:35	9.2.1	-55.08329	-36.36661	246.5	transect section 9.2to 9.1 begun at 10 knots
28/12/2004 01:23	9.3.2	-55.09285	-36.36927	255.48	end of transect
28/12/2004 00:06	9.3.2	-55.26912	-36.4987	2479.48	Starting transect from 9.3 to 9.2 @ 10 kts
27/12/2004 20:58	9.4.3	-55.27035	-36.50065	1752.86	end of transect
27/12/2004 19:46	9.4.3	-55.27035	-36.50065	1752.86	start run back from 9.4 to 9.3 10 knots
27/12/2004 15:45	9.5.4	-55.44785	-36.62316	3506.74	end of transect
27/12/2004 14:30	9.5.4	-55.62554	-36.73955	3490.02	Starting transect from 9.5 to 9.4 @ 10 kts
27/12/2004 10:04	9.6.5	-55.62623	-36.74944	3480.26	end of transect
27/12/2004 08:51	9.6.5	-55.79882	-36.87532	3594.19	Starting transect from 9.6 to 9.5 @ 10 kts
27/12/2004 04:27	9.7.6	-55.80493	-36.87719	3598.13	end
27/12/2004 03:08	9.7.6	-55.98539	-37.00686	3643.6	start run back from 9.7 to 9.6 10 knots not passing through waypoint at speed
26/12/2004 22:33	9	-55.98445	-37.00303	3644.93	End of transect offshore (9.7)
26/12/2004 15:39	9	-54.91689	-36.24921	185.24	Transect start at inshore end (9.1)

# Zooplankton

Shreeve, Ward, Pond, Hirst

## Introduction

Zooplankton samples were collected as part of a longer term data set at 57 stations, arrayed along nine transects running across shelf from the South East of South Georgia around to the North West. At all stations 2 bongo net hauls were completed, each haul comprising a 100 µm and 200 µm net sample fitted with a solid cod end. Nets were deployed to 200 metres and hauled vertically, except where water depth did not allow. The detailed bongo logs with locations, times, sampled depth and notes can be found in the general event log (<http://www.jcr.nerc-bas.ac.uk/eventlog/analyst/> Password eK60, Username eK60 Bongo Event Log).

The first sample was sorted for individuals of *Calanoides acutus* stages CIV and CV, 30 of each were picked from most stations, rinsed in ammonium formate, dabbed dry and placed in to pre-weighed ultra-light weight tin foil capsules for dry mass and elemental composition analysis back in the UK laboratories. Samples were immediately stored at -80°C. The second haul was preserved intact in buffered 4% formaldehyde in seawater, these samples will be used for community composition analysis back in the UK. At 2 stations only 1 sample was taken as weather conditions were marginal, it has been recorded at these stations what animals were removed for mass analysis prior to preservation of the sample in formaldehyde. Results from this cruise will be used in conjunction with those taken from the previous 10 years to look at longer term variability in biomass of these key species.

We had planned to incubate female *Rhincalanus gigas* which looked on the point of spawning whenever possible to look at their length, dry carbon mass and the number of eggs each spawned. However too few fully ripe females were found on this cruise to conduct this work.

## Food quality

At each station water samples were taken from the 20m water bottle on the CTD. 0.9 litres were routinely filtered for POC, fatty acids and pigments, in addition to a 250ml Lugol's sample for taxonomic identification of microplankton. POC log can be found as an attachment to the general event log (<http://www.jcr.nerc-bas.ac.uk/eventlog/analyst/> Password eK60, Username eK60 Particulates Event Log).

## Preliminary results

All the samples to the south of the island showed very similar characteristics in terms of the phytoplankton and zooplankton species present and their abundance. *Thalassiothrix sp.* was the main large diatom found in all samples, turning the sample into a thick brown soup. *Calanoides acutus* stages CIII – CV dominated the samples, with very few smaller copepods present. Towards the north of the island *Rhincalanus gigas* became more abundant.

## Notes on Bongo nets

Bouyancy aids: 3 floats were used on the bongo net, to counteract the extra weight of the 5mm wire now used on the motion compensating mechanism.

The springs have a lifetime of 20,000 cycles. During each minute of deployment the springs cycle 6 times and therefore the depth, duration and proposed number of hauls should always be taken into account when a cruise is planned. About 200 deployments to 200 m are a rough guideline, but springs should be changed between each cruise. Spare springs should be ordered to allow for failure during a cruise. The 5mm wire used between the winch wire and springs should also be changed every 70 or so deployments, and definitely every year (12.5 metres of 5 mm required for this). Periodically check the condition of the towing wire and carry enough spare bungee and spare taps for the cod-ends.

## **Krill**

Length and maturity stage were recorded for 100 individuals from each RMT haul (events 006, 186, 312, 357) (where numbers permitted), more detailed description of krill work can be found in the report of Tarling & Johnson.

## **Stable isotope tracer experiments**

Female *Calanus similimus* obtained from bongo hauls were fed <sup>13</sup>C labelled freeze dried diatoms. Eggs were collected every 24 hours and preserved. Future GC-MS analyses of the eggs in the UK will allow the relative importance of dietary and somatic lipid pool for egg production to be quantified.

# Net catches and krill biology

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## Net catches

The RMT8 was deployed was 3 main purposes:-

- 1) Targetted hauls in order to catch krill in good condition for experimentation (TARGET) and/or to determine the species composition of acoustic targets
- 2) Standard hauls in the Western Core Box (Net 1 open 0-250m or close to bottom, Net 2 open on return to surface) and fixed positions (STANDARD)
- 3) Target identification around the Shallow and Deep Moorings (MOORING)

Table 1 details the times, depths and purpose of all RMT 8 nets deployed during this cruise. If available, a brief summary of the main species in the catch is given in Table 2.

### Summary of operations and catches

**Target hauls:** The original field plan was to target fish on all 9 transects. However, the original length of the present cruise was shortened because of logistical problems (failure to reach Rothera beforehand). Therefore, the number of target hauls was reduced to 7. Three of these catches contained krill, one deployment failed because of re-cogging problems. The priority for these catches was to transfer the living krill to holding containers in the controlled temperature room and then into the incubation tank. A length-frequency distribution of a random sub-sample of this catch was taken where possible. The rest of the catch was described qualitatively but not preserved.

**Standard hauls:** We completed 5 out of the 6 standard hauls on the Western Core Box. W1.2 (N and S) and W2.2 (N and S) were carried out on consecutive nights. However, there was a gap of 3 days before carrying W3.2S because of logistical obligations. We did not carry out a standard haul at W3.2N. The hauls were not analysed before preservation as there was insufficient manpower during the night-shifts. The exception was W3.2S, which was described qualitatively (see Table 2).

**Moorings hauls:** 4 RMT hauls were carried out in the vicinity of the moorings. 2 deployments were carried out at the deep mooring during nighttime, covering the depth zones: 500-300m, 300-200m, 200-100m, 100-10m. The ADCP is situated around 200m. A day and a nighttime deployment was carried out at the shallow mooring. The night-time haul covered the depth zones 285-200m, 200-10m. The daytime haul did not unfortunately cover these same depth zones because of a miscommunication between operators – the realised haul was: Net 1 10-250m; Net 2 250-10m. All catches were analysed semi-quantitatively and preserved.

Event Number	Position	Net 1 open (GMT)	Net 1 closed (GMT)	Net 1 depths	Net 2 open (GMT)	Net 2 closed (GMT)	Net 2 depths	Purpose	Analysis of sample	Length-frequency on krill	Sample preserved in Formalin
6	-55.03962 -36.33599	26/12/04 14:22	26/12/04 14:33	146-155m	26/12/04 14:34	26/12/04 14:46	155-133m	TARGET	Qualitative	Yes	No
85	-55.14673 -37.54813	29/12/04 15:08	29/12/04 15:25	80-200m	29/12/04 15:25	29/12/04 15:41	70-90m	TARGET	Qualitative	No	No
105	-55.14673 -37.54813	30/12/04 13:48	30/12/04 13:53	75-80m	30/12/04 13:53	30/12/04 13:58	80-85m	TARGET	Qualitative	No	No
158	-54.57842 -38.28341	02/01/05 05:00	02/01/05 05:14	117-130m	02/01/05 05:15	02/01/05 05:26	152-121m	TARGET	Qualitative	No	No
186	-54.54346 -37.64956	03/01/05 01:57	03/01/05 02:03	26-35m	03/01/05 02:05	03/01/05 02:12	35-0m	TARGET	Qualitative	Yes	No
288	-53.84331 -39.14864	07/01/05 00:42	07/01/05 01:12	20-250m	07/01/05 01:12	07/01/05 01:43	255-10m	STANDARD W1.2S	No	No	Yes
289	-53.53844 -39.22165	07/01/05 03:34	07/01/05 04:04	8-252m	07/01/05 04:04	07/01/05 04:34	251-0m	STANDARD W1.2N	No	No	Yes
312	-53.77906 -38.49517	08/01/05 12:03	08/01/05 12:33	10-205m	08/01/05 12:33	08/01/05 13:00	204-10m	STANDARD W2.2S	Qualitative	Yes	Yes
331	-53.40179 -38.05753	09/01/05 06:53	09/01/05 07:23	10-250m	09/01/05 07:24	09/01/05 07:53	255-9m	STANDARD W2.2N	No	No	Yes
349	-53.79627 -37.91969	09/01/05 23:41	09/01/05 23:46	285-200m	10/01/05 23:46	10/01/05 00:30	200-10m	MOORING	Semi-quantitative	Yes	Yes
350	-53.79351 -37.93619	10/01/05 00:39	10/01/05 00:42	50-31m	10/01/05 00:42	10/01/05 00:47	31-20m	TARGET	Qualitative	No	No
357	-53.76239 -37.92335	12/01/05 00:39	12/01/05 01:11	10-130m	12/01/05 01:12	12/01/05 01:42	134-10m	STANDARD W3.2S	Qualitative	Yes	Yes
358	-53.75961 -37.94474	12/01/05 02:40	12/01/05 02:54	95-120m	12/01/05 02:54	12/01/05 03:00	~30m	TARGET	Not fired properly, no sample		
369	-53.51853 -37.77307	13/01/05 00:03	13/01/05 00:17	490-300m	13/01/05 00:17	13/01/05 00:25	292-195	MOORING	Semi-quantitative	No	Yes
370	-53.48895 -37.85311	13/01/05 01:11	13/01/05 01:18	200-100m	13/01/05 01:18	13/01/05 01:26	100-5m	MOORING	Semi-quantitative	No	Yes
371	-53.79284 -37.94523	13/01/05 11:00	13/01/05 11:32	19-248m	13/01/05 11:32	13/01/05 12:02	248-4m	MOORING	Semi-quantitative	Yes	Yes

Table 1: A list of all the RMT8 carried out during the JR116 survey

Event	Date and Time (start)	Type of analysis	Displacement volume	Catch	Preserved in formalin
6	26/12/04 14:22	Qualitative		Dominated by krill and mysids	No
85	29/12/04 15:08	Qualitative		Dominated by <i>Themisto</i> and a few salps	No
105	30/12/04 13:48	Qualitative		Mainly salps and a couple of <i>Electrona calenbergii</i>	No
158	02/01/05 05:00	Qualitative		<i>Themisto</i> and some icefish	No
186	03/01/05 01:57	Qualitative		Dominated by krill and a few <i>Themisto</i>	No
312	08/01/05 12:03	Qualitative		Numbers of krill present, especially in Net 1	Yes
349	09/01/05 23:41	Semi-quantitative	Net 1: 240ml Net 2: 3959 ml	<b>Net 1:</b> ( <u>in ½ sample</u> ) – 15 krill, 1 <i>Crangon</i> , 14 <i>E. triacantha</i> , 12 <i>Antarctomysis maxima</i> , 1 other mysid, 7 cf. <i>Orchomene</i> , 81 <i>Themisto</i> , 182 <i>Thysanoessa</i> , >500 <i>Rhincalanus gigas</i> , ~5 <i>Pareuchaeta</i> , 1 Polychaet worm, 2 Petropods <b>Net 2:</b> ( <u>200 ml sample</u> ) – 171 krill, 186 <i>Thysanoessa</i> , 67 <i>Themisto</i>	Net 1: ½ catch preserved Net 2: 500ml preserved
350	10/01/05 00:39	Qualitative		Krill in both nets	No
357	12/01/05 00:39	Semi-quantitative		Mainly <i>Themisto</i> and krill in both nets (krill dominated by the +50 mm size class)	Yes
369	13/01/05 00:03	Semi-quantitative	Net 1: 170ml Net 2: 140ml	<b>Net 1:</b> ( <u>whole sample</u> ) 1 <i>Sergia</i> sp., 1 krill, 3 siphonophores, 3 myctophids, several clupeoid fish larvae, 3 small octopod, 1 large octopod, 1 <i>Periphylla periphylla</i> , 37 <i>Themisto</i> , 10 <i>Paradania boeckii</i> , 55 <i>E. triacantha</i> , 2 winged pteropods, 2 giant ostracods, >100 chaetognaths, 10 <i>Primno macropa</i> , 5 cf <i>Cyphocaris</i> , 26 red pteropods, >200 <i>Thysanoessa</i> <b>Net 2:</b> ( <u>whole sample</u> ) - 29 <i>E. triacantha</i> , 43 <i>Themisto</i> , 1 Myctophid, 1 larval fish (clupeoid), >500 <i>Euchaeta</i> , >500 <i>Rhincalanus gigas</i> , 12 red pteropods, >250 <i>Thysanoessa</i> , ~50 chaetognaths, 5 siphonophores, 1 <i>Vibilia</i> , 5 <i>Primno macropa</i>	Yes
370	13/01/05 01:11	Semi-quantitative	Net 1: 300ml Net 2: 100ml	<b>Net 1:</b> ( <u>whole sample</u> ) – 14 <i>Tomopteris</i> , 6 krill, 2 myctophids, 1 squid, 8 <i>E. triacantha</i> ; ( <u>1/8 subsample</u> ) – 200 adult <i>Thysanoessa</i> (many larval <i>Thysanoessa</i> besides), 202 <i>Themisto</i> , 3 <i>Primno macropa</i> <b>Net 2:</b> ( <u>whole sample</u> ) – 128 <i>Themisto</i> , 1 <i>Hyperia macrocephala</i> , 3 <i>E. superba</i> , 1 myctophid, 1 <i>Calycopsis</i> , 1 siphonophore, 4 <i>Primno macropa</i> , 2 <i>Vibilia</i> , 28 <i>E. triacantha</i> , 1 <i>Tomopteris</i> , 127 <i>Thysanoessa</i>	Yes
371	13/01/05 11:00	Semi-quantitative		<b>Net 1:</b> 26 litres of krill <b>Net 2:</b> ( <u>1/10 sample</u> )- 78 krill, 244 <i>Themisto</i> , 55 <i>Thysanoessa</i> , 2 <i>E. triacantha</i> , 3 <i>Primno macropa</i>	1/10 subsample of Net 2 preserved

Table 2: catches in all RMT8 nets that were analysed

## Length-frequency distributions

Krill: 6 catches were analysed to give length-frequency distributions. Around 100 animals from each catch were measured from the front of the eye to the tip of the telson to the nearest mm. The maturity status (modified scale of Makarov and Denys, 1980) and attachment of spermatophores to females was also noted. Events 6, 186, 312 and 357 were measured by RS; Events 349 and 371 were measured by GT. Fig 1 is a combined plot of all these events. The rawdata is contained within the file "LF.xls" in the folder "Krill Biology". The distribution shows that there were probably 3 modes in the population, with peaks at 37 mm, 48 mm and 55 mm.

