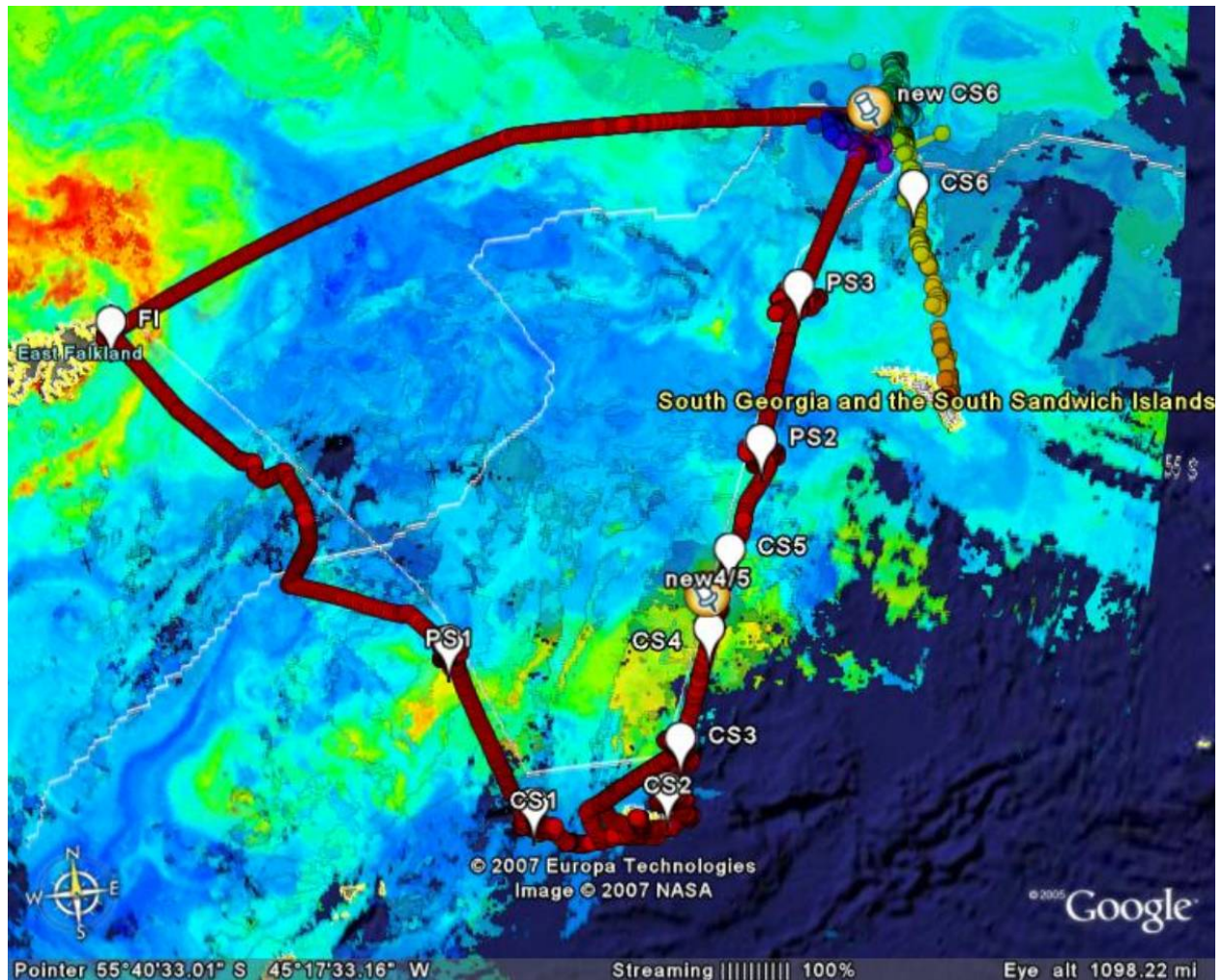


# Discovery 2010 Spring Cruise



JR 161

October 24<sup>th</sup> - December 3<sup>rd</sup> 2006

A study of pelagic marine food web interactions  
and condition factors of zooplankton across the  
Scotia Sea



**British  
Antarctic Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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## **Discovery 2010 Spring cruise**

**JR 161: October 24<sup>th</sup> – December 3<sup>rd</sup>**

### **A study of pelagic marine food web interactions and condition factors of zooplankton across the Scotia Sea.**

***Rachael Shreeve PSO***

#### ***Background***

Three cruises, to be conducted in austral spring, summer and autumn, are planned as part of the Discovery 2010 programme. The remit of this programme is to investigate and describe the responses of the Southern Ocean ecosystem to climate variability, change and commercial exploitation. ‘Discovery 2010’ builds on the previous BAS programme DYNAMOE, a key finding of which was that highest primary production occurs down stream of South Georgia, almost certainly as a result of enhanced iron concentrations. It has also been demonstrated that this enhanced production has strong links to the mesozooplankton abundance and condition. During the next three field seasons we wish to investigate regions that contrast within this system, to enable us to understand the mechanisms that control productivity and how these affect the food web as a whole. Recent research has show that the idea of a simple foodweb dominated by krill is rather simplistic, and that other zooplankton groups do play an important role in secondary production. Their importance in the food web however, has yet to be fully quantified. The aim of this first cruise was therefore to broaden our understanding of carbon flux through different trophic pathways during austral spring, in contrasting regions.

For more information about the science planned during Discovery 2010 please see ‘Discovery 2010 programme statement’ (appendix 2).

#### ***Cruise Design***

During the planning of this series of cruises we chose to occupy fewer stations than on previous surveys, but to study those we do in more detail. We spent up to 4 days at a location in order to fully characterise it and its associated variability. Sampling was planned to take place at nine stations in total. Three of which were to be occupied for 4 consecutive days (our main process stations) and six other for two days each (condensed stations).

The locations of the three main process stations were chosen on the basis of their contrasting primary productivity regimes. The first was located in an area that has historically been described as a typical High Nutrient Low Chlorophyll environment, in waters lying between the Polar Front and SACCF, in the western region of the Scotia Sea. The second station was placed in an area upstream of the Island of South Georgia that normally displays low productivity and the third was situated down stream of South Georgia, where the influence of the island creates areas of high productivity. At each location observations were made on ocean physics, micro and macronutrients, phytoplankton, zooplankton and higher predators. Repeat

measurements on three consecutive days were made of the physical characteristics, nutrient and phytoplankton composition. Primary productivity incubation experiments were set up, and phytoplankton response to iron enrichment monitored. The iron limitation work was conducted in collaboration with students from NOC, and relied on equipment hired from UKORS (NMF Sea Systems).

Zooplankton were collected using a variety of nets that gave depth resolution of different size classes of plankton. The LHPR was deployed routinely to 1000 m to profile the water column with a high degree of resolution, mainly capturing the smaller zooplankton size classes, mainly copepods. The MOCNESS, and later in the cruise the Multinet which was used when the MOCNESS failed, were deployed to 1000m and nets fished in 125m intervals to capture copepods for CHN analysis, and to provide pteropods for studies of the condition on their shells. The RMT 25 net was used throughout to sample fish, krill and larger zooplankton. Finally the bongo net was used to collect live copepods in the top 400m for experimental purposes, principally *Oithona sp.* grazing and to describe community composition.

Mesoscale acoustic surveys were undertaken at each station and higher predator observations were routinely taken in daylight both whilst underway and at stations.

At the condensed stations a similar range of equipment was deployed, the main difference being that over two days there was less repetition. The condensed stations were aimed mainly at looking at the differences in community composition and body condition of copepods across a latitudinal range, from the ice edge to the Polar Front.

## Cruise outline

The transect and station positions are given in Fig. Proposed Cruise Track. The first transect ran from the Falkland Islands to the ice edge near to Signy Island (South Orkneys). On the first part of this transect we ran the Continuous Plankton Recorder (CPR). This was recovered once we reached the position of the first main process station. This was sited in an area that was generally thought to be of a very High Nutrient and Low Chlorophyll regime. Having successfully sampled this station we moved off to our first Condensed station site. The position of this had to be changed slightly due to the original site being in uncharted waters, we also moved further south to be as close to the ice edge as possible. One of the logistics requirements of the cruise was to undertake the opening of the summer only base at Signy during the first third of the cruise. Signy relief was not possible at this time due to sea ice conditions which were too thin to allow a sea ice relief and too thick to allow the deployment of boats. Given that we had other stations in the area and also 12 hours of AFI fishing to do (AFI Rock/Carvalo) we moved off to sample these before heading back to Signy.

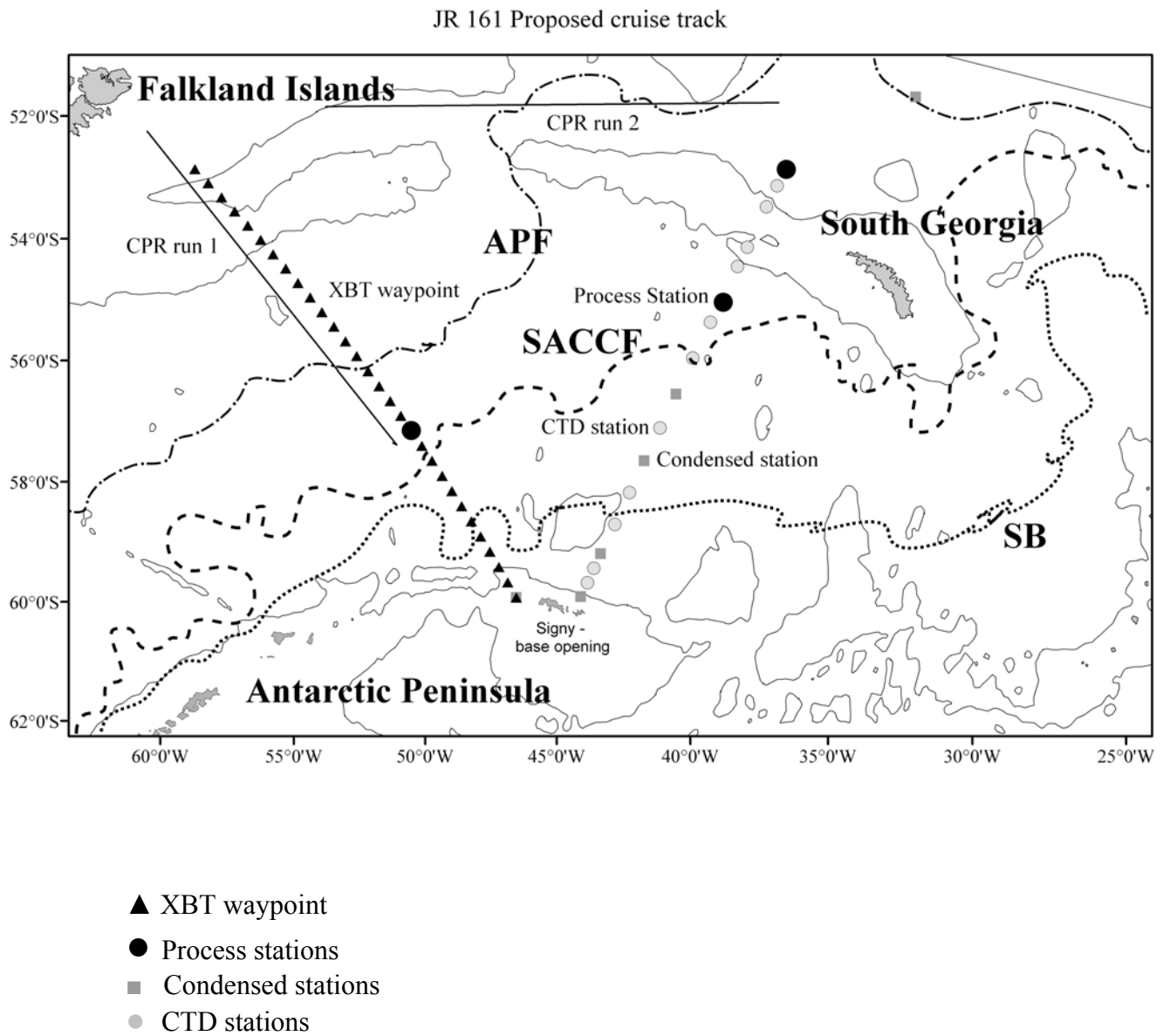
Eventually we managed to get all cargo ashore at Signy, but at a loss of 3.5 science days, which meant we lost 4 CTD stations, one full condensed station and had to reduce the sampling at another. We then moved off to sample the other stations along our main transect which ran from Signy towards the Polar Front to the North of South Georgia, under the path of a satellite altimeter track. Stations along this transect were between 40 and 180 nm apart. The location of the final condensed station was dictated by the position of satellite tagged king penguins out on a foraging trip from South Georgia earlier in November.

We were due to deploy 2 moorings with sediment traps, one in the unproductive waters upstream of South Georgia (PS2) and one downstream in the highly productive region (PS3). In the end we were only able to deploy 1 of these due to equipment not arriving in time. We deployed the sediment trap in the productive site (PS3) and have an agreement to deploy the other trap later in the season.

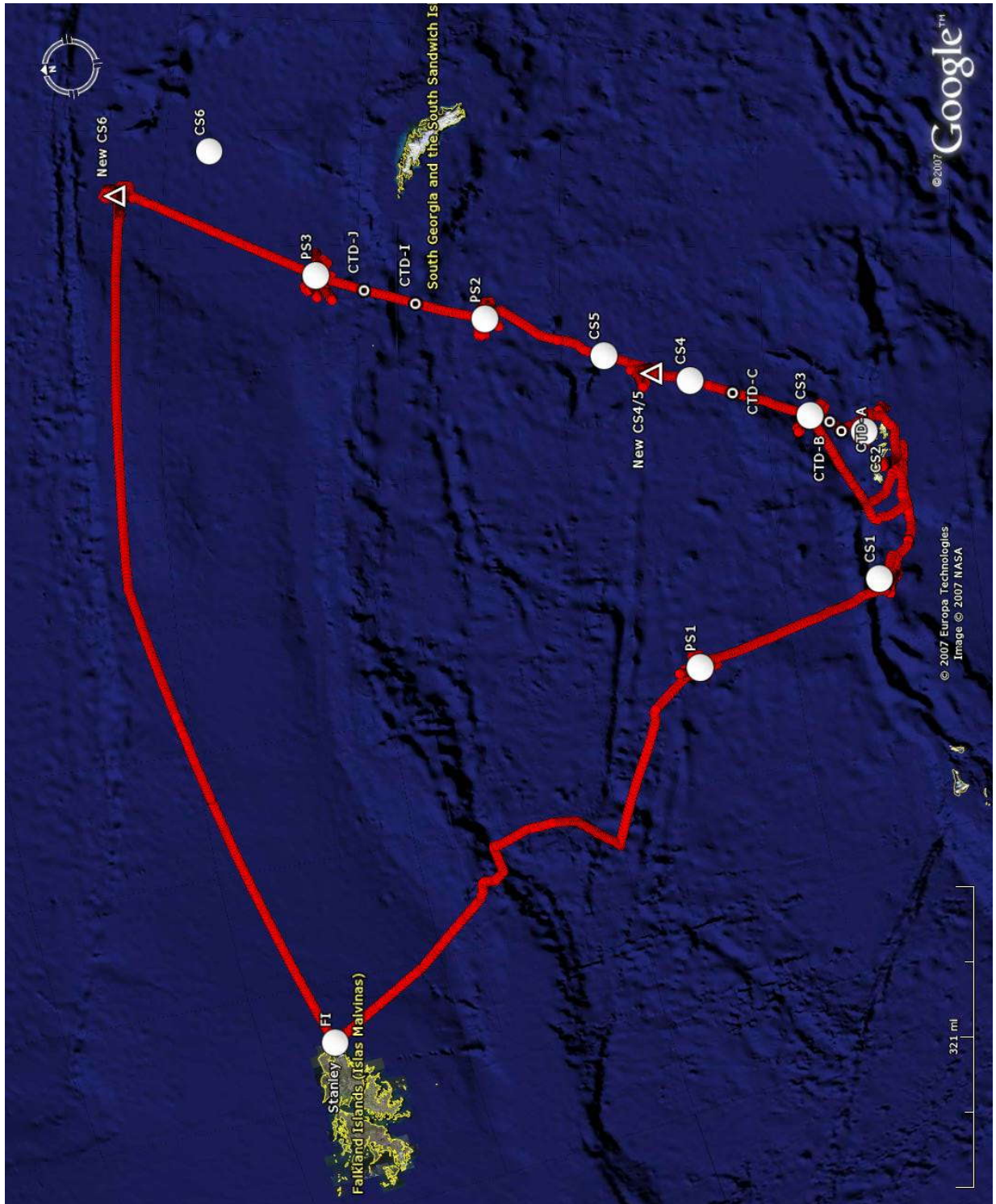
The CPR was deployed once again on the transect running from the final condensed station back towards Stanley, crossing over the Maurice Ewing Bank en route.

ADCP, SWATH and Acoustics. These three activities were not compatible on this cruise. There was interference that caused bad acoustic data whenever the ADCP or SWATH were turned on, equally the ADCP data was compromised when the SWATH was turned on. A decision was made to prioritise the Acoustic data along most of the transects. SWATH was only turned on when we were looking for a site in which to deploy the sediment trap mooring. ADCP data was collected on the way back to Stanley as this was needed in order to calibrate the oceanography data.

# Figure: Proposed Cruise Track



# Actual Cruise Track



## **Cruise Narrative**

### ***PSO Diary***

19/10/2006 21:55

Thursday 19<sup>th</sup> October. All science party fly from Brize Norton to Falkland Islands. Arrived to a windy, cloudy FI, but on time. Moved onboard JCR straight away with a welcome from many familiar faces and a few new ones.

20/10/2006 21:57

Friday 20<sup>th</sup> October. 08:00 hrs started mobilisation of cruise JR 161. Unpacked containers and now most of equipment for the cruise is onboard and distributed around the labs. There are some issues with equipment not being delivered by UKORS that we are looking into. Assembling of all nets systems has begun.

21/10/2006 22:01

Saturday 21<sup>st</sup> October. 08:00 hrs continued mobilisation. There have been problems finding all chemicals for the cruise, some of which have been packed in large crates too big for the chemical lockers onboard and different hazard classes mixed together. All chemicals were found by the end of the day. We are experiencing a number of problems with the equipment from UKORS. Firstly we cannot locate the lowered ADCP that we were expecting. In addition there are no bottles or release mechanisms for the 24 CTD frame either. Finally the clean chemistry container laboratory is not suitable for use on deck. There are large gaps in the doors which have leaked on the way down causing some internal damage, we are looking into how we can make this seaworthy for our cruise.

22/10/2006 22:10

Sunday 22<sup>nd</sup> October. 08:00 hrs continued mobilisation. 13:00 hrs safety brief from shipside followed by brief introduction for all science party on the running of the cruise and ship.

23/10/2006 22:11

Monday 23<sup>rd</sup> October. LADCP arrived unexpectedly from UKORS. Assembly of 24 CTD frame with the LADCP and 12 BAS water bottles started.

24/10/2006 22:13

Tuesday 24<sup>th</sup> October. Shore leave expired at 13:30 followed by general emergency drill for all scientists. Sailed from FIPAS at 16:00. Tried the CTD 12 bottles on the 24 bottle frame, all working OK. Got underway and deployed the magnetometer and CPR. Bit of a swell.

25/10/2006 22:14

Wednesday 25<sup>th</sup> October. Started XBT's in the early hours. Most failed to deploy properly. XBTs are type T5, for which we need to deploy at a ship speed of 5 knots. This alone would slow us down, but in addition the swell is against us we are also changing course for their deployment. We will no longer slow down for their deployment as we are losing 20 mins every 2 hrs for them. Currently there is a large swell against us with winds around force 7. There have been 2 false fire alarms in the



UKORS clean chemistry container. The current system has been replaced by JCR engineers and is now working properly.

26/10/2006 22:26

Thursday 26<sup>th</sup>. Bad weather has impeded our progress and we have diverted off course to allow a more comfortable passage to the first process station. This has allowed the repair of the mid ships gantry and the marking and loading of wire for the bongo net. We bought in the magnetometer, which allowed us to turn whilst still towing the CPR. PM, we started making our way back towards our transect line. Once we rejoined the cruise track we brought in the CPR, and continued on our way to process station 1. Around 22:00 we arrived at first station, the sea swell had gone down as had the wind, so we began the station fishing with the MOCNESS system. We lost contact with this at 300m and the haul was aborted, however this was a minor cable problem that was easily rectified once it was back on deck.

27/10/2006 13:00

Friday 27<sup>th</sup>. Station activities continued as planned, weather much abated. CTD water bottles put on in reverse order, but now rectified. Some minor changes made to the running order of equipment deployment to make a more efficient use of time. A lot more production was found at this station than expect for an area believed to be of a high nutrient low chlorophyll profile. There has been a failure of the RMT 25 release mechanism for which we have no spares or up to date documentation. This has now been resolved using the spare RMT 8 mechanism, however this remains a major cause of concern, as without this we can't undertake the science we have planned. This should be addressed promptly when we return to Cambridge.

28/10/2006 13:01

Saturday 28<sup>th</sup>. Started off rather badly with the LHPR not spooling gauze on correctly, this again is a result of an old net monitoring system for which we have few spare parts and little documentation. Thorough review of this system is urgently needed. We lost communications with the CTD whilst it was at 3000m. The fault was traced to the deck unit that had blown both fuses. At present we do not know why this happened and we are now using the only spare deck unit we have onboard. MOCNESS and RMT 25 currently working OK. Bongo, go flo and FRRF also working OK at present, although the UKORS winch for the go flo bottles is leaking hydraulic oil.

29/10/2006 20:01

Sunday 29<sup>th</sup>. Third day of Process Station 1. Work continued according to the station plan. LHPR worked OK on the daytime deployment and the failed night time deployment was repeated. The Bongo frame came loose from its lashing and fell to the deck. This caused some damage to the frame but no one was hurt, however this is a major safety concern.

30/10/2006 22:53,

Monday 30<sup>th</sup> October. RMT 25 fishing continued, little was caught in the upper layers during daylight. Acoustic survey undertaken in a box pattern around the waypoint. More water was collected via Go flo and tow fish for the Iron limitation work because there seems to be some contamination of the water. The failed MOCNESS night time haul was repeated.

31/10/2006 22:53

Tuesday 31<sup>st</sup> October. On passage to the first condensed station that will be at the ice edge to the west of Signy. XBTs have worked much better without the Magnetometer out, although are still not giving full depth profiles at 12 knots, reduced to 8 knots for one XBT and got a good deep profile. After breakfast had a safety brief for the opening of Signy, and after lunch a brief science meeting. Nathan gave an overview of using the L drive to archive all data for the cruise, and also the polar view google earth project which maps ice cover, JCR track and a few other links. Summary of station so far, high nutrients and low primary productivity and chlorophyll as was expected, the water column being well mixed. Zooplankton higher in the water column than may have been expected and some species showing signs of reproduction, full ovaries and some nauplii stages present. Myctophid layer showing most of the time but no krill swarms in the area. There is a 0.6 degree change in temperature, from - 0.2 to + 0.4 oC as we go backwards and forwards fishing, which may be due to an eddy of sorts; the myctophids are only found in the colder water. Myctophids had little in their guts and showed a high level of net avoidance in daylight in the shallow nets. Arrived at Condensed station 1 at 17:45, the location of this station has been moved to a. avoid uncharted waters and b. to get nearer to the ice edge. Started the station activities with an RMT haul.

01/11/2006 11:51

Wednesday 1<sup>st</sup> November. MOCNESS computer failed but a replacement has been put together and the system is now up and running again. Sea is being very kind to us and we have been able to deploy all instruments today.

02/11/2006 11:50

Thursday 2<sup>nd</sup> November. All net sampling went according to plan and we had 2 extra hours for Acoustic survey. Summary for the first condensed station; good contrast with first process station in that much of the zooplankton was still at depth still displaying overwinter characteristics. A few krill marks have been seen acoustically, too small and infrequent to target fish, but a shallow trawl did catch a few hundred krill, a mixture between small juveniles and larger adults. The station was completed at 17:00 and we made our way towards Signy. Hit ice towards dark and we heaved to awaiting daylight. A quiz in the bar in the evening was enjoyed by all.

03/11/2006 10:58

Friday 3<sup>rd</sup> November. Pushed through ice all day towards Signy, arrived late afternoon. The fast ice covers the whole of Borge Bay from the east, running right in to the Base. It was too late to begin assessing the pack ice, this will happen first thing tomorrow.

04/11/2006 19:03

Saturday 4<sup>th</sup>. November. Sea ice was tested by Matt Jobson and Dave Routledge and found to be too thin to support a sea ice relief. As the ice is also too thick to allow the deployment of boats, we have elected to move out to the west and do the AFI 6/16, JR 152, fishing for fish larvae, followed by condensed station 2, CTD station A & B and Condensed station 3, before reassessing the situation. Spent 10 hours fishing for fish larvae with the RMT 25 and Neuston net. Caught only 6 fish larvae of the species required, also numerous krill. Moved off towards Condensed station 2.

05/11/2006 11:09

Sunday 5<sup>th</sup>. November. Undertook day one of the second condensed station, starting with deep CTD cast. Ice hindered fishing to some extent and hauls had to be undertaken in a restricted manner or cut short.

06/11/2006 11:50

Monday 6<sup>th</sup>. Continued with condensed station 2. Ice has restricted what fishing can be done, but we now have at least one profile of each net type. The phytoplankton is very healthy around here, but there is not a great concentration of chlorophyll, whilst krill seem to be feeding well and there are lots of faecal pellets in the water. There were some nice patterns between krill acoustic targets and birds diving for food, observed whilst running the acoustic transect.

07/11/2006 19:05

Tuesday 7<sup>th</sup>. Moved off to Condensed station 3. Started activities with RMT target fishing at around 18:00. RMT mechanism not working properly – this has now been resolved.

08/11/2006 19:05

Wednesday 8<sup>th</sup>. Continued with activities on CS3.

09/11/2006 19:06

Thursday 9<sup>th</sup>. Continued with final day of condensed station 3, finishing with acoustic survey. Made our way back towards Signy 18:00.

10/11/2006 19:06

Friday 10<sup>th</sup>. Off Signy. Conditions suitable to run Humbers but not cargo tender, into landing point near hut. Put Signy personnel ashore and ran some essential cargo ashore that could be hand carried across the hill and down to the base. Signy personnel returned to ship late afternoon to stay the night on the ship. Remained offshore all night.

11/11/2006 19:07

Saturday 11<sup>th</sup>. Conditions suitable to run Humbers with essential and light weight cargo. Cargo runs continued all day, and now most of the cargo that can be hand carried over the hill has been done. The sun came out around lunchtime and gave us one of the best days we could expect at Signy.

12/11/2006 19:07, Sunday 12<sup>th</sup>. Weather conditions deteriorated, winds high although ice is starting to break out form around the island. Remained in the vicinity all day.

13/11/2006 20:10, Monday 13<sup>th</sup>. November. Weather conditions again unsuitable for cargo relief to Signy. Remained in vicinity all day.

14/11/2006 20:12

Tuesday 14<sup>th</sup>. November. Weather conditions suitable to run the cargo tender. We shipped all cargo to the base, finishing around 18:30. After making the ship ready for sea we departed to continue with the science.

15/11/2006 20:17

Wednesday 15<sup>th</sup>. November. Having lost 3.5 days to Signy relief we have steamed back to the track from where we broke off on the 9th. We will have to cut 4 CTD stations and most of condensed station 4 and possibly all condensed station 5 in order to preserve Process stations 2 & 3 and condensed station 6. We should arrive at the first CTD station at 19:00 this evening. We will continue to CTD station E where we will also undertake condensed station 4.

16/11/2006 14:14

Thursday 16<sup>th</sup>. Deployed XBTs on way to CTD station E. Started Condensed station 4 at around 08:00 with a bongo net. Followed by rest of station activities.

17/11/2006 14:14

Friday 17<sup>th</sup>. Condensed station 4 – There was a huge quantity of phytoplankton at this station, Centric diatoms, *Thalassiotrix antarctica* and *Nitzschia fragilariopsi*. Stage CV *Calanoides acutus* dominated the upper layers with very few males or females compared to previous stations at any depth. Krill were in the area and their faecal pellets were of various colours and consistencies. Fin whales were also observed in the area.

18/11/2006 14:14

Saturday 18<sup>th</sup>. Finished CS 4 and moved off to CTD station F. Conditions were too bad to deploy the CTD here, so we deployed XBTs and moved off to Process station 2. This station started with a Deep CTD at around 03:30 ship time. Activities continued, communication with the LHPR was poor, especially upon recovery. The MOCNESS was deployed in the night and a similar failure happened during hauling. A krill swarm was targeted in the late evening with the RMT 25 that yielded a 150kg haul of *E. superba*. This ripped the net and needs repairing before we can re-deploy.

19/11/2006 11:34

Sunday 19<sup>th</sup>. One of the Bottles on the CTD has cracked and has been replaced. The RMT 25 net is repaired. Peter is looking into the termination of the Biowire as a source of the problem with both the LHPR and MOCNESS.

20/11/2006 11:34

Monday 20<sup>th</sup>. The linking ring on the biowire has been replaced and LHPR is working OK on deck now. The MOCNESS has stopped all communications. There is nothing obvious at fault and without wiring diagrams and spares it is almost impossible to rectify at sea. The Multinet has been made ready for deployment, and we will use this to characterise the water column at 5 depths (1000 – 700, 700 – 500, 500 – 400, 400 – 200m, 200 – 125 and the top 125 will be sampled with the bongo net.

21/11/2006 11:35

Tuesday 21<sup>st</sup>. Both Down Wire Net Monitors (DWNM) appear to have minor faults. These are being repaired as best we can but these units are living on borrowed time. They are very flaky and we are losing time with having to repeat hauls, some of these repeated hauls are still not working. The Multinet and RMT are working OK with the DWNM's but the communication with the LHPR is intermittent. The fault appears to occur once we start hauling on the Biowire. This wire has now been re-terminated.

22/11/2006 11:44

Wednesday 22<sup>nd</sup>. Finished station with the FRRF in the dark and proceeded to CTD station I. Full depth CTD. Proceeded to CTD station K, undertook full depth CTD there too. Moved off towards Process station 3. Started station activities with a targeted RMT, which very successfully caught krill. Waiting for the biowire re-termination to set before use.

23/11/2006 11:44

Thursday 23<sup>rd</sup>. Started the day with an FRRF and moved through the normal station activities. Bad weather stopped deck work around 13:00. We tried to run acoustics, but the data was poor, so we switched to SWATH and surveyed the area for a suitable area for the mooring site. Whales everywhere, mostly fin whales.

24/11/2006 11:45

Friday 24<sup>th</sup>. Around 8:00 weather conditions had calmed sufficiently to deploy the CTD. Station work continued as the sea continued to subside. Biowire was tested and OK. LHPR deployed followed by RMT.

25/11/2006 13:39

Saturday 25<sup>th</sup>. Station work continued at around 05:30 with CTDs and Bongo nets. SWATH was used to find a suitable area to deploy the mooring. We were lucky to have a very calm sea, the mooring deployment went well and it now sits at.

26/11/2006 17:25

Sunday 26<sup>th</sup>. Continued with PS3 activities.

27/11/2006 17:26

Monday 27<sup>th</sup>. Moved off towards CS 6 at around 02:00.

28/11/2006 17:26

Tuesday 28<sup>th</sup>. Arrived at CS6 later afternoon and started with an RMT deployment.

29/11/2006 17:26

Wednesday 29<sup>th</sup>. Continued with Station activities, a few King Penguins have been spotted. Bad weather stopped play around 15:00.

30/11/2006 17:26

Thursday 30<sup>th</sup>. Weather improved by around 07:00. Fault finding deployment of LHPR to 500m. Software still registering more gauze advances than have actually occurred. This is possibly due to net monitor problems, but needs to be addressed before next season. A targeted RMT 25 haul finished the station activities at CS6 and we set a course of 270 back to Stanley. The magnetometer was deployed at CS6. The CPR was deployed at 16:00 to be towed across the Maurice Ewing Bank up to 500 Nm.

01/12/2006 23:35

Friday 1<sup>st</sup>. Starting demobilisation, dismantling net systems and generally packing. There was a fire drill for all science personnel followed by safety videos. An evening buffet and quiz was a pleasant evening to mark the end of the cruise.

02/12/2006 23:35

Saturday 2<sup>nd</sup>. Continued demobilisation. Recovered the CPR, magnetometer and tow fish at 10am. Intensive report writing and packing,

03/12/2006 18:37

Sunday 3<sup>rd</sup>. Docked at 8am to a glorious Falklands day. Got straight into cargo and finished all by 16:00.

## **Daily Activities and Timings**

### **Wednesday 25<sup>th</sup> October science**

XBTs deployed at waypoints, ship speed 6 knots.

Bongo wire to be marked and put onto winch.

Deploy tow fish – pm.

Go flo bottles to be trialed on deck.

### **Thursday 26<sup>th</sup> October Science – weather permitting**

Start activity which is scheduled for that time of day on the timetable for Process station.

Complete all activities for that day, this may mean looping back on the timetable to the start of that day. Before starting day 2, again at whatever activity we are due to do at that time.

Target fishing for krill – We will only fish for targets if we see good ones! Sophie will mark any we see on the way into the station. We will go back to these and try and fish them if there is any chance of finding them again. Failing this will adopt a search for krill targets. This will consist of travelling down wind looking for targets, once targets are located we will make the bridge aware, we can then turn the ship around and fish. The amount of time we can spend looking for targets will be variable and will be determined nearer the time.

### **Thursday 26<sup>th</sup> October Science – second entry**

Sort out cable on tow fish for easy deployment

If XBT's continue to fail we can try bringing in the magnetometer. We will no longer slow down and change course for their deployment.

ETA to first process station currently 5pm Thursday 26<sup>th</sup> (as of 19:00 Wednesday)

Based on this, science will proceed on Thursday as follows going into Friday

Mini bongo 2\* 400 m

RMT 25 (or 8) target fishing and Tow fish (if method of deployment of tow fish sorted and ship side happy)

MOCNESS (Recover tow fish or bring to near surface as ship side dictates)

FRRF (must be in the dark)

CTD \* 2 for phytoplankton

Go flo bottles

FRRF (must be in the light)

CTD \* 2 for DP

Bongo 2\* 400 m

CTD for Oithona 1\*400m

RMT 25 target fishing

LHPR

When we get to station - start which ever activity is scheduled for that time of day on the timetable for Process stations

Complete all activities for that day, this may mean looping back on the timetable to the start of that day. Once the whole of the activities for day 1 are complete start day 2 again at whatever activity we are due to do at that time of day.

Target fishing for krill – We will only fish for targets if we see good ones! Sophie will mark any we see on the way into the station. We will go back to these and try and fish them if there is any chance of finding them again. Failing this will adopt a search for krill targets. This will consist of travelling down wind looking for targets, once targets are located we will make the bridge aware, and ask them to turn the ship around and start fishing. The amount of time we can spend looking for targets will be variable and will be determined nearer the time. We must be ready and in place down wind of the way point to start fishing the next piece of equipment at the set time on the plan.

### **Friday 27th science and rest of Process Station 1**

Continue though the activities on the station plan.

CTD, go flo, FRRF, bongo and mini bongo all undertaken at the waypoint. Reposition where necessary to be at waypoint, but if short of time do not waste time getting to the exact position.

RMT target fishing – fishing location to be advised based on where the targets are, or we head down wind searching for targets and fish as soon as we find some. Watch leader to advise bridge

LHPR, MOCNESS, RMT depth profile – all to be fished into wind through the way point. Reposition as far as a possible to allow this but do not waste time getting to the exact location.

Acoustic survey – aim is to survey in relation to the prevailing current if other weather conditions allow good data in this direction. Sophie will advise nearer the time. The plan is to travel 1 hour with the prevailing current on our port side, turn and run 1 hour with the current, turn run 1 hour with current on starboard side, turn and run 2 hours though waypoint against the current, turn and run 1 hour with current on starboard side, turn run one hour with current. End of survey and pick up cruise track

NB there will be no mooring deployment at this station.

If the MOCNESS is fixed we will try again to do a night profile on the 4<sup>th</sup> day.

### **Saturday 28<sup>th</sup> Science plan**

According to timetable for day 2 of Process station

LHPR – haul in dark

FRRF – in dark



CTD \* 2– 1 \* 10 m off bottom and 1 \* shallow in daylight  
Goflo – 1000m in light  
FRRF – in light  
CTD \* 2– 1 \* 2000m and 1 \* 400m  
MOCNESS – 1000m daylight  
CTD – chl max.  
RMT 25 target fishing. 1 or more deployments depending on target availability.

It is not necessary to stick to the times exactly on the timetable, so long as activities marked in ‘dark’ or ‘daylight’ are done in those light regimes and other activities follow in sequence.

### **Sunday 29th Science plan (day 3 of process station 1)**

Continue with RMT 25 depth profiles (1000 – 0 m and 400 – 0m)  
FRRF in dark  
CTD \* 1. Deep (10 m off bottom)  
Bongo 1\* 400m  
CTD Shallow 140m.  
Go flo bottles  
FRRF daylight  
CTD shallow for DP (chl max)  
Bongo 1 \* 400 m  
Deep CTD 2000m for DP.  
LHPR 1000m  
Bongo 1\*400m  
RMT 25 target fishing

### **Tuesday 31<sup>st</sup> Activities**

XBT’s along transect at waypoints. Do not slow down or change direction for XBTs.  
No magnetometer to be deployed.  
Lizzy to advise bridge on waypoints wanted for XBTs on route to new position of Condensed Station 1. New position is required to avoid uncharted waters and get near ice edge.

Signy Brief , 9 am in bar Tue 31<sup>st</sup>.

Tuesday 2 pm in bar  
Data management info from Nathan and brief science up date from anyone who has any interesting observations so far. All interested/ available science party to attend.

Physics.  
Nutrients  
Phytoplankton  
Zooplankton & krill  
Fish  
Acoustics  
Higher predators

Most likely situation is that we will go to Condensed station 1 tomorrow

ETA = 17:00 31 October

Given this ETA of 17:00 running order for Condensed station 1 is

RMT 25 target fishing  
LHPR  
MOCNESS  
FRRF  
CTD deep for phyto  
CTD shallow for phyto  
Go flo  
FRRF  
MOCNESS  
Mini bongo  
LHPR  
RMT target fishing  
RMT depth stratified hauls \*2  
CTD for Oithona (400 m)  
Bongo 3 \* 400 m  
RMT 25 depth stratified \* 2  
Acoustic Survey.

End of Condensed station 1

**Signy Relief – safety meeting Tuesday 9am in the bar.**

Jerry and I have yet to decide if we will go straight to Signy or do Condensed station 1 first. This depends on weather conditions and how the ice looks when we leave this station. Whatever the final plan, we need to do a safety brief for Signy, including going out in the humbers etc.

So, there will be a meeting for all science personnel on Tuesday morning at 9am in the bar. If you attended a brief last leg then you do not need to attend, everyone else must attend – please let me know if you have a problem with this. I suspect a couple will, so please let me know and I will see what I can do about it.

Shift patterns and midnight meals.

The ship need as much help as possible during the day to run cargo ashore. I do not expect those on nights to come right round onto days, but if you can slip a few hours here and there to help it would be much appreciated. If we work hard and get done in time we may get chance to go for walks ashore, but the priority is work and getting cargo done quickly. Midnight meals of some sort will still be available, but please let me know if you do want one during Signy relief so I can let the galley know.

Once we get to Signy I am looking for 8 ‘volunteers’ to help dig snow in the first instance, then everyone will be needed to help with cargo. Please sign up below for this.

That’s about it for now, more info when I get it.  
Rachael.

### **Rest of Condensed station 1.**

MOCNESS – daylight – deploy 14:00

Reposition ship to station (latest position of)

If time allows deploy 1 bongo net to 400 m (no later than 18:20)

MOCNESS – dark – deploy at 19:00. can deploy in light conditions, but only start hauling from 1000m once we are into dusk

RMT 25 target fishing

RMT 25 depth stratified 400 – 0 m

start 04:00

CTD 400 m

Mini bongo 400m

CTD shallow (deep chla max)

Bongo 1\* 400 m

RMT 25 1000m and 400 m day profiles

Acoustics

### **Wednesday 1<sup>st</sup> Science plan and rest of condensed station 1**

Day 1 condensed station

Midnight MOCNESS dark

FRRF (in dark)

CTD deep (10 m off bottom)

Bongo 400 m \*1

CTD shallow (140 m)

Go flo

FRRF (daylight)

MOCNESS (daylight)

LHPR daylight

Day 2 condensed station

RMT fishing

RMT depth stratified deep dark

RMT depth stratified shallow dark

CTD ( 400m oithona)

Mini bongo ( 400 m)

RMT depth stratified deep daylight

RMT depth stratified shallow daylight

Acoustic survey finish at 18:00 on Thursday

Move off station, head for Signy. ETA 05:30 Friday 3rd November

### **After Signy – Saturday 5<sup>th</sup> November**

Target fishing for Rock AFI (fish larvae)

Locations. Neuston. Net and RMT 25 or 8 required.

200m depth of water – 2 ideal locations, but anywhere on shelf near Signy would be acceptable. Failing this, then possibility of fishing at Shag rocks or SG what is the diversion time off from transect to Shag rocks? Needs to be nighttime fishing.

New position of C6

Lat first degrees min decimal min

Long second degrees min decimal minutes

-50 lat

-38 long

### **Sundays science (5<sup>th</sup> November)**

Start condensed station 2. water depth here will be around 800m!

Assuming arrival at station at 04:00

Day 1

CTD – 10 m off bottom

Bongo 400m

CTD – shallow (140m)

Go Flo bottles

FRRF (light)

MOCNESS

LHPR

RMT 25 target fishing

LHPR

MOCNESS

FRRF (dark)

Day 2

CTD – Oithona

Mini Bongo

CTD – to chlorophyll max.

Bongo

Bongo

RMT 25 depth profile 1 (light)

RMT 25 depth profile 2 (light)

Acoustic survey

RMT target fishing

RMT 25 depth profile 1 (night)

RMT 25 depth profile 2 (night)

### **Mondays 6<sup>th</sup> science plan**

FRRF in dark 02:30

CTD – Oithona 04:00

|                        |       |
|------------------------|-------|
| Mini Bongo             | 04:45 |
| CTD – Deep chl max     | 05:30 |
| Bongo                  | 06:00 |
| Bongo                  | 06:40 |
| RMT deep (daylight)    | 08:00 |
| RMT shallow (daylight) |       |
| Acoustic Survey        | 14:00 |
| RMT target             | 18:00 |
| RMT deep (dark)        | 22:00 |

Tuesday 7<sup>th</sup> Finish CTD B. Deploy tow fish at station ready to tow to CS3

Condensed station 3

RMT 25 target fishing – aim to have back on board by 20:30.

LHPR 1000m

FRRF in dark

MOCNESS 1000m

CTD deep

Bongo

CTD shallow

Go Flo

FRRF

Mocness

LHPR

RMT 25 target fishing

RMT 25 deep (dark)

RMT 25 shallow (dark)

CTD - Oithona

Mini bongo

CTD – DCM

RMT 25 deep (day)

RMT 25 shallow (day)

Acoustic Survey.

Decision on Signy

**Tuesday 7<sup>th</sup> Finish CTD B. Deploy tow fish at station ready to tow to CS3**

Condensed station 3

RMT 25 target fishing – aim to have back on board by 20:30.

LHPR 1000m

FRRF in dark

MOCNESS 1000m

CTD deep

Bongo

CTD shallow

Go Flo

FRRF

Mocness

LHPR

RMT 25 target fishing

RMT 25 deep (dark)  
 RMT 25 shallow (dark)  
 CTD - Oithona  
 Mini bongo  
 CTD – DCM  
 RMT 25 deep (day)  
 RMT 25 shallow (day)  
 Acoustic Survey.

Decision on Signy

### **Wednesday 15<sup>th</sup> November and condensed station 4**

CTD station D ETA around 19:00

Condensed station 4 taking place at CTD station E – ETA around 05:00

| Approximate Time | Activity                   |
|------------------|----------------------------|
|                  |                            |
| 04:00            | CTD near bottom            |
| 07:00            | Bongo 400 m                |
| 08:00            | CTD shallow (140 m)        |
| 08:30            | Go flo                     |
| 10:00            | FRRF (light)               |
| 10:30            | MOCNESS                    |
| 14:00            | Acoustic survey            |
| 18:00            | RMT target fishing         |
| 21:00            | RMT deep stratified - dark |
| 00:30            | FRRF dark                  |
| 01:00            | RMT shallow Stratified     |
| 04:00            | CTD Oithona                |
| 04:30            | Mini bongo                 |
| 05:20            | CTD chl max                |
| 06:00            | Bongo                      |
| 06:40            | Bongo                      |
| 07:30            | LHPR                       |

### **Condensed stations 4 and 5, and CTD stations.**

We have lost some science time due to Signy relief and will therefore have to cut activities accordingly to fit in with the time we have left.

I want to preserve Process stations 2 and 3 intact and also Condensed 6. Therefore the cuts will be made in condensed 4 & 5 and some CTD stations.

Condensed station 4 will take place at CTD E station position and will have cuts as follows: all daylight stratified RMT hauls, 1 LHPR, 1 MOCNESS, 1 RMT targeted haul. I will reassess after this station, we may have to cut CS 5 altogether, or we may be able to run a reduced sampling protocol.

CTD stations, C, G, H and K will be cut.

Sequence of activities at the condensed stations will change slightly depending on what time of day we arrive at station (before or after 14:00) to maximise the use of time.

Revised Condensed – start before 14:00 – start at whatever time we arrive and work through list, then back to the top to finish off.

| Time  | Activity                   |
|-------|----------------------------|
| 04:00 | CTD near bottom            |
| 07:00 | Bongo 400 m                |
| 08:00 | CTD shallow (140 m)        |
| 08:00 | Go flo                     |
| 10:00 | FRRF (light)               |
| 10:30 | MOCNESS                    |
| 14:00 | Acoustic survey            |
| 18:00 | RMT target fishing         |
| 21:00 | RMT deep stratified - dark |
| 00:30 | FRRF dark                  |
| 01:00 | RMT shallow Stratified     |
| 04:00 | CTD Oithona                |
| 04:30 | Mini bongo                 |
| 05:20 | CTD chl max                |
| 06:00 | Bongo                      |
| 06:40 | Bongo                      |
| 07:30 | LHPR                       |

Start after 14:00 start at whatever time we arrive and work through list, then back to the top to finish off.

| Time  | Activity                   |
|-------|----------------------------|
|       |                            |
| 15:00 | CTD oithona                |
| 15:30 | Mini bongo                 |
| 16:20 | CTD chlo max               |
| 17:00 | Bongo                      |
| 18:00 | Bongo                      |
| 21:00 | RMT deep stratified - dark |
| 00:30 | FRRF dark                  |
| 01:00 | RMT shallow Stratified     |
| 04:00 | CTD near bottom            |
| 07:00 | Bongo 400 m                |
| 08:00 | CTD shallow (140 m)        |
| 08:00 | Go flo                     |
| 10:00 | FRRF (light)               |
| 10:30 | MOCNESS                    |
| 14:00 | Acoustic survey            |
| 18:00 | RMT target fishing         |
| 22:00 | LHPR                       |

Thursday night and Friday 17<sup>th</sup> November

| Approximate Time | Activity |
|------------------|----------|
|------------------|----------|

|                |                            |
|----------------|----------------------------|
| 18:00 Thursday | RMT target fishing         |
| 21:00          | RMT deep stratified - dark |
| 00:30 Friday   | FRRF dark                  |
| 01:00          | RMT shallow Stratified     |
| 04:00          | CTD Oithona                |
| 04:30          | Mini bongo                 |
| 05:20          | CTD chl max                |
| 06:00          | Bongo                      |
| 07:00          | LHPR                       |
| 10:00          | CTD near bottom            |

Leave station at 13:00  
Head to CTD Station F  
CTD full depth  
Head to Process station 2.

Deploy XBT's at 8 knots at sites as follows  
Half way between CTD E and CS5,  
CS5 position  
Half way between CS5 and CTD station F  
CTD station G

#### **Thursday night and Friday 17<sup>th</sup> November**

| Approximate Time | Activity                   |
|------------------|----------------------------|
| 18:00 Thursday   | RMT target fishing         |
| 21:00            | RMT deep stratified - dark |
| 00:30 Friday     | FRRF dark                  |
| 01:00            | RMT shallow Stratified     |
| 04:00            | CTD Oithona                |
| 04:30            | Mini bongo                 |
| 05:20            | CTD chl max                |
| 06:00            | Bongo                      |
| 07:00            | LHPR                       |
| 10:00            | CTD near bottom            |

Leave station at 13:00  
Head to CTD Station F  
CTD full depth  
Head to Process station 2.

Deploy XBT's at 8 knots at sites as follows  
Half way between CTD E and CS5,  
CS5 position  
Half way between CS5 and CTD station F  
CTD station G

#### **Saturday 18<sup>th</sup> November Science ETA to PS2 06:00**

| Approx time | Activity |
|-------------|----------|
|-------------|----------|



|                   |  |
|-------------------|--|
| 06:00             | Bongo 400 m  |
| 06:40             | CTD shallow  |
| 07:30             | Go flo   |
| 09:30             | FRRF (light)   |
| 10:00             | Shallow CTD (for DP)   |
| 10:30             | Bongo 400m   |
| 11:20             | CTD 2000m  |
| 13:20             | Mini bongo 400 m   |
| 14:00             | LHPR (if time allows)  |
| 16:30             | RMT target fishing mainly for krill – swap with MOCNESS slot if darker conditions wanted |
| 22:00             | MOCNESS - night  |
| 01:30 Sunday 19th | FRRF dark  |
| 03:00             | CTD – full depth   |
| 06:00             | Shallow CTD  |
| 06:30             | Go flow  |
| 08:30             | FRRF light   |
| 09:00             | CTD 2000m (DP)   |
| 11:00             | CTD Oithona  |
| 11:30             | MOCNESS - day  |
| 15:00             | CTD shallow (DP)   |

### 20 /21<sup>st</sup> November science plan

|                            |                    |
|----------------------------|--------------------|
| 16:00 20 Nov               | LHPR –day          |
| 19:30                      | LHPR - night       |
| 22:15                      | FRRF - night       |
| 22:30                      | RMT – dark Shallow |
| 01:30 21 <sup>st</sup> Nov | Acoustic survey II |
| 08:30                      | RMT – day deep     |
|                            | RMT – day shallow  |
|                            | relocate           |
| 16:00                      | Multinet - day     |
| 19:30                      | Mutlinet - night   |
| 23:00                      | RMT - targets      |
| 02:00                      | FRRF dark          |

End of PS2.

### PS3

| Approx time               | Activity         |
|---------------------------|------------------|
| 04:00 day 1 Saturday 18th | CTD - full depth |
| 06:00                     | Bongo 400 m      |
| 06:40                     | CTD shallow      |
| 07:30                     | Go flo           |
| 09:30                     | FRRF (light)     |

|                             |  |
|-----------------------------|--|
| 10:00                       | CTD Shallow (for DP)                             |
| 10:30                       | Bongo 400m                                       |
| 11:20                       | CTD 2000m  |
| 13:20                       | Mini bongo 400 m                                 |
| 14:00                       | LHPR - day - (if time allows)                    |
| 16:30                       | RMT 25 target fishing mainly for krill           |
| 22:00                       | MOCNESS – night -                                |
| 01:30 day 2 Sunday<br>19th  | FRRF dark  |
| 03:00                       | CTD – full depth                                 |
| 06:00                       | CTD - Shallow                                    |
| 06:30                       | Go flow  |
| 08:30                       | FRRF light                                       |
| 09:00                       | CTD 2000m (DP)                                   |
| 11:00                       | CTD Oithona                                      |
| 11:30                       | CTD shallow (DP)                                 |
| 12:00                       | Acoustic Survey                                  |
| 19:00                       | RMT 25 - Target fishing based on acoustic survey |
| 23:00                       | RMT 25 - Deep stratified                         |
| 03:00 day 3 Monday<br>20th  | CTD – full depth                                 |
| 05:30                       | Bongo 400 m                                      |
| 06:10                       | CTD - shallow                                    |
| 07:00                       | Go flo   |
| 09:00                       | FRRF –light-                                     |
| 09:30                       | CTD shallow (DP)                                 |
| 10:00                       | Bongo 400 m                                      |
| 10:40                       | CTD 2000m (DP)                                   |
| 12:30                       | Bongo 400 m                                      |
| 13:10                       | Mooring deployment                               |
| 19:00                       | LHPR – night -                                   |
| 22:00                       | RMT 25 - shallow Stratified                      |
| 01:00 day 4 Tuesday<br>21st | FRRF - dark-                                     |
| 04:00                       | MOCNESS – day                                    |
| 07:30                       | RMT 25 – day, shallow stratified                 |
| 10:30                       | RMT 25 Deep                                      |
| 14:30                       | LHPR – day (if not done already)                 |
| 17:00 – 03:00               | RMT target fishing.                              |

### Science 24<sup>nd</sup> November Process Station 3.

| Approx time                     | Activity   |
|---------------------------------|--|
| 16:30 22 <sup>nd</sup> November | RMT 25 target fishing mainly for krill           |
| 23:00                           | Multinet night – biowire not working - postponed |
| 02:00 23 <sup>rd</sup> November | FRRF dark  |
| 03:00                           | CTD - full depth                                 |
| 06:30                           | Bongo 400 m                                      |
| 07:20                           | CTD shallow                                      |

|                                 |  |
|---------------------------------|--|
| 07:50                           | Go flo   |
| 09:50                           | FRRF (light)   |
| 10:20                           | CTD Shallow (for DP)   |
| 11:00                           | Bongo 400m   |
| 11:40                           | CTD 2000m  |
| 13:20                           | Bad weather stopped deck work – too rough for Acoustics too.                                   |
| 14:00                           |  |
| 20:00                           |  |
| 23:00                           |  |
| 02:00 24 <sup>th</sup> November |  |
| 03:00                           |  |
| 06:00                           |  |
| 06:30                           |  |
| 08:15                           | CTD 2000m (DP)   |
| 09:45                           | Mini bongo 400 m   |
| 10:40                           | CTD - Shallow  |
| 11:20                           | FRRF light   |
| 11:50                           | CTD Oithona  |
| 12:20                           | Bongo 125 m  |
| 12:40                           | CTD shallow (DP)   |
| 13:15                           | Go flow  |
| 14:45                           | CTD – full depth   |
| 17:15                           | LHPR - day -   |
| 20:00                           | LHPR – night -   |
| 22:30                           | FRRF - dark-   |
| 23:00                           | RMT 25 - Deep stratified –dark -   |
| 03:00 25 <sup>th</sup> November | CTD – full depth   |
| 05:30                           | Bongo 400 m  |
| 06:10                           | CTD - shallow  |
| 06:40                           | Go flo   |
| 08:20                           | FRRF –light-   |
| 08:50                           | CTD shallow (DP)   |
| 09:20                           | Bongo 400 m  |
| 10:00                           | CTD 2000m (DP)   |
| 11:30                           | Bongo 400 m  |
| 12:10 – as long as it takes     | Mooring deployment   |
| 18:00                           | Multinet – day (postpone if necessary) or RMTs if Moorings went well and Peter E OK to do RMTs |
| 21:00                           | Multinet – night (or RMT's)  |
| 24:00                           | FRRF –dark-  |
| 00:30 26 <sup>th</sup> November | Bongo – 125 m dark -   |
| 05:00                           | RMT 25 – day, shallow stratified   |
| 08:00                           | RMT 25 day deep stratified   |
| 12:00                           | Acoustic Survey  |
| 19:00                           | RMT 25 - Target fishing based on acoustic survey   |
| 22:00                           | RMT 25 - shallow Stratified – dark (or multinet – depending on what was deployed last night)   |
| 01:00 27 <sup>th</sup> November | RMT 25 target fishing. (or multinet depending on what was deployed last night) )               |