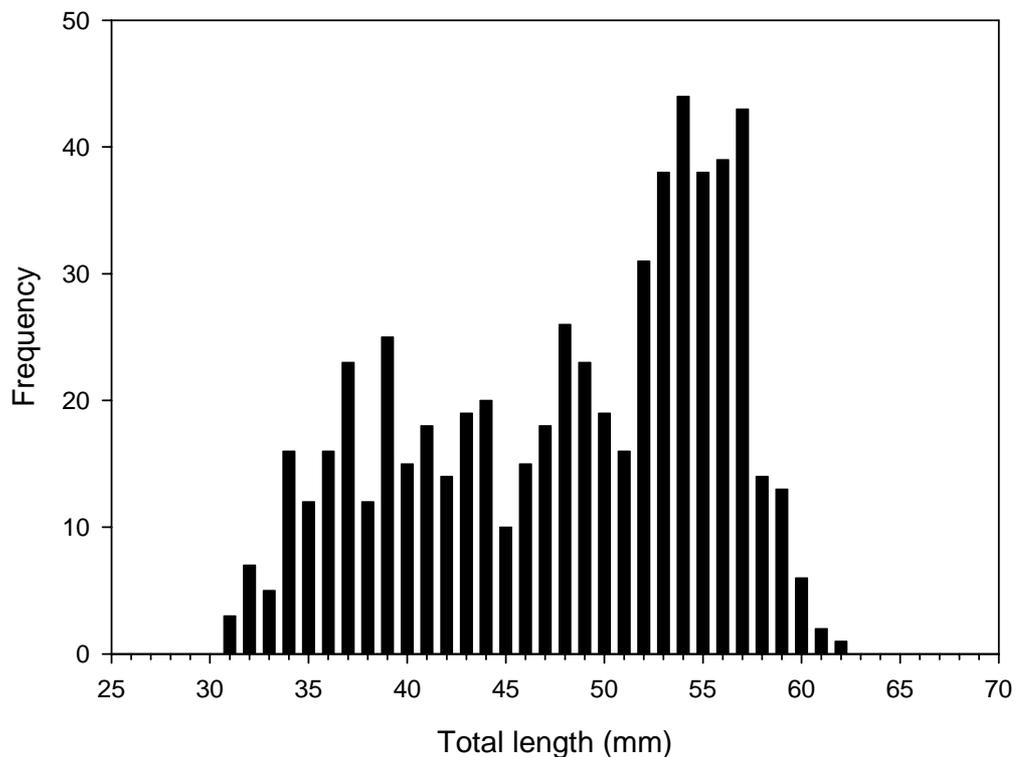


Fig 1:Length-frequency distribution of all krill measured during JR116

Mysids: *Antarctomysis maxima* frequently occurred in RMT8 nets on shelf. Event 158 contained sufficient numbers to carry out a length-frequency distribution analysis. The analysis revealed that there were 3 modes in the population, with peaks at 15 mm, 30 mm and 38 mm.

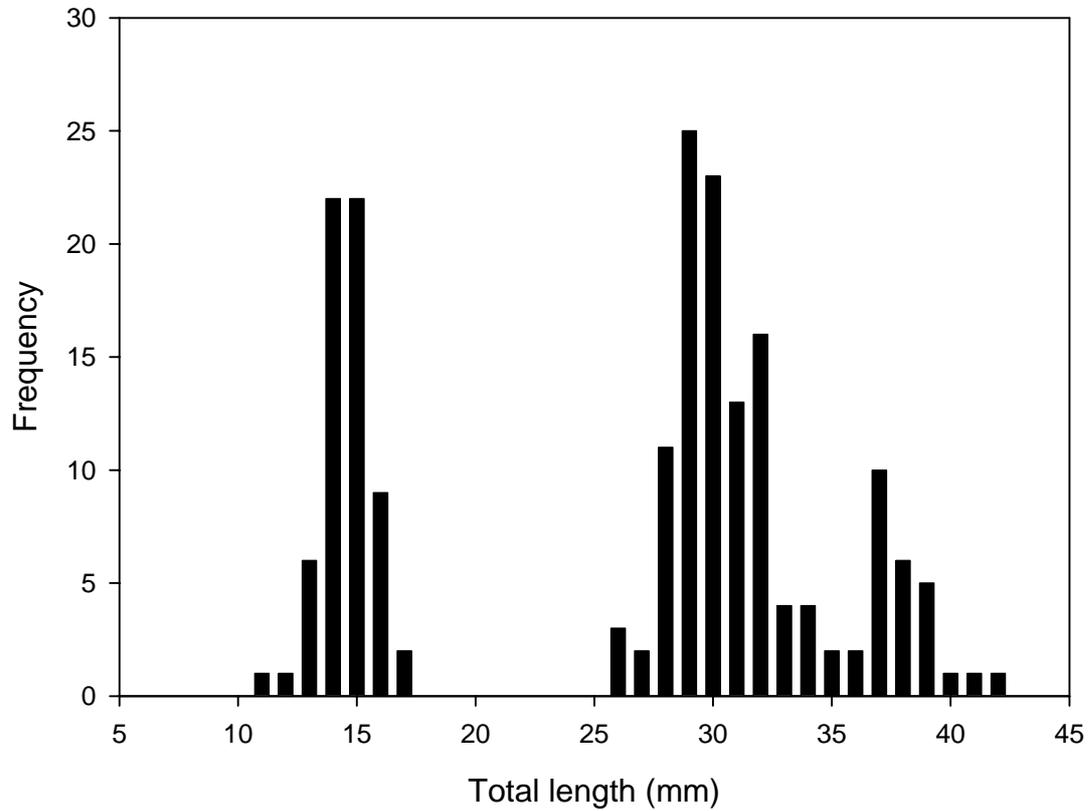


Fig 2: Length-frequency distribution of *Antarctomysis maxima* from event 158 (net 1)

## **Krill spawning studies**

Gravid females frequently occurred in all krill net catches. The spawning performance of a small subset of animals from 3 events was monitored over a number of days to answer the following questions:

- 1) do female krill with distended thoraxes at South Georgia release eggs into the water column?
- 2) do they release eggs in more than one spawning episode?
- 3) do they moult soon after spawning?

10 females from Event 6 and 9 females from Event 186 were placed in 1.5 litre incubation jars containing either ambient surface water or filtered surface water. The jars contained an inner filtering chamber that kept the animals from the bottom of the jar, so preventing cannibalism of eggs which generally fall to the bottom once spawned.

The jars were checked every day and water was frequently changed. Some of the spawned eggs were incubated to determine whether hatching took place, but successful hatching was never achieved. The spawning and moulting performance of these two sets of females are detailed in Tables 3 and 4.

The majority of krill spawned (90% in Event 6, 70% in Event 186). Although many of these animals subsequently moulted during the course of the experiment, others died soon after spawning and their moulting performance could not be assessed.

The number of eggs released during a spawn was assessed in 3 females that were tethered to a pendulum during spawning (see Section in this cruise report on “Krill Behaviour Experiments”). This ensured that they could not cannibalise the eggs either during or after spawning. The total numbers of eggs released was 1480 (female TL of 54mm), 5560 (female TL of 60 mm) and 6540 (female TL of 55 mm).

	Female 1	Female 2	Female 3	Female 4	Female 5	Female 6	Female 7	Female 8	Female 9	Female 10
12/26/04	started 2-6 h after capture									
12/27/04										
12/28/04	spawned, sent to short exp			spawned, sent to short exp						
12/29/04		spawned, reincubated	spawned, dead		spawned, reincubated			spawned, reincubated	spawned, reincubated	spawned, reincubated
12/30/04										
12/31/04								small spawn		
01/01/05								small spawn	small spawn	small spawn
01/02/05								small spawn	moulted	
01/03/05										
01/04/05							spawned			
01/05/05										
01/06/05					dead					
01/07/05										
01/08/05							Dead			
01/09/05								dead		
01/10/05										
01/11/05										
01/12/05										
01/13/05		dead in moult				dead and moult				moult
01/14/05										
01/15/05										

Table 3: spawning and moulting performance of females from Event 6 (red = spawned, yellow = moulted, grey = animal no longer alive, black = animal taken out of experiment for another purpose)

	Female 1	Female 2	Female 3	Female 4	Female 5	Female 6	Female 7	Female 8	Female 9
01/03/05	Started	Started	Started	Started	Started	Started	Started	Started	Started
01/03/05									
01/04/05		Spawned			Spawned				
01/05/05				Spawned	Spawned, moul	Spawned			
01/06/05	Dead								
01/07/05			Spawned, died	Spawned			Dead		spawned
01/08/05									
01/09/05									
01/10/05									
01/11/05									
01/12/05				moult and died					
01/13/05		Dead						moult	
01/14/05									

Table 4: spawning and moulting performance of females from Event 186 (red = spawned, yellow = moulted, grey = animal no longer alive, black = animal taken out of experiment for another purpose)

## **AFI project CGS6/16**

### Individual behavioural responses of krill to stimuli: an approach to understanding swarming

Geraint Tarling (BAS) and Magnus Johnson (SCCS, University of Hull)

#### **Background**

The swarming behaviour of krill is a fundamental aspect of the ecosystem dynamics of the Southern Ocean, impacting on how lower trophic levels are grazed and on how higher trophic levels must forage. Studying how individual krill respond to environmental and biological variables is key to understanding swarming behaviour. Recently, an approach has been pioneered where swimming behaviour of krill (*Meganyctiphanes norvegica*) was measured in response to various stimuli and in various physiological states using a rotational displacement transducer (Thomasson et al. 2003). Using the apparatus, power output from pleopod swimming was shown to be related to moult stage and size. The apparatus has the potential to examine swimming response in relation to a number of biological and environmental variables, which will have great value in the parameterisation of models able to simulate swarm formation and maintenance. We used this apparatus during the present cruise to (i) establish the technique further (ii) enhance the scientific outcomes of the DYNAMOE PELAGICS programme and (iii) trial the technique as a means of examining individual behaviour and life-history in the upcoming Q4 programme.

#### **Implementation of field plan**

In the outline proposal, we requested the following support:

1. 1 day dedicated – anchored inshore (to take place either side of the acoustic calibrations)
2. Krill in good condition from targeted net hauls carried out at regular intervals (every 2 days on average) as was normal practise in previous cruises (e.g. JR70 and JR82)
3. Space in the dry lab. and the controlled temperature (CT) room, including holding tanks to keep krill alive before experimentation.

Problems encountered by the previous cruise when trying to enter Rothera station meant that our cruise was shortened. The sampling protocols for the present cruise were adjusted as a result. One consequence was that the amount of krill fishing was reduced. Attempts to catch live krill with RMT 8 nets are detailed in “Net catches and krill biology” elsewhere in this cruise report. Table 1 gives only those net catches from which krill were incubated for experimentation (local time = GMT – 3 h)

Event	Date and Time (GMT)	Net open depths
006	26/12/04 14:12	133 – 151 m
186	03/01/05 01:49	0 – 35 m
312	08/01/05 11:59	10 – 205 m
349	09/01/05 23:23	0 – 285 m
350	09/01/05 00:32	20-50 m

Table 1: RMT8 net catches from which krill were incubated and used for swimming experiments

Once brought on board, the animals were transferred rapidly to 100 litre holding tanks containing ambient surface seawater. Healthy, swimming krill were spooned into 250 ml polypropylene pots (1 per pot) and placed in an incubation tank where ambient seawater was run through at a steady rate (this water was only filtered by a coarse grill so contained phytoplankton and microzooplankton). The tank had the capacity to hold around 250 animals in individual pots. Around 30 animals a day were extracted from this tank for experimentation. Animals were held in the incubation tank for a maximum of 9 days. Mortality rates in the tank were generally low (1% – 2 % per day). Light levels in the tank were low because pots were placed in opaque plastic tubes.

### **Experimental Methods**

Power output was measured by attaching the animals to the arm of an MLT0015 rotational displacement transducer (AD Instruments) using cyanoacrylate glue. Over the period of the cruise the swimming performance of 432 animals was observed. Transfer of free-swimming krill to the experimental chamber took less than 30 s. Movement of the rod caused by swimming performance was read in degrees and recorded on a PowerLab SP8 (AD Instruments) set at a sampling rate of 100 Hz. Thrust was calculated from  $F = (w + k) \sin\theta$  where  $F$  = thrust in mg,  $w$  = the weight of the rod,  $k$  = the weight of the krill in water and  $\theta$  = the angle through which the rod was displaced. Pleopod beat rate was assessed using Fast Fourier Transform, which in most cases made it possible to discern the small and regular movement of the shrimp due to the metachronal pleopod cycle from background noise and larger movements due to thrust generated.