### Science 23<sup>rd</sup> November Process Station 3.

| Approx time                     | Activity   |
|---------------------------------|--|
|                                 |  |
| 11:00 23 <sup>rd</sup> November | Mini bongo 400 m cancelled – bad weather. Run SWATH  |
| 12:00                           | Acoustic Survey  |
| 20:00                           | RMT 25 - Target fishing based on acoustic survey if conditions allow, If not then LHPR if conditions allow this– night - |
| 23:00                           | RMT 25 - shallow Stratified - dark   |
| 02:00 24 <sup>th</sup> November | FRRF - dark-   |
| 03:00                           | CTD – full depth   |

|       |                  |
|-------|------------------|
| 06:00 | CTD - Shallow    |
| 06:30 | Go flow          |
| 08:30 | FRRF light       |
| 09:00 | CTD 2000m (DP)   |
| 11:00 | CTD Oithona      |
| 11:30 | CTD shallow (DP) |

We'll see from there! Weather permitting!

|   |   |
|---|---|
| Move off around 02:00 ETA to CS 6<br>1 <sup>st</sup> activity RMT deep stratified | 18:00 27 <sup>th</sup> Nov                        |
| 19:00   | 27 <sup>th</sup> Nov RMT - deep stratified - dark |

|                       |   |
|-----------------------|---|
| 23:00                 | FRRF – dark.  |
| 23:30                 | RMT - shallow stratified- dark  |
| Reposition to station | 28 <sup>th</sup> Nov  |
| 03:00                 | CTD near bottom   |
| 06:00                 | Bongo 400m  |
| 06:40                 | CTD shallow   |
| 07:20                 | Go Flo  |
| 09:20                 | FRRF – day-   |
| 09:50                 | LHPR - day  |
| 13:00                 | RMT shallow day   |
| relocate              |   |
| 17:00                 | RMT deep stratified - day   |
| 21:00                 | LHPR night  |
| 00:30                 | 29 <sup>th</sup> Nov MULTINET night   |
| Reposition to station |   |
| 04:00                 | CTD oithona   |
| 04:30                 | Mini bongo  |
| 05:20                 | CTD (DP) chl max  |
| 06:00                 | Bongo   |
| 06:40                 | Bongo   |
| 07:20                 | Acoustic survey   |
| 14:20                 | Target fishing based on Acoustics   |
| 16:20                 | Multinet day  |
| 19:30                 | RMT – dusk haul?  |
| 23:00                 | RMT target fishing  |
| 02:00                 | 30 <sup>th</sup> Nov RMT – dawn haul?                                       |
| 05:00                 | LHPR trial deployment   |
| 08:00                 | Repeat any failed hauls   |
| 12:30                 | End of CS 6. Deploy CPR head back to Stanley.<br>Run SWATH and Magnetometer |
|                       | Deploy CPR on route (2 deployments in total)                                |

Condensed 6 - and transect back to Stanley

### End of PS 3

|                |         |
|----------------|---------|
| RMT stratified | fishing |
| RMT target     | 23:30   |
| FRRF           | 01:00   |
| Bongo 400m!    | 01:30   |

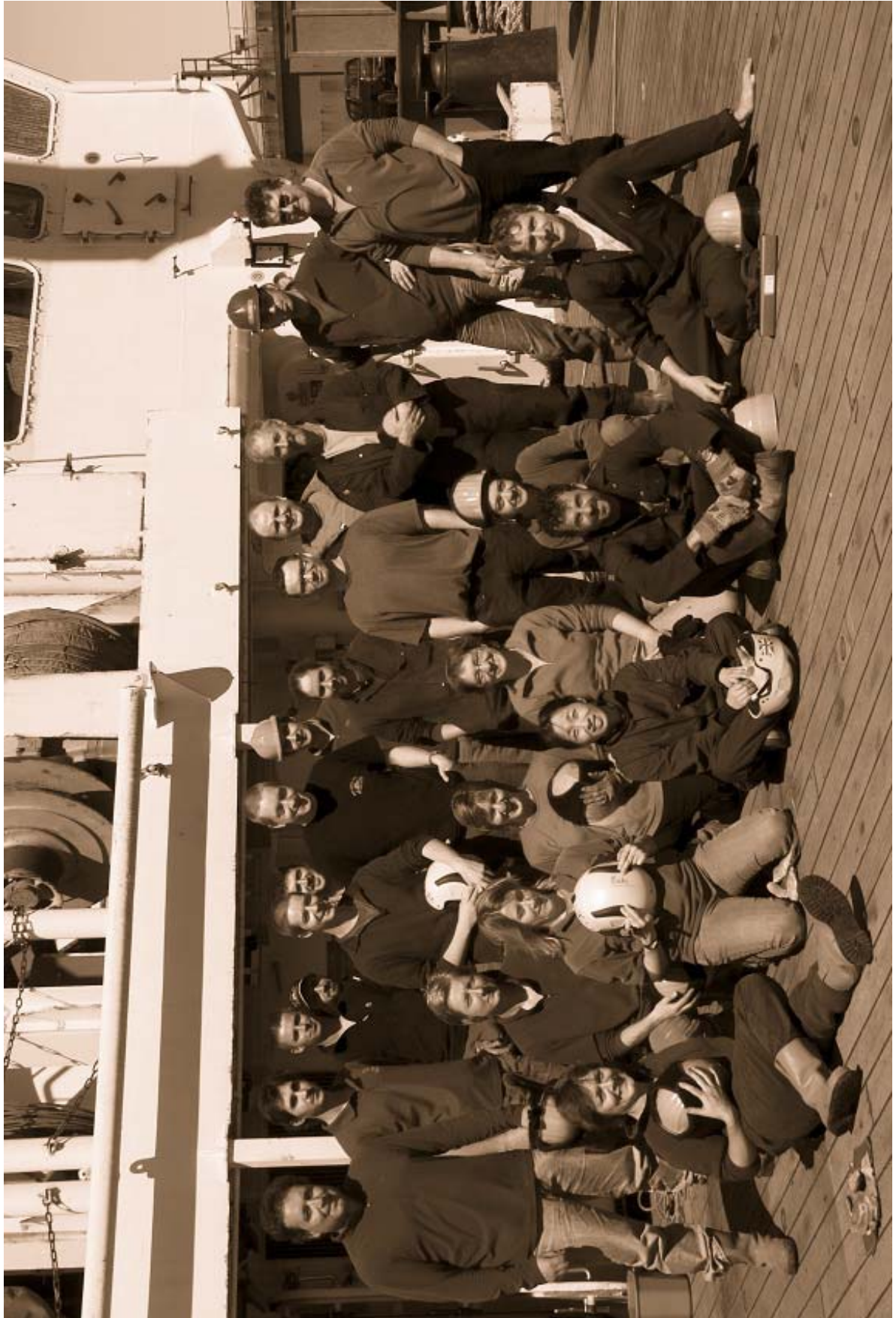
## Process Station Timings

| Time  | Day 1                  | Day 2                  | Day 3                  | Day 4                 |
|-------|------------------------|------------------------|------------------------|-----------------------|
| 01:00 | MOCNESS                | RMT 25                 | RMT 25                 | RMT 25 target fishing |
| 02:00 | 0 – 1000 m             | Target fishing         | Depth stratified       |                       |
| 03:00 |                        | LHPR                   | 1000 – 400 m           | Mooring               |
| 04:00 | Tow Fish               | 0 – 1000m              | 400 – 0 m              | Deployment            |
| 05:00 | FRRF darkness 120 m    |                        |                        |                       |
| 06:00 |                        | FRRF 120 m             |                        |                       |
| 07:00 | CTD – 10 m off sea bed | CTD – 10 m off sea bed | CTD – 10 m off sea bed |                       |
| 08:00 |                        |                        |                        |                       |
| 09:00 | CTD 140 m              | CTD 140 m              | CTD 140 m              |                       |
| 10:00 |                        |                        |                        | RMT 25                |
| 11:00 | Go Flo                 | Go Flo                 | Go Flo                 | Depth stratified day  |
| 12:00 |                        |                        |                        |                       |
| 13:00 | FRRF – daylight 120 m  | FRRF – daylight 120 m  | FRRF – daylight 120 m  |                       |
| 14:00 | CTD – HPLC 2000 m      | CTD – HPLC 2000 m      | CTD – HPLC 2000 m      |                       |
| 15:00 |                        |                        |                        | Acoustic Survey       |
| 16:00 | CTD 140 m              | MOCNESS 0 – 1000m      | LHPR - daylight        |                       |
| 17:00 | Bongo 3 * 400 m        |                        |                        |                       |
| 18:00 | Mini bongo 1 * 400 m   |                        |                        |                       |
| 19:00 | RMT 25                 | Bongo 3 * 400 m        | Bongo 3 * 400 m        |                       |
| 20:00 | Target fishing         |                        |                        |                       |
| 21:00 |                        | RMT 25                 | RMT 25                 | RMT 25                |
| 22:00 |                        | Target fishing         | Target fishing         | Target fishing        |
| 23:00 |                        | RMT 25                 |                        |                       |
| 24:00 |                        | Depth stratified night |                        |                       |

## Condensed Station Timings

| Time  | Day 1                 | Day 2                 |
|-------|-----------------------|-----------------------|
| 01:00 | LHPR                  | RMT 25                |
| 02:00 | Tow fish              | Depth stratified      |
| 03:00 | MOCNESS               |                       |
| 04:00 |                       |                       |
| 05:00 |                       |                       |
| 06:00 | FRRF                  |                       |
| 07:00 | CTD                   | CTD                   |
| 08:00 |                       |                       |
| 09:00 |                       | Bongo                 |
| 10:00 | Go Flo                |                       |
| 11:00 | FRRF                  | RMT 25                |
| 12:00 |                       | Depth Stratified      |
| 13:00 |                       |                       |
| 14:00 | MOCNESS               |                       |
| 15:00 |                       |                       |
| 16:00 |                       |                       |
| 17:00 | Minibongo             | Acoustic Survey       |
| 18:00 | LHPR                  |                       |
| 19:00 |                       |                       |
| 20:00 |                       |                       |
| 21:00 | RMT 25 Target fishing | RMT 25 Target fishing |
| 22:00 |                       |                       |
| 23:00 |                       |                       |
| 24:00 | LHPR                  |                       |

## Cruise Photo



## Scientific and Services Personnel

|                      |                       |  |
|----------------------|-----------------------|--|
| Bibby - Thomas       | Optics                | tsb.soc.nerc@noc.soton.ac.uk   |
| Collins - Martin     | Zooplankton-fish      | macol@nerc-bas.ac.uk   |
| Cunningham - Nathan  | Data manager          | njcu@nerc-basa.c.uk  |
| Enderlein - Peter    | Gear Technology       | pend@nerc-bas.ac.uk  |
| Fielding - Sophie    | Acoutics              | sof@nerc-bas.ac.uk   |
| Gordon - Marina      | Phytoplankton         | msgo@nerc-bas.ac.uk  |
| Hawker - Elizabeth   | Oceanography          | ejha@nerc-bas.ac.uk  |
| Hirst- Andrew        | Zooplankton           | aghi@nerc-bas.ac.uk  |
| Korb - Rebecca       | Phytoplankton         | <a href="mailto:rk@nerc-bas.ac.uk">rk@nerc-bas.ac.uk</a>                       |
| Mitsis - Christos    | Oceanography          | C.Mitsis@uea.ac.uk   |
| Nielsdottir - Maria  | Phytoplankton         | <a href="mailto:mcn.soc.nerc@noc.soton.ac.uk">mcn.soc.nerc@noc.soton.ac.uk</a> |
| Pond – David         | Biochemist            | dwpo@nerc-bac.ac.uk  |
| Preston - Mark       | ETS                   | mopr@nerc-bas.ac.uk  |
| Robst – Jeremy       | ITS                   | jpro@nerc-bas.ac.uk  |
| Saunders - Ryan      | Zooplankton           | ras19@st-andrews.ac.uk   |
| Schmidt - Katrin     | Zooplankton           | kasc@nerc-bas.ac.uk  |
| Shreeve - Rachael    | PSO Zooplankton       | rssh@nerc-bas.ac.uk  |
| Stowasser - Gabriele | Zooplankton           | <a href="mailto:gsto@nerc-bas.ac.uk">gsto@nerc-bas.ac.uk</a>                   |
| Tullis – Ben         | ITS                   | btull@nerc-bas.ac.uk   |
| Vijande – Enrique    | Oceanography          | <a href="mailto:evv101@noc.soton.ac.uk">evv101@noc.soton.ac.uk</a>             |
| Wakefield – Ewan     | Predator Observations | ewdw@nerc-bas.ac.uk  |
| Ward - Peter         | Zooplankton           | pwar@nerc-bas.ac.uk  |
| Whitehouse - Mick    | Nutrient chemist      | <a href="mailto:mjwh@nerc-bas.ac.uk">mjwh@nerc-bas.ac.uk</a>                   |



## **Ships Officers and Crew**

|                      |                          |
|----------------------|--------------------------|
| Burgan M. Jerry      | Master                   |
| Page Timothy S       | Ch officer               |
| King David J         | 2 <sup>nd</sup> Officer  |
| Cox Joanna L         | 3 <sup>rd</sup> Officer  |
| Summers John W       | D.O.Si.Ops               |
| Gloistein Michael EP | ETO Comms                |
| Anderson Duncan S    | Ch Engineer              |
| Kurec Artur          | 2 <sup>nd</sup> Engineer |
| Stevenson James S    | 3 <sup>rd</sup> Engineer |
| Jones Gareth         | 4 <sup>th</sup> Engineer |
| Trevett Douglas P    | Deck Engineer            |
| Rowe A Keith         | ETO Engineer             |
| Turner Richard J     | Purser                   |
| Peck David J         | Bosun                    |
| Bowen A. Martin      | Bosun's Mate             |
| Chappell Kelvin E    | SG1                      |
| Raper I              | SG1                      |
| Dale George          | SG1                      |
| Holmes Kevin J       | SG1                      |
| Estribeiro Anthony J | SG1                      |
| Smith Bruce D        | MG1                      |
| Mackaskill Angus L   | MG1                      |
| Huntley, Ashley A    | Chief Cook               |
| Lee, Jamie E         | 2 <sup>nd</sup> Cook     |
| Jones, Lee J         | Sr Steward               |
| Greenwood            | Steward                  |
| Raworth Graham       | Steward                  |
| Weirs Michael        | Steward                  |
| Gill Andrew D        | Dk Cadet                 |

## **Acknowledgments**

I would like to sincerely thank Captain Jerry Burgan, his Officers and Crew for all their support during this cruise. Whilst having spent numerous seasons in the field on the RRS James Clark Ross as a junior scientist, it was not until this season as the PSO that I truly appreciated all the expertise onboard. We are dependant on their cooperation and knowledge to successfully complete a cruise. Having lost only a handful of days to Signy relief and rough weather we completed pretty much all the science we had planned and so have a great start to the shipboard field work that underpins the Discovery 2010 programme.

Rachael Shreeve PSO

# JR161 and JR152, JR159 Recommendations

## 1. Meteorology

1.1. We recommend that some time is spent producing a solution whereby SMG and CMG for the RVS truewind calculation can be obtained from one of the other GPS instruments, ideally the Seapath or Ashtech ADU5.

## 2. ADCP

2.1. During the trials cruise, it was noted that the OS75 causes interference with most of the other acoustic instruments on *JCR*, including the EM120 swath bathymetry system. To circumvent this, all acoustic instruments were set to ping sequentially through the SSU, however this acts to reduce the ping rate. As noted by Dr. Sophie Fielding, when in deep water the swath can take 20 to 30 seconds from ping to end of listening, as a result this means the ADCP only pings once every 25 or so seconds.

2.2. A further problem is that the ADCP appears to “time out” every other ping when it has to wait a long time between pings (i.e when running in deep water alongside the EM120). This results in it rebooting and waking the ADCP instrument up every other ping, which simply exacerbates the problem. A fix is promised by BAS AME, but requires a firmware upgrade from RDI which is not presently available.

2.3. During Jr161 the swath bathymetry system was not turned on because of the severe effects on data sampling rate and data quality. Several trial setups were undertaken to try to synchronise the ADCP with the EK60 (these are recorded in the setup log files (within the cruise ADCP directory) and within the EK60/Acoustic cruise log)), the final setup established using the SSU was to ping the ADCP synchronously with the EK60 and EA600. The EK60 was the master instrument (this was established using the command CX1,3 in the ADCP setup script) and was set to a constant ping rate of 2.5 seconds, the ADCP and EA600 were slaves. The SSU setup is described in the EK60 methods section of this cruise report. This created good data for both the ADCP and the EK60, only when the ADCP was set in narrowband – bottom tracking off mode. This method **does not work** with the ADCP in bottom tracking mode. More effort is required to establish how to interface all these instruments together with a minimum of interference to all.

## 3. CTD

3.1. At first there were problems with the new external pump that draws the sample into the salinometer. It was introducing many microbubbles into the cell causing the readings to be highly unstable and fluctuate abnormally. As a result the analysis of the first crate of salts lasted well over 3.5 hours. It was found that the clamps holding the tube inside the pump were too tight. After loosening the clamps the bubbles ceased to flow into the cell, however the salinometer readings continued to be highly unstable, taking a very long time to stabilize. The reading would regularly creep up or down 30-40 digits before stabilizing at a particular value (eg. 1.98321 – 1.98365). This occurred typically in all three readings per bottle, causing the analysis of an entire crate to take over 3.5 hours each time. Several attempts at

solving the problem were made, including re-calibrating the salinometer & varying the pump flow speed. Neither of these had any effect, therefore the majority of bottles were analysed successfully despite unusual behaviour and instability of the salinometer.

3.2. The solution was finally found by replacing the new pump by one of the old peristaltic pumps. After the replacement the salinometer readings stabilized much quicker, with the first reading typically varying less than 10 units, and subsequent readings usually only oscillating 3-5 units. This reduced the “crate analysis time” to a more normal two hours.

3.3. The possible problem of the new pump was the right sized tubing had not been delivered with the pump for this cruise, therefore a thinner diameter tube had to be used. It is believed that with such a small tube, the pump would vaporize the water inside the tube causing micro-bubbles which were not visible to the naked eye, but were seriously affecting the salinometer readings. The old tried and tested peristaltic pump caused the salinometer to behave in its usual manner.

3.4. A small problem was found with the peristaltic pump; the highest flow setting was producing too much pressure on the outgoing tube causing it to pop out releasing water into the pump casing. The only solution that was found for this problem was to use superglue to physically stick the two tubes together. After this, everything worked fine.

#### **4. LADCP**

4.1. Initially the master/slave command files used were adjusted from those found on the LADCP PC, and did not appear to work successfully. As described below the correct command files were used from CTD cast 015 onwards and only data from this point onwards has been processed

4.2. Communication with the LADCP was flaky. Although appearing to successfully go through the pre-deployment tests, on some casts data could only be recovered from one or other of the master and slave. Additionally, when data was recovered after a cast a variable number of files (instead of the expected one file) were found. Since the LADCP memory was cleared before every deployment, these files were all belonging to the cast in question. The initial processing (reported by scan.prl) often showed that these files were apparently empty - giving nonsense depths and times.

4.3. The scan.prl step (results recorded in *~/proc/proc.dat*) revealed that for a number of casts the start and end times and depths did not match those recorded in the CTD log. On some casts only the downcast appeared to be recorded, or part of the downcast. The initial processing steps were carried out as far as possible, although for a number of cases the *do\_abs* matlab script failed due to the mismatch between downcast and upcast.

4.4. The scripts will need adjusting back at BAS for any further processing of the data to be completed.

## **5. Gear Report**

- 5.1. Replacing the current DWNM is still top priority. Doug Bone and myself have raised this issue for many years. The system is old, flaky and needs replacing. Finally there is now some money made available to replace the system and AME has agreed to develop the new system. Jim Fox has been tasked with the Job. The idea is that we have a prototype on board for next season to use it along with the old one and then replace the old system in the following season.
- 5.2. It seems that the non-filtering cod-ends are getting more and more preferred against the filtering. In the moment we have only one pair of these cod-ends, therefore more RMT non-filtering cod-end should be bought.
- 5.3. If the old MOCNESS is used again a new deck unit and a new PC as well as spares are needed. Also some kind of documentation would be quite helpful. If BSD is going for a new one, again spares and documentation should be bought with it.
- 5.4. If the intension is to use the AMPS again – either as the main net or as a back up to the MOCNESS - a decision has to be made sooner then later to give time to sort out the issues encountered on this trip. Also proper non-filtering cod-ends for the AMPS should be designed and get made.
- 5.5. The LHPR spooling mechanism needs to be sorted to overcome the mismatch between fired commands and the real amounts of turns. Also the catch diverter device (opening and closing mechanism), which doesn't work with the existing DWNM, has to be incorporated into the new system with a second command and feed back line.
- 5.6. If we continue with the amount of RMT 25 fishing we need another new RMT 25 net. Also the existing new net has to go back to the net maker to get holes for dropping wires made.
- 5.7. The old RMT 25 nets have been deployed more than 50 times on this trip. They need some major refurbishing and have to go back to the net maker.
- 5.8. Due to the amount of deployments the RMT 25 side wires suffered quite a bit and had to be replaced, to increase the life expectancy freely.
- 5.9. The feedback on the RMT25 release mechanism needs checking. Also it has to be replaced in one of the RMT8 release from where it had been taken out. Further a couple of new ones should be made to take as spares.
- 5.10. By next season the new USBL tracking system will be fully implemented and this should further improve any fishing activity regarding position and depth of gear in the water.
- 5.11. On a more general note mobilisation and demobilisation relied on good weather condition during passage from and to the Falklands. If the weather would have been unworkable the time given for mobilisation and demobilisation would not been sufficient. More time should be allocated for future cruises especially if the same

amount of gear will be used. swivels should be put on top of the side wires to allow the side wires to rotate

## **6. RMT 25 Fishing**

6.1. It is essential to carry a full set of spares for the RMT 25 release mechanism and net monitors. Fortunately we were able to remove parts from the RMT8 release to keep the RMT25 system working. With the exception of one haul the net monitor worked reliably with the RMT25, but given the problems that were encountered with other gears, a new net monitoring system is essential.

6.2. The current set of nets is extremely worn out, with lots of rips that have been hurriedly repaired. We have one spare net, which needs slight adjustment to fit to the bars and a second net is on order. The old nets will be OK as emergency spares.

6.3. The RMT25 is clearly unable to catch fish in the surface waters during daylight, so to get any idea of fish abundance night time hauls must be used. This may present problems during summer cruises, when darkness is limited and there is pressure from other gears for darkness slots.

## **7. MOCNESS**

7.1. We had problems with this net system though, and on most deployments around half the nets failed to actually fire, even though the software indicated all was well. Therefore we are unsure about which depth horizons were sampled with the Multinet, however samples were taken to give some indication of the condition of *C. acutus* at the different sites.

7.2. Failure of the MOCNESS system half way through the cruise caused us to substitute this sampling with the Multinet. This system proved to be flakey, possibly linked to the net monitor system has caused problems with collecting samples. It is essential that before next cruise that we have a fully operating system to collect multiple samples on one deployment of plankton that is in good condition. Sea trials during summer 2007 will be essential to test this system out prior to the main cruise.

## **8. LHPR**

8.1. With a new net monitor being planned for use on future cruises it is important to ensure that it incorporates a better (more precise) way of disabling the LHPR motor during fishing, rather than further reliance on the reed-switch.

8.2. It also needs to take into account the requirements to be able to increase the time period that gauzes fish (presently 99 seconds max) as well as incorporating a flow diverter in the cod-end allowing the net to be vented until it is appropriate to switch.

8.3. A specification needs to be drawn up before work progresses much further on this project.

## **9. POC2 Activities**

9.1. Breakdown in communication at a number of points, both technical and personal, have been behind a number of the problems encountered. If near-real time (NRT) e-mail communications between the pCO<sub>2</sub> system and Dartcom/PML had been established on departure from Immingham, the water ingress problems could have been spotted earlier and the severe damage to the system potentially avoided. A gap in the communication of the need for ship's underway data logging meant that valuable data collected by the pCO<sub>2</sub> instrument on the leg south cannot be processed to the highest possible standards. Conversely, good communications between the ship, PML and Dartcom during this cruise have allowed for many of the problems encountered to be adequately dealt with and repairs made where necessary. Good communications between the ship and Dartcom/PML, by telephone and e-mail, must be maintained if this trial is to succeed.

9.2. Another contributing factor to the problems encountered has been the lack of adequate training so far. This was looked into and accepted as not feasible before the cruise, but must be prioritised for the future. Simon Wright (shipside, Deck Engineer) was given very basic level training before departure from Immingham, which he passed on to Doug Trevy (shipside, Deck Engineer) when the crew changed over. Mark Preston has been trained in operation of the system for this season during this cruise but should attend further training at Dartcom if he is to be responsible for the instrument over future seasons. Ideally, more than one responsible person needs to be trained so operations are not dependent on one person and it would also be useful if both BAS technical personnel and the ship's Deck Engineers could be trained.

9.3. Expense precludes providing a full set of spare parts for each pCO<sub>2</sub> system, but provision of a basic set of Swagelok fittings, tubing, Snoop leak detector, filters and regulator as a minimum has proved useful on this cruise. Spare gas cylinders should also be provided in future (these have been ordered). Other (small) parts can be transported by scientific personnel heading south, as has been undertaken during the changeover between this cruise and JR161.

9.4. These risks are well known and the diagnostic sensors in the tray have worked adequately in alerting to these. These failure modes are the most likely to cause full system shutdown so must be avoided at all costs. Any evidence of these must be treated with the utmost urgency.

9.5. So far, the harsh Southern Ocean environment has not caused significant problems for the instrument. The freezing-up of the marine air line may be partly attributable to negative air temperatures, but this has only been a minor issue and appropriate procedures have been established to deal with it. The cruise has not encountered blockage by large diatoms but these may become an issue later in the season. It has also not been exposed to the lowest temperatures or sea ice. Ongoing assessment of these possible issues needs to be undertaken throughout the season.

## **10. GENE Flow in the Antarctic**

10.1. During the transect from Stanley to South Georgia the EK60 38 kHz signal was extremely noisy. This feature was also noted during cruise JR129 and was

discovered to have been solve by replacing the 38 kHz GPT (Serial No. 00907203400b). This process was undertaken during this cruise also. The serial number of the 38 kz GPT being used during this season is 009072033fa5

10.2. Echolog appeared to be extremely temperamental this trip and stalled regularly if used to compress files in real time, although live viewing could be run permanently if no compression was used. Ultimately, Jeremy discovered that there was a problem with new Samba software Ver. 3.0.23c loaded onto the Sun server. Reloading the older version (Ver. 2.2.12) fixed the problem and normal Echolog saving could resume.

10.3. Both the EK60 main processor and the EK60 workstation computers were networked differently this cruise – onto a more secure network. There were some teething problems after this that were fixed by Jeremy Robst actually.

10.4. A comcontainer.exe error arose on several occasions with the ER60 software, crashing the EK60 echosounder. This seems to arise when there is a conflict between the SSU and the EK60 and requires the power cycling of the EK60 and turning the trigger off on the SSU.

## **11. Macronutrient Analysis**

11.1. It can't be overemphasised how much more efficient and reliable our water sampling operation would have been with a Ti CTD together with a 24 bottle rosette. Instead of one 24 bottle CTD cast it was necessary to make two 12 bottle casts and deploy 6 Go-flo bottles to collect sufficient water for macro- and micronutrient analysis. Also note that Go-flo bottle deployment required five people, the depths of water collection were nominal, there is no concurrent oceanographic measurements and the bottles didn't always close correctly.

11.2. Throughout the cruise there were black soot or dust particles coming out of the ship's deckhead vents in the chemistry and the prep lab. Can the system be cleaned during refit?

11.3. All hazardous chemicals for the cruise were shipped in one case. I'm pleased to see minimal packing used and presumably the mix of chemicals met with shipping regulations. However, in future, might it be a good idea to separate flammables from corrosives and labelling cases on several sides with cruise, full contents list and consigners names would be mighty useful when they're being searched for in a ship's hold.

11.4. Requested chemical waste drums were not labelled specifically enough and were left in Stanley. Fortunately there were enough surplus drums onboard to suffice otherwise we would have had big problems.

## **12. Primary Productivity**

12.1. On of the major problems with the cruise was that we were unable to borrow the UKORS titanium CTD. Instead of one 24 bottle CTD, we had to deploy a 12 bottle CTD twice and collect "clean" water with GoFlo bottles. As noted by Whitehouse, the GoFlo bottle deployment required five people, the depths of water



collection were nominal, there is no concurrent oceanographic measurements and the bottles didn't always close correctly.

12.2. At the beginning of the cruise the lab was cleaned out to remove soot or dust particles. However, after this the lab was repeatedly covered with dust/soot from the deckhead vents. It seems pointless to clean bottles etc thoroughly and follow clean techniques if the lab is so badly and regularly contaminated with dirt from the vents.

12.3. It was noted that one of the chemical waste drums from the rad lab containing seawater with <sup>14</sup>C leaked whilst being moved to the CTD annex. The leak came from one side of the drum lid, which may have been faulty. Whilst the rad leak from this one drum was contained and did not present a danger to anyone, there may have been other incidences of leaky drums (this was never confirmed to me) which could present a real hazard to those moving the waste drums.

12.4. The BAS FRRF died near the very end of the cruise at condensed station 6. The problem most likely lies with the flashcard. Due to the death of the FRRF, an instrument response function test could not be performed on the instrument whilst at sea.

12.5. Internet access was often annoyingly slow. At times, it was difficult to download the satellite images that were sent to me which makes near real time cruise support a bit pointless!

12.6. To end this report on a positive note, I would like to say how useful the online event logs were for finding out both event numbers and underway oceanographic parameters e.g. PAR and fluorescence. Well done Nathan and Jeremy!

### **13. ARPS**

13.1. Mooring weights and chains could not be found in FIPASS.

13.2. Mooring riggings for the ARPs were considered amateurish and need complete re-rigging.

13.3. Future redeployments of ARPs will require a sufficiently powerful vacuum pump to be onboard the JCR.

13.4. Concern was raised that the ARPs are small and very difficult to see and may be difficult to locate during recovery. It is suggested that future ARP deployments should be equipped poles and flags to ensure successful recovery.

13.5. Management of data from the ARPs requires careful consideration as no provision for backing up the ARP data had been made prior to JR152, 159. Jeremy Robst therefore created a copy of each disk for security. These backups will be transferred to BAS via LTO tape and restored to SAN. Nathan Cunningham will ensure that Tony Martin is aware of where the data resides. For future cruises it is recommended that an external coupling mount for the 2.5" hard disks is purchased to ease the data transfer/backing up process and a copy of the software is available so the data can be transferred from binary format to ASCII and appropriately tagged with metadata as soon as possible.

## **14. Study of phytoplankton response to naturally iron enriched regions of the Scotia Sea**

14.1. In future cruises it is highly recommend that these stations are selected with respect to real-time satellite chlorophyll data and data obtained during the cruise. This is essential to ensure the maximal potential scientific output of such cruises.

14.2. Also, the on-deck bioassay incubation experiments provide a valuable demonstration of the limiting nutrients in selected regions of the Scotia Sea and an insight in the response of the phytoplankton community to these inputs. However, owing to the low-temperatures responses can be slow (> 10 days). It would be beneficial if cruise logistics would ensure time for the completion of these experiments. During JR161 the cooling of the bioassay work was achieve by the pumping surface sea water – this is not ideal when the ship is moving through diverse bodies of water and it is recommended that a self contained water cooling system be used in future.

## **15. A study of the iron distribution in the Scotia Sea**

15.1. The initial results show that the first Process station was not as HNLC condition as planned. Therefore it would be advisable for future cruises that the cruise line would be take into account the latest satellite images.

15.2. For future cruises in this region a more cold resistant kind of tubing should be used as the tubing became very brittle in the water and snapped in half when pressure was put on it. Also, gaffa tape is better as use as tape as the grey tape I had was too brittle for the cold weather.

15.3. Access to the container should be avoided when the wire for the net comes in again as during the winch time a brush is washing the wire coming in spraying iron water all over the place and onto the container. See picture 1

15.4. For future work, it would be a wish to bring at least one more person on the cruise to assist with the iron work and bioassay. This would improve the coverage of underway sampling and having an extra person would mean that a bigger suite of nutrient and light combinations for the bioassay experiments could be done.

15.5. The clean container: The UKORS clean container was used as a lab. The back and front door had both big visual gaps. Please see picture 2. The back door was sealed using silicon gel to avoid water, air and other contaminants to enter the clean space. The front door was left untouched.

15.6. The milli-Q system in the clean container had visual algal growth in the pipes and therefore it was decided to use the ships MQ system instead.

15.7. During the cruise on the 19.11.06 in the early morning it was noticed that one of the windows facing the afterdeck was cracked. There is no clue what has caused this accident.

15.8. The Go-Flos worked very well. Only comment for future cruises would to have a meter counter on the winch.



Picture 1, clean container covered in iron spray.



Front door

Back door

Picture 2, Cracks in door seals

## **16. Krill Studies**

16.1. Comparisons of length-frequency distributions obtained with RMT25 and RMT8 net: possibility of under sampling small krill with RMT25 due to larger mesh size.

## **17. Acoustic Report**

17.1. Investigate value of BAS1 Echoview dongle – should we replace parallel port dongle for USB dongle?

17.2. Real-time current information would be useful when deciding what direction to run the acoustic transect in.

17.3. The UOR should be brought on subsequent cruises. It is obvious from the underway TSG that the survey sites are regions of high variability. The vertical structure of this should be investigated.

17.4. The method of searching for targets downwind and then fishing on them upwind worked very well (typically also because of the responsiveness of all the crew and officers onboard – thank you). It is recommended that this method is used in the future.

17.5. The acoustic transects should occur at the beginning of the stations rather than at the end so that the viability of target fishing can be evaluated rather than wasting valuable fishing time doing non-target target fishing or not targeting the right location within the survey area.

17.6. THE ADCP AND EK60 NEED INTERFACING PROPERLY. THIS REQUIRES DEDICATED TIME ON BOARD THE JCR WITH AN ADCP EXPERT, MYSELF AND IT SUPPORT. Until this happens biological and physical data will be compromised.

17.7. A night time slot should be allocated to undertake a shallow RMT tow for live krill experiment catches.

17.8. The Doppler logger of the ship causes interference with the EK60 120 kHz data quality. An investigation into whether the Doppler logger is still required or whether it could be interfaced with the SSU would be desirable. This will be raised by Pete Enderlein in the STEG.

## **18. Predator Observations**

18.1. The method of counting animals whilst on station was felt to be inadequate because it was only possible to systematically count animals close to the ship. These animals tended to be species that were attracted to the ship (although this tendency could be exploited as a sampling method). They usually congregated around the stern in the prop wash (while in station use of the ship's DP system to hold the vessel head to wind meant there was always some prop wash) or midway along the beam, where the ship's macerators discharged food waste. Counting animals from the stern and bow might have been preferable to counting from the sides as this would give some indication of which animals were attracted to the ship and which were simply passing by. Alternatively, animals in an area further from the ship could be counted using binoculars but this method would only be effective in low sea states and good

visibility.

18.2. It was possible at most but not all times for an observer to collect and enter data simultaneously. This was due mainly to the use of the rugged laptop, which was invaluable and performed very well throughout the cruise (although see below). However, at times when the animal density was high a data recorder was necessary in order for the observer not to miss a significant number of animals. Furthermore, because there was only one observer data could not be collected continuously whilst underway. This meant that important features such as fronts were often crossed while no predator data was being collected. An ideal situation would be to have two trained observers working shifts assisted by data recorders drawn from the scientific party or people in transit.

18.3. The movement codes were over complicated. Flight type could have been more succinctly described as direct, turning or circling.

18.4. The laptop's touch-screen backlight occasionally switched off unexpectedly making it nearly impossible to use the screen. This seemed to happen if the laptop was left outside in the cold on standby during breaks, etc. Hence, it was always taken inside when not in use. Having spoken to the manufacturers it seems that this is a fault and should be fixed before the laptop is used on another cruise.

18.5. During underway observations all birds in flight passing through the transect were recorded (with some marked as in snapshot). For some studies this level of detail may be unnecessary and it may be acceptable to record only birds seen in the snapshot counts. Taking this approach would mean more time could be devoted to recording birds' behaviour.

18.6. Working from the bridge wings was effective and is common practice among predator observers. However, it did at times cause some disruption to the bridge officers. Given that cetacean or air-breathing predator surveys are often undertaken from the *RRS James Clark Ross* it might be worth considering fitting a permanent or removable shelter on the monkey island for observers. Such shelters have apparently been fitted to the *Polar Stern* and other research ships operating in the Southern Ocean.

## **19. AME**

19.1. When working on slip rings it is very important that the cover is installed properly and that the cable that enters the cover is orientated and adjusted properly. At one point in the cruise the net monitor was behaving most erratically, this was eventually traced to the slip rings. The large multi-core wire that enters the cover was placed such that too much of the cable was inside the housing. This meant that over time several of the inner cores gradually rubbed on the rotating slip ring and eventually started to cause an intermittent short.

19.2. A 'last look' with a torch and mirror is a good idea before closing the cover after PPM or problems.

## **20. ITS**

20.1. The SCS is suffering from age (it only just installed on a Windows 2000

machine), and is not a good fit for the way the data logged is used on board. A new data logging system should be investigated, possible for installation in Summer 2007.

20.2. The UPS situation in the Computer Office is very poor, both in the capacity and the lack of graceful shutdown ability. This needs to be investigated and proper UPS provisioning provided.

## **Oceanography**

### **Vessel-mounted Acoustic Doppler Current Profiler (VM-ADCP)**

***Elizabeth Hawker***

#### **1. Introduction**

*RRS James Clark Ross* had a 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP installed during August 2005, replacing the old 150 kHz RDI unit that had seen many years of service. The OS75, in principle, is capable of profiling to deeper levels in the water column, and can also be configured to run in either narrowband or broadband modes. As such, it represents a useful advance in the science capability of the *JCR*.

#### **2. Instrument and configuration**

The OS75 unit is sited in the transducer well in the hull of the *JCR*. This is flooded with a mixture of 90% de-ionised water and 10% monopropylene glycol. With the previous 150 kHz unit, the use of a mixture of water/antifreeze in the transducer chest required a post-processing correction to derived ADCP velocities. However, the new OS75 unit uses a phased array transducer that produces all four beams from a single aperture at specific angles. A consequence of the way the beams are formed is that horizontal velocities derived using this instrument are independent of the speed of sound (vertical velocities, on the other hand, are not), hence this correction is no longer required.

The OS75 transducer on the *JCR* is aligned at approximately 60 degrees relative to the centre line. This differs from the recommended 45 degrees. The hull depth was measured by Robert Patterson (Chief Officer), and found to be 6.47m. Combined with a value for the distance of the transducer behind the sea-chest window of 100-200mm and a window thickness of 50mm, this implies a transducer depth of 6.3m. This is the value assumed for JR161.

During the trials cruise, it was noted that the OS75 causes interference with most of the other acoustic instruments on *JCR*, including the EM120 swath bathymetry system. To circumvent this, all acoustic instruments were set to ping sequentially through the SSU, however this acts to reduce the ping rate. As noted by Dr. Sophie Fielding, when in deep water the swath can take 20 to 30 seconds from ping to end of listening, as a result this means the ADCP only pings once every 25 or so seconds. A further problem is that the ADCP appears to “time out” every other ping when it has to wait a long time between pings (i.e when running in deep water alongside the EM120). This results in it rebooting and waking the ADCP instrument up every other

ping, which simply exacerbates the problem. A fix is promised by BAS AME, but requires a firmware upgrade from RDI which is not presently available. During Jr161 the swath bathymetry system was not turned on because of the severe effects on data sampling rate and data quality. Several trial setups were undertaken to try to synchronise the ADCP with the EK60 (these are recorded in the setup log files (within the cruise ADCP directory) and within the EK60/Acoustic cruise log)), the final setup established using the SSU was to ping the ADCP synchronously with the EK60 and EA600. The EK60 was the master instrument (this was established using the command CX1,3 in the ADCP setup script) and was set to a constant ping rate of 2.5 seconds, the ADCP and EA600 were slaves. The SSU setup is described in the EK60 methods section of this cruise report. This created good data for both the ADCP and the EK60, only when the ADCP was set in narrowband – bottom tracking off mode. This method **does not work** with the ADCP in bottom tracking mode. More effort is required to establish how to interface all these instruments together with a minimum of interference to all.

The heading feed to the OS75 is the heading from the Seapath GPS unit. This differs from the previous ADCP setup on *JCR*, which took a heading feed from the ship's gyrocompass and required correction to GPS heading (from Ashtech) in post-processing.

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The logging PC also had Version 1.13 of the RDI WinADCP software installed and running, to act as a realtime monitor of data. The OS75 ran in two modes during JR161: narrowband (with bottom-tracking on) and narrowband (with bottom-tracking off). Narrowband profiling with bottom-tracking on was enabled with sixty-five 16 meter bins, and with bottom-tracking off with seventy 16 meter bins. Narrowband profiling was also enabled with an 8 meter blanking distance. The time between pings was set to 2 seconds, again following advice from Dr. Deb Shoosmith (Note this 2 second rate was only during periods of bottom tracking where the ADCP was in control of itself. For the greater percentage of time the ping rate was 2.5 seconds as controlled by the SSU and EK60 master). Salinity at the transducer was set to zero, and Beam 3 misalignment was set to 60.08 degrees (see above discussion). The full configuration files for each of the modes used are given in the Appendix.

### **3. Notes for Instrument Setup**

Set up the ADCP to run in narrowband mode

Open VMDAS

> file > collect data  
> options > edit data options

ADCP setup tab: ADCP set up from file (using required command file)  
set time between ensembles to 2 seconds

Recording tab:name: JR161\_ (filenames will then update in correct format)  
number:1  
max size: 10

dual output directories:

U: drive (making unix the primary drive)  
C: local (as secondary drive)

Transform tab: heading source: nmea/prdid  
tilt source: fixes tilts 0, 0

Command Files should have line of code added to run the ADCP through the SSU:  
; Set Trigger In/Out [ADCP run through SSU]  
CX1,3

ADCP needs to be pinging every five seconds or faster for decent data  
- can be checked by looking at \*N1R files and picking out lines starting \$PADCP

#### **4. Outputs**

The ADCP writes files to a network drive that is samba-mounted from the Unix system. (Should the network fail, there is an alternative write path to the local ADCP PC hard drive to preserve data until the link is restored). When the Unix system is accessed (via samba) from a separate networked PC, this enables post-processing of the data without the need to move files.

Output files are of the form JR161\_XXX\_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte.

ZZZ are the filename extensions, and are of the form:-

.N1R (NMEA telegram + ADCP timestamp; ASCII)  
.ENR (Beam coordinate single-ping data; binary)  
.VMO (VmDas configuration; ASCII)  
.NMS (Navigation and attitude; binary)  
.ENS (Beam coordinate single-ping data + NMEA data; binary)  
.LOG (Log of ADCP communication and VmDas error; ASCII)  
.ENX (Earth coordinate single-ping data; binary)  
.STA (Earth coordinate short-term averaged data; binary)  
.LTA (Earth coordinate long-term averaged data; binary)

#### **5. Post-processing of data**

OS75 data were processed on JR161 using Matlab code originated by IFM Kiel. This was adapted by Dr. Mark Inall and Dr. Deb Shoosmith for use with the JCR system. The master file for the processing is "OS75\_JCR\_FINAL\_JR161.m", which calls a lengthy sequence of routines to execute the following steps:-

1. Read RDI binary file with extension .ENX and ASCII file with extension .N1R into Matlab environment.
2. Remove missing data and data with bad navigation
3. Merge Seapath attitude data with single-ping ADCP data.
4. Correct for transducer misalignment and velocity scaling error (calculated during first run-through of code, applied during second)



5. Derive ship velocity from Seapath navigation data
6. Perform quality control on data, such that four-beam solution is only permitted. Other screening is performed based on maximum heading change between pings, maximum velocity change between pings, and the error velocity.
7. Average data into ensembles of pre-defined length (120 seconds for JR139)
8. Calculates transducer misalignment and velocity scaling error (computation done on first run-through of code, to be applied during second)
9. Velocities from depths deeper than 86% of the bottom-tracking depth are set to missing.
10. Determine absolute velocities from either bottom-track ship velocity or Seapath GPS.

**Final data are stored in Matlab format. Filenames are of the form:**

- 1) JR161\_000\_000000\_A\_hc.mat, where A is the highest number of the user-incremented files. (This is the number that VmDas increments every time logging is stopped and restarted). This contains structured arrays “c” (ensembled-averaged data), and “b” (absolute velocities)
- 2) JR161\_00A\_00000Bd.mat, where A is as above, and B is the number VmDas increments every time filesize exceeds 10 Mbyte. This contains single-ping data in structured array “d”.
- 3) JR161\_00A\_00000Bd\_ATT.mat. As (2), but containing ship’s attitude data rather than ADCP data.
- 4) JR161\_00A\_000000\_ATT.mat. As (3), but for the whole section of data in the user-incremented series A

## **Appendix 1: Command File without Bottom Tracking**

```
-----\  
; ADCP Command File for use with VmDas software.  
;  
; ADCP type: 75 Khz Ocean Surveyor  
; Setup name: default  
; Setup type: low resolution, Long range profile(Narrowband) deep water  
;  
; NOTE: Any line beginning with a semicolon in the first  
; column is treated as a comment and is ignored by  
; the VmDas software.  
;  
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).  
; Modified Last: 28August2005  
-----/  
  
; Restore factory default settings in the ADCP  
cr1  
  
; set the data collection baud rate to 38400 bps,  
; no parity, one stop bit, 8 data bits  
; NOTE: VmDas sends baud rate change command after all other commands in  
; this file, so that it is not made permanent by a CK command.  
cb611  
  
; Set for narrowband single-ping profile mode (NP), seventy (NN) 16 meter bins  
(NS),  
; 8 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)  
  
; Switch Narrowband ON NP1  
NP1  
nn70  
ns1600  
nf0800  
  
; Switch Broadband OFF WP0  
  
WP000  
WN065  
WS800  
WF0200  
  
WV390  
  
; Disable single-ping bottom track (BP),  
; Set maximum bottom search depth to 1200 meters (BX)
```

; Bottom track OFF  
BP00  
BX12000

; output velocity, correlation, echo intensity, percent good  
WD111100000

; One and half seconds between bottom and water pings  
TP000150

; Two seconds between ensembles  
; Since VmDas uses manual pinging, TE is ignored by the ADCP.  
; You must set the time between ensemble in the VmDas Communication options  
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading  
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer  
; temperature sensor  
EZ1020001

; Output beam data (rotations are done in software)  
EX00000

; Set transducer misalignment (hundredths of degrees)  
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]  
ED00063

; Set Salinity (ppt) [salinity in transducer well = 0]  
ES0

; Set to trigger by SSU  
CX1,3

; save this setup to non-volatile memory in the ADCP  
CK

## **Appendix 2: Command File with Bottom Tracking**

```
-----\
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: default
; Setup type: low resolution, Long range profile(Narrowband) 1000 m
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
-----/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty five (NN) 16 meter bins
(NS),
; 8 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)

; Switch Narrowband ON NP1
NP1
nn65
ns1600
nf0800

; Switch Broadband OFF WP0

WP000
WN065
WS800
WF0200

WV390

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX) (decimeters)
BP01
```

BX12000

; output velocity, correlation, echo intensity, percent good  
WD111100000

; Two seconds between bottom and water pings  
TP000200

; Three seconds between ensembles  
; Since VmDas uses manual pinging, TE is ignored by the ADCP.  
; You must set the time between ensemble in the VmDas Communication options  
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading  
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer  
; temperature sensor  
EZ1020001

; Output beam data (rotations are done in software)  
EX00000

; Set transducer misalignment (hundredths of degrees)  
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]  
ED00063

; Set Salinity (ppt) [salinity in transducer well = 0]  
ES0

; Set Trigger In/Out [ADCP run through SSU]  
; CX0,0  
CX1,3

; save this setup to non-volatile memory in the ADCP  
CK

# CTD Data Acquisition and Deployment

***Elizabeth Hawker, Christos Mitsis, Enrique Vidal with additional support from Nathan Cunningham, Data Manager***

## ***1. Introduction***

A Conductivity-Temperature-Depth (CTD) unit was used on JR161 to vertically profile the temperature and salinity of the water column. In total 63 CTD casts were completed. The method of acquisition and calibration of the data are described below. A test of the CTD was performed before the first process station.

A summary of all CTD deployments is given in Table ctd1. During the cruise we carried out three 4-day Process Stations, five 2-day Condensed Stations, and five full depth Transect Stations. The CTD protocol for these stations were as follows:

### *Process Station:*

Day 1 full-depth cast, shallow cast, shallow cast to chl max, cast to 2000m  
Day 2 full-depth cast, shallow cast, shallow cast to chl max, cast to 2000m, 400m cast for Oithona  
Day 3 full-depth cast, shallow cast, shallow cast to chl max, cast to 2000m  
Day 4 no CTD casts

### *Condensed Stations:*

Day 1 full-depth cast, shallow cast  
Day 2 400m cast for Oithona

### *Transect Stations:*

Full depth CTD cast

The bottle firing protocols for these stations were:

- a) full depth cast: 10m off bottom, 3000m, 2500m, 2000m, 1500m, 1000m, 800m, 600m, 400m, 200m, 180m, 160m
- b) shallow cast: 140m, 120m, 100m, 80m, 60m, 50m, 40m, 30m, 20m, 10m, 5m, final bottle at chl. max
- c) shallow cast to chl max.: all bottles to be fired at depth of chl. max
- d) cast to 2000m: all bottles to be fired at depth of 2000m
- e) 400m cast for Oithona: 400m, 400m, 300m, 300m, 200m, 200m, 100m, 100m, 50m, 50m, and two bottles as close to surface as possible

On all full-depth casts salinity samples were taken, and samples for O18 were also collected on all full-depth casts during the transect (detailed in Table ctd1).

## ***2. CTD unit and deployment***

A full sized SBE 24 carousel water sampler, holding 12 bottles, connected to an SBE 9 plus CTD and an SBE 11 plus deck unit was used to collect vertical profiles on the water column. The deck unit provides power, real time data acquisition and control.

The underwater SBE 9 plus unit featured dual temperature (SBE 3 plus) and conductivity (SBE 4) sensors, and a *Paroscientific* pressure sensor. A TC duct and a pump-controlled flow system ensure that the flow through the T-C duct is constant to minimize salinity spiking. Used in conjunction with the SBE 32 and SBE 911, the SBE 35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle file confirmation is confirmed. A file containing the time, bottle position and temperature is recorded allowing comparison of the SBE 35 record with the CTD and bottle data.

In addition, an altimeter, a fluorometer, an oxygen sensor and a PAR sensor were attached to the carousel. The altimeter gave real time accurate measurements of height off the sea-bed once the instrument package was within approximately 100 m of the bottom. The Simrad EA600 system would sometimes lose the bottom or give erroneous readings on station, so care was needed to interpret these digitised records.

Although collected, the fluorometer, PAR and oxygen data have not been processed beyond the initial SBE data processing package and will thus not be discussed further.

For all stations two UKORS LADCPs (one upward looking, the other downward looking) were attached to the main CTD frame. A fin was also added to the frame to reduce rotation of the package underwater (see LADCP section of this cruise report).

The CTD data were logged via the deck unit to a 1.4GHz P4 PC, running Seasave Win32 version 5.37b (Sea-Bird Electronics Inc.). This new software is a great advance on the DOS version, allowing numerical data to be listed to the screen in real time, together with several graphs of various parameters. The data rate of recorded data for the CTD was 24 Hz.

The CTD package was deployed from the mid-ships gantry and A-frame, on a single conductor torque balanced cable connected to the CTD through the BAS conducting swivel. This CTD cable was made by Rochester Cables and was hauled on the 10T traction winch. The general procedure was to start data logging, deploy, and then to stop the CTD at 10 m cable out. The pumps are water activated and typically do not operate until 30-60 seconds after the CTD is in the water. If the word display on the Deck Unit is set to 'E' then the least significant digit on the display indicates whether the pumps are off (0) or on (1). After a 2 minute soak, the package was raised to just below the surface and then continuously lowered to near bottom, with the Niskin bottles being closed during the upcast. The final CTD product was formed from the calibrated downcast data averaged to 2 db intervals.

### **3. Data Acquisition**

At the end of each CTD cast, four files were created by the Seasave Win32 version 5.28e module:

*161\_[nnn].dat* a binary data file

*161\_[nnn].con* an ascii configuration file containing calibration information

*161\_[nnn].con* an ascii header file containing the sensor information

*161\_[nnn].bl* a file containing the data cycles at which a bottle was closed on the rosette

where [nnn] refers to the CTD cast number. These files were saved directly to the \\samba\pstar drive.

The CTD data was converted to ascii and calibrated by running the Sea-Bird Electronics Inc. Data Processing software version 5.37b *Data Conversion* module. This program was used only to convert the data from binary, although it can be used to derive variables. This outputted an ascii file *161\_[nnn].cnv*.

The pressure sensor was calibrated following:

$$P = C \left( 1 - \frac{T_0^2}{T^2} \right) \left( 1 - D \left( 1 - \frac{T_0^2}{T^2} \right) \right)$$

where  $P$  is the pressure,  $T$  is the pressure period in  $\mu S$ ,  $U$  is the temperature in degrees Centigrade,  $D$  is given by  $D = D1 + D2U$ ,  $C$  is given by  $C = C1 + C2U + C3U^2$ ,  $T_0$  is given by  $T_0 = T1 + T2U + T3U^2 + T4U^3 + T5U^4$ .

The conductivity sensor was calibrated following:

$$cond = \frac{(g + hf^2 + if^3 + jf^4)}{10(1 + \delta t + \varepsilon p)}$$

where  $p$  is pressure,  $t$  is temperature, and  $\delta = CTcorr$  and  $\varepsilon = Cpcorr$ .