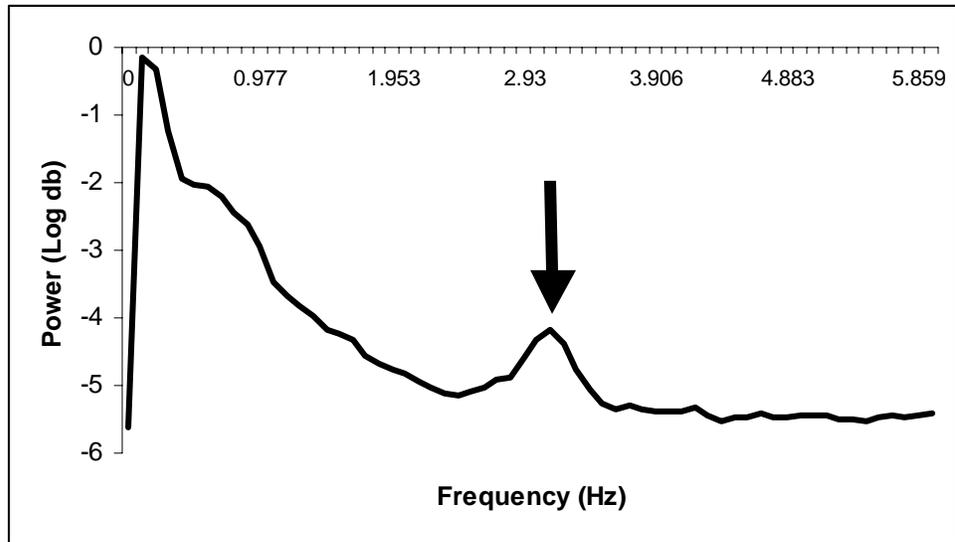


Figure 1: Fast Fourier Transform of the trace produced by a krill swimming while attached to a pendulum. The arrow highlights the easily visible peak at 3.12 Hz which directly corresponds to the pleopod beat rate of the animal.

Preparations were allowed to swim for 10 min and then removed for immediate morphometric and moult stage analysis. Ship movement was subtracted from raw pendulum movement data by means of a control (dead) animal that was recorded on a pendulum simultaneously with the active swimmers. The experimental krill were killed after 10 min and their movements due to the ship related to the control krill through linear regression of a 220 s record sampled at 0.2 Hz. Using the record of the control animal and the regressions of dead experimental against control krill it was possible to predict what the position of the pendulum would have been had the experimental animal not been swimming. This was then subtracted from the raw pendulum movement data to give movement of the pendulum due to the performance of the krill (Figure 2). This system will be checked and calibrated by comparing the results with those from an overnight session carried out while the ship was sheltered in Stromness bay for acoustic calibration and movements was therefore minimal.

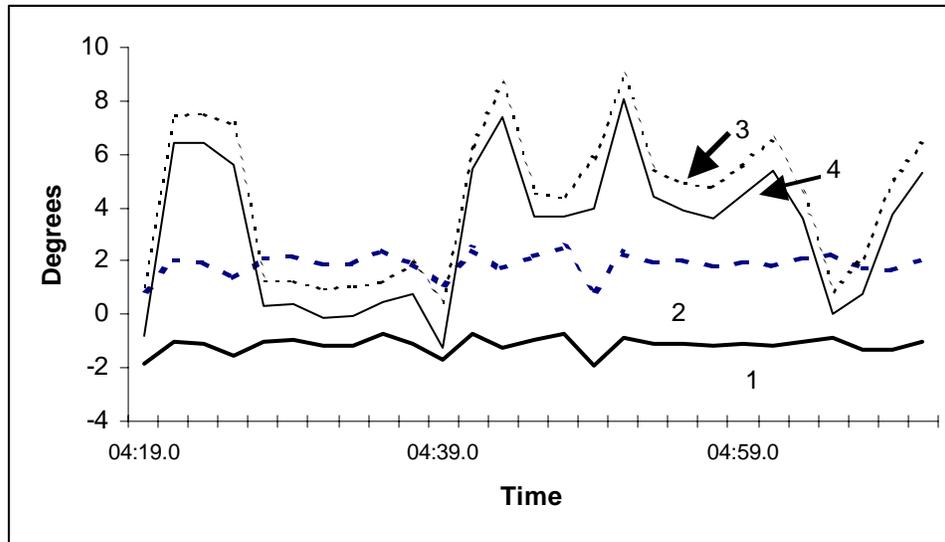


Figure 2: Typical example of krill swimming performance (sampling reduced from 100 Hz to 0.5 Hz for clarity) recorded on a PowerLab. 1 = Control krill, 2 = Estimated position of experimental animal due to ships movement, 3 = Raw data recorded for experimental animal, 4 = Movement of the krill after accounting for ship movement.

#### Influence of physiological condition on swimming performance

All animals were staged for the sexual maturity (modified scale of Makarov and Denys, 1980) and moult status (Buchholz 1985) once swimming performance had been monitored. It was possible to estimate gut fullness in the first 100 animals since they were not sacrificed after monitoring. A semi quantitative scale was adopted for this purpose (full to empty was scaled as A-C for stomach and 1-5 for intestine; A1 is completely full, C5 empty). These animals were frozen immediately afterwards (-80°C) to examine total lipid content, CN content back at Cambridge.

#### Influence of environmental factors on swimming performance

**Light:** Preliminary investigations were carried out into the reactions of krill to light stimuli and low frequency vibration. Light stimuli were delivered using 470 nm LEDs

connected to a signal generator that either delivered a constant intensity or a series of low frequency bell-shaped flashes (upper half of a sine wave) to mimic bioluminescence.

**Vibration:** Low frequency vibrations (either a constant 20 Hz or simulating a basic blue whale song of 28 Hz for 10 s followed by 18 Hz for 10 s) were delivered and monitored via piezoelectric transducers scavenged from some defunct sonar bouys. For both light and vibration some individuals showed a definite response. However it will require further work in order to characterise the response and develop a system that delivers reliable results.

**Feeding:** We carried out 3 experiments to determine the effect of starvation and feeding on swimming performance. In each, we starved the animals in filtered seawater for at least 48 h. Then, one set of animals were exposed either to food saturated conditions (Experiment 1) or ambient surface water (Experiments 2 and 3). The other set of animals remain starved for the duration. Animals were removed from their respective feeding environments every hour for between 9 and 12 hours and their performance monitored.

Two different maturity stages were used in Experiment 1: juveniles and gravid females. Fed and starved animals were extracted every hour to measure performance levels. Given that we had 4 chambers, this meant experimental animals occupied all 4. This meant there was not a dead krill to provide a ship movement control. Their reactions to light were also monitored (see above). The animals were still alive when extracted so it was possible to estimate gut contents.

Experiment 2 was carried out with gravid females only. This meant that performance was monitored in just 2 animals every hour. A third chamber was occupied by a dead control. We used the spare fourth chamber to measure another random animal (nothing to do with the experiment – they were males mainly). Reactions to light were determined during monitoring. The animals were sacrificed and compared to the dead control. It was not possible to estimate gut contents.

Experiment 3 followed the protocol of Experiment 2 but juveniles were used instead of gravid females. Animals were starved for longer than 72 hours before the start of the experiment.

#### Long-term activity patterns

Krill swimming activity was monitored over longer time scales through housing 2 rotational displacers in the controlled temperature room, set at 2°C. The 2 signals (Channel 1 and 2) were recorded on a MacLab system (Apple Mac PC). Unfortunately, it was necessary to house the pendulums in 2 differently sized aquaria since there were no matching pairs – it is likely that water in each aquarium had a different mode of oscillation in relation to the ship's movement. There were no controls (e.g. dead krill on similar apparatus) to account for ship movement.

Animals were monitored for periods of 24 h or longer. Most were still alive when removed from the pendulum after this time. They were subsequently measured and staged. In 3 instances, gravid females spawned whilst attached to the pendulum. The spawning episodes were simultaneously recorded on video (see below).

#### Ground-truthing transducer patterns

Certain actions of the krill on pendulums will have characteristic signatures (e.g. tail flip response, grooming, swimming down). In order to relate specific activities to PowerLab signatures some video records were made at the same time. A total of 60 hours of video was recorded from 7 different animals, which included 3 females in the process of spawning, 2 non-spawning females and 2 males. Standard CCTV cameras were used to obtain the images, placed around 30 cm away from the aquaria. Fluorescent tube lighting was present with some shading by black bin liners that were present to minimise disturbance.

## **Metadata analysis**

In total, we measured the swimming performance of around 500 krill. 405 of these were exposed to ambient surface seawater before analysis, the remainder being exposed to various concentrations of food to determine the effect of starvation and feeding on performance levels.

Out of those exposed to ambient surface seawater before analysis, 106 were not sacrificed before being detached from the pendulum whilst 299 were sacrificed. *[NB1. Sacrificing the krill allowed an offset to be calculated between the pendulum containing the dead krill and the pendulum in question. An offset is generated for each krill because the process of gluing the krill to the pendulum is inexact. Once performance has been monitored, the krill is sacrificed and its baseline angle compared with that of the dead krill. The difference is added to that already obtained through comparing the movement of the live krill and dead krill during the experiment. The calculation of the movement of the pendulum due to the swimming performance of krill alone then becomes more accurate. Taking the krill off the pendulum whilst it is still alive, although less accurate, gives the advantage of allowing gut fullness to be estimated and the krill to be frozen for lipid and CN analysis]. [NB2 Sacrificing involved injecting the krill with alcohol; tissues high in fat were often dissolved as a side effect of this process].*

Maturity Stage	Not-sacrificed	Sacrificed	Measured while at anchor	Feeding/Starvation
Female adult	25	74	7	42
Male adult	1	63	9	0
Female sub-adult	2	6	0	0
Male sub-adult	34	99	9	0
Juvenile	44	57	4	42
<b>Total</b>	<b>106</b>	<b>299</b>	<b>29</b>	<b>84</b>

Table 2: Distribution of maturity stages in the different protocols used for measuring swimming performance

Table 2 shows that swimming performance was measured in all the major maturity stages, although numbers of sub-adult females was relatively low.

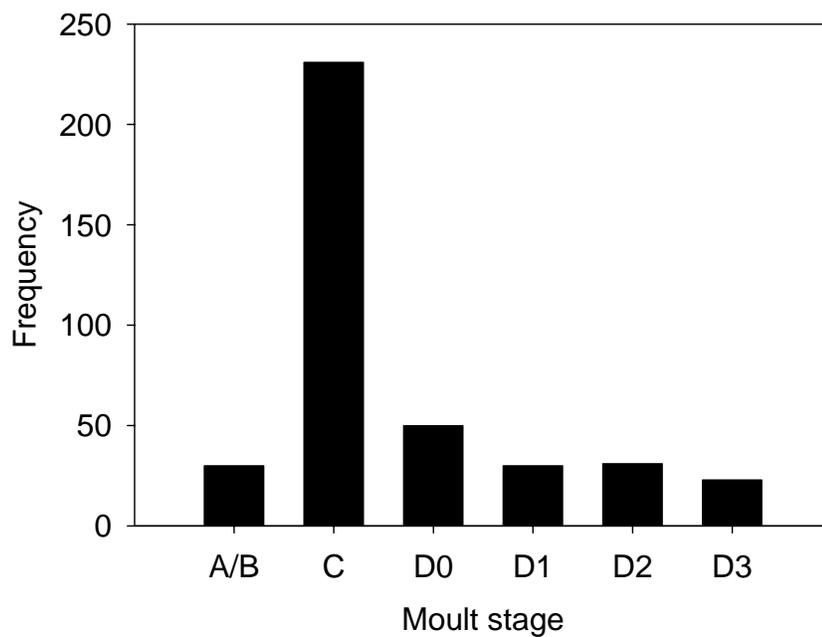


Fig. 3: Distribution of moult stages amongst animals measured for swimming performance.

The swimming performance of all major moult stage categories was measured through the course of our investigations. The least common stage was D3 (premoult), with 23 animals, followed by A/B (postmoult), with 30 animals. The vast majority of animals were in stage C (intermoult), totalling 231 of animals measured. The large numbers moult stage C means that further analyses could be carried out on this stage alone, so controlling for moult stage whilst looking for the effect of other factors

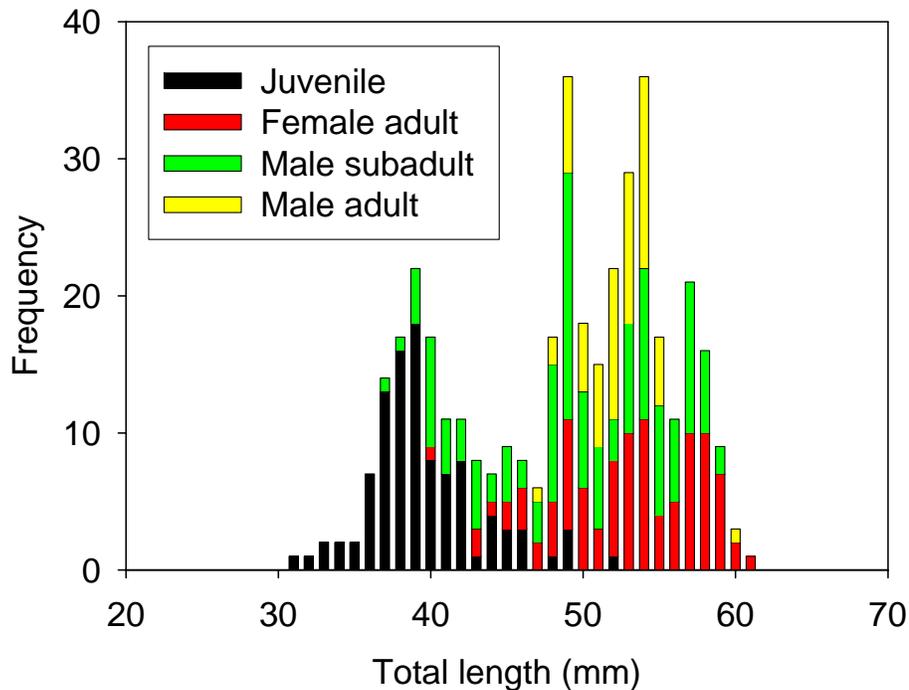


Fig. 4: The length-frequency distribution and maturity stage of animals used in the swimming performance analysis

The animals used in the analysis were mainly from 2 main modes in the population; 1 around 40 mm and another above 50 mm total length. Juvenile specimens dominated the smaller size classes. There was a relatively even mix of female adults, male adults and male sub-adults in the larger size classes. This makes it possible to control for size when making comparisons between (i) males and females (ii) mature vs immature specimens – at least in males.

### Preliminary results

The following analyses were made on a partial dataset mid-way through the cruise. They were generated in order to determine whether our measurements were sensitive enough to detect significant differences between animals. They are presented here as indicators of the type of results we may expect when analysing the complete dataset.