The temperature sensor was calibrated following:

$$Temp(ITS - 90) = \left\{ \frac{1}{g + h(\ln(f_0/f)) + i(\ln^2(f_0/f)) + j(\ln^3(f_0/f))} \right\} - 273.15$$

where  $f$  is the frequency output by the sensor.

The Sea-Bird Electronics Inc. Data Processing software version 5.37b was then used to apply the following three processing steps:

- *Filter module*. A low pass filter was applied to the conductivity and pressure to increase the pressure resolution prior to the *loopedit module*. Output file is of the form *161\_[nnn]\_f.cnv*.

- *Cell Thermal Mass module*. This was used to remove the conductivity cell thermal mass effects from the measured conductivity. This takes the output from the data conversion program and re-derives the pressure and conductivity to take into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output file is of the form *161\_[nnn]\_fc.cnv*. This correction followed the algorithm:

$$Corrected\ Conductivity = c + ctm$$

where,

$$ctm = (-1.0 * b * previous\ ctm) + (a * dcdt * dt),$$

$$dt = (temperature - previous\ temperature),$$

$$dcdt = 0.1 * (1 + 0.006 * (temperature - 20)),$$

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



and  $b = 1 - (2 * a / \alpha)$  with  $\alpha = 0.03$  and  $\beta = 7.0$

- *Loopedit module*. This routine marks scans where the CTD package is moving less than minimum velocity or travelling backwards due to ship roll. Minimum velocity was fixed, and set to 0.25 m/s. Output file is of the form *161\_[nnn]\_fcl.cnv*.

All processed files were saved to the \\samba\pstar drive, and the *\_fcl.cnv*, *.ros* and *.bl* files also copied to *~/pstar/JR161/jr161\_ctd/processed/161\_[nnn]/*

#### **4. SBE35 High Precision Thermometer**

The BAS SBE35 high-precision thermometer was fitted to the CTD frame. Each time a water sample was taken using the rosette, the SBE35 recorded a temperature in EEPROM. This temperature was the mean of  $8 * 1.1$  seconds recording cycles (therefore 11 seconds) data. The thermometer has the facility to record 157 measurements but the data was downloaded approximately every few casts.

To process the data, communication was established between the CTD PC and the SBE35 by switching on the deck unit. The *SeaTerm* programme was used to process the data. This is a simple terminal emulator set up to talk to the SBE35. Once you open the program the prompt is ">". The SBE35 will respond to the command 'ds' (display status) by telling you the date and time of the internal clock, and how many data cycles it currently holds in memory. A suitable file name can be entered via the 'capture' toolbar button, and the data downloaded using the command 'dd' (dump data).

The data currently held in the memory is listed to the screen. This can be slow due to the low data transfer rate. Once the download is completed the 'capture' button should be clicked to close the open file, and the memory of the SBE 35 cleared using the command "*samplenum=0*". To check the memory is clear the command 'ds' should again be entered before shutting down the system.

The SBE35 data files were divided into separate files for each station with up to 12 records (one level for each bottle, see section) called *jr161sbe[nnn].txt*. These files were saved directly to the \\samba\pstar drive *~/pstar/cruise/ctd/jr161\_sbe35/*.

#### **5. Salinity Samples**

At each full-depth CTD station 12 Niskin bottles were closed at varying depths through the water column and then sampled for salinity analysis. Salinity samples were not collected on the shallower casts.

The primary purpose of collecting salinity samples is to calibrate the salinity measurements made by the CTD sensors. Samples were taken in 200 ml medicine bottles. Each bottle was rinsed three times and then filled to just below the neck, 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, a plastic seal was inserted into the neck of the bottle and the screw cap was replaced. The bottle crates were colour coded and numbered for reference. The salinity samples were placed close to the

salinometer and left for at least 24 hours before measurement. This allowed the sample temperatures to equalise with the ambient temperature of the lab.

The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360 against Ocean Scientific standard seawater (hereafter OSIL) from batch P146. At the start of the cruise the salinometer was standardised with OSIL P146. At the beginning, and at the end of each crate of samples one vial of OSIL standard seawater was run through the salinometer enabling a calibration offset to be derived and to check the stability of the salinometer.

Once analysed, the conductivity ratios were entered by hand into an EXCEL spreadsheet and converted to salinities. This spreadsheet was used by the matlab scripts for further CTD data processing.

### **Problems:**

At first there were problems with the new external pump that draws the sample into the salinometer. It was introducing many microbubbles into the cell causing the readings to be highly unstable and fluctuate abnormally. As a result the analysis of the first crate of salts lasted well over 3.5 hours. It was found that the clamps holding the tube inside the pump were too tight. After loosening the clamps the bubbles ceased to flow into the cell, however the salinometer readings continued to be highly unstable, taking a very long time to stabilize. The reading would regularly creep up or down 30-40 digits before stabilizing at a particular value (eg. 1.98321 – 1.98365). This occurred typically in all three readings per bottle, causing the analysis of an entire crate to take over 3.5 hours each time. Several attempts at solving the problem were made, including re-calibrating the salinometer & varying the pump flow speed. Neither of these had any effect, therefore the majority of bottles were analysed successfully despite unusual behaviour and instability of the salinometer.

The solution was finally found by replacing the new pump by one of the old peristaltic pumps. After the replacement the salinometer readings stabilized much quicker, with the first reading typically varying less than 10 units, and subsequent readings usually only oscillating 3-5 units. This reduced the “crate analysis time” to a more normal two hours.

The possible problem of the new pump was the right sized tubing had not been delivered with the pump for this cruise, therefore a thinner diameter tube had to be used. It is believed that with such a small tube, the pump would vaporize the water inside the tube causing micro-bubbles which were not visible to the naked eye, but were seriously affecting the salinometer readings. The old tried and tested peristaltic pump caused the salinometer to behave in its usual manner.

A small problem was found with the peristaltic pump; the highest flow setting was producing too much pressure on the outgoing tube causing it to pop out releasing water into the pump casing. The only solution that was found for this problem was to use superglue to physically stick the two tubes together. After this, everything worked fine.

## 6. **Samples for O<sup>18</sup> analysis**

Samples were taken for O<sup>18</sup> analysis on all full depth CTD casts along transect T (ie all stations except PS1 and C1). The relevant stations are detailed in table ctd1. Samples were collected in 50ml glass bottles. Each bottle was rinsed three times and then filled to just below the neck. A plastic seal was inserted into the neck of the bottle, and a metal cap fixed in place using a crimper in order to seal the bottle. The bottles were labeled with the CTD cast number scratched on to the glass and marked in permanent pen. A further label (written on duct tape) was placed on each bottle with cruise name, CTD cast number, and station description. The bottles were then boxed up for return to the UK at the end of the season for analysis.

## 7. **CTD data processing**

Further processing of the CTD data was completed using matlab scripts written by Mike Meredith and modified by Deb Shoosmith. No use has been made of IPTS-68 temperatures, instead all calculations are done using version 3.0 of the CSIRO seawater toolbox using ITS-90 temperatures.

The MATLAB routines applied are as follows and are an amalgamation of those used on JR116, JR139 and JR151:

1. *ctdread.m* reads the status stored in the **jr161\_nnn\_fcl.cnv** file into MATLAB matrices by invoking *cnv2mat.m* routine, and names them accordingly. Output is of the form **ctdnnn.cal**.
2. *offpress.m* applies an offset pressure based on CTD deck pressure (using the median value of all negative pressure data). It sets variables to missing (NaN) if pumps were not operational. Output is of the form **ctdnnn.wat**.
3. *spike.m*: removes the larger spikes in the CTD datastreams. Output is of the form **ctdnnn.spk**.
4. *interpol.m*: interpolates missing data in the CTD datastreams. Outputs to **ctdnnn.int**.
5. *makebot.m* reads the SeaBird **ctdnnn.ros** file and the **ctdnnn.wat** to create a bottle file of the form **botnnn.1st**. CTD data corresponding to the bottle firings are derived as the median values between the start and stop scans given in the **.ros** file. Temperature on the IPTS-90 scale is derived (used for input to MATLAB seawater routines), and salinity and potential temperature calculated using *ds\_salt.m* and *ds\_ptmp.m*. Warnings are written if large standard deviations in the CTD data corresponding to the bottle firings are obtained.
6. *readsal.m* loads the Niskin bottle numbers and corresponding salinities from the excel spreadsheet (**Salinity\_Master\_jr161.xls**). Missing samples are represented as NaNs. Output is of the form **salnnn.mat**.
7. *addsal.m* reads the **botnnn.1st** file and adds the sample salinity. Output is of the form **botnnn.sal**.

8. *setsalflag.m* sets the salinity flag in the **botnnn.sal** file to zero for instances when the standard deviation of any of the conductivity or temperature data (from either sensor) at the bottle firing levels is greater than 0.002.
9. *salplot.m* produces plots of: 1. CTD and bottled salinity with depth, 2. Difference between the CTD and bottled salinities with depth. This can be used to determine which bottles should be selected to compute offsets to be applied to the CTD data to reconcile them with the bottle data, however for preliminary processing, no salinity samples were excluded. This is a visual check and no output is generated. Further bottles can be excluded from the calibration by adjusting *salflag*.
10. *salcal.m* calculates the adjustment to nominally calibrated CTD salinity required to get the best fit to (non flagged) bottle data. It calls the *sw\_cndr.m* routine to calculate conductivity from the bottle salinities at the temperature and pressure of the corresponding CTD salinities. The derived offsets are placed in the **botnnn.sal** file.
11. *salcalapp.m* applies the derived offsets to the CTD conductivities, and then calculates salinity, potential temperature, and potential densities. Output is of the form **ctdnnn.var** and **botnnn.cal**.
12. *splitcast.m* divides the CTD cast into an upcast and downcast, with the dividing point being determined by the maximum value of pressure. Output is of the form **ctdnnn.var.dn** and **ctdnnn.var.up**.
13. *gridctd.m* reads the downcast profile and derives 2 dbar averages of all properties. Output is of the form **ctdnnn.2db**.

The above programmes were run for each station in two stages using:

**m00\_jr161\_runCTDprocessing.m**

followed by

**m00\_jr161\_runCTDprocessing.m**

for full depth casts with salinity samples

or **m00\_jr161\_runCTDprocessing.m**

for casts without salinity samples

The procedure explained above was used for calculating the derived conductivity offsets for calibration of casts with salinity samples. This calibration was then used for the shallower casts on that station. The calibration offsets are given in Table ctd1.

**Table ctd1: Summary of JR161 CTD deployments. The test station is not listed.**

| STATION | Event | Date       | JDay | Time at bottom (GMT) | Longitude | Latitude | Water depth | Max CTD pressure | Station Description           | Samples                | Conductivity offset (calibration) |
|---------|-------|------------|------|----------------------|-----------|----------|-------------|------------------|-------------------------------|------------------------|-----------------------------------|
| 001     | 019   | 27/10/2006 | 300  | 08:11:33             | 50 26.31  | 57 44.52 | 4116        | 4139             | PS1.1 full depth              | salts                  | -0.0025                           |
| 002     | 020   | 27/10/2006 | 300  | 10:35:00             | 50 26.30  | 57 44.51 | 4116        | 144              | PS1.1 shallow phyto           |                        | -0.0025                           |
| 003     | 023   | 27/20/2006 | 300  | 14:01:00             | 50 26.20  | 57 44.55 | 4118        | 22               | PS1.1 shallow to chl max (DP) |                        | -0.0025                           |
| 004     | 026   | 27/10/2006 | 300  | 16:10:00             | 50 25.27  | 57 44.58 | 4134        | 2033             | PS1.1 to 2000m (DP)           |                        | -0.0025                           |
| 005     | 032   | 28/10/2006 | 301  | 08:12:12             | 50 26.30  | 57 44.42 | 4115        |                  | Lost communication on upcast  |                        |                                   |
| 006     | 035   | 28/10/2006 | 301  | 12:04:30             | 50 25.30  | 57 44.57 | 4135        | 143              | PS1.2 shallow phyto           |                        | -0.0025                           |
| 007     | 036   | 28/10/2006 | 301  | 14:22:06             | 50 25.30  | 57 44.57 | 4134        | 4192             | PS1.2 full depth              | salts                  | -0.0020                           |
| 008     | 037   | 28/10/2006 | 301  | 16:40:00             | 50 23.58  | 57 44.48 | 4164        | 406              | PS1.2 shallow Oithona         |                        | -0.0020                           |
| 009     | 040   | 28/10/2006 | 301  | 20:48:00             | 50 23.57  | 57 41.70 | 4176        | 43               | PS1.2 shallow to chl max (DP) |                        | -0.0020                           |
| 010     | 045   | 29/10/2006 | 302  | 09:38:35             | 50 26.19  | 57 44.53 | 4117        | 4150             | PS1.3 deep                    | salts                  | -0.0020                           |
| 011     | 047   | 29/10/2006 | 302  | 11:58:00             | 50 25.96  | 57 44.60 | 4124        | 143              | PS1.3 shallow phyto           |                        | -0.0020                           |
| 012     | 050   | 29/10/2006 | 302  | 14:50:51             | 50 24.80  | 57 44.66 |             | 42               | PS1.3 shallow to chl max (DP) |                        | -0.0020                           |
| 013     | 052   | 29/10/2006 | 302  | 17:02:50             | 50 24.01  | 57 44.72 | 4164        | 2035             | PS1.3 to 2000m (DP)           |                        | -0.0020                           |
| 014     | 075   | 01/11/2006 | 305  | 09:20:45             | 48 41.80  | 60 38.89 | 1709        | 1676             | CS1.1 full depth              | salts                  | -0.0035                           |
| 015     | 077   | 01/11/2006 | 305  | 10:54:00             | 48 41.85  | 60 38.95 | 1703        | 143              | CS1.1 shallow phyto           |                        | -0.0035                           |
| 016     | 086   | 02/11/2006 | 306  | 07:17:52             | 48 41.91  | 60 38.88 | 1703        | 404              | CS1.2 shallow Oithona         |                        | -0.0035                           |
| 017     | 088   | 02/11/2006 | 306  | 08:23:38             | 48 42.03  | 60 38.85 | 1698        | 40.3             | CS1.2 shallow to chl max(DP)  |                        | -0.0035                           |
| 018     | 099   | 05/11/2006 | 309  | 11:49:05             | 44 40.18  | 60 25.22 | 1205        | 1192             | CS2.1 full depth              | salts, O <sup>18</sup> | -0.0010                           |
| 019     | 101   | 05/11/2006 | 309  | 13:31:53             | 44 40.75  | 60 25.13 | 1213        | 143              | CS2.1 shallow phyto           | O <sup>18</sup>        | -0.0010                           |
| 020     | 109   | 06/11/2006 | 310  | 07:12:11             | 44 36.99  | 60 26.40 | 748         | 405              | CS2.2 shallow Oithona         |                        | -0.0010                           |
| 021     | 111   | 06/11/2006 | 310  | 08:29:30             | 44 37.17  | 60 26.30 | 800         | 61               | CS2.2 shallow to chl max (DP) |                        | -0.0010                           |
| 022     | 120   | 07/11/2006 | 311  | 11:15:41             | 44 31.00  | 60 05.87 |             | 5201             | T-A full depth                | salts, O <sup>18</sup> | -0.0035                           |

|     |     |            |     |          |          |          |           |      |  |                        |         |
|-----|-----|------------|-----|----------|----------|----------|-----------|------|--|------------------------|---------|
| 023 | 121 | 07/11/2006 | 311 | 16:12:47 | 44 14.09 | 59 56.44 | 4740      | 4780 | T-B full depth   | salts, O <sup>18</sup> | -0.0045 |
| 024 | 127 | 08/11/2006 | 312 | 09:24:58 | 44 03.58 | 59 40.81 | 4100      | 4128 | CS3.1 full depth (stopped on downcast due to wrong EA600 depth readings) | salts, O <sup>18</sup> | -0.0037 |
| 025 | 129 | 08/11/2006 | 312 | 11:48:30 | 44 03.57 | 59 40.79 | 4109      | 143  | CS1.2 shallow phyto  |                        | -0.0037 |
| 026 | 137 | 09/11/2006 | 313 | 07:12:00 | 44 03.58 | 59 40.70 |           | 404  | CS3.2 shallow Oithona  |                        | -0.0037 |
| 027 | 139 | 09/11/2006 | 313 | 08:12:43 | 44 03.49 | 59 40.69 | EA600 off | 31   | CS3.2 shallow to chl max (DP)  |                        | -0.0037 |
| 028 | 148 | 15/11/2006 | 319 | 23:51:00 | 43 19.79 | 58 35.50 | 3098      | 3094 | T-C full depth   | salts, O <sup>18</sup> | -0.0025 |
| 029 | 152 | 16/11/2006 | 320 | 09:48:09 | 42 37.03 | 57 26.29 | 3289      | 142  | CS4.1 shallow phyto  |                        | -0.0025 |
| 030 | 161 | 17/11/2006 | 321 | 08:56:06 | 42 36.99 | 57 26.27 | 3289      | 404  | CS4.2 shallow Oithona  |                        | -0.0025 |
| 031 | 163 | 17/11/2006 | 321 | 10:04:00 | 42 37.04 | 57 26.29 | 3289      | 10   | CS4.2 shallow to chl max (DP)  |                        | -0.0025 |
| 032 | 166 | 17/11/2006 | 321 | 14:20:20 | 42 40.38 | 57 31.98 | 3113      | 3111 | CS4.2 full depth   | salts, O <sup>18</sup> | -0.0025 |
| 033 | 173 | 18/11/2006 | 322 | 07:29:40 | 41 14.77 | 55 12.35 | 3241      | 3236 | PS2.1 full depth   | salts, O <sup>18</sup> | -0.0055 |
| 034 | 175 | 18/11/2006 | 322 | 09:35:11 | 41 14.62 | 55 12.36 | 3233      | 143  | PS2.1 shallow phyto  |                        | -0.0055 |
| 035 |     | 18/11/2006 | 322 | 12:13:22 | 41 14.56 | 55 12.44 | 3233      | 41   | PS2.1 shallow to chl max (DP)  |                        | -0.0055 |
| 036 |     | 18/11/2006 | 322 | 13:48:56 | 41 14.5  | 55 12.50 | 3235      | 2030 | PS2.1 to 2000m (DP)  |                        | -0.0055 |
| 037 | 189 | 19/11/2006 | 323 | 05:30:00 | 41 14.76 | 55 12.36 | 3236      | 3232 | PS2.2 full depth   | salts                  | -0.0042 |
| 038 | 190 | 19/11/2006 | 323 | 07:33:00 | 41 13.07 | 55 12.83 | 3203      | 2032 | PS2.2 to 2000m (DP)  |                        | -0.0042 |
| 039 | 191 | 19/11/2006 | 323 | 08:58:00 | 41 12.80 | 55 12.84 | 3199      | 43   | PS2.2 shallow to chl max (DP)  |                        | -0.0042 |
| 040 | 194 | 19/11/2006 | 323 | 11:38:00 | 41 12.42 | 55 13.18 | 3199      | 143  | PS2.2 shallow phyto  |                        | -0.0042 |
| 041 | 195 | 19/11/2006 | 323 | 12:36:10 | 41 12.39 | 55 13.22 | 3199      | 406  | PS2.2 shallow Oithona  |                        | -0.0042 |
| 042 | 202 | 20/11/2006 | 324 | 06:27:00 | 41 14.80 | 55 12.49 | 3234      | 3241 | PS2.3 full depth   | salts                  | -0.0021 |
| 043 | 203 | 20/11/2006 | 324 | 08:37:00 | 41 14.18 | 55 12.78 | 3233      | 2029 | PS2.3 to 2000m (DP)  |                        | -0.0021 |
| 044 | 204 | 20/11/2006 | 324 | 09:40:30 | 41 14.43 | 55 12.60 | 3236      | 141  | PS2.3 shallow phyto  |                        | -0.0021 |
| 045 | 207 | 20/11/2006 | 324 | 12:27:00 | 41 14.04 | 55 12.91 | 3233      | 63   | PS2.3 shallow to chl max (DP)  |                        | -0.0021 |
| 046 | 225 | 22/11/2006 | 326 | 11:32:48 | 40 48.82 | 54 14.29 | 2013      | 2045 | T-I full depth   | salts, O <sup>18</sup> | -0.0030 |
| 047 | 226 | 22/11/2006 | 326 | 17:28:30 | 40 27.82 | 53 31.41 | 2058      | 2044 | T-J full depth   | salts, O <sup>18</sup> | -0.0031 |
| 048 | 232 | 23/11/2006 | 327 | 06:48:00 | 40 05.83 | 52 51.54 | 3792      | 3807 | PS3.1 full depth   | salts, O <sup>18</sup> | -0.0040 |

|     |     |            |     |          |          |          |      |      |                               |                        |         |
|-----|-----|------------|-----|----------|----------|----------|------|------|-------------------------------|------------------------|---------|
| 049 | 234 | 23/11/2006 | 327 | 08:55:55 | 40 05.81 | 52 51.62 | 3792 | 142  | PS3.1 shallow phyto           |                        | -0.0040 |
| 050 | 237 | 23/11/2006 | 327 | 11:36:30 | 40 05.58 | 52 52.40 | 3795 | 32   | PS3.1 shallow to chl max (DP) |                        | -0.0040 |
| 051 | 239 | 23/11/2006 | 327 | 13:08:55 | 40 05.47 | 52 52.52 | 3795 | 2036 | PS3.1 to 2000m (DP)           |                        | -0.0040 |
| 052 | 241 | 24/11/2006 | 328 | 11:51:00 | 40 08.35 | 52 52.21 | 3812 | 2034 | PS3.2 to 2000m (DP)           |                        | -0.0044 |
| 053 | 243 | 24/11/2006 | 328 | 12:23:09 | 40 08.35 | 52 52.21 | 3811 | 144  | PS3.2 shallow phyto           |                        | -0.0044 |
| 054 | 245 | 24/11/2006 | 328 | 14:47:03 | 40 08.35 | 52 52.51 | 3793 | 405  | PS3.2 shallow Oithona         |                        | -0.0044 |
| 055 | 247 | 24/11/2006 | 328 | 15:53:15 | 40 08.35 | 52 52.21 | 3800 | 32   | PS3.2 shallow to chl max (DP) |                        | -0.0044 |
| 056 | 249 | 24/11/2006 | 328 | 18:50    | 40 08.38 | 52 52.21 | 3793 | 3813 | PS3.2 full depth              | salts                  | -0.0044 |
| 057 | 254 | 25/11/2006 | 329 | 08:38:00 | 40 05.81 | 52 51.54 | 3792 | 142  | PS3.3 shallow phyto           |                        | -0.0044 |
| 058 | 257 | 25/11/2006 | 329 | 11:08:16 | 40 05.60 | 52 51.71 | 3792 | 31   | PS3.3 shallow to chl max (DP) |                        | -0.0044 |
| 059 | 259 | 25/11/2006 | 329 | 12:40:25 | 40 05.47 | 52 51.81 | 3793 | 2033 | PS3.3 to 2000m (DP)           |                        | -0.0044 |
| 060 | 276 | 28/11/2006 | 332 | 08:07:40 | 49 59.97 | 38 00.05 | 5132 | 5217 | CS6.1 full depth              | salts, O <sup>18</sup> | -0.0039 |
| 061 | 278 | 28/11/2006 | 332 | 10:44:46 | 50 00.25 | 37 59.56 | 5133 | 142  | CS6.1 shallow phyto           |                        | -0.0039 |
| 062 | 286 | 29/11/2006 | 333 | 06:19:10 | 50 00.00 | 37 59.99 | 5134 | 403  | CS6.2 shallow Oithona         |                        | -0.0039 |
| 063 | 288 | 29/11/2006 | 333 | 07:26:50 | 50 00.32 | 38 00.02 | 5134 | 25   | CS6.2 shallow chl max (DP)    |                        | -0.0039 |

## Table ctd2: JR161 CTD setup and calibration details

Date: 10/28/2006

ASCII file: D:\data\JR161\jr161cal.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 : 1/06/06  
G : 4.37187000e-003  
H : 6.40301000e-004  
I : 2.08044000e-005  
J : 1.58065000e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

### 2) Frequency, Conductivity

Serial number : 2875  
Calibrated on : 1/06/06  
G : -1.04861000e+001  
H : 1.44287000e+000  
I : 2.44973000e-003  
J : -1.00114000e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

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

Serial number : 93686-0771  
Calibrated on : 15/04/04  
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 : 2191  
Calibrated on : 1/06/06  
G : 4.31887000e-003  
H : 6.37084000e-004  
I : 2.15409000e-005  
J : 1.88209000e-006  
F0 : 1000.000

Slope : 1.00000000  
Offset : 0.0000

### 5) Frequency, Conductivity, 2

Serial number : 1912  
Calibrated on : 1/06/06  
G : -4.15313000e+000  
H : 5.34134000e-001  
I : -1.87130000e-004  
J : 3.35086000e-005  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

### 6) A/D voltage 0, Altimeter

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

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

### 8) A/D voltage 2, Oxygen, SBE 43

Serial number : 0676  
Calibrated on : 23/3/04  
Soc : 4.1960e-001  
Boc : 0.0000  
Offset : -0.4840  
Tcor : 0.0004  
Pcor : 1.35e-004  
Tau : 0.0

### 9) A/D voltage 3, Free

### 10) A/D voltage 4, Fluorometer, Chelsea Aqua 3

Serial number : 88249  
Calibrated on : 22/06/06  
VB : 0.433200  
V1 : 2.011100  
Vacetone : 0.432300  
Scale factor : 1.000000  
Slope : 1.000000  
Offset : 0.000000

### 11) A/D voltage 5, Free

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

Serial number : 7274  
Calibrated on : 30/05/06  
M : 1.00000000  
B : 0.00000000  
Calibration constant : 67114093959.73153700  
Multiplier : 1.00000000  
Offset : -0.02119270

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



# LADCP

**Elizabeth Hawker with additional support from Nathan Cunningham, Data Manager**

## 1. Introduction

Cruise JR161 used two RDI Workhorse WH300 ADCP (WH) units to collect direct current velocity (LADCP) data. A single 300 kHz RDI WH unit (*DWH; serial number 4908*) was deployed in a downward facing position mounted off-centre at the bottom of the CTD frame. A second WH unit was deployed in an upward facing position on the side of the CTD. These were used in a master and slave configuration respectively. A fin was added to the CTD frame to reduce spinning.

Between stations, each ADCP was connected to a controlling PC in the Underway Instrument Control (UIC) room through a serial cable for delivery of pre-deployment instructions and post-deployment data retrieval. The battery package was recharged after each deployment, by connection to a charging unit via a power lead.

The LADCP deployments and processing are summarized in Tables `ladcp1` and `ladcp2`.

## 2. Problems

We unfortunately had a number of problems with the LADCP on JR161. A summary of the CTD casts on which the LADCP was deployed is given in Table `ladcp1`.

1. Initially the master/slave command files used were adjusted from those found on the LADCP PC, and did not appear to work successfully. As described below the correct command files were used from CTD cast 015 onwards and only data from this point onwards has been processed
2. Communication with the LADCP was flaky. Although appearing to successfully go through the pre-deployment tests, on some casts data could only be recovered from one or other of the master and slave. Additionally, when data was recovered after a cast a variable number of files (instead of the expected one file) were found. Since the LADCP memory was cleared before every deployment, these files were all belonging to the cast in question. The initial processing (reported by `scan.prl`) often showed that these files were apparently empty - giving nonsense depths and times.

All raw files were saved to `U:\cruise\ladcp\JR161\jr161_[nnn]\` where *nnn* is the CTD cast number. They were named `jr161_[nnn]m[X].000` or `jr161_[nnn]s[X].000` where *nnn* is the CTD cast number, *m* or *s* refers to master or slave and *X* denotes a letter of the alphabet to identify between the multiple files recovered.

The initial processing required the files to be copied placed in `~/raw/jr0610/ladcp` and to be of the format `j[nnn]02.000` or `j[nnn]03.000` where *nnn* is the station number and the digit 2 represents master or the digit 3 represents slave.

For deployments where more than one file was recovered, each file was copied to *~/raw/jr0610/ladcp* in turn and investigated using *scan.prl* (see processing details below). Since only one file for each cast was found to contain data that file was retained in the directory *~/raw/jr0610/ladcp* and used in the further steps of the initial processing.

The *scan.prl* step (results recorded in *~/proc/proc.dat*) revealed that for a number of casts the start and end times and depths did not match those recorded in the CTD log. On some casts only the downcast appeared to be recorded, or part of the downcast. The initial processing steps were carried out as far as possible, although for a number of cases the *do\_abs* matlab script failed due to the mismatch between downcast and upcast.

The scripts will need adjusting back at BAS for any further processing of the data to be completed.

### 3. JR161 LADCP configuration files

The initial configuration files used (found on the LADCP PC from a previous cruise using master/slave configuration) did not appear to work successfully. After helpful discussions with Dr. Brian King (NOC) the correct configuration files were emailed to the ship, and used from CTD cast 015 onwards. Each station consisted of a single down- and upcast without pause except for bottle firing. For such stations the priority is to obtain the best possible current estimates despite package motion and a short observation period for each part of the water column. As is usual for this purpose, the ADCPs were operated with 16 large (10 m) bins and short ensembles (1 ping per ensemble; average 1 ping/second).

**Table ladcp3: LADCP command files used on JR161**

| Command File: whm jr161 cmd | Command File: whs jr161 cmd |
|-----------------------------|-----------------------------|
| PS0                         | PS0                         |
| CR1                         | CR1                         |
| CF111101                    | CF111101                    |
| EA00000                     | EA00000                     |
| EB00000                     | EB00000                     |
| ED00000                     | ED00000                     |
| ES35                        | ES35                        |
| EX111111                    | EX111111                    |
| EZ00111111                  | EZ00111111                  |
| TE00:00:01.00               | TE00:00:01.00               |
| TP00:01.00                  | TP00:01.00                  |
| LD1111100000                | LD1111100000                |
| LF0500                      | LF0500                      |
| LN016                       | LN016                       |
| LP00001                     | LP00001                     |
| LS1000                      | LS1000                      |
| LV250                       | LV250                       |
| LJ1                         | LJ1                         |
| LW1                         | LW1                         |
| LZ30,220                    | LZ30,220                    |
| SM1                         | SM2                         |
| SA001                       | SA001                       |
| SW05000                     | ST0                         |
| CK                          | CK                          |
| CS                          | CS                          |

## ***Instructions for LADCP deployment and recovery during JR161***

This set of instructions is based on the LADCP section of previous NOC cruise reports (including JR139 Stansfield et al., 2005). It can be used in conjunction with the LADCP log sheet included in the present report.

### **4. JR161 LADCP DEPLOYMENT**

Connect the communications and battery leads for both instruments.

Go to controlling PC:

#### **A) MASTER (downward looking workhorse DWH)**

1. Open BBTALK window for COM1  
Press <F3> to create log file for all output: filename of the form  
**c:\ladcp\jr161\log\_files\WHM###m.txt**  
where ### is ctd cast number, and m refers to master status
2. Press <END> to wake up DWH  
If this fails, check communications lead
3. Type **TS? <ENTER>** to check DWH clock against scientific clock  
gives time in form YYMMDDhhmmss  
  
Type **TSYYMMDDhhmmss <ENTER>** if required to reset DWH clock
4. Type **RS? <ENTER>** to check available memory of DWH  
  
If you need to clear memory, type **RE ErAsE <ENTER>**  
Only clear if backed up to UNIX drive
5. Type **PA <ENTER>** to run diagnostic checks
6. If batteries were recharged, switch off battery charge unit and check battery voltage.
7. Press <F2> select DWH master configuration file
8. Press <F3> to stop log file

The master DWH should now be pinging.

#### **B) SLAVE (upward looking workhorse UWH)**

Repeat steps 1 - 8 in adjacent window noting:

1. UWH log file should be called **c:\ladcp\jr161\log\_files\WHS####s.txt** (s refers to slave)
2. Select slave UWH configuration file

**Detach communication and charger cables and fit blanks to cable ends.**

## **5. JR161 LADCP RECOVERY**

Remove Blanks and attach communications and charger cables.

1. Open BBTALK COM1 window (for master) and COM2 window (for slave)

Press <END> in both windows to wake up the LADCPs

2. Check battery voltage and switch on charger if needed.
3. type RA? <ENTER> to check number of deployments

Reset Baud rate to 115200 to allow for faster recovery of the data by typing CB811

To transfer data to PC:

Go to FILE, RECOVER RECORDER

Select c:\ladcp\jr161\master\ for DWH and c:\ladcp\jr161\slave for UWH as destination files

Reset Baud rate by typing CB411

Type CZ <ENTER> once data are transferred to power down LADCPs

4. Rename the default filenames to  
c:\ladcp\jr161\master\jr161m###.000 and  
c:\ladcp\jr161\slave\jr161s###.000

## **6. LADCP data processing**

LADCP data was processed following the instructions laid out in the JR115 and JR139 cruise reports (Sparrow and Hawker, 2005 and Stansfield and Meredith, 2005). The required software was provided by Dr Brian King (NOC) prior to the cruise. The directory structure and environment variables were set up at the start of the cruise. Helpful discussions with Dr Brian King by email during the early part of the cruise helped to troubleshoot problems with the initial set up and the processing paths were successfully set in place.

### **Initial Data Processing**

The initial steps of data processing on JR161 were as follows:

- (i) Log onto one of the UNIX machines as pstar, password pstar.  
You must be logged on to jruh to get access to the matlab licence
- (ii) *cd ladcp* (ensures you're in the correct directory)  
*setup jr115matlab* (set up matlab)  
*source LADall* (set up paths)
- (iii) *perl -S scan.prl NNN\_02* (allows the user to check the start and end times for the downcast and upcast. The duration of the downcast and upcast should be similar. The minimum and maximum depths should also be checked).
- (iv) *putpos2 NNN 02* (collects start and stop times, positions, and gets the magnetic variation correction using a matlab routine. Updates stations.asc and magvar.tab. Note that if you run this more than once for the same station then you should go into these files and delete the invalid entry. You may wish to check the files for duplicates, test file entries, etc. before you proceed.)
- (v) *perl -S load.prl NNN\_02* (loads data into the CODAS database, correcting for magvar.tab. It is very important that this step is only done once. If you need to do it again, for example if you discover an error in step 5, then you must delete the database files first. For JR161 these are found in proc/casts/jNNN\_02/scdb).
- (vi) *perl -S domerge.prl -c0 NNN\_02* (merge single pings into long shear profiles)
- (vii) *cd Rnav*  
setup files for retrieving location data from ship's navigation streams; see readme file for more detailed instructions. For JR161, data from the NMEA GPS stream was used.  
*updatesm.exec* (updates a navigation file)  
*cd proc*
- (ix) In matlab the data can be plotted and checked using the following command:  
*do\_abs* setting *plist = NNN.02* or *NNN.03* to give cast and master/slave information

This generates five plots showing the various velocity components and information about the sensor such as its heading, tilt and angle).

## Secondary Processing (absolute velocities)

Any further processing of the data will be done at BAS. The following procedures can be used to calculate the absolute velocities, once the CTD data has been processed as far as a 1 Hz file:

- (i) In UNIX:  
*cd proc*  
*cd Rctd* (copy your CTD 1Hz files into this directory)  
*ctd1hz\_links* (creates links so *ctd\_in* can find the files)
  
- (ii) In Matlab:  
*cd to proc/Pctd* (Matlab doesn't seem to be able to use the *\$cdpath* shell variable to find its way around, so you will have to use *pwd* liberally)  
*ctd\_in(NNN,02)*  
*cd to proc/Fitd* (as above)  
*plist = NNN.02* (set the cast and master/slave information)  
*fd* (check vertical velocities from CTD (line) and LADCP (x) agree)
  
- (iii) In UNIX:  
*cd proc*  
*perl -S add\_ctd.prl NNN\_02* (add the CTD data to the CODAS database)  
*perl -S domerge.prl -c1 NNN\_02* (merge the ping profiles using the CTD data)
  
- (iv) In Matlab:  
*plist = NNN.02*  
*do\_abs* (When the velocity profiles are plotted they should be a similar shape to the profiles at the end of the 'first look' data processing, but with a mean velocity, so that the U and V velocities have a mean offset).

| STATION | Event | Date       | JDay | Time at bottom<br>(GMT) | Longitude | Latitude | Water depth | Max CTD pressure | Station Description          | Data Recovery   | Processing Notes |
|---------|-------|------------|------|-------------------------|-----------|----------|-------------|------------------|------------------------------|---|------------------|
| 001     | 019   | 27/10/2006 | 300  | 08:11:33                | 50 26.31  | 57 44.52 | 4116        | 4139             | PS1.1 full depth             | none  |                  |
| 005     | 032   | 28/10/2006 | 301  | 08:12:12                | 50 26.30  | 57 44.42 | 4115        |                  | Lost communication on upcast | jr161_005mA.000<br>jr161_005mB.000<br>jr161_005sA.000<br>jr161_005sB.000  | not processed    |
| 007     | 036   | 28/10/2006 | 301  | 14:22:06                | 50 25.30  | 57 44.57 | 4134        | 4192             | PS1.2 full depth             | jr161_007mA.000<br>jr161_007mB.000<br>jr161_007mC.000<br>jr161_007mD.000<br>jr161_007mE.000<br>jr161_007sA.000<br>jr161_007sB.000<br>jr161_007sC.000<br>jr161_007sD.000 | not processed    |
| 010     | 045   | 29/10/2006 | 302  | 09:38:35                | 50 26.19  | 57 44.53 | 4117        | 4150             | PS1.3 deep                   | jr161_010mA.000   | not processed    |

|     |     |            |     |          |          |             |      |      |                       |   |                     |
|-----|-----|------------|-----|----------|----------|-------------|------|------|-----------------------|---|---------------------|
|     |     |            |     |          |          |             |      |      |                       | jr161_010mB.000<br>jr161_010mC.000<br>jr161_010mD.000<br>jr161_010mE.000<br>jr161_010mF.000 |                     |
| 014 | 075 | 01/11/2006 | 305 | 09:20:45 | 48 41.80 | 60<br>38.89 | 1709 | 1676 | CS1.1 full depth      | jr161_014mA.000<br>jr161_014mB.000<br>jr161_014mC.000                                       | not<br>processed    |
| 015 | 077 | 01/11/2006 | 305 | 10:54:00 | 48 41.85 | 60<br>38.95 | 1703 | 143  | CS1.1 shallow phyto   | jr161_015m.000  | MASTER<br>processed |
| 016 | 086 | 02/11/2006 | 306 | 07:17:52 | 48 41.91 | 60<br>38.88 | 1703 | 404  | CS1.2 shallow Oithona | jr161_016m.000  |                     |
| 018 | 099 | 05/11/2006 | 309 | 11:49:05 | 44 40.18 | 60<br>25.22 | 1205 | 1192 | CS2.1 full depth      | jr161_018m.000<br>jr161_018s.000  |                     |
| 022 | 120 | 07/11/2006 | 311 | 11:15:41 | 44 31.00 | 60<br>05.87 |      | 5201 | T-A full depth        | jr161_022m.000  |                     |



|     |     |            |     |          |          |             |      |      |  |  |  |
|-----|-----|------------|-----|----------|----------|-------------|------|------|--|--|--|
| 023 | 121 | 07/11/2006 | 311 | 16:12:47 | 44 14.09 | 59<br>56.44 | 4740 | 4780 | T-B full depth   | jr161_023mA.000<br>jr161_023mB.000<br>jr161_023mC.000<br>jr161_023mD.000<br>jr161_023mE.000<br>jr161_023sA.000<br>jr161_023sB.000<br>jr161_023sC.000 |  |
| 024 | 127 | 08/11/2006 | 312 | 09:24:58 | 44 03.58 | 59<br>40.81 | 4100 | 4128 | CS3.1 full depth (stopped on downcast due to wrong EA600 depth readings) | jr161_024mA.000<br>jr161_024mB.000<br>jr161_024mC.000<br>jr161_024mD.000<br>jr161_024s.000   |  |
| 028 | 148 | 15/11/2006 | 319 | 23:51:00 | 43 19.79 | 58<br>35.50 | 3098 | 3094 | T-C full depth   | none   |  |
| 032 | 166 | 17/11/2006 | 321 | 14:20:20 | 42 40.38 | 57<br>31.98 | 3113 | 3111 | CS4.2 full depth   | jr161_032mA.000<br>jr161_032mB.000<br>jr161_032s.000   |  |

|     |     |            |     |          |          |             |      |      |                  |  |
|-----|-----|------------|-----|----------|----------|-------------|------|------|------------------|--|
| 033 | 173 | 18/11/2006 | 322 | 07:29:40 | 41 14.77 | 55<br>12.35 | 3241 | 3236 | PS2.1 full depth | jr161_033mA.000<br>jr161_033mB.000   |
| 037 | 189 | 19/11/2006 | 323 | 05:30:00 | 41 14.76 | 55<br>12.36 | 3236 | 3232 | PS2.2 full depth | jr161_037mA.000<br>jr161_037mB.000<br>jr161_037mC.000<br>jr161_037mD.000<br>jr161_037mE.000<br>jr161_037mF.000<br>jr161_037s.000 |
| 042 | 202 | 20/11/2006 | 324 | 06:27:00 | 41 14.80 | 55<br>12.49 | 3234 | 3241 | PS2.3 full depth | jr161_042mA.000<br>jr161_042mB.000<br>jr161_042mC.000  |
| 046 | 225 | 22/11/2006 | 326 | 11:32:48 | 40 48.82 | 54<br>14.29 | 2013 | 2045 | T-I full depth   | jr161_046mA.000<br>jr161_046mB.000<br>jr161_046s.000   |

|     |     |            |     |          |          |             |      |      |                  |  |  |
|-----|-----|------------|-----|----------|----------|-------------|------|------|------------------|--|--|
| 047 | 226 | 22/11/2006 | 326 | 17:28:30 | 40 27.82 | 53<br>31.41 | 2058 | 2044 | T-J full depth   | jr161_047mA.000<br>jr161_047mB.000<br>jr161_047sA.000<br>jr161_047sB.000 |  |
| 048 | 232 | 23/11/2006 | 327 | 06:48:00 | 40 05.83 | 52<br>51.54 | 3792 | 3807 | PS3.1 full depth | None   |  |
| 056 | 249 | 24/11/2006 | 328 | 18:50    | 40 08.38 | 52<br>52.21 | 3793 | 3813 | PS3.2 full depth | jr161_056mA.000<br>jr161_056mB.000<br>jr161_056s.000                     |  |
| 060 | 276 | 28/11/2006 | 332 | 08:07:40 | 49 59.97 | 38<br>00.05 | 5132 | 5217 | CS6.1 full depth | None   |  |

**Table ladcp1: LADCP deployments during JR161**

**Table ladcp2: Notes on LADCP processing during JR161**

| STATION | Event | MASTER Processing Notes   | SLAVE Processing Notes   |
|---------|-------|---|--|
| 001     | 019   | not processed   | not processed  |
| 005     | 032   | not processed   | not processed  |
| 007     | 036   | not processed   | not processed  |
| 010     | 045   | not processed   | not processed  |
| 014     | 075   | not processed   | not processed  |
| 015     | 077   | times and depths match CTD, processed up to <i>do_abs</i>         | no data  |
| 016     | 086   | times and depths match CTD, processed up to <i>do_abs</i>         | no data  |
| 018     | 099   | times and depths match CTD, processed up to <i>do_abs</i>         | processed; times and depths match CTD, <i>do_abs</i> failed    |
| 022     | 120   | downcast only , processed up to <i>do_abs</i>                     | no data  |
| 023     | 121   | half downcast, <i>do_abs</i> failed                               | half downcast, <i>do_abs</i> failed                            |
| 024     | 127   | times match CTD downcast only; <i>do_abs</i> failed               | mismatched times and depths with ctd; <i>do_abs</i> failed     |
| 028     | 148   | no data   | no data  |
| 032     | 166   | times and depths match CTD; <i>do_abs</i> failed                  | times match CTD, incorrect depth reading; <i>do_abs</i> failed |
| 033     | 173   | no data   | no data  |
| 037     | 189   | times match CTD, incorrect depth reading; <i>do_abs</i> failed    | times match CTD, incorrect depth reading; <i>do_abs</i> failed |
| 042     | 202   | mismatch to CTD time, correct depth reading; <i>do_abs</i> failed | no data  |

|            |            |  |   |
|------------|------------|--|---|
| <b>046</b> | <b>225</b> | <b>mismatch to CTD time, correct depth reading; <i>do_abs</i> failed</b> | <b>times match CTD, incorrect depth reading; <i>do_abs</i> failed</b> |
| <b>047</b> | <b>226</b> | <b>times match CTD, incorrect depth reading; <i>do_abs</i> failed</b>    | <b>times match CTD, incorrect depth reading; <i>do_abs</i> failed</b> |
| <b>048</b> | <b>232</b> | <b>no data</b>   | <b>no data</b>  |
| <b>056</b> | <b>249</b> | <b>times match CTD, incorrect depth reading; <i>do_abs</i> failed</b>    | <b>times match CTD, incorrect depth reading; <i>do_abs</i> failed</b> |
| <b>060</b> | <b>276</b> | <b>no data</b>   | <b>no data</b>  |

### LADCP log sheet: – JR97

|          |  |       |  |        |  |
|----------|--|-------|--|--------|--|
| CTD CAST |  | Date: |  | JDAY   |  |
| Lat:     |  | Long: |  | Depth: |  |

LADCP Deployment / Recovery Log Sheet

Pre-Deployment (Comms. and Charge leads should be in place)

|  |  |                          |                          |
|--|--|--------------------------|--------------------------|
| <b>In BBTALK:</b>  |  | MASTER                   | SLAVE                    |
| 1. Log file name (F3)                                    |  | .txt                     | .txt                     |
| 2. Time check (TS?) and time correction if necessary     |  | : :                      | : :                      |
| 3. Memory unused (RS?) and erase if necessary (RE ErAsE) |  | Mb                       | Mb                       |
| 4. Run tests (PA)  |  | <input type="checkbox"/> | <input type="checkbox"/> |

5. Battery Voltage  V (max. 52V) measure across charger

**Deployment**

|  |   |
|--|---|
| 6. MASTER deployment time, from master clock | <input style="width: 40px;" type="text"/> : <input style="width: 40px;" type="text"/> : |
| <b>Recovery</b>                              |   |

|                                    |  |
|------------------------------------|--|
| <b>In BBTALK</b>                   |  |
| 7. Time of stopping MASTER logging | <input style="width: 40px;" type="text"/> : <input style="width: 40px;" type="text"/> : Stop SLAVE |

8. Battery Voltage  V Measure on charger

**Data Transfer**

|                                |  |   |   |
|--------------------------------|--|---|---|
| <b>In BBTALK</b>               |  | MASTER                                    | SLAVE                                     |
| 9. Number of deployments (RA?) |  | <input style="width: 40px;" type="text"/> | <input style="width: 40px;" type="text"/> |
| 10. Default filename           |  | -RDI-.000                                 | -RDI-.000                                 |
| 11. Renamed file               |  | m.000                                     | s.000                                     |

|                         |  |   |   |
|-------------------------|--|---|---|
| <b>In BBLIST</b>        |  | MASTER                                    | SLAVE                                     |
| 12. File size           |  | <b>Kb</b>                                 | Kb  |
| 13. Number of ensembles |  | <input style="width: 40px;" type="text"/> | <input style="width: 40px;" type="text"/> |

|              |
|--------------|
| 16. Comments |
|--------------|

**Figure ladcp1: LADCP logsheet.**

## Underway measurements

### **Christos Mitsis (UEA)**

Underway measurements during the scientific cruise JR161 fall into three categories; navigation data, oceanlogger/meteorological data, and echosounder depth data. The data are being logged by the SCS (Scientific Computer System) of JCR and are available for users under `scs` and `rvs` format for unix and `scs` format for PC. We used the `unix-rvs` format. The datastreams are available under `U:/cruise/rvs/raw_data - /rvs/pro_data` by using a unix machine (i.e `jr161`) or any ssh client(i.e `putty`) in order to log on to the unix machine. The process of the data can be distinguished in two stages; the retrieval of the datastreams using unix based scripts (i.e `get_underway`) and the processing using matlab (scripts originally developed by Mike Meredith for the *Charles Darwin* cruise, CD160).

### **Navigation data**

The navigation data that were logged and processed are:

- Ashtec ADU5 4 antennae GPS: Antenna 1 used to determine the ships position; antennae 2-4 used to determine roll, pitch and yaw.
- Ashtec GLONASS GG24: Positional information only.
- Seatex GPS (Seapath 200): Position and heading.
- GPS NMEA (Furuno GP32). Positional information only.
- Gyro (Seapath 200 heading). The best heading information available. The Sperry Mk 37 Gyrocompass is no longer recorded (discussed later).

The following texts name the scripts that describe the processing route for the above data.

`get_nav` Calls the unix scripts `get_gyro`, `get_bestnav`, `get_gpsash`, `get_gpsglos`, `get_gpsnmea`, `get_seatex` and `get_tsshrip`, which invoke the RVS `listit` command to retrieve 24 hours of heading (now fed from Seatex heading), `bestnav(/rvs/pro_data)`, Ashtec (ADU5), Ashtec Glonass (GG24), GPS NMEA, Seatex and `tsshrip` (heave, roll and pitch) data, corresponding to `JDAY XXX`, and write to ascii files “`gyro.XXX`”, “`bestnav.XXX`”, “`gpsash.XXX`”, “`gpsglos.XXX`”, “`gpsnmea.XXX`”, “`seatex.XXX`” and “`tsshrip.XXX`”. Note that, although recorded and saved, the Ashtec Glonass and heave, roll and pitch (`tsshrip`) data, as also the Ashtec (ADU5) position information data from `jday 308` and on were not processed further using matlab.

### **Gyrocompass**

`loadgyro.m` Matlab code to read “`gyro.XXX`”, arrange into structure arrays and name accordingly. Saves output as “`gyroXXX.mat`”. Produces a rough plot of heading against time, for quick check of data completeness and integrity.

`gyroall.m` Matlab code to append “`gyroXXX.mat`” to the master file “`gyro_all_jr141.mat`”.

## Bestnav

**loadbestnav.m** Matlab code to read “bestnav.XXX”, arrange into structure arrays and name accordingly. Saves output as “bestnavXXX.mat”. Produces a rough plot of ship’s position over the 24 hour period, for quick check of data completeness and integrity.

**bestnavall.m** Matlab code to append “bestnavXXX.mat” to the master file “bestnav\_all\_jr141.mat”

## Ashtech

**loadgpsash.m** Matlab code to read “gpsash.XXX”, arrange into structure arrays and name accordingly. Saves output as “gpsashXXX.mat”. Produces a rough plot of ship’s position over the 24 hour period, for quick check of data completeness and integrity.

**gpsashall.m** Matlab code to append “gpsashXXX.mat” to the (raw data) master file “gpsash\_all\_jr141.mat”

## GPS NMEA

**loadgpsnmea.m** Matlab code to read “gpsnmea.XXX”, arrange into structure arrays and name accordingly. Saves output as “gpsnmeaXXX.mat”. Produces a rough plot of ship’s position over the 24 hour period, for quick check of data completeness and integrity.

**gpsnmea\_all.m** Matlab code to append “gpsnmeaXXX.mat” to the master file “gpsnmea\_all\_jr141.mat”

## Seatex

**loadseatex.m** Matlab code to read “seatex.XXX”, arrange into structure arrays and name accordingly. Saves output as “seatexXXX.mat”. Produces a rough plot of ship’s position over the 24 hour period, for quick check of data completeness and integrity.

**seatex\_all.m** Matlab code to append “seatexXXX.mat” to the master file “seatex\_all\_jr141.mat”

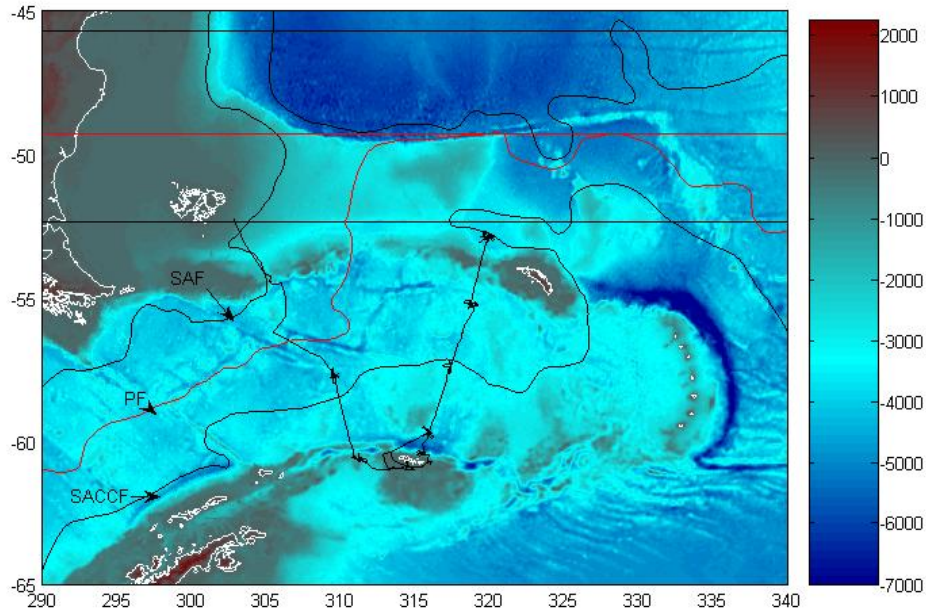
During the analysis of the navigation data for cruise JR161 starting from days 298 to 302 we realized that the gyrocompass stream was storing unequally the heading points for the two first days ending up with 86347-86394 respectively. The stored points for the next days were 86400 which are what we expected since the streaming of the heading is every second.

On jday 308 we have noticed the absence of data in the rvs system for the Ashtec gps. This was due to the instability of the instrument at the time. We stopped processing the Ashtec gps datastream after jday 314.

Minor changes applied to the matlab scripts to point to the directories used for this cruise.

An example of the datastream bestnav after the processing at the end of PS3 can be seen in *figure 1*.





**Figure 1: Bestnav data since the start of the cruise and until the end of PS3 after processing with the routines described above. The bathymetry used is from Smith & Sandwell ver.6.2.**

### **Echosounder data**

Depth information was retrieved from the Simrad ea600 single-beam echosounder.

### **Simrad ea600**

**get\_sim500** Invokes the RVS `listit` command to retrieve 24 hours of ea600 data, corresponding to JDAY XXX, and write to an ascii file “sim500.XXX”.

**loadsim500.m** Matlab code to read “sim500.XXX”, arrange into structure arrays and name accordingly. Saves output as “sim500\_XXX.mat”. Produces a rough plot of uncorrected depth over the 24 hour period.

**cleansim500.m** Loads “sim500\_XXX.mat”, removes large spikes with **dspike.m**, and launches basic interactive editor for further cleaning. A second run of **dspike.m** is enabled, followed by a 101-point median filter. Discarded depths are interpolated across, and output saved to “sim500\_XXXclean.mat”.