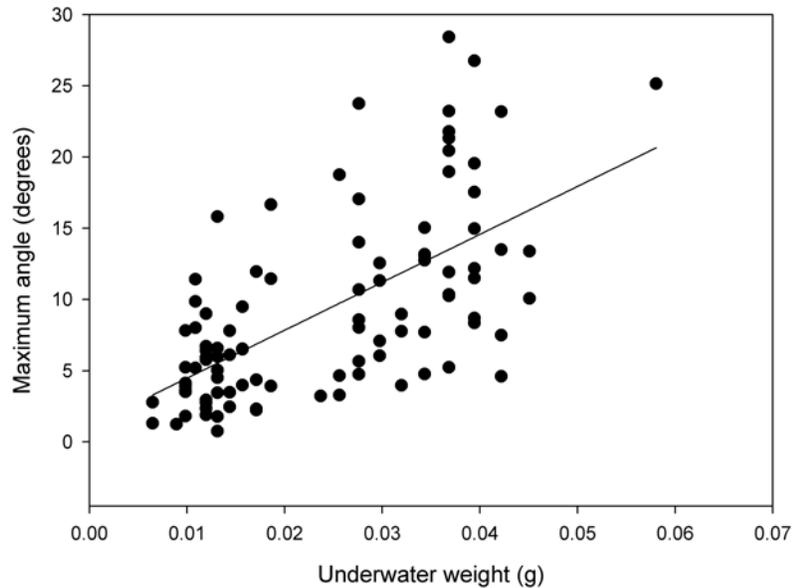


Fig. 5: The maximum angle of deflection resulting from the swimming performance of an animal compared to its underwater weight (calculated from Kils 1981); only data from measurements where the animal was sacrificed after observation was used [ $R^2 = 0.4$ ;  $P < 0.0001$ ].

We found that the maximum swimming performance of an individual was positively related to its size, measured here as its underwater weight. Ultimately, maximum angle will be converted to amount of weight lifted, which requires estimation of the displacement volume and weight of the pendulum as well as the underwater weight of the animal.

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	10	46.055	4.6055	0.89511
Column 2	33	141.667	4.292939	0.56563
Column 3	17	65.155	3.832647	0.7271

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4.210648	2	2.105324	3.175554	0.049254	3.158846
Within Groups	37.78977	57	0.662978			
Total	42.00042	59				

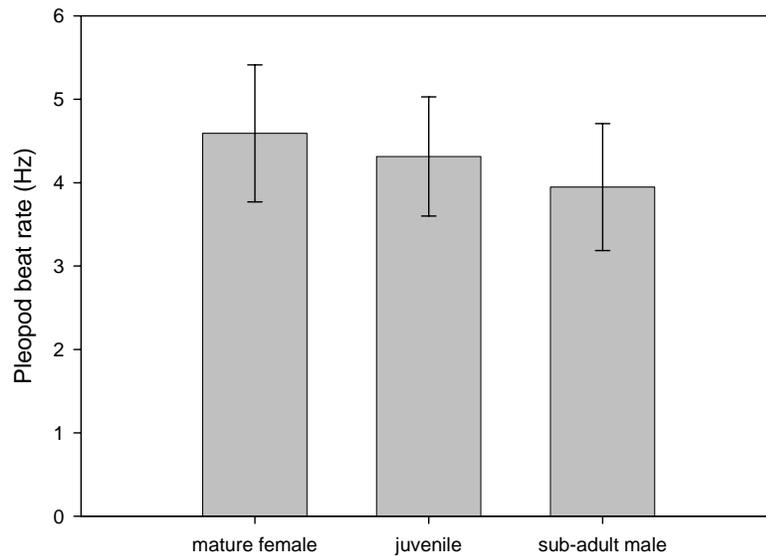


Fig. 6: The pleopod beat rate of different maturity stages

Here we found that the pleopod beat rate differed significantly between maturity stages. Females, which are generally larger than the other 2 categories, has the highest beat rate. However, sub-adult males, which are the next largest, have a slower beat rate than juveniles. Therefore, it appears that maturity stage influences pleopod beat rate more than the size of the animal. All 3 categories have a beat rate around 4 to 4.5 Hz. By comparison, the beat rate of *Meganyctiphanes norvegica* is around 6 Hz (Thomasson et al. 2003). It is interesting to note that the negative correlation of pleopod beat rate with size found in *M. norvegicus* was not noted here for *E. superba*.

t-Test: Two-Sample Assuming Equal Variances

	Variable 1	Variable 2
Mean	-4.707548	-5.264
Variance	0.599774	0.723541
Observations	42	20
Pooled Variance	0.638967	
Hypothesized Mean Difference		
df		60
t Stat	2.562316	
P(T<=t) one-tail	0.006463	
t Critical one-tail	1.670649	
P(T<=t) two-tail	0.012926	
t Critical two-tail	2.000297	

Fig. 7: Comparison of the signal to noise ratio between intermoult and pre/post moult animals

When examining the swimming traces at high temporal resolution, the distinctness of the pleopod beat above the underlying noise varies between individuals. We termed this characteristic the signal to noise ratio, which is a LOG scale. Moulting stage made a significant difference to the size of this ratio. Intermoult animals, with harder exoskeletons, had a greater signal to noise ratio than pre- or postmoult animals, with softer shells. This suggests that moulting stage makes a significant difference to the power an animal may impart with each pleopod beat. Further data analysis may reveal whether

softer animals compensate for this difference in other ways (higher beat rate, longer bouts of swimming etc.).

## 1.1 Introduction

SEaOS is an international and inter-disciplinary program aimed at providing accurate temperature and salinity data from the Southern Ocean using specially developed instruments deployed on southern elephant seals. Collaborators include oceanographers and biologists from Australia, France, and the United Kingdom.

The importance of near real-time monitoring of ocean processes for long-term weather and climate analyses and forecasting is increasingly being recognized. Innovative remote samplers such as moorings, buoys, gliders etc. are being developed, each of which can return data on rapid timescales. Ultimately, programs such as the Global Ocean Observation System (GOOS) will enable the assimilation of such near real-time data into state-of-the-art general circulation models, with the intention of accurately representing and predicting climate variability on seasonal and longer timescales. The primary aim of the project is to demonstrate convincingly that we can use marine mammals to carry instruments to obtain conductivity (salinity)/temperature/depth (CTD) profiles at high frequency and in near real-time from remote, relatively inaccessible parts of the ocean, thus significantly advancing progress towards this goal. We use custom-built ARGOS-linked recorders mounted on Southern elephant seals (*Mirounga leonina*) to provide CTD profiles from key areas within the Southern Ocean, such as the Antarctic sea ice zone and frontal systems within the Antarctic Circumpolar Circulation (ACC). In principal, this is an extremely cost-effective means of adding to existing global oceanographic data archives. It has the potential to complement existing sampling methods, especially for regions and times from which data are scarce and where these alternative methods may be difficult and/or expensive to implement. Secondly, near real-time CTD profiles obtained from these instruments will also allow us to explore the links between seal behaviour, foraging activity, and oceanographic features, such as frontal systems, local eddies and thermoclines. This program builds upon experiences from a preliminary study where we deployed a prototype instrument on a beluga whale during freeze-up in an Arctic fjord in Svalbard.

The British component of this program is a collaboration between the Sea Mammal Research Unit and Dr. Mike Meredith at the British Antarctic Survey. During 2004/05, thirteen ARGOS-linked CTD instruments will be deployed at South Georgia in the South Atlantic, and will provide CTD casts in near real-time throughout the seals' migrations through the ACC and to the Antarctic Continent. Once the potential of this technique has been demonstrated we expect wide-spread interest from international organizations involved in operational oceanography (GOOS, ARGO, etc), and after rigorous quality checks, these data will be lodged with the British Oceanographic Data Center (BODC) and ultimately also with the World Ocean Database (WOD).

The main aim during this cruise was to check these satellite loggers (tags) using the ship-based CTD before they will be deployed on elephant seals in Husvik on South Georgia.

## 1.2 Methods

All SRDLs were compared to a SBE 911plus CTD. The CTD temperature was checked against a high precision temperature probe (SBE 35). Salinity samples were taken at each station at different depths, analysed with a Guildline Autosol 8400B (S/N 65763) and the results were used to calibrate the CTD conductivity cell.

To deploy the tags to the CTD frame, four plastic plates were built with holes to attach the tags using cable ties (Figure 1.1). The plates have following dimensions:

No.	width	length
1	14.3cm	16.0cm
2	11.8cm	21.5cm
3	14.4cm	17.3cm
4	11.9cm	21.6cm

The plates were spanned within the CTD frame at the height of the sample bottles. Before each deployment the internal clock of the tag was set to UTC to have a basis to compare the data to the CTD measurements. The CTD is set to UTC before each cast using a GPS and the measurements are stored with time readings. The sampling rate of the tags was set to one second except tag 10040 on cast 209, which was set to four seconds to see if that makes a difference. All tags measured at the same time. None of them were programmed with an offset. The antenna of the tag was pointed upwards within the CTD frame to simulate the ascending part of an animal dive. So this position is assumed to be more likely. After deploying the CTD it was lowered to 10 m depth and left there for about 3 minutes to climatize the CTD sensors and to start the water pump of the SBE CTD. Then it was hauled to the surface to start the hydrographic profile. The first 150 m the speed was about 0.5 m/s to reduce the risk of capsizing the CTD. Then the speed was raised to about 1 m/s. About 10 meters above the bottom the cast was stopped and the first sample bottle was taken. During the upcast, the last 11 sample bottles were closed at different depths. At each of these depths the hauling was stopped for about 1 minute. After each cast, the tags were removed (not the plates) and cleaned with freshwater. Then data were stored on a PC. Each tag was deployed at least twice, one deep and one shallow CTD cast (Table 1.1). One tag (10053) was deployed on all different plates to check if they influence the conductivity measurements.

## 1.3 Calibration

The data obtained from the tags were checked against CTD measurements. Because the CTD is well calibrated, differences between both show if a tag is offset or not. All sensors of the tags were calibrated by the manufacturer. But after they were build into the epoxy housing, no quality check had been done, although their behaviour may have changed.

Cast no.	2	35	42	48	87	106	175	209
Depth (m)	200	1765	250	184	140	1450	1350	1650
10038	2				3			4
10040	3						4	1(4sec)
10041	4					1		
10042		1			2			2
10043		3			4			
10044		4			1			
10045			1				2	
10046			2			3		
10047			4				1	
10049				1		2		3
10050				2			3	
10052				3		4		
10053	1	2	3	4				

**Table 1.1:** Serial numbers of the SRDLs and the corresponding CTD cast numbers. The numbers 1 to 4 indicate on which plate on which CTD cast the specific SRDL was deployed.

### 1.3.1 Pressure

The pressure measurements of the CTD and the tags are compared using time as a reference. The CTD is set to UTC before each cast using GPS. The tags internal clocks are set manually. This result in small time differences (Table 1.2). The differences between the CTD and tags measurements of pressure were up to 12 dbar apart (Figure 1.2a).

New calibration coefficients were calculated. So the raw readings of the pressure sensor of the tag were compared to the CTD pressure readings. Because the CTD measurements are used as a reference a regression between both quantities will result in better coefficients for the tag. With these new calibration coefficients the new tag pressure was calculated from the raw readings (Figure 1.2b). The error between the 'true' values and the tags is better than 1 dbar (Table 1.2).

One tag (10047) showed some strange behaviour. While the differences between the tag and CTD measurements are relatively normal during the downcast, the pressure readings jump to a higher value at the deepest point and this offset decreases during the upcast (Figure 1.3).

### 1.3.2 Temperature and Conductivity

After correcting the tags pressure, temperature and conductivity are compared using pressure as a reference. Each cast was separated into down- and upcast and then interpolated onto 1 dbar intervalls. Again new calibration coefficients were calculated. So the raw readings of the specific sensor of the tag were compared to the CTD readings. A regression between both quantities resulted in better coefficients for the

S/N	max error	time correction
10038	0.5	-0.8
10040	0.5	-0.8
10041	1	0.7
10042	3	2
10043	0.5	3.1
10044	1	2.8
10045	0.5	-1
10046	0.5	1
10047	1	0
10049	0.5	1.2
10050	1	-1
10052	1	1.4
10053	1	1.9

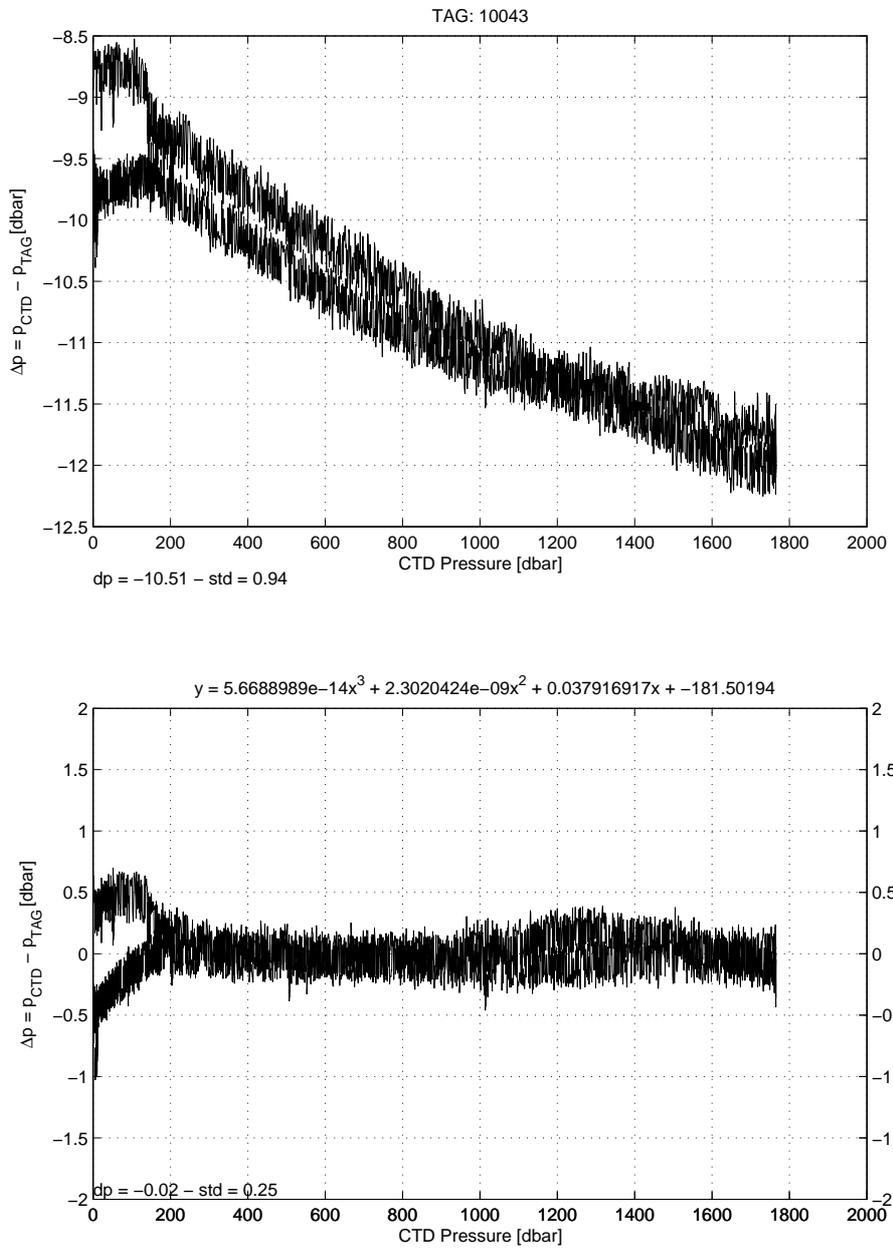
**Table 1.2:** Serial numbers of the SRDLs and the corresponding time correction. The mean deviation from the CTD pressure is shown after calculationg new calibration coefficients.

tag. With these new calibration coefficients the new values were calculated from the raw readings (Figure 1.4). All temperature sensors had at least an offset of about  $-0.68^{\circ}C$ . After correcting the data, the errors between the 'true' values and the tags are better than  $0.18^{\circ}C$  in temperature and  $0.20\text{ mS/cm}$ . This could yield to wrong salinity values with an error up to 0.5.