**sim500nav.m** Loads file “sim500\_XXXclean.mat”, interpolates across missing values and puts data on a regular 5 second interval, from which 2 minute averages are derived. The bestnav master file “bestnav\_all\_jr141.mat” is loaded, and latitudes and longitudes interpolated to the times of the sim500 timestamps. A quick plot of depth along the ship’s track is produced, and data are saved to a file “sim500\_XXXnav.mat”.

**sim500all.m** Load “sim500\_XXXnav.mat”, and appends to master file “sim500\_all\_jr141.mat”

The bathymetry data have been processed using the m files *loadsim500.m* and *cleansim500.m* but without any interactive editing (or only where obvious editing needed) applied. Primarily,

we thought the navigation data (long, lat) should be appended to the bathy (*sim500nav.m*) in order a comparative approach with already consolidated high-resolution bathymetric databases to take place. Any interactive suppression could be applied afterwards.

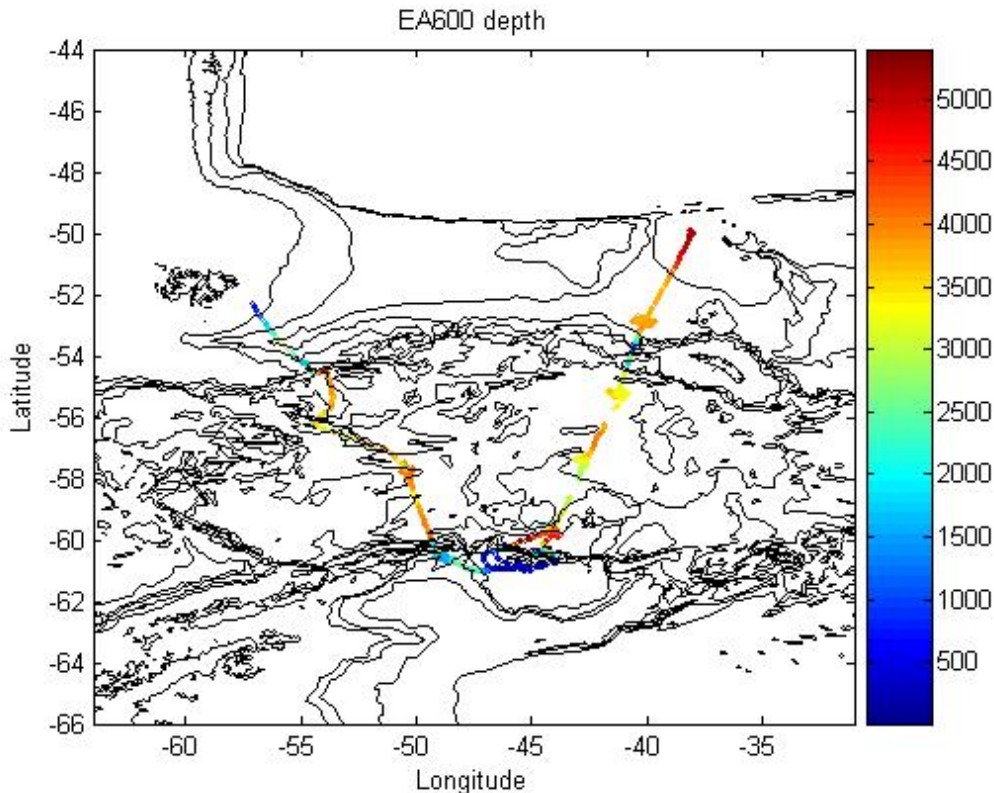
The script *sim500nav.m* did not work with the data files *sim500\_30[3,5].m*. This is due to the fact that both files after the conversion of the time using the matlab functions *datenum* and *datevec* seem to never have the condition '*datevector (5)/2==floor (datevector (5)/2 & datevector (6) =0*' satisfied. This occurs because although all the files have datastreams where time is being logged every 7 and 8 seconds sequentially a time interval decrease arises after a point which 'allows' the condition to be satisfied for the rest of the files but not for the two files mentioned above. To decipher the problem I used an interval of 1 second for the first interpolated time points and the new interpolated time file as the one from which the start and stop points are derived. The final script used is the *test\_sim500\_nav.m* (for comparisons with the *sim500nav.m*).

There were numerous times when the instrument was not logging. This can be seen as zero bathymetry at the final files produced (*figure 2*).

Again, as in cruise JR141 we did not use the routine "prodep", which applies corrections to the single-beam (EA600) echosounder depths based on Carter's tables. Instead of that we use the matlab script indicated below, at the end of the cruise. The following notes are appended here exactly as in cruise report JR141.

### ***Note on correction of echosounder depths (Written by Mike Meredith, JR139?)***

It was not possible on JR139 to run the RVS routine "prodep", which applies corrections to the single-beam (EA600) echosounder depths based on Carter's tables. (Depths returned by the EA600 assume that the speed of sound through the water column is 1500 m/s; use of Carter's tables corrects this using a more accurate speed of sound for the area in question). The problem was caused by a conflict with the RVS "bestnav" routine, but the exact source (and hence a solution) was not discovered, despite investigations by ITS. To circumvent this problem, a Matlab function ("carter.m") was written and applied to the final echosounder dataset. This function looks up the lat/long position for each echosounder datapoint in a digital version of Carter's tables, derives the Carter correction area, and returns this and a corrected depth. The lookup table is stored in two parts, "BOUNDARY2.DAT", and "CORRECTN2.DAT". Following execution of this function, the final EA600 file "sim500\_all\_jr139.dat" has two extra variables stored in the sim500 structured array, namely *sim500.cordepth\_ave* (the corrected depths) and *sim500.correction\_area* (the Carter correction area).



**figure 2: EA600 bathymetry after applying the Matlab routines described above.**

### ***The oceanlogger and meteorological systems***

The oceanlogger is comprised of a thermosalinograph and fluorometer connected to the ship's non-toxic pumped seawater supply, plus meteorological sensors measuring duplicate air pressure, duplicate air temperature, duplicate humidity, duplicate total incident radiation (TIR) and duplicate photosynthetically available radiation (PAR). The instruments and calibration information are detailed below. Any queries regarding calibration should be addressed to Pat Cooper (BAS, AME).

### **Oceanlogger**

- SeaBird Electronics SBE45 CTD, s/n 4524698-0018, calibrated 5/3/04
- Turner Designs 10-AU Fluorometer, s/n 6465RTX

### **Meteorological Data**

- Photosynthetically Active Radiation 1, Parlite Quantum Sensor, Kipp & Zonen, s/n 030335, calibrated 4/7/03
- Photosynthetically Active Radiation 2, Parlite Quantum Sensor, Kipp & Zonen, s/n 010224, calibrated 1/11/04
- Transmissometer 1, Proto1 SPLite, Kipp & Zonen, s/n 032374, calibrated 30/6/03
- Transmissometer 2, Proto1 SPLite, Kipp & Zonen, s/n 011403, calibrated

22/10/01

- Air temperature/humidity 1, Chilled Mirror Hygrometer MBW, PM-20251/1, Temperature Sensor Pt100, PM-20252/1, s/n 28552 023, calibrated 30/05/03
- Air temperature/humidity 2, Chilled Mirror Hygrometer MBW, PM-20251/1, Temperature Sensor Pt100, PM-20252/1, s/n 18109 036, calibrated 12/12/00
- Anemometer
- 

The processing route for these data is given below.

**get\_underway** Calls the unix scripts **get\_oceanlog**, **get\_anemom** and **get\_truewind**, which invoke the RVS `listit` command to retrieve 24 hours of underway data, corresponding to JDAY XXX, and write to ascii files “oceanlog.XXX”, “anemom.XXX” and “truewind.XXX”.

**loadunderway.m** Matlab code, which calls functions **loadoceanlog.m**, **loadanemom.m** and **loadtruewind.m** to read “oceanlog.XXX”, “anemom.XXX” and “truewind.XXX”, arrange into structure arrays and name accordingly. Saves outputs as “oceanlogXXX.mat”, “truewindXXX.mat” and “anemomXXX.mat”. The program also calls **cleanoceanlog.m**, which uses **dspike.m** to remove large spikes in conductivity, housing (CTD) temperature and remote (hull) temperature. Interpolates across removed points, then launches basic interactive editor for further cleaning of conductivity, housing temperature and remote temperature. Calls **ds\_salt.m** to calculate surface (uncalibrated) salinity from conductivity and housing temperature. Output saved to “oceanlogXXXclean.mat”. Produces rough plots of sea surface conductivity, remote (hull) temperature and housing (CTD) temperature over the 24 hour period. Truewind, anemometer and cleaned oceanlog data are written to “underwayXXX.mat”.

**truewind\_derive.m** Loads file “underwayXXX.mat” and master file “gyro\_all\_jr141.mat”. Interpolates gyro (Seapath) heading onto same time stamps as underway, and ensures that they lie in the range 0 to 360. Note that, on the JCR, the convention is that the underway wind direction is the direction the wind is blowing FROM. Real wind direction is obtained by adding underway direction to Seapath heading and then converting to the direction the wind is blowing TO. Underway wind speeds and (real) directions are broken into east and north velocity components and velocities are changed from knots to  $\text{ms}^{-1}$ . Ship’s velocity is derived from position fixes, and this speed and angle are converted to ship’s east and north velocities. These are interpolated to the same timestamps as the underway data. East and north components of real wind and derived by adding the east and north components of ship’s velocity and wind velocity. These are converted back to true wind speed and direction, with direction forced to lie in range 0 to 360. Two direction variables are defined, one being the direction the wind is blowing to and the other being the direction the wind is blowing from. Output is file “underwayXXXtrue.mat”.

**underwaynav.m** Loads file “underwayXXXtrue.mat” and master file “bestnav\_all\_jr141.mat”, then interpolates latitude and longitude to timestamps of underway data. Produces quick plots of sea surface temperature, sea surface salinity (uncalibrated), and wind vectors along ship’s track. Saves output to master file “underwayXXXnav.mat”. Ensure that **truewind\_derive.m** is run immediately before **underwaynav.m**.

**underwayall.m** Loads “underwayXXXnav.mat” and appends to master file “underway\_all\_jr141.mat”. Produces quick plots of sea surface temperature, sea

surface salinity and wind vectors along ship's track for the duration of the cruise to date.

The *truewind* datastream was not being logged to the rvs system. Hence, all the pre-processing of the data does not include truewind data. These can be appended to the file *underwayXXX.mat* later, after having evaluation of truewind from the relative direction of the wind (in respect of the ship's direction) and the heading of the ship. We appended the bestnav data to the oceanlog data but not the anemom data as these are also direction and speed comparative to the ship's position.

Minor changes applied to the matlab scripts, mainly during the editing of the oceanlog datastream, i.e plotting the flow rate in addition to the editing window in order to make a better decision during the interactive suppression of the data.

The editing was confined in deleting data points, which in comparison with the flow rate diagram, indicated the entry in the sea-ice region (*figure 3*).

During our passage in and out of the ice there were frequent periods where the oceanlog system did not function due to ice blockage of the intake pumps. Those days are still present in the final file and are being represented by a point or small intervals (most of the data were deleted and only small sections were retained in order to go on with the processing sequence of days). They should not be taken into account.

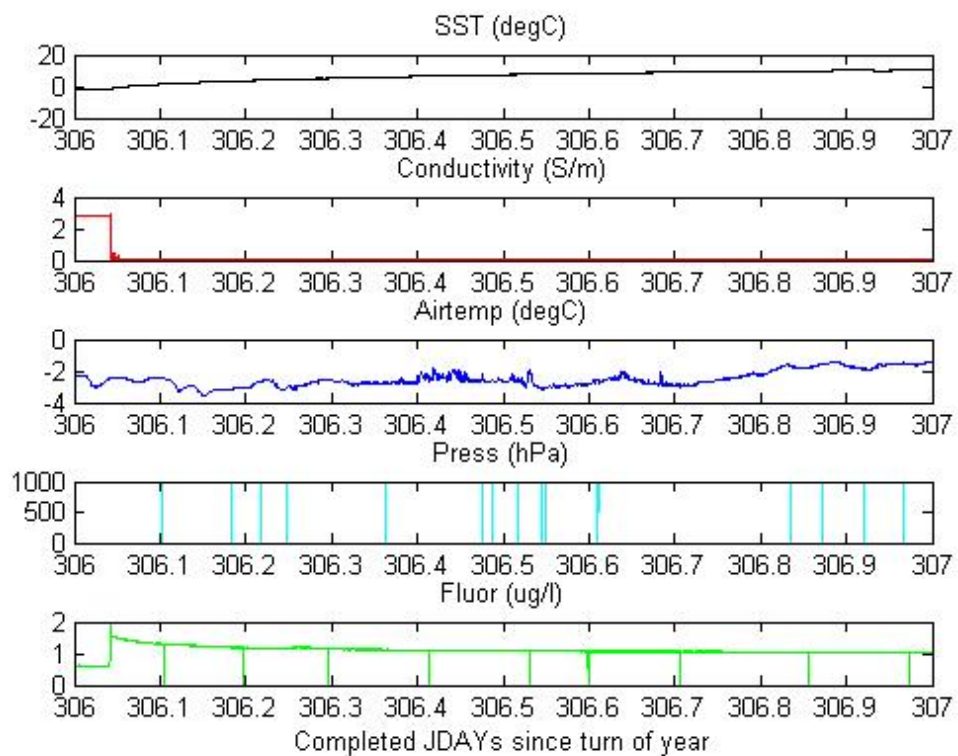
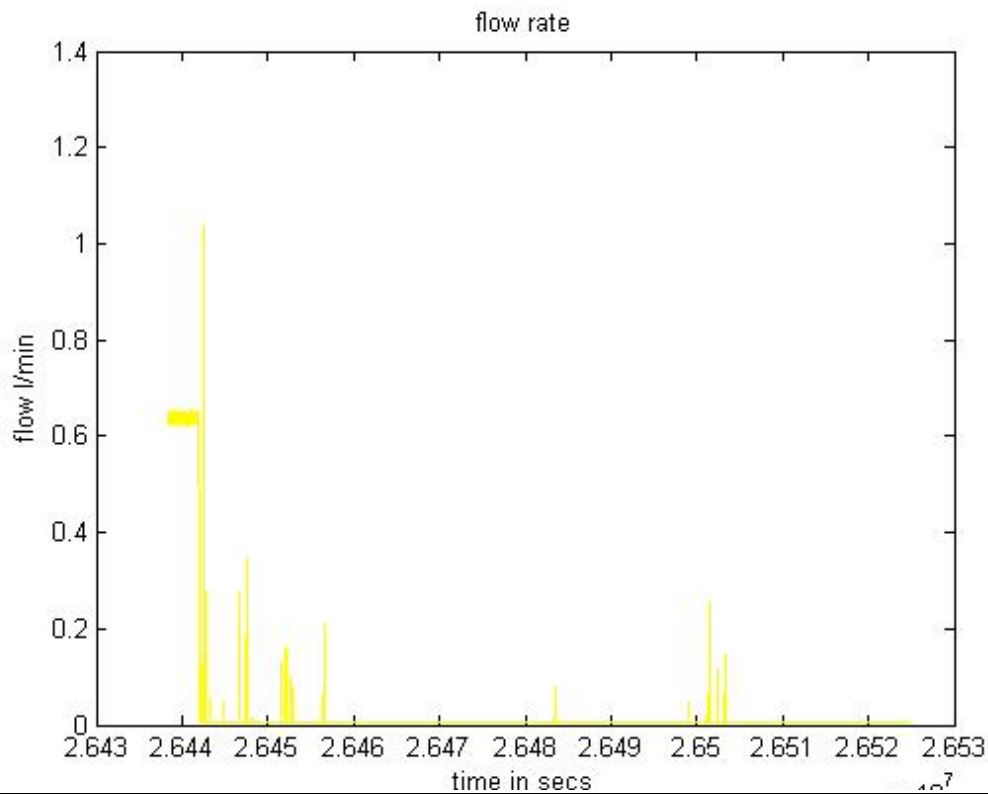
The jdays where the intake pumps are switched off are the following: 307, 314-318.

Also, during the start of the cruise on **jday298** there is an incident of high values of fluorescence, conductivity and housing (CTD) temp occurring at latitude, longitude position [-54.53, 305.7]. The event (fluorescence) which lasts for 310secs and is present at the Jday interval 297.705 to 297.715, presents a peak value of 6.218 (fluor) while the median for this dataset is 0.5580 excluding from the dataset all the values before 297.60 Jday where the value of fluorescence is constant at 0.241. It hasn't been removed during the despiking of the dataset.

The following notes are appended here exactly as in cruise report JR141.

**Note on derivation of "truewind"** (Written by Mike Meredith, JR139)

From the start of JR139, we logged anemometer wind speed and direction routinely, and also the RVS datastream "truewind", which consists of these same properties corrected for ship's heading and speed. It was noted, however, that the RVS truewind would oscillate wildly when the ship was stationary, and return realistic values only when the ship was in motion. Because of this problem, a Matlab script ("truewind\_derive.m"; see above), originally written on CD160, was modified and implemented to derive useful wind data in earth coordinates even for periods when the ship was stationary. The source of the problem was investigated, and it is believed that it originates from the RVS truewind datastream deriving its ship's heading and speed (in terms of CMG and SMG) from the GLONASS GPS datastream. This is not a high-quality navigational datastream, and has been observed previously to offer substandard data when the ship is stationary. We consulted with ITS engineer on board, but there was no obvious fix for the RVS truewind that could be easily implemented, since other GPSs were not offering CMG and SMG for the calculation. Thus the RVS truewind data, although logged, should be regarded as poor, and the Matlab-derived truewind should be used in their place. We recommend that some time is spent producing a solution whereby SMG and CMG for the RVS truewind calculation can be obtained from one of the other GPS instruments, ideally the Seapath or Ashtech ADU5.



**Figure 3: Diagrams of flow rate and datastreams from the oceanlogger during enter in the sea-ice region on jday 307.**

## **Expendable Bathythermographs (XBTs)**

***Elizabeth Hawker, Christos Mitsis, Enrique Vidal with additional support from Nathan Cunningham, Data Manager***

A sequence of XBT drops were performed from RRS *James Clark Ross* during JR161. The details of the XBT drops are listed in Table xbt1.

Sippican T5 probes were used and launched using a hand held launcher from the rear of the aft deck. The ship decreased its speed to 8 knots for deploying most probes. Data were logged by a Viglen IBM-type 486 PC running the Sippican WinMk12 software. Once a successful drop had been performed, data were transferred via samba to the central Unix system (jruf). The data was also streamed back to Cambridge in real time.

Further processing of the XBT profiles will take place at BAS using matlab scripts.

In general the XBT deployments were successful. However, during the passage from Falklands to Process Station 1 (PS1), the magnetometer was also deployed. This resulted in a number of XBTs successful only to a depth of about 600m. Excessive spiking or clearly unrealistic values were logged, identified mid-drop, and the drop aborted and restarted with a new probe. Ship speed was maintained at above 10 knots for a few deployments, unfortunately this resulted in data being collected to only a depth of 1000m. For future deployments of T5 probes it is advisable to slow to at least 8 knots.

**Table xbt1: JR161 XBT deployments**

| EVENT No. | PC Filename  | JDAY | DATE & TIME       | Latitude      | Longitude | Coment                         |
|-----------|--------------|------|-------------------|---------------|-----------|--------------------------------|
| 227       | T5_00033.EDF | 326  | 22/11/06<br>20:26 | -<br>53.14892 | -40.27139 | Depth:<br>1692.7m<br>(SUCCESS) |
| 224       | T5_00032.EDF | 326  | 22/11/06<br>08:58 | -<br>54.57817 | -40.99875 | Depth:<br>1644.6m<br>(SUCCESS) |
| 173       | T5_00031.EDF | 322  | 18/11/06<br>03:33 | -<br>55.63362 | -41.28801 | Depth:<br>1308.0m              |
| 172       | T5_00030.EDF | 321  | 17/11/06<br>23:38 | -<br>56.22098 | -41.82070 | Depth:<br>560.7m<br>(FAIL)     |
| 171       | T5_00029.EDF | 321  | 17/11/06<br>23:33 | -<br>56.22081 | -41.82065 | Depth:<br>525.4m<br>(FAIL)     |
| 170       | T5_00028.EDF | 321  | 17/11/06<br>21:31 | -<br>56.52646 | -42.03956 | Depth:<br>1691.0m<br>(SUCCESS) |
| 169       | T5_00027.EDF | 321  | 17/11/06<br>19:44 | -<br>56.83958 | -42.25923 | Depth:<br>1657.0m<br>(SUCCESS) |
| 167       | T5_00026.EDF | 321  | 17/11/06<br>17:55 | -<br>57.14028 | -42.44077 | Depth:<br>1066.5m              |
| 150       | T5_00025.EDF | 320  | 16/11/06<br>07:21 | -<br>57.69293 | -42.85154 | Depth:<br>1603.3m<br>(SUCCESS) |
| 149       | T5_00024.EDF | 320  | 16/11/06<br>05:34 | -<br>57.97897 | -42.94920 | Depth:<br>1830.5m<br>(SUCCESS) |
| 147       | T5_00023.EDF | 319  | 15/11/06<br>20:45 | -<br>58.87562 | -43.51105 | Depth:<br>1810.3m<br>(SUCCESS) |
| 146       | T5_00022.EDF | 319  | 15/11/06<br>17:10 | -<br>56.52646 | -42.03956 | Depth:<br>1087.3m              |
| 70        | T5_00021.EDF | 304  | 31/10/06<br>19:19 | -<br>60.54269 | -49.06830 | Depth:<br>1636.9m<br>(SUCCESS) |
| 69        | T5_00020.EDF | 304  | 31/10/06<br>16:38 | -<br>60.04291 | -49.31406 | Depth:<br>1146.6m              |
| 68        | T5_00019.EDF | 304  | 31/10/06<br>14:31 | -<br>59.73530 | -49.47017 | Depth:<br>1640.5m<br>(SUCCESS) |
| 67        | T5_00018.EDF | 304  | 31/10/06<br>11:45 | -<br>59.73530 | -49.47017 | Depth:<br>1087.7m              |
| 67        | T5_00017.EDF | 304  | 31/10/06          | -             | -49.65940 | Depth:                         |



|    |              |     |                   |               |           |                                |
|----|--------------|-----|-------------------|---------------|-----------|--------------------------------|
|    |              |     | 11:40             | 59.35834      |           | 222.7m<br>(FAIL)               |
| 66 | T5_00016.EDF | 304 | 31/10/06<br>09:32 | -<br>58.92132 | -49.87822 | Depth:<br>1200.9m<br>(SUCCESS) |
| 65 | T5_00015.EDF | 304 | 31/10/06<br>07:35 | -<br>58.53982 | -50.05935 | Depth:<br>1223.0m<br>(SUCCESS) |
| 64 | T5_00014.EDF | 304 | 31/10/06<br>05:06 | -<br>58.12104 | -50.22607 | Depth:<br>1384.5m<br>(SUCCESS) |
| 15 | T5_00013.EDF | 298 | 25/10/06<br>20:38 | -<br>54.70493 | -53.81599 | Depth:<br>87.1m<br>(FAIL)      |
| 14 | T5_00012.EDF | 298 | 25/10/06<br>16:36 | -<br>54.55091 | -54.50433 | Depth:<br>141.9m<br>(FAIL)     |
| 13 | T5_00011.EDF | 298 | 25/10/06<br>16:30 | -<br>54.55182 | -54.52654 | Depth:<br>~130m<br>(FAIL)      |
| 12 | T5_00010.EDF | 298 | 25/10/06<br>13:59 | -<br>54.55182 | -54.52654 | Depth:<br>118.3m<br>(FAIL)     |
| 11 | T5_00009.EDF | 298 | 25/10/06<br>13:52 | -<br>54.22310 | -54.79378 | Depth:<br>649.7m<br>(FAIL)     |
| 10 | T5_00008.EDF | 298 | 25/10/06<br>12:08 | -<br>54.07392 | -55.17821 | Depth:<br>1830.5m<br>(SUCCESS) |
| 9  | T5_00007.EDF | 298 | 25/10/06<br>11:59 | -<br>54.05264 | -55.20666 | Depth:<br>597.2m<br>(FAIL)     |
| 8  | T5_00006.EDF | 298 | 25/10/06<br>10:10 | -<br>53.80429 | -55.52188 | Depth:<br>1830.5m<br>(SUCCESS) |
| 7  | T5_00005.EDF | 298 | 25/10/06<br>08:20 | -<br>53.55108 | -55.84499 | Depth:<br>581.6m<br>(FAIL)     |
| 6  | T5_00004.EDF | 298 | 25/10/06<br>08:13 | -<br>53.53468 | -55.86592 | Depth:<br>559.4m<br>(FAIL)     |
| 5  | T5_00003.EDF | 298 | 25/10/06<br>06:30 | -<br>59.65189 | -44.11644 | Depth:<br>115.6m<br>(FAIL)     |
| 4  | T5_00002.EDF | 298 | 25/10/06<br>06:23 | -<br>53.29035 | -56.17998 | Depth:<br>143.3m<br>(FAIL)     |



# **Gear Report JR161**

***Peter Enderlein***

## ***General***

This was a cruise with one of the most deployments of towed gear during a single cruise. Because of the number of different towed gears and their different requirements the cable and the DWNM and its sensors needed lots of swapping over. This always causes certain wear and tear to the equipment and reduces its reliability. But overall it worked fine. All equipment was deployed to the maximum depth of 1000 m. At one point the 'Bio wire' was re-terminated because there seemed to be a fault in the first part of the cable. In the end the fault was found in the slip ring where due to wear on a few cables the insulation was sheered off shortening the cables.

## ***Down Wire Net Monitor***

During this cruise the DWNM has been used on the 'Biological wire' for the RMT8 the LHPR, the AMPS and the MOCNESS Net, and on the 17mm co-ax cable (ROV Cable) for towing the RMT25.

Considering the huge amount of nearly 100 deployments done during this cruise with all the change overs between the different gear overall the DWNM has performed satisfactorily, but it became clear that the system is at the edge of its lifetime and becomes more and more unreliable.

Apart from minor problems with connectors and some difficult to understand problems with no- advancing of the LHPR and the AMPS there was one major problem when one of the Net-Monitors stopped working completely. After replacing a blown relay on the circuit board the fault was finally identified by AME as a kind of short at the terminal block. Separating the two contacts finally solved the problem.

The designer of the net monitor electronics, and author of the current software has left BAS, much of the information required to modify both the electronics and the software (particularly), has been lost. In order to overcome these problems and enable the system to keep up with new requirements it is planned to develop a new version of the monitor, incorporating the best of the current system but also taking the opportunity to eliminate some of the problems. This is now in progress and hopefully the new system will be available for the next season as a trial and test version (see also recommendations).

## ***RMT25***

This net was used to make 56 hauls, more than on any previous cruise. It proved to be very effective, and gave only little trouble. Initially there was a problem with the release gear, when the fault was identified to be the broken feed back electronics. These were replaced with the similar ones from the second RMT 8 release unit. After that everything worked fine apart from another small problem with the release unit, when a cable came loose. Due to the number of deployments and the wear and tear in sometimes not ideal conditions the side wires were worn out and needed replacing with the spares. After a certain amount of deployments the side wires encounter a

good amount of twisting and in the future swivels should be put on the top of the side wires so they can turn freely.

Also the nets suffered from the number of deployments and the use in sometimes not ideal conditions. The age of the nets is showing now. The nets need good refurbishing by the net maker. On several occasions a big krill swarm was caught (up to 150 kg) and to get the net in the support of the Gilson winch was required. On one of the recoveries the non-filtering cod-end was ripped completely and needed a serious amount of stitching it back together.