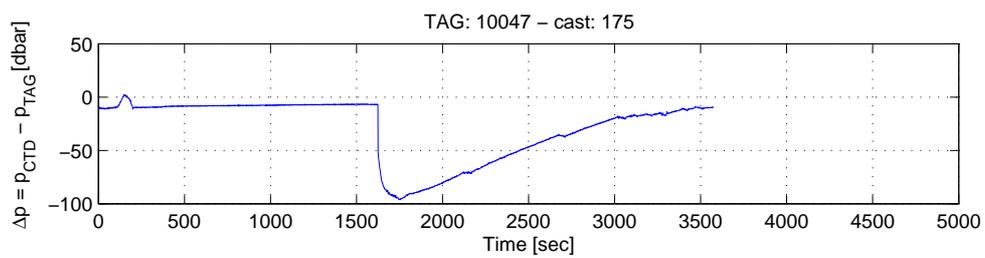
But both measurements are affected by their time constant and by pressure. In the upper 400 m the differences between CTD and tag are huge and unstable due to the dynamic response of the sensors (Figure 1.5). The temperature sensor response time can be seen in Figure 1.4 with two offsets: a negative one for the downcast and a positive one for the upcast. The conductivity sensor is affected by pressure. The deviations at greater depth are uncorrectable using the calibration formular. Figure 1.6 shows the deviation in conductivity of tag 10046.



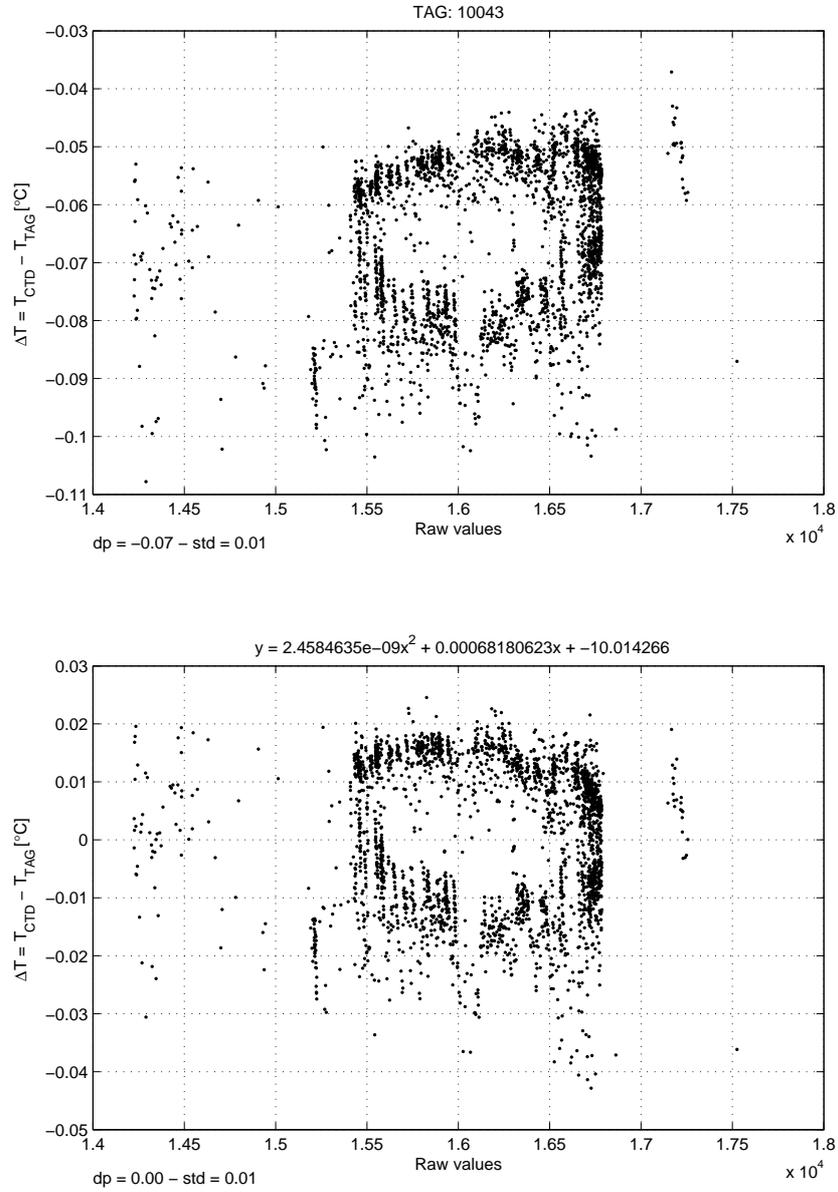
**Figure 1.1:** Plastic plates and how they were used to attach the tags to the CTD frame.



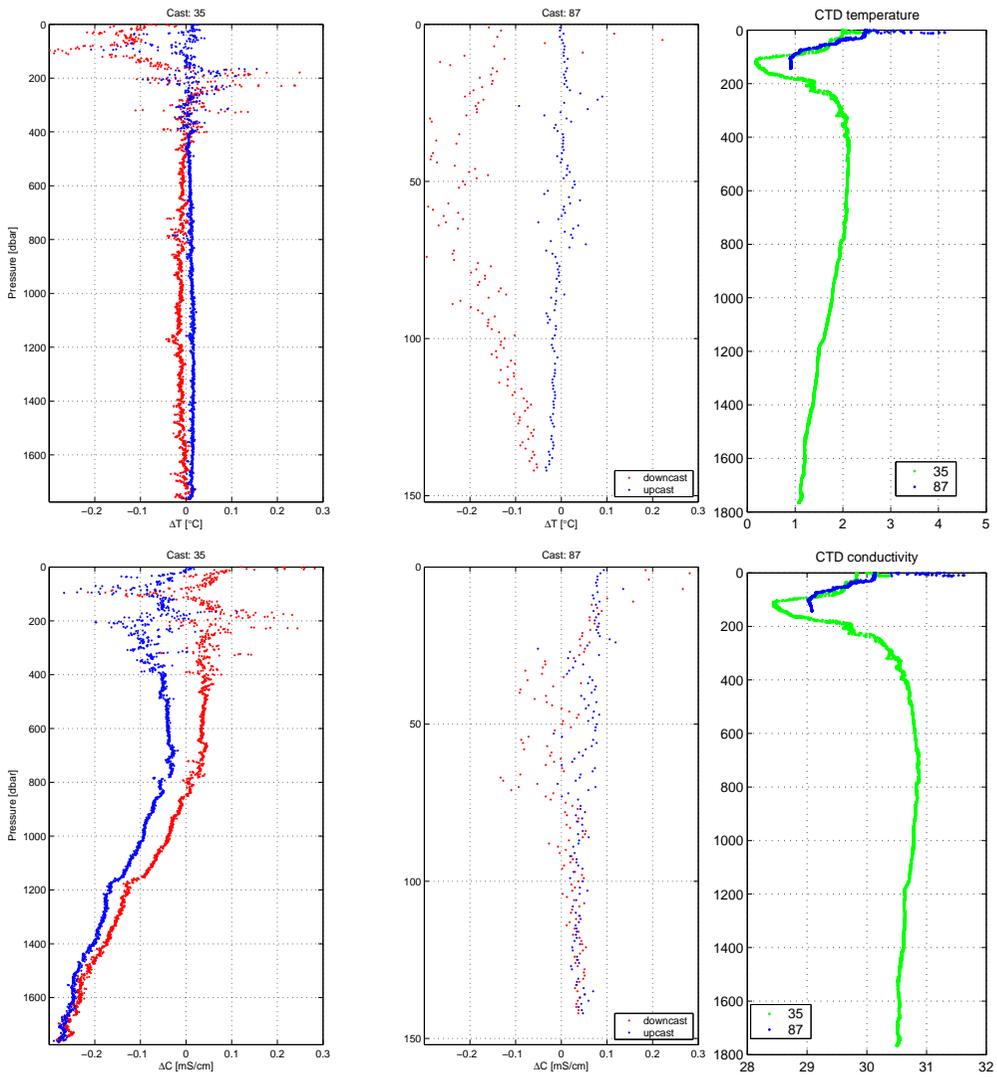
**Figure 1.2:** Evolution on the pressure correction for tag 10043. *TOP:* Differences between the CTD and tag pressure readings depending on CTD pressure. No time constant was included and the calibration coefficients were not changed. *Bottom:* Same as above, except that new calibration coefficients were calculated and used.



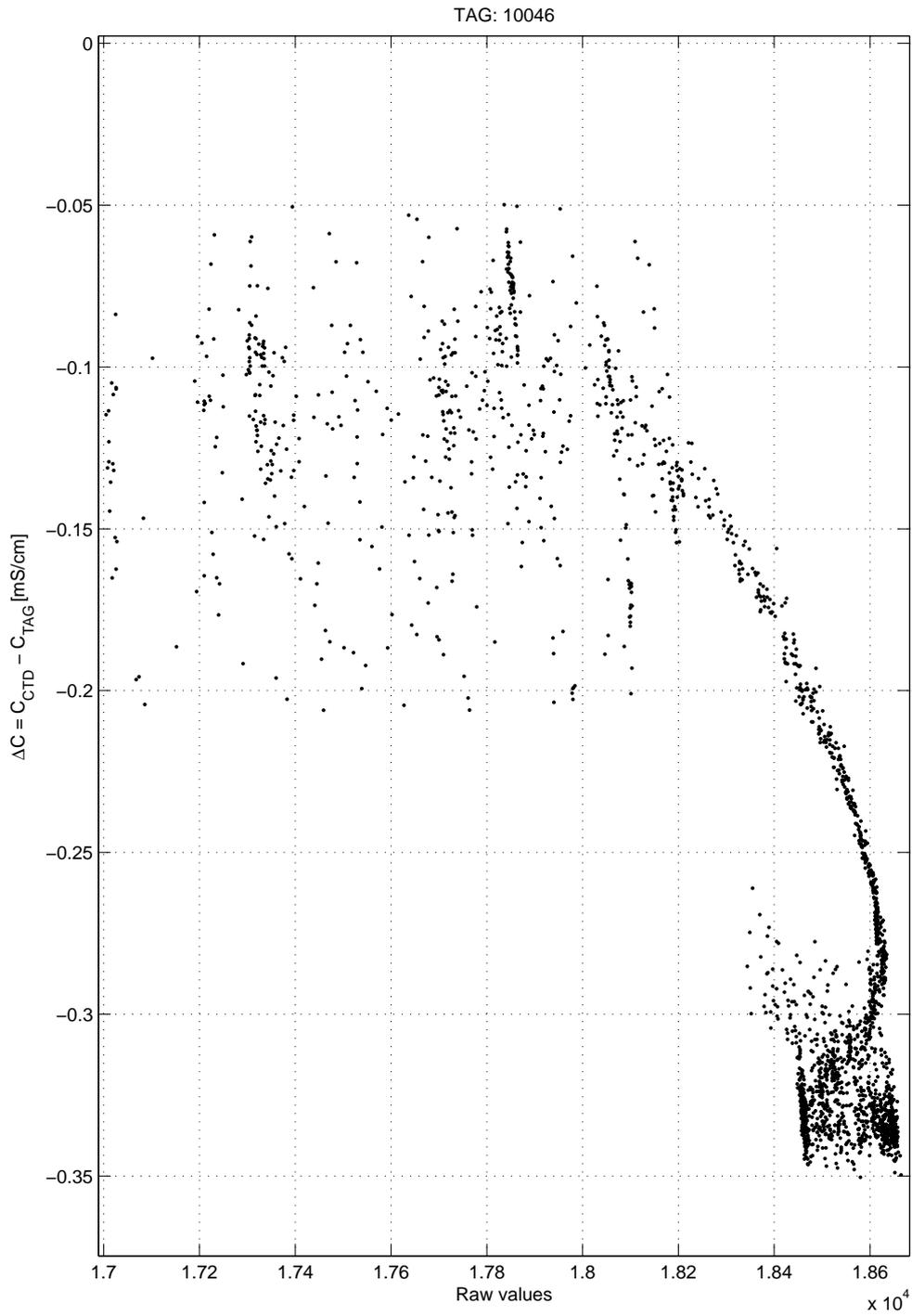
**Figure 1.3:** Pressure differences between the CTD and tag 10047 during CTD cast 175.



**Figure 1.4:** Evolution on the temperature correction for tag 10043. *TOP:* Differences between the CTD and tag temperature readings depending on raw units. No time constant was included and the calibration coefficients were not changed. *Bottom:* Same as above, except that new calibration coefficients were calculated and used.



**Figure 1.5:** Differences between tag 10043 and the corresponding CTD measurements. CTD profiles are also shown.



**Figure 1.6:** Differences between the CTD and tag conductivity readings depending on raw units. New calibration coefficients were calculated and used. This relationship could be more linear, but shows that the conductivity readings are pressure dependent.

# Visual And Acoustic Surveys for Cetaceans

René Swift and Deborah Salmon

## Introduction

Up until the 1960s the South Georgia region was subjected to the greatest concentration of whaling anywhere in the world, with approximately a quarter of a million whales being killed and processed in the area, leaving less than 10% of their original numbers. Despite recent work by the IWC little is known about the current status of whale populations in the waters around South Georgia, and even less about their temporal and spatial distributions. However, work in the Southern Ocean is both temporally and spatially restricted by weather and cost. Dual mode surveys for marine mammals can overcome these problems by combining the spatial coverage of visual surveys with the temporal coverage of fixed ocean bottom acoustic recording packages (ARPS).

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 the large baleen whales: blues (*Balaenoptera musculus*); fins (*B. physalus*); humpbacks (*Megaptera novaeangliae*); and southern rights (*Eubalaena australis*). 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.

## Aims

The objective of the cetacean observations on JR116 were to collect systematic survey data to determine the distribution and abundance of cetaceans around South Georgia in conjunction with underway hydrographic data. These data may allow investigations of the relationship between cetacean distribution and oceanographic processes or prey abundance.

The acoustic goal was to obtain acoustic recordings of various species of whales by both the systematic and opportunistic deployment of sonobuoys. These recordings are helpful in confirming absence/presence of species and in verifying species identification, both of which provide some insight into the spatial distribution of different species. Additionally high quality acoustic recordings of the different baleen vocalisations were required to improve the efficacy of automated detection algorithms.

## Methods

### *Visual surveys*

Visual surveys during JR116 followed the methodology described by Leaper and Van Waerebeek (JR82 Cruise Report, 2003), that was based on protocols used during the CCAMLR synoptic survey in 2000 (Leaper et al., 2001; Reilly et al., 2000).

Observations were conducted according to the protocol for single platform observations. Survey effort was conducted in 'passing mode' (the vessel did not divert to investigate cetacean sightings) along pre-determined transects. Two observers (Deborah Salmon and René Swift) searched an 180° sector (90° either side of the vessel trackline for each observer) ahead of the vessel with 7x50 binoculars. Observations were made from the roof of the bridge (Monkey Island) behind a wind-deflecting screen 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 Logger software (IFAW, 2003). 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, sea temperature, salinity and solar radiation were measured by the ship's instrumentation system. If the horizon was present, distance to each sighting was measured from the angle of dip from the horizon to the whale using Steiner 7x50 reticle binoculars. If the horizon was not clear then distances were estimated. 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. When it was too windy or choppy a second platform was used centred on the compass binnacle at an eye height of 18.7m with 10° reference marks on both the base and the windshield.

In addition to the cetacean sightings, data on pinniped sightings were also recorded. However, due to the high fur seal density in many areas, only fur seals within 150m either side of the vessel were recorded.

### *Acoustic surveys*

Sonobuoys were deployed systematically at every other station (not at every station to make sure that the recordings were independent) and opportunistically if whales were seen near a station. 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 30 or 140m) 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. Sonobuoys can transmit for a maximum of 8 hours before scuttling and sinking, but usually were set to 4 hours as this was more than enough time for station work to be completed and the vessel to be get underway again.

The sonobuoys were LOFAR omnidirectional (ie can not determine the direction of the sound source) and have hydrophones that can register signals up to 6 kHz. The aerial used during the cruise was one of the JCR's marine VHF antennae. The maximum range for the radio transmission during this cruise was approximately 4 nm, but was variable dependant on weather conditions. We used a handheld AOR-8000 wideband receiver and recorded the analogue signal to harddisk using Logger's tapedeck function (IFAW, 2003). Raw data was sampled at 48kHz and down sampled to 1000kHz (equivalent to 500Hz bandwidth) to provide increased resolution at lower frequencies, signals were viewed in Syrinx (J. Burt, 2003) and monitored aurally.

## Results

Approximately 150 hours of survey effort were conducted along 2544 km (1581 miles) of trackline (Figure 1). This resulted in a total of 84 encounters with individual animals or animal groups (Table 1, Figures 2 and 3), and 1714 encounters with fur seals (Table 2, Figure 4).

A total of 35 sonobuoys were deployed. Five sonobuoys failed giving a failure rate of 14%. However, most of these failures occurred in areas of high bird densities and were probably due to the floats getting attacked by birds and the sonobuoy sinking.

In addition to the listed species a Peale's dolphin (*Lagenorhynchus australis*) was observed when not on effort off the coast of the Falklands.

No clear large baleen whale calls were identified from the initial scanning of the sonobuoy recordings, but further analysis of the recordings is needed that were possibly not detected during the preliminary review.

## Problems Encountered

Poor weather and the seven day cut in the cruise schedule due to the Ice at Rothera affected the amount of visual effort that was carried out. Visibility off the southern coast of South Georgia and across the Shelf Break were severely curtailed by thick fog, and changes to the cruise schedule meant that many of uninterrupted (Krill Acoustics only) occurred during periods of observer downtime. Although inevitable for this area, the limited visual effort highlights the need for a combined visual and passive acoustic approach to marine mammals surveys around South Georgia and throughout the Southern Ocean.

Sonobuoy recordings were hampered by the use of low quality receiver and poor low frequency modification by the receiver manufacturer which gave a distorted audio output. In addition the increasing shelf life of the sonobuoys and cold water effects on battery power output may need to be addressed. It is suggested that the programme invest in a high quality receiver with a calibrated low frequency output and dedicated aerial for the JCR. Noise levels from the JCR were significant at low frequencies during dynamic positioning and these would have reduced our signal to noise ratio and thus increased our detection threshold for both the Right Whale and Humpback. Below 100Hz noise levels drop off and noise during dynamic positioning may be less of a problem for recording fin and blue whale vocalisations.

## References

Reilly, S., Hedley, S., Hewitt, R., Leaper, R., Thiele, D., Pitman, R.L., Naganobou, M., Watkins, J. and Holland, R. 2000. SOWER 2000: initial results from the IWC-CCAMLR program to study whales and krill in the Southern Ocean. Paper SC/52/E21 presented to the IWC Scientific Committee, June 2000, Adelaide, Australia (unpublished).19pp.

**Table 1 Marine mammal sightings**

<b>Species name / grouping</b>	<b>Number of Sightings</b>	<b>Total Number of Animals</b>
Antarctic minke whale ( <i>Balaenoptera bonaerensis</i> )	1	1
Undetermined minke whale ( <i>Balaenoptera bonaerensis/acutorostrata</i> )	6	9
Fin whale ( <i>Balaenoptera physalus</i> )	8	12
Humpback whale ( <i>Megaptera novaeangliae</i> )	4	8
Southern right whale ( <i>Eubalaena australis</i> )	21	30
Sperm whale ( <i>Physeter macrocephalus</i> )	2	2
Killer whale ( <i>Orcinus orca</i> )	2	7
Hourglass dolphin ( <i>Lagenorhynchus cruciger</i> )	6	16
Un-identified cetacean	1	1
Un-identified large baleen whale	13	16
Un-identified large whale	4	7
Un-identified rorqual	8	12
Un-identified small delphinid	4	5
Elephant seal	1	1
Total	84	130

**Table 2: Fur Seal sightings**

<b>Number of sightings</b>	<b>Total number of animals</b>
1714	4474

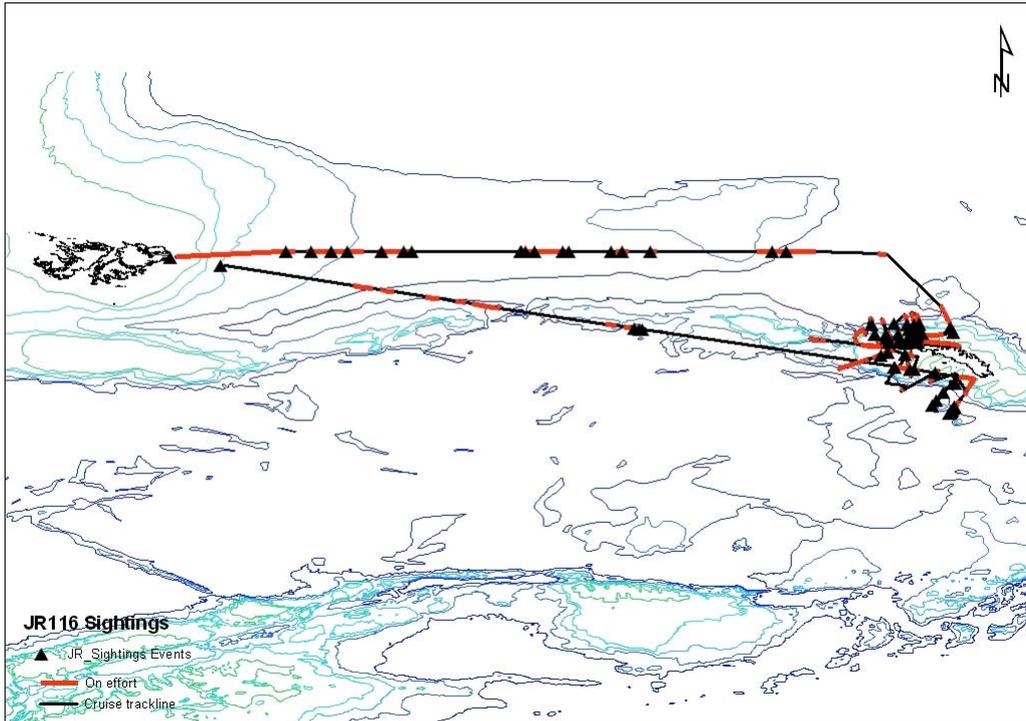


Figure 1. Cruise trackline and marine mammal sightings.

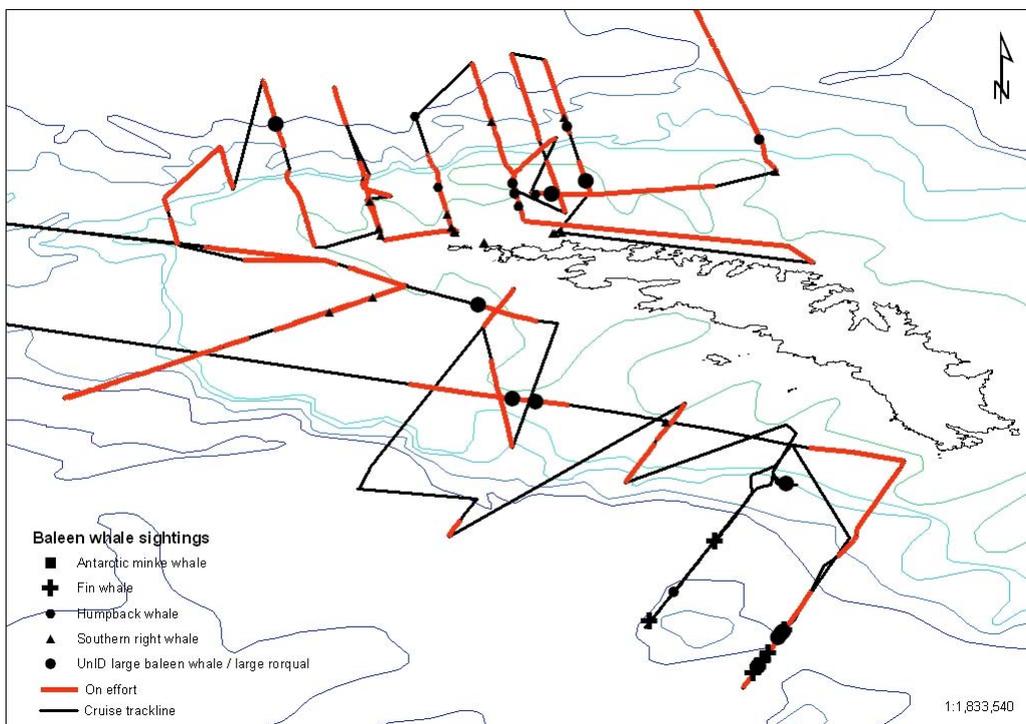


Figure 2. Baleen whale sightings and cruise trackline around South Georgia.

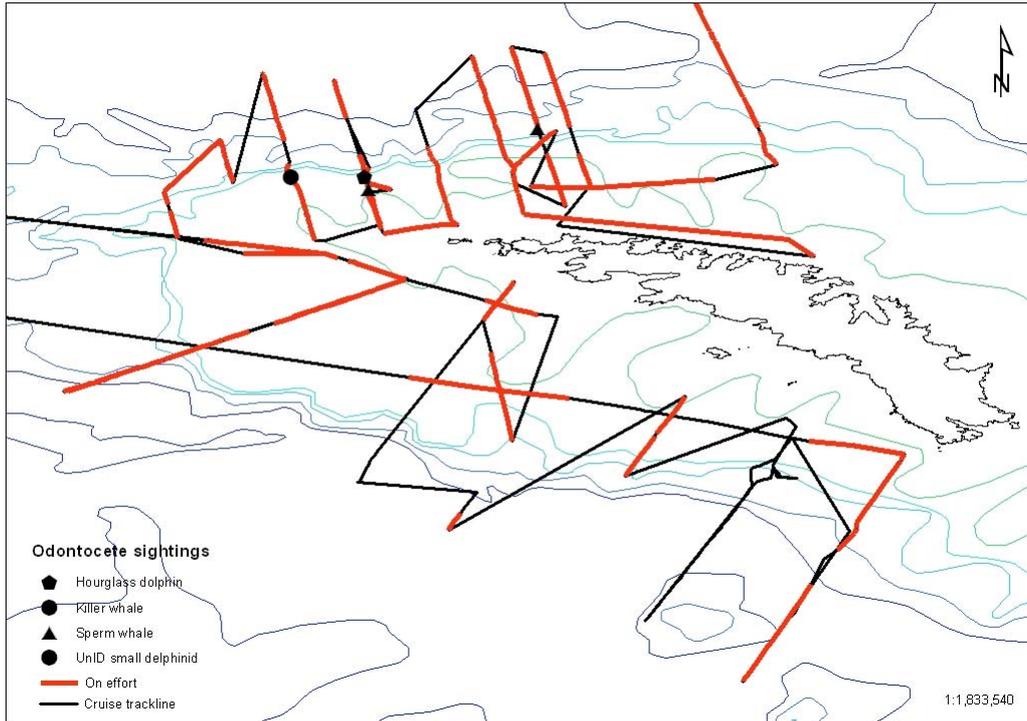


Figure 3. Odontocete sightings and cruise trackline around South Georgia.

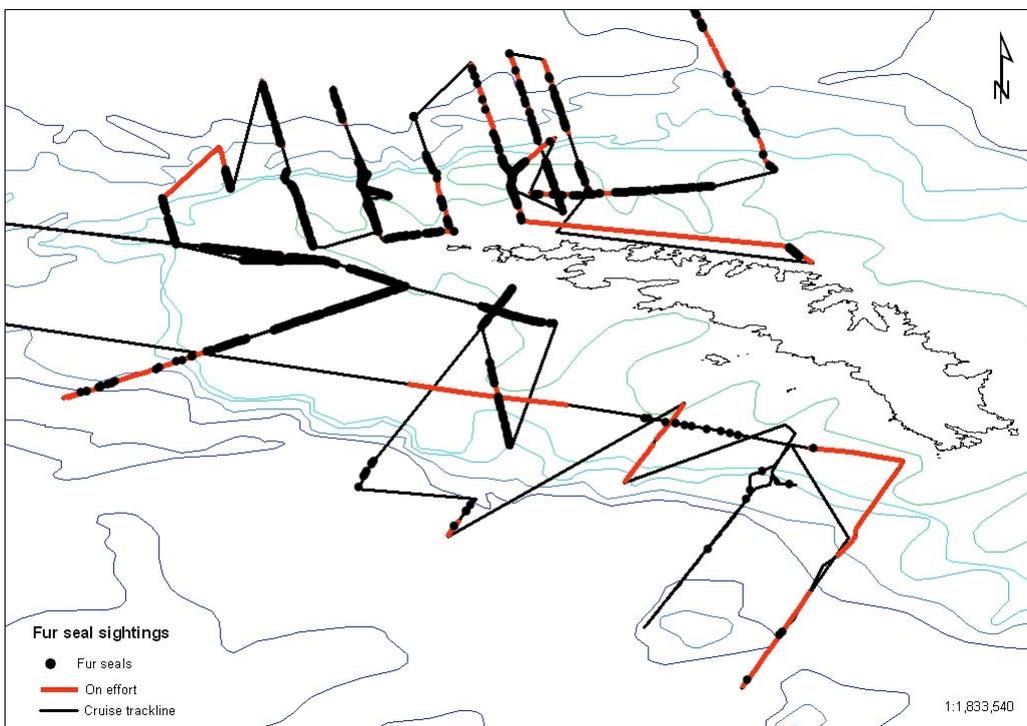


Figure 4. Fur seal sightings and cruise trackline around South Georgia.

# ETS cruise report for JR116

Mark Preston

There is very little to report as all systems worked well with few failures.

Below is a list of equipment and comments on operation

## **EK60**

No real problem here. The system still seems a little unstable. Occasionally the system will 'hang' and sometime the system fails to start, but these are uncommon occurrences and no data was lost as a result.

## **XBT system**

No problems with this system at all. Failed XBTs were caused by wind and waves bring the conducting wire into contact with the ship. Considering these factors is essential when deploying and if necessary the launcher needs to be moved to another position.

## **CTD sysem**

The system worked well for the most part although there are four points worth mentioning.

- a) On one cast the CTD appeared to stop communication with the deck unit. The software was restarted, communication re-established and the cast continued without further problems. No similar problems occurred during the rest of the cruise. I suspect that this was a software problem but without it appearing again it is difficult to go any further.
- b) It was noted part way through the cruise that the transmissometer was outputting a fixed value. The unit (CST-527DR) was replaced with the spare (CST-396DR) and work continued.
- c) The CTD software (seasave) sometimes (circa 50%) would take about 10 second to display the normal start-up set of graphs. Normally these are displayed pretty immediately. Because the software was working correctly in other respects it was prudent not to interfere. This situation needs investigating at a time when the CTD isn't going to be needed for some time in case other problems are un-earthed.
- d) An offset in salinity was noted between the primary and secondary conductivity. The primary conductivity is suspected to be in error. This need investigating and the primary needs changing for the spare.

## **Swath**

No problems with this system

## **ADCP**

No problems with this system

## **Oceanlogger**

No problems with this system

## **SSU**

This did crash a couple of times, but was quickly re-booted and recovered OK. It is noted though that the four button 'keypad' is terribly unreliable and regularly 'double enters' a direction command. This is frustrating and confusing and needs investigating.

Any other systems used on the cruise and not included in this list worked without problem.



# British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

## ITS Cruise Report

<b>Cruise ID</b>	<b>JR116</b>
<b>Principal Scientist</b>	<b>Peter Ward</b>
<b>ITS Support</b>	<b>JPRO</b>
<b>Date</b>	<b>22/12/2004 – 17/01/2005</b>

### Data Logging Systems

#### SCS

The SCS performed well throughout the trip; the machine is now several years old and is bulky and underpowered compared to modern machines; this season should be its last. If the JCR computer room refit goes ahead in summer 2005 with shared (e.g. SAN/iSCSI) storage installed, a couple of 1U HP servers should be bought to replace the machine and spare.

#### *SCS Event Log 1.3.Instruments*

<i>Date</i>	<i>Time (GMT)</i>	<i>Event</i>
<b>23/12/2004</b>	<b>14:23</b>	<b>SCS started at start of cruise</b>
<b>28/12/2004</b>	<b>15:55 – 16:00</b>	<b>Ashtec heading loss (until power-cycle)</b>
<b>03/01/2005</b>	<b>03:43 – 10:47</b>	<b>Ashtec heading loss (until power-cycle)</b>
<b>08/01/2005</b>	<b>12:06 – 15:41</b>	<b>Ashtec heading loss (until power-cycle)</b>
<b>09/01/2005</b>	<b>11:33 – 11:44</b>	<b>UPS in Nav locker failed, all Nav locker instrumentation not logged until UPS removed.</b>
<b>14/01/2005</b>	<b>18:08 – 20:34</b>	<b>Ashtec heading loss (until power-cycle)</b>
<b>17/01/2005</b>	<b>23:30:00</b>	<b>SCS shutdown at end of cruise</b>

#### *Ashtec ADU5 GPS*

The Ashtec would not log to the SCS at the start of the cruise; the SCS output from the Ashtec is set to 4800 baud, but the SCS configuration file was set to 9600. Once changed there were no problems logging the Ashtec.

As on previous cruises, the Ashtec stops outputting heading information, though position information is still output. A power cycle fixes the problem.

As can be seen from the SCS eventlog above the Ashtec heading loss has been reasonably regular, almost every 5 days.

### *Trimble GPS*

At the start of the cruise the Trimble GPS input to the Tardis software on the SCS machine was working; however nothing was being received by the SCS software.

ETS (Mark Preston) investigated and discovered a loose pin in the connector inside the bridge locker on the cable from the GPS patch panel on the bridge to the cable coming from the Serial to FC multiplexor in the Nav Locker.

ETS replaced the pin and the Trimble has logged successfully for the whole trip. At some point the cables / connectors should be rebuilt.

### *ADCP PC*

At the start of the trip the ADCP PC showed only a blank screen and wouldn't start. However after a couple of reboots the machine came up and has worked with no problems throughout the cruise.

### *Simrad EA600*

On 03/01/2005 the Simrad EA600 stopped outputting data to the SCS or the Microplot system for several hours before being noticed; the EA600 screen display was updating correctly. The mate shutdown & restarted the EA600 software and the serial output resumed.

### *Java Logging System*

As usual the Java logging programs worked very well throughout the cruise; though they are now of decreasing utility. There is now a gyro output that the SCS can log and the 'new\_stem' instrument currently doesn't work; any replacement will be designed to be logged by the SCS. A small modification was provided by Andy Barker to the Gyro Java program so enable it to cope with leap years. In the Gyro.java file the line tempjday = 365 was replaced with tempjday = 366 and the software recompiled with javac Gyro.java and restarted. This will need to be reverted before the end of 2005.

### *Perl Monitoring Programs*

A UOR Altitude warning program to display the height of the UOR above the seabed with a green / red / yellow background depending on a safe height, dangerous height (currently 30m or less) or warning of lack of data respectively was written in perl and installed on the SCS remote display PC in the UIC and the UOR control PC. A copy of the source code is with the Bioscience Data Manager.

This program uses mostly generic routines, including a library to read SCS files. Much of the code is shared with the Netmon Trawl Delay program (see below) and the Ashtec heading loss-warning program. New programs to monitor other SCS variables in ways the SCS cannot easily do can simply be written by modifying the code of these programs.

### *EM120 / Topas*

The EM120 was run whenever it did not conflict with the cruise science (e.g. the EK60) and worked well throughout.

The Topas was not used on the cruise.

### *EK60*

A Netmon trawl delay program was written for the EK60 in to assist with fishing trawls. The program was written in perl using the same libraries / structure as the UOR altitude warning

program, and displays the time / speed / cable out / delay of net behind the ship's position. This requires a drive mapped to \\JCR-NOAA-S1\SCSLog (typically R:).

It was installed on the EA600 machine, and was also installed on the EK60 Workstation 2 and modified to produce an Echoview line file in an attempt to automatically display the current position of the net. However the Echolog software won't automatically update a line file. The line file produced is still useful after the trawl to review the net's progress. The source code is with the Bioscience Data Manager.

### *1.8. Instrumentation Network*

With the introduction of CODIS (and even before; though it wasn't as much of an issue); there is a potential for viruses(/worms/trojans/etc) to infect PCs on board. Whilst normal desktop PCs can be secured with anti-virus programs and automatic update services; this is not always possible or desirable for PCs used as data loggers. It is also more common for scientific instruments (e.g. EA600, EK60, Scintillation Counter) to be Windows/PC based and networked; these too are at risk from virus infections.

Therefore, it is strongly recommended that a separate instrumentation network is setup in refit, with a very restrictive firewall between the main network and the instrumentation network. All data logging PC/PC based instruments should be connected to this network and hence protected.

To install such a network, only an extra switch in the computer office would be required, all logging PCs would be connected to this switch (through the existing patch cables), and then the firewall connected to this switch and the main LAN. Logging PCs on decks other than the Upper Deck would need to be patched through the backbone CAT5 cabling rather than Deck switches, but this is not a problem.

## **CODIS**

The CODIS link performed very well throughout the trip; with only minor outages (apparently mostly due to human mistakes in Aberdeen); the RO has details.

The link has made ITS work on board much easier as it is no longer necessary to bring large amounts of software (drivers / applications / etc) on the off chance they may be needed. Instead, any necessary drivers can be downloaded either from Cambridge or the Internet as and when needed.

In addition, there is sufficient outgoing bandwidth to transfer underway data (e.g. SCS / RVS data) back to Cambridge in (near) realtime during a cruise; this will be investigated on future cruises. At the end of this cruise the compressed RVS/SCS data was transferred back to Cambridge in under 24 hours and then setup on the Cambridge central storage ready for use.

## **Web Applications**

### *MediaWiki*

MediaWiki 1.3.9 was installed on JRUA and is accessible from <http://www.jcr.nerc-bas.ac.uk/wiki>

A wiki is a publicly modifiable website (through web based forms) with modification history and the ability to revert invalid modifications.

The JCR wiki was used to record general events throughout the cruise and to document ITS actions (e.g. the installation of packages, the rebuild of JRUI) and has proved to be a very useful tool in make it easy to create and keep up to date web based documentation.

### *Bridge Science Log / Event Log*

The Eventlog software (at <http://www.jcr.nerc-bas.ac.uk/eventlog/analyst>) was updated to include a Bridge Science Log for the Officer On Watch to update with events. This replaces the paper based Science Log and allows anybody on board (or in Cambridge via CODIS) to easily see the up to date event log / event numbers etc.

The Eventlog software was also updated to link each individual log to the Bridge Science Log for that cruise allowing easier log keeping and reducing the chances of event logs becoming out of sync with the Bridge log.

At the end of a cruise these logs can be downloaded and imported into Excel etc to become part of the cruise report.

## **Network Hardware**

### *UPSes*

On 02/01/2005 the UPS powering the network stack in the Gravity Meter room failed causing the tween deck's network to fail. The RO (Mike Gloistein) removed the UPS and plugged the network hardware directly into the ship's supply.

On 09/01/2005 the UPS powering the network stack in the Nav Locker failed; this not only stopped the bridge network working, but cause a 12 minute data loss for all the instruments connected through the nav locker.

(e.g. GPSes, Doppler Log, Electromagnetic Log). Fortunately the ship was on station at the time and so this was less serious than if the ship was underway.

In both these cases the UPS was approximately 4 years old and had not been tested or had batteries replaced. This was also the only time that power problems had affected the network. Therefore it is recommended that all network UPSes be removed from the ship's network stacks in the summer refit.

Since the ship's 240V AC supply is very clean and regular, there is only a need for UPSes where loss of power has the risk of hardware failing (e.g. servers) and the systems can be setup to shutdown safely. This is not the case for network switches where they are only useful if the machines on the network have power (e.g. when the ship's power is OK); in which case the switches will have power as well.

Whilst the ship's power is very reliable and generally outages imply a severe problem it may be the case with the introduction of VOIP phones that some network switches need power to

provide power to the phone system; if so the UPS batteries should be regularly serviced and replaced every 3 years.

## **Switches**

At the start of the cruise (22/12/2004) the network connections on the main deck were found to be very intermittent with some PCs unable to see the rest of the network or the servers. On investigation it looked likely that the 3300 switch in the Main Lab had failed. On a previous cruise there had been problems with this network stack and the RJ45 cables were moved from the 3300 switch to the 1100s.

However, since the 3300 switch has the FC interface to the ship's backbone, and also is connected to the 1100s via matrix cables, traffic still flows through the 3300 switch. This switch was replaced with the spare 3300 switch from the cage; the FC interface from the old switch had to be used as the spare had no FC interface. When the new 3300 switch was put in place network access reliability increased significantly.

The 2<sup>nd</sup> 1100 switch from the top still had problems; because there is only 1 spare 1100 the patch cables were moved to the 1<sup>st</sup> 1100 switch. The network on the main deck has performed without problems for the rest of the cruise.

## **Network / PCs**

### *PC*

The bridge Microplot PC was rebuilt twice during the trip, once on 23/12/2004 and once on 15/01/2005; the second time including a fresh Windows 2000 install.

The PC used for the Microplot system and the ship spares used are all several years old and lack memory, which is the main cause which necessitates rebuilds.

The RO has requested that this PC (at the moment part of the ship's kit) be placed in the IT indent and replaced every 3 years (starting summer 2005) as part of the normal upgrade process.

The PC is fairly standard, the only extra card being the MOXA Technologies Serial Card, which has easily installed drivers for NT/2000/XP from MOXA Technologies Website so would not be a burden for ITS to support and is an important part of ship operations.

### *EK60 Workstation 1*

With the EK60 this machine is no longer needed as part of the acoustics setup and so on 24/12/2004 was rebuilt with Windows 2000 to become a standard workstation for the EK60 operators. The graphics card was swapped for a spare ATI Rage to overcome a poor display. A spare ITS flatscreen monitor was loaned to the EK60 operators for use with this PC.

### *Surgery PC*

The Surgery PC was failing to always recognise both CDRW & DVD drives on every boot. After some investigation (including changing the drives/cables) configuring the CDRW as the IDE master and DVD drive as the IDE slave (the reverse of the original setup) appeared to fix the problem, using the original drives & cables.

## **Unix Systems**

### *JRUA*

On 26/12/2004 it was noticed the JRUA wasn't synchronizing its time to JCR-NOAA-S1 (which synchronizes to the Trimble GPS). There was an approximate 1 minute time difference. NTP was restarted and the machine resynched by 2253.

Small modifications were made to the JRUA software configuration and some packages upgraded, see the JCR wiki for details.

### *JRUI*

JRUI was running Solaris 8 and since it wasn't in use on the cruise was rebuilt with Solaris 9; details on are the JCR wiki.

# Data Management Cruise Report

Nathan Cunningham

Underway data was logged to the SCS. The following streams were logged.

## SCS Streams for JR116

Stream Name	Start Time	End Time
Anemometer	16:31 23/12/04	17/01/05 23:00
NGyro	16:31 23/12/04	17/01/05 23:00
Doppler Log	16:31 23/12/04	17/01/05 23:00
Emlog	16:31 23/12/04	17/01/05 23:00
GPS-ADU	16:31 23/12/04	17/01/05 23:00
Glonass	16:31 23/12/04	17/01/05 23:00
Net-Monitor	16:31 23/12/04	17/01/05 23:00
OceanLogger	16:31 23/12/04	17/01/05 23:00
Seatex	16:31 23/12/04	17/01/05 23:00
Simrad-ea500	16:31 23/12/04	17/01/05 23:00
Simrad-em120	16:31 23/12/04	17/01/05 23:00
TSSHHP	16:31 23/12/04	17/01/05 23:00
Trimble	16:31 23/12/04	17/01/05 23:00
Truewind-spd	16:31 23/12/04	17/01/05 23:00
Winch	16:31 23/12/04	17/01/05 23:00
gyro	16:31 23/12/04	17/01/05 23:00
minipack	16:31 23/12/04	17/01/05 23:00
minipack-real	16:31 23/12/04	17/01/05 23:00
new_stcm	16:31 23/12/04	17/01/05 23:00
pmlbox	-- No Data --	-- No Data --

The EK60 was logged to the Unix machine. The Gyro and the STCM are logged using Andy Barkers' Java Data Logging system.

Any breaks in the streams were logged and documented by ITS. The SCS performed well and the data has been collected and backed up to return to Cambridge.

Jeremy Robst has provided web services for directly accessing the SCS files. Below is a brief project description for the web based JCR Data Logging Interface and JCR Log sheets

### ***The functionality of the RVS listit command***

It would be useful to be able to select a time period from which a data stream can be selected, displayed and a CSV text file produced. The main reason for this is to enable the user to easily generate local data sets of transects, station events etc. Ideally, the ability to request data from

any of the streams would offer the greatest flexibility to the user, but this is not a critical function.

#### ***Graphing tool***

Graph any data stream(s) from a user defined period (or current time).

#### ***Template Tool***

Setting up user-defined templates for the Data Logging, the Log sheets and the Graphing tools. This would allow the user to select any data streams and variables and save this selection to a reusable template, for example met data from the ocean logger and the anemometer and call this data set Meteorology Data. The same would work for event logs.

#### ***Amend and Delete to JCR Log Sheets***

This would allow to the log sheet creator to have administrator rights and could amend the sheet (column order, add a column, delete a column) and delete or amend records. Any user generating a new instance of the event would be allowed to amend and delete their records, but not the entire sheet or other user records.

#### ***Amend and Delete functionality to other tools***

As outlined above, based on administrator and user read, write execute privileges. The main use would be for user editing when creating a template.

#### ***Save screen output as an csv file***

This would produce an image file from the current output of SCS Interface tool being used. This would be especially useful for the graph tool to quickly analyse interesting events.

## **Hubris (Web based data logging system)**

This is a web based data management system for scientific data.

#### ***Keywords and Phrases***

Use non-propriety formats for the data and metadata delivery and storage.

Open source.

Scalable.

Limited redundancy of data sets.

On the fly approach to generating 'Scientific data object'

#### ***Design Features***

Data needs to be available over the web allowing the scientists to build their own scientific data set. The scientific data set is a combination of experimental data (e.g. the scientist on field data) and extra statistical data (e.g. underway data ).

The 'science data object' is will contain information to place reference what it is a digital abstraction of. These objects will have inheritance, forward and backward references and metadata. The basic information will be something like spatial, temporal, assumptions {universal, simplifying, statistical}.

The barriers to entry to HUBRIS should be low and not inhibit the scientist from developing scientific data objects. It needs to be implicit that these objects are digital representations based on a set of defined assumption (inherent in the properties of a scientific data object), and exploring deferent assumptions (mainly the statistical) new objects can be generated.

The tools required to mathematically express the objects will be available as web services – e.g. scripts, algorithms. These will generate new objects with their assumptions of reality updated (again I am thinking about the statistical assumptions).

Hubris will be designed to follow the Error-Statistical Scientific Process.

### *Feature List*

Approximate decreasing importance

Cruise data streams access - old cruises + current cruise.

Combination variable download by time.

start / end / interval time selector.

start / end / interval transect time select.

CSV times list.

Combination variable download by position

Implement templates.

Variable graph + cruise track.

New streams created as function of old streams.

Link into the event log to generate new object.

Auto fill functions with most likely user input (e.g. event number, date, user details).

Download option screens along the lines of MS Excel - choose separator, common file formats,

XYZ n.....nnn column sorter.

Tool to make other data HUBRIS compliant (sql, excel, arc gis etc).

Tool for implementing new functions.

Metadata generator and DMS uploader.

### *Summary*

It is hoped the user community will use these tools as the primary way of accessing the underway data and generate their own data set for visualisation (which in the bioscience community is predominantly in MS Excel). Along with the move to Matlab from Pstar, the old RVS system etc can gradually be phased out as it is becoming dated and the skill base in the user community is very low or non-existent.

Future work will include heuristic cleaning the scs streams, matlab processing suite and arc marine geodatamodel.

# Gear Report

Doug Bone, Peter Enderlin, Nathan Cunningham

## Down Wire Net Monitor

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 earthling 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 nets.

## RMT System.

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.

## UOR

This season we have again been using a new Chelsea Technologies Group (CTG) NuShuttle vehicle, (Serial No 029). This is fitted with, Minipack CTD, 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. The UOR has performed well and appears to be quite stable. There are problems with the PAR sensor , this will be followed up with Chelsea upon returning to Cambridge.

Operating the shuttle requires two PCs, one to 'fly' the vehicle, the other to control the instrumentation and logging of data. The MINIPACK software is flaky , 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; and could take up to ten times to establish comms, and would drop comms every now and then. Comms was always re-established and there was no need to recover the vehicle.

*NSHUTTLE, preferred setup. (e-mail to Chelsea)*

Possible changes to our Nushuttle setup that we have discussed in the passed year.

As I am sure you are aware, the main aim of the changes that we want to make to the way in which our NuShuttle is operated is to increase the reliability. In particular we want to eliminate the big Amplicon card with its 8 serial port breakout box. We see this piece of hardware as very vulnerable to damage and a liability.

We have looked at the diagrams in the Report that Andy Rawkins did back in July (2012-002-RP) and feel that we can simplify the situation even further. Our ideas are set out in the diagram below.

We have found that we can operate the minipack successfully without the 'minipack' PC at all, sending the data directly to our Shipboard Computer System (SCS) where it is time stamped and converted to real units using the calibration certificates and equations. We consider this to be the most robust way of ensuring that we log the correct data. Graphical displays can easily be generated from the data after this stage.

What we need in order to simplify the flight control setup is a modification of the flight control software (or something completely new) that will do what NSHUTTLE does at present in terms of sending flight parameter data to the servo, producing graphics of the flight trajectory and logging the flight data, but communicating directly through serial ports built into the PC, only 2 of which would now be required.

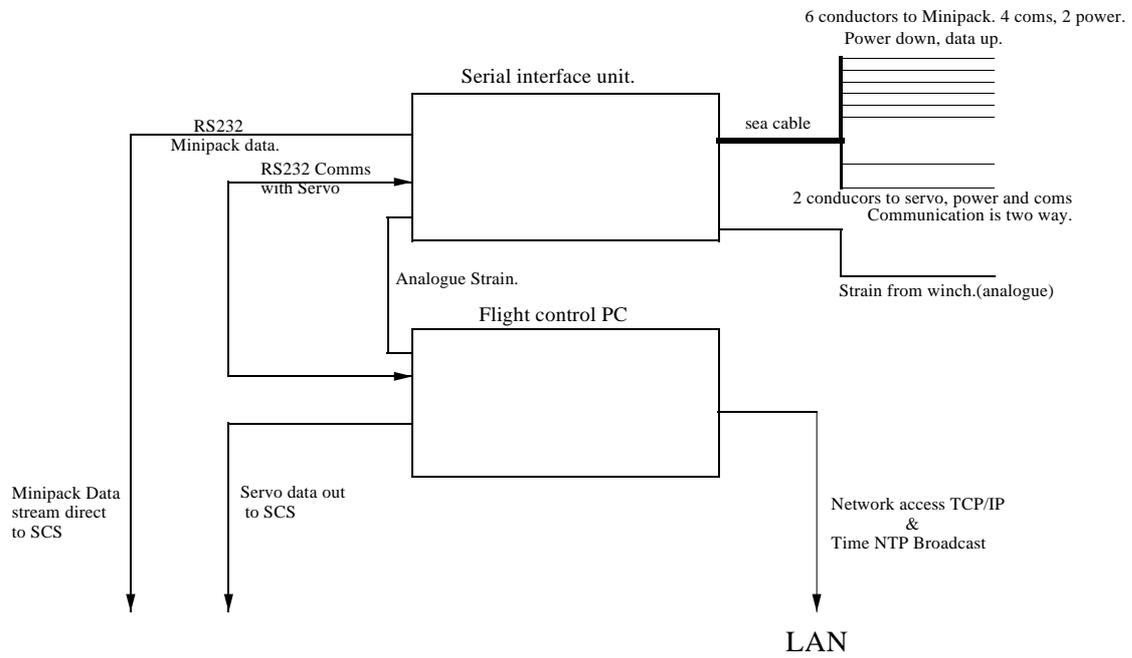
If possible we would also like to include logging of the information that can only be accessed at present by looking at the (ALT S) \$, #, !, ? pages in order to make diagnosing possible future flight control problems easier.

When we discussed this some time ago you indicated that it would not be economic for either CTG or ourselves for you to do the re-programming, but that you would be willing to give us the information necessary for the work to be carried out at BAS. Is my understanding of this correct? My aim at the moment is simply to mark out the playing field and establish the goalposts so that we can go to the appropriate people in BAS with a mature proposal/work request.

Please see diagram below.

Doug Bone, Nathan Cunningham  
05.01.05

Future situation.



*Schematic of new UOR system*

## Scientific Staff

Boehme L		Physical Oceanographer
Bone D		Gear Technology
Carrie I		Optics
Cunningham N		Data Manager
Enderlin		Gear Technology
Gordon M		Phytoplankton & Nutrients
Goss C		Acoustics
Handcock L		Doctor
Hirst A		Zooplankton
Johnson M		Krill Physiologist
Korb B		Phytoplankton Production
Morley S		Phytoplankton
North A		Zooplankton
Pond D		Biochemist
Possi-Walker Z		Physical Oceanographer
Preston M		ETS
Robst J		ITS
Salmon D		Whale Observer
Shreeve R		Zooplankton
Swift R		Whale Observer
Tarling G		Zooplankton
Thorpe S		Physical Oceanographer
Ward P	PSO	Zooplankton
Whitehouse M		Nutrient Chemist

## Ships Crew

Mackaskill A	MG1
Burgan MJS	Captain
Liddell A	1 <sup>st</sup> /Off
King D	2 <sup>nd</sup> /Off
Cox J	3 <sup>rd</sup> /Off
Summers J	Deck Off
Walder A	Cadet
Smith B	MG1
Wright W	Cadet
Glostein M	R/O
Anderson D	Ch Eng
Smith C	2 <sup>nd</sup> /Eng
Robson N	3 <sup>rd</sup> /Eng
Balfe T	4 <sup>th</sup> /Eng
Raper I	SG1
Trevett D	Deck Eng
Rowe A	Elec
Turner R	Purser
Lang C	Bosun
Peck D	Bosun's Mate
Bowen A	SG1
Mullane C	SG1
Dale G	SG1
Holmes K	SG1
Hyslop W	Ch/Cook
Hockley S	2 <sup>nd</sup> /Cook
Jones L	Snr Steward
Greenwood L	Steward
Raworth G	Steward
Weirs M	Steward

# **Acknowledgements**

Peter Ward

We are indebted to Captain Jerry Burgan and his team for their sterling support in keeping the cruise on track, despite the overall loss of a week occasioned by the disruption to the ships schedule caused by ice at Rothera. In the end, we were blessed with benign weather and managed to sample pretty much all of the stations we originally planned and thus complete what was a fitting end to our Q3 fieldwork.

We gratefully acknowledge the efforts of BAS Logistics and Operations in getting us into the field.