The new net was checked and the idea was to test it as well. Unfortunately the net came with no holes for the dropping wires and therefore could not be tested. It has to go back to the net maker in order to make the necessary changes.

### **RMT8**

Use of the RMT8 was limited to some hauls during the previous cruise in the Western Core Box, and a limited number of target hauls for fish larvae for an AFI. The net was rigged in what has become the standard configuration for this work employing two nets, rigged so that the second does not open when the first closes but requires a further 'firing' of the release. Also the non-filtering cod-ends were used (see also RMT25). The net together with the DWNM worked fine and we encountered no problems.

### **LHPR**

The LHPR was used 17 times. The idea was to use a catch diverter device to allow the descent to be done with the mechanism inactive. The diverter vents the catch from the cod-end of the net until the first advance command is sent, at that point it lines up with the recorder box and the catch enters. The electronics that allowed the catch diverter to respond just once to an advance command which were potted into the cable connection between the DWNM and the recorder box failed during JR 116.

Subsequently these were replaced by a set built into the monitor housing by Vsevolod Afanasyev. Despite several tests during this cruise it seems that the replacement did not work any longer. Therefore the LHPR had to be used without the catch diverter.

Unfortunately the number of gauze advances often did not match the advances given by the software. There seems to be a problem with the mechanical turning in the spooling box and the use of relays on the spooling device not advancing properly giving wrong feed backs and stopping the spooling at the wrong time. This has to be addressed back in CB.

### **AMPS**

The AMPS net was brought on board as a back up system for the MOCNESS Net and had to be used after the complete failure of the MOCNESS Net. The Net was deployed 6 times and never worked probably. The initial problems were with the new non-filtering cod-ends, which were not designed correctly and caused a strong backwash in the net as well as the cod ends ended up on top of the net. By changing the cod-ends to filtering cod-ends and putting a protective net on top of the frame this problem could be solved. Unfortunately the firing mechanism caused major problems on the reliability of nets fired in water. On deck the deck unit and the release

mechanism worked fine and the firing could be repeated without any problems. Once deployed however the release mechanism did not work reliably and we had holes were we had command ok and feedback ok responses as expected but the release mechanism had only released 3 nets. This fault needs to be further investigated if the AMPS is to be used again on further cruises. One other small problem was the extension lead, which caused some connector problems. Because the other equipment were using the DWNM system as well, there was never enough time to do more testing of the system to make it more reliable.

### ***MOCNESS Net***

The MOCNESS Net was a loan from the Gatti Marine Lab in Oban. It was tested and trialled during the Summer trials cruise where it worked fine but was considered to be flaky due to improper storage and maintenance eg. PC was stored in damp place... back in the UK. During the cruise we made 11 deployments with the MOCNESS Net where it worked, in general, satisfactorily. There were some initial problems with the release wires breaking, but after replacing the worn out ones with new ones, they worked fine. On the 1.11.06 the very old main PC failed completely (not unexpected) but thanks to IT support we were able to build the PES PC with the required hardware, the old Windows 3.1 software and the MOCNESS control software. After that the Net worked fine until the 20.11.06 when the electronics in the main housing stopped responding. After testing all other possibilities like sea cable, modem, PC and connectors, the problem was clearly identified to be the deck unit and therefore prevented any further deployment of the MOCNESS. The complete failure was not to unexpected because it was an old system especially the PC, but without any documentation and spares there was no possibility to repair it on board.

For further cruises a new PC, documentation, spares and so on should be brought to be able to cope with any major problems with a complex system like the MOCNESS Net.

### ***Bongo and Mini-Bongo Net***

The Bongo and Mini-Bongo net were deployed 35 times and worked very well. On one occasion the Bongo wire slipped of the block and was damaged. Therefore the wire needed to be cut of by 30m and reterminated. Also on one occasion the Bongo Net was not lashed properly causing the Net to fall on deck. Fortunately nobody was in the vicinity and the only damage was to the net. All bars were bent and needed straightening. The wire of the spring system was damaged and had to be replaced by completely dismantling and rebuilding the spring mechanism. Further damage was done to the main studs holding the main bars to the top frame.

### ***Neuston Sledge***

The Neuston Sledge was deployed only two times to catch surface animals. The first time the conditions were marginal with lots of little ice bits in the water, the second time conditions were good and the Sledge caught lots of Themisto, unfortunately the wrong species, so no further deployments were made.

## ***Recommendations:***

1. Replacing the current DWNM is still top priority. Doug Bone and myself have raised this issue for many years. The system is old, flaky and needs replacing. Finally there is now some money made available to replace the system and AME has agreed to develop the new system. Jim Fox has been tasked with the Job. The idea is that we have a prototype on board for next season to use it along with the old one and then replace the old system in the following season.
2. It seems that the non-filtering cod-ends are getting more and more preferred against the filtering. In the moment we have only one pair of these cod-ends, therefore more RMT non-filtering cod-end should be bought.
3. If the old MOCNESS is used again a new deck unit and a new PC as well as spares are needed. Also some kind of documentation would be quite helpful. If BSD is going for a new one, again spares and documentation should be bought with it.
4. If the intension is to use the AMPS again – either as the main net or as a back up to the MOCNESS - a decision has to be made sooner then later to give time to sort out the issues encountered on this trip. Also proper non-filtering cod-ends for the AMPS should be designed and get made.
5. The LHPR spooling mechanism needs to be sorted to overcome the mismatch between fired commands and the real amounts of turns. Also the catch diverter device (opening and closing mechanism), which doesn't work with the existing DWNM, has to be incorporated into the new system with a second command and feed back line.
6. If we continue with the amount of RMT 25 fishing we need another new RMT 25 net. Also the existing new net has to go back to the net maker to get holes for dropping wires made.
7. The old RMT 25 nets have been deployed more than 50 times on this trip. They need some major refurbishing and have to go back to the net maker.
8. Due to the amount of deployments the RMT 25 side wires suffered quite a bit and had to be replaced, to increase the life expectancy swivels should be put on top of the side wires to allow the side wires to rotate freely.
9. The feedback on the RMT25 release mechanism needs checking. Also it has to be replaced in one of the RMT8 release from where it had been taken out. Further a couple of new ones should be made to take as spares.
10. By next season the new USBL tracking system will be fully implemented and this should further improve any fishing activity regarding position and depth of gear in the water.
11. On a more general note mobilisation and demobilisation relied on good weather condition during passage from and to the Falklands. If the weather would have been unworkable the time given for mobilisation and demobilisation would not been sufficient. More time should be allocated for future cruises especially if the same amount of gear will be used.

## Whale Acoustic Recording Packages (ARPs)

Three freestanding ARPs were deployed during JR152, 159 (see event log for details). A fourth ARP was recovered from the shallow water mooring and this was replaced with a 5th ARP when the mooring was redeployed. It had been the intention to re-deploy the shallow mooring ARP as a freestanding unit but this was not possible as the vacuum pump onboard the JCR was unable to achieve the required vacuum. It is recommended that a number of issues regarding the management of the ARP project and deployments should be resolved before the next Discovery2010 cruise.

1. Mooring weights and chains could not be found in FIPASS.
2. Mooring riggings for the ARPs were considered amateurish and need complete re-rigging.
3. Future redeployments of ARPs will require a sufficiently powerful vacuum pump to be onboard the JCR.
4. Concern was raised that the ARPs are small and very difficult to see and may be difficult to locate during recovery. It is suggested that future ARP deployments should be equipped poles and flags to ensure successful recovery.
5. Management of data from the ARPs requires careful consideration as no provision for backing up the ARP data had been made prior to JR152, 159. Jeremy Robst therefore created a copy of each disk for security. These backups will be transferred to BAS via LTO tape and restored to SAN. Nathan Cunningham will ensure that Tony Martin is aware of where the data resides. For future cruises it is recommended that an external coupling mount for the 2.5" hard disks is purchased to ease the data transfer/backing up process and a copy of the software is available so the data can be transferred from binary format to ASCII and appropriately tagged with metadata as soon as possible.

| Serial Number | Assigned HDD # | # Written on HDD | Location of Buoy | Date Recovered                           | Backup copy made |
|---------------|----------------|------------------|------------------|--|------------------|
| 41YK4JTW4H    | 26             | 184              | KEP Mooring      | 9/06 rescued mooring by Norwegian vessel | Yes              |
| N5AT4214126   | 76             | 70               | WCB Mooring      | 12/10/2006                               | Yes              |

## 3700m Discovery2010 sediment trap mooring

Deployed at: 19:52:00 25/11/2006

Mooring position: **-52.72321 S -40.14731 W**

Water depth: 3779.13 meter

NOVATEC beacon: U07-029, Ch A, 154.585 MHz

### **Acoustic Releases:**

Deck unit mode: **B FR2 – FR2**, to release press: **safety + command**

#### Codes:

Release No: 572                      release code: **15E0 + 1555**

Release No: 573                      release code: **15E1 + 1555**

Acoustic releases: 572 + 573

ARGOS beacon: *SN 280, ID 60210*

NOVATEC Combo beacon: *U07-029*

### **CTD 37 SMP 43742: 4852 on main buoy**

- set-up instrument for re-deployment
  - set real time clock to PC clock (p. 28)
  - check instruments is ok and clock is set properly by using “DS”command (p. 27)
  - set-up instrument for “Autonomous Sampling” following the instructions on page 24
  - samplenum=0 automatically makes entire memory available for recording
  - sample interval: 900 sec
- create a .txt file with instrument settings and save file in correct folder

### **CTD 37 SMP 43742: 4855 at estimated 500 m**

- set-up instrument for re-deployment
  - set real time clock to PC clock (p. 28)
  - check instruments is ok and clock is set properly by using “DS”command (p. 27)
  - set-up instrument for “Autonomous Sampling” following the instructions on page 24
  - samplenum=0 automatically makes entire memory available for recording



- sample interval: 900 sec
- ☐ create a .txt file with instrument settings and save file in correct folder

### **ADCP WHS300 – I – UG26: 7522**

- ☐ set-up instrument for re-deployment
  - erase data (p.16 WinSC)
  - start WinSC for set up instrument
  - set-up instrument
    - Number of bins: 30 (1-128)
    - Bin size (m): 8 (0.2-16)
    - Pings per Ensemble: 10
    - Interval: 15 min
    - Duration: 550 days
    - Transducer depth: 200 m
  - save deployment settings in prepared folder
  - set up ADCP real time clock to PC clock
  - don't verify the compass (needless on a ship)
  - run pre-deployment tests to check instrument
- ☐ check if instrument is working (you can hear it pinging)

### **PopUp unit 54**

- The Cornell PopUp was taken out of the original mooring rigging and was placed in a stainless steel frame, which was put inline with the moorings just beneath the main buoy.
- the unit needed a new code which was loaded just before setting up the instrument.
- The old file: V7.2 was replaced with new file: BAS IK50. AHX V9.0 from 14.10.04
- **setup:**
  - DSM ID: 361
  - HDD model no: HTS421280H9AT00
  - HDD serial no: 334AKJU5XPE
  - Firmware: HA30A7OG
  - Total Sectors: 156235952
  - Recording Time: 462.92 days
  - pressure: 680 Mb
  - ID: ok
  - external piezo: ok
  - Hello command: ok
  - start recording: 14.26 GMT, 25.11.06

### **Sediment trap: Parflux No – on toolbox - at estimated 2000 m water depth**

#### **Parflux sediment trap deployment settings (21 cups)**

McLane Research Laboratories, USA



***Current meter: Aquadopp No A2L - 1792 at estimated 2000 m water depth***

**Aquadopp current meter deployment settings**

Deployment → planning

Measurement intervals (s) 900

Average interval (s) 60

Measurement load (%) 4 tick in auto box

Blanking distance 0.35

Compass 900

Speed sound, measured 34 (appro salinity at 2000m)

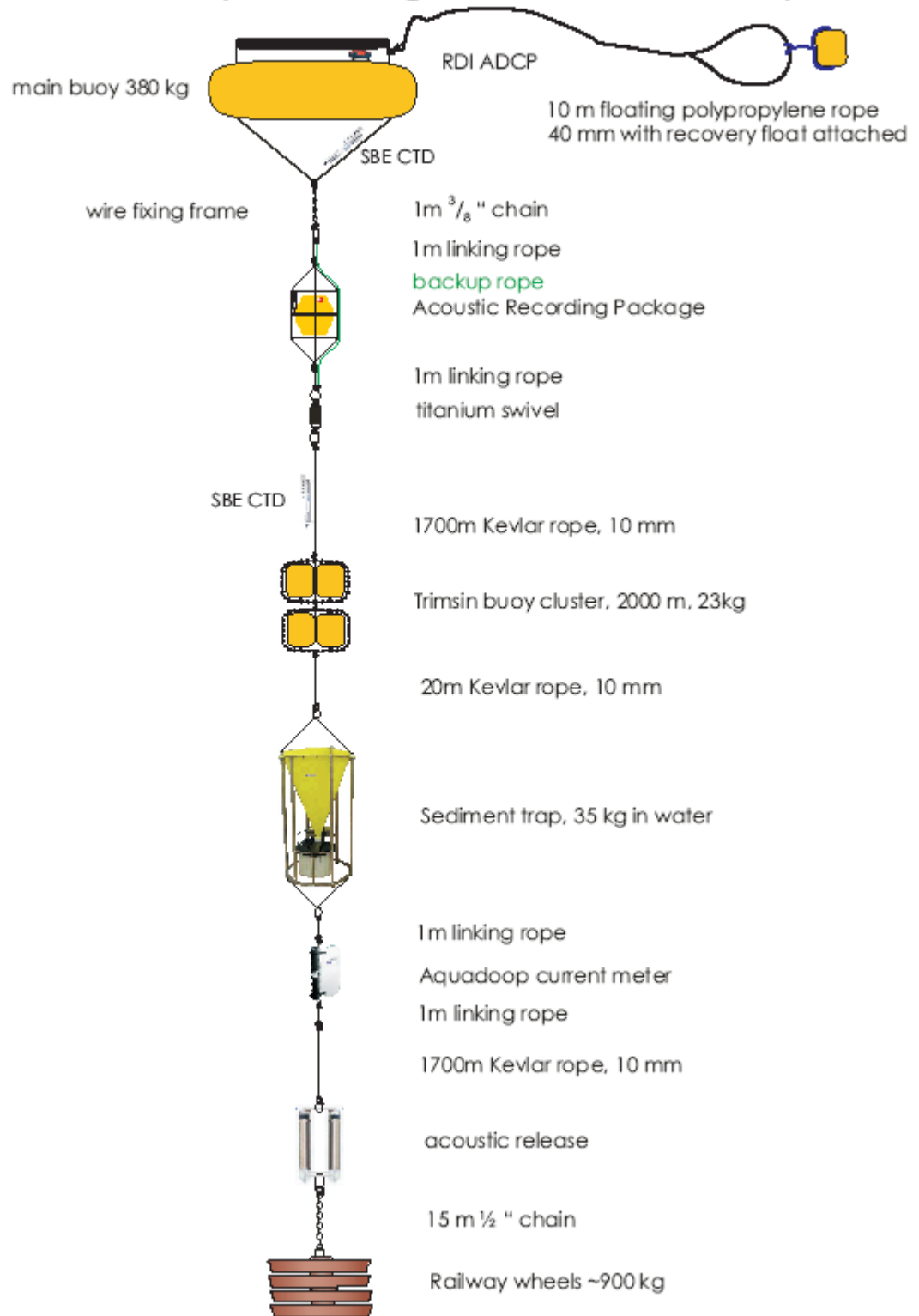
Coordinate system ENU

Diagnostics do not tick enable

Deployment planning assumed duration 430 days

Battery utilisation approx 200 % (can use up to 400% for Lithium battery).

## Sediment trap mooring (3700m water depth)



**Figure of Sediment Trap Mooring**

# Cruise JR161 Macronutrient Analysis

***Mick Whitehouse and Min Gordon***

## ***Introduction***

Overall, the Southern Ocean is rich in macronutrients that are generally underutilized by phytoplankton. Scarcities of micronutrients, inadequate light and grazing are some of the factors that have been cited previously as potential controls on phytoplankton growth and thus macronutrient use. However, there are exceptions to this “high-macronutrient, low-chlorophyll” phenomenon, especially in the Scotia Sea. Among the explanations for this is the relief from Fe-stress brought about by natural Fe sources from sites at the Antarctic Peninsula and oceanic islands such as South Georgia. However, due to the Southern Ocean’s latitudinal gradient of  $\text{Si(OH)}_4$  abundance (low to the north, high to the south) diatom growth in the northern Scotia Sea is susceptible to silica-stress.

South Georgia’s blooms regularly comprise chlorophyll *a* concentrations  $>10 \text{ mg m}^{-3}$  and may be sustained for four months or more. They seed the ocean for hundreds of kilometres downstream and are associated with the strongest predicted carbon sink in the Southern Ocean. Furthermore, the enhanced primary production supports a rich food web. To sustain such substantial blooms, Fe is likely to be re-supplied to the euphotic layer throughout the growing season. The availability of  $\text{Si(OH)}_4$  in the surface waters will determine whether the bloom is dominated by diatoms or whether a seasonal succession of other phytoplankton species occurs. Despite intense research, the dynamics of seasonal phytoplankton growth and nutrient utilization in the northern Scotia Sea remain poorly understood.

## ***Aims***

Three cruises are planned to examine seasonality in the Scotia Sea: the spring cruise JR161 is the first of these with summer and autumn cruises to follow. Macronutrient measurements are a component part of the examination of phytoplankton dynamics and will complement micronutrient and phytoplankton growth measurements. The Process stations are sited so that growth rate measurements can be made in Fe-poor,  $\text{Si(OH)}_4$ -rich waters and Fe-rich, seasonally  $\text{Si(OH)}_4$ -poor waters. Lugols-fixed sample will be examined to ascertain the seasonal taxonomic composition of the phytoplankton. Macronutrients were measured at other stations and during transects so as to help characterize these other localities.

## ***Sample collection and analytical methods***

Vertical profiles of macronutrient distribution were measured at all Process and Condensed stations where samples were taken from a shallow and a deep CTD cast (see physical oceanography section for depths) to give a full depth profile. Process station profiles were obtained on three successive days. Samples were also taken from all Go-flo bottle casts made to obtain “clean” water for Fe analysis (see Fe analysis section for details). Along major transects near-surface waters (~7 m depth) pumped through the ship’s non-toxic seawater supply were monitored continuously for nutrient levels. For the bioassays initiated at the Process stations, nutrients were measured at intervals over the course of the experiments.

All samples 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 ( $\text{NO}_3+\text{NO}_2\text{-N}$ ), 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 to a PC once every ten seconds using a LabVIEW 6i (National instruments) acquisition programme and to a Kipp and Zonen BD300 data acquisition recorder.

The analyser was refurbished substantially leading up to the present cruise and details of this rebuild will be documented elsewhere. For this report it is worth noting that the instrument performed exceedingly well. The greatest improvements to the system’s operation are the switch to programmable proportioning pumps (Ismatec) and the use of high durability ismaprene (PharMed) pump tubing. This allows much faster start-up and shut-down routines along with a low-speed standby mode and has virtually eliminated maintenance down time. As well as improving the analyser’s efficiency, reagent use is more economical which in turn has reduced the volume of chemical waste produced.

## ***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 time-lag adjustments to individual chemistry lines. Additionally, for full verification of the vertical nutrient profiles the contemporaneous physical oceanographic measurements from the CTD are required. Therefore, a detailed evaluation of the data is not feasible for this report. However, a cursory glance at the raw data indicates that there were ample macronutrients for phytoplankton growth at all sites with the exception of Condensed station 6 where  $\text{Si(OH)}_4$  concentrations were particularly low in the top 50 m of the water column. At most stations macronutrient concentrations were fairly uniform between the surface and >80 m. However, at Condensed station 4 depletion had occurred in the top 20 m of the water column. Depletion was evident in the top 30 m at Process station 3 but following a modest storm, the water column was more uniform a day later and nutrient concentrations had increased marginally. A full evaluation of all the data should be completed during summer 2007.

## ***Problems***

It can't be overemphasised how much more efficient and reliable our water sampling operation would have been with a Ti CTD together with a 24 bottle rosette. Instead of one 24 bottle CTD cast it was necessary to make two 12 bottle casts and deploy 6 Go-flo bottles to collect sufficient water for macro- and micronutrient analysis. Also note that Go-flo bottle deployment required five people, the depths of water collection were nominal, there is no concurrent oceanographic measurements and the bottles didn't always close correctly.

Throughout the cruise there were black soot or dust particles coming out of the ship's deckhead vents in the chemistry and the prep lab. Can the system be cleaned during refit?

All hazardous chemicals for the cruise were shipped in one case. I'm pleased to see minimal packing used and presumably the mix of chemicals met with shipping regulations. However, in future, might it be a good idea to separate flammables from corrosives and labelling cases on several sides with cruise, full contents list and consigners names would be mighty useful when they're being searched for in a ship's hold.

Requested chemical waste drums were not labelled specifically enough and were left in Stanley. Fortunately there were enough surplus drums onboard to suffice otherwise we would have had big problems.

## ***Methods references***

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.

## Biochemistry/organic geochemistry

### *David Pond*

Particulate material was collected from the chlorophyll maxima to determine the food availability for meso- and macro-zooplankton communities at each site (Table 1).

Additional large volume samples of particulate material were collected from dedicated CTDs to provide sufficient material for the analysis of a wide suit of lipid biomarkers (Table 2). Krill, where present were sampled and these specimens will be analysed for PCBs to link with similar studies on higher predators (Table 3).

*Calanoides acutus* were sampled from the depth horizon where they were most abundant. The lipid content and composition of the 205 individuals of stage V and females will be analysed to provide insights into their diapause and reproductive strategies (Table 4).

**Table 1. Samples taken from bottle 12 of the shallow CTD. The downcast fluorescence trace was used to establish depth of the chlorophyll maxima.**

| Event | Date       | Depth | Fatty acid<br>(litres) | Stable isotope<br>(litres) | POC, PON<br>(litres) |
|-------|------------|-------|------------------------|----------------------------|----------------------|
| 20    | 27/10/2006 | 20    | 3                      | 1                          | 1                    |
| 35    | 28/10/2006 | 20    | 3                      | 1                          | 1                    |
| 47    | 29/10/2006 | 40    | 3                      | 1                          | 1                    |
| 77    | 01/11/2006 | 40    | 3                      | 1                          | 1                    |
| 101   | 05/11/2006 | 50    | 3                      | 1                          | 1                    |
| 129   | 08/11/2006 | 40    | 3                      | 1                          | 1                    |
| 152   | 16/11/2006 | 10    | 3                      | 1                          | 1                    |
| 175   | 18/11/2006 | 40    | 3                      | 1                          | 1                    |
| 194   | 19/11/2006 | 40    | 3                      | 1                          | 1                    |
| 204   | 20/11/2006 | 60    | 3                      | 1                          | 1                    |
| 234   | 23/11/2006 | 30    | 3                      | 1                          | 1                    |
| 243   | 24/11/2006 | 30    | 3                      | 1                          | 1                    |
| 254   | 25/11/2006 | 30    | 3                      | 1                          | 1                    |
| 278   | 28/11/2006 | 40    | 3                      | 1                          | 1                    |



**Table 2. Large volume water collections from the chlorophyll maxima and 2000m to correspond with the depth of the sediment traps deployed at process stations 2 and 3.**

| <b>Event</b> | <b>Date</b> | <b>Litres filtered</b> | <b>Depth</b> |
|--------------|-------------|------------------------|--------------|
| CS2          | 05/11/2006  | 125                    | non-toxic    |
| 23           | 27/10/2006  | 125                    | 20           |
| 26           | 27/10/2006  | 125                    | 2000         |
| 40           | 28/10/2006  | 125                    | 40           |
| 50           | 29/10/2006  | 125                    | 2000         |
| 20           | 29/10/2006  | 125                    | 40           |
| 139          | 07/11/2006  | 125                    | 30           |
| 163          | 17/11/2006  | 100                    | 10           |
| 175          | 18/11/2006  | 125                    | 40           |
| 180          | 18/11/2006  | 125                    | 2000         |
| 190          | 19/11/2006  | 125                    | 2000         |
| 191          | 19/11/2006  | 100                    | 40           |
| 203          | 20/11/2006  | 125                    | 2000         |
| 207          | 20/11/2006  | 125                    | 60           |
| 237          | 23/11/2006  | 125                    | 30           |
| 239          | 23/11/2006  | 125                    | 2000         |
| 241          | 24/11/2006  | 125                    | 2000         |
| 247          | 24/11/2006  | 125                    | 30           |
| 257          | 25/11/2006  | 125                    | 30           |
| 259          | 25/11/2006  | 125                    | 2000         |
| 288          | 29/11/2006  | 125                    | 20           |

**Table 3 Bulk samples of krill for lipid and PCB analysis.**

| <b>Event</b>       | <b>Date</b> |
|--------------------|-------------|
| Non-toxic seawater |             |
| supply filter      | 01/11/2006  |
| 46                 | 29/10/2006  |
| 76                 | 01/11/2006  |
| 85                 | 02/11/2006  |
| 92                 | 02/11/2006  |
| 95                 | 04/11/2006  |
| 96                 | 04/11/2006  |
| 105                | 05/11/2006  |
| 106                | 05/11/2006  |
| 112                | 06/11/2006  |
| 127                | 08/11/2006  |
| 135                | 09/11/2006  |
| 153                | 16/11/2006  |
| 186                | 18/11/2006  |
| 197                | 19/11/2006  |
| 228                | 23/11/2006  |
| 229                | 23/11/2006  |
| 234                | 23/11/2006  |
| 253                | 16/11/2006  |
| 289                | 29/11/2006  |

**Table 4. Individual stage V and female *Calanoides acutus* for lipid analysis. The prorosome and oil sac dimensions were determined for each copepod.**

| <b>Event</b> | <b>Net</b> | <b>Stage</b> | <b>Number of individual copepods</b> |
|--------------|------------|--------------|--------------------------------------|
| E39          | MOC 7      | F            | 3                                    |
|              |            | V            | 5                                    |
| E46          | BONGO      | F            | 6                                    |
|              |            | V            | 6                                    |
| E63          | MOC 2      | V            | 1                                    |
| E76          | BONGO      | F            | 10                                   |
|              |            | V            | 5                                    |
| E81          | MOC 7      | F            | 10                                   |
|              |            | V            | 7                                    |
| E104         | MOC 4      | F            | 10                                   |
|              |            | V            | 4                                    |
| E112         | BONGO      | F            | 7                                    |
|              |            | V            | 8                                    |
| E128         | BONGO      | F            | 10                                   |
|              |            | V            | 10                                   |
| E149         | BONGO      | F            | 10                                   |
|              |            | V            | 10                                   |
| E155         | MOC 5      | F            | 2                                    |
|              | MOC 7      | F            | 3                                    |
| E175         | BONGO      | F            | 4                                    |
|              |            | V            | 10                                   |
| E197         | BONGO      | F            | 7                                    |
| E220         | MOC 1      | F            | 1                                    |
|              | MOC 2      | F            | 2                                    |
| E233         | BONGO      | F            | 10                                   |
|              |            | V            | 10                                   |
| E264         | MULTINET   | F            | 10                                   |
| E272         | BONGO      | F            | 10                                   |
| E277         | BONGO      | F            | 4                                    |
|              |            | V            | 10                                   |

# Tissue sampling for stable isotope analysis

**Gabi Stowasser**

## **Study:**

Trophic relationships and carbon flow in the Scotia Sea food web

## **Background:**

This project targets key components within the food webs of the Scotia Sea. This area is of special importance since not only does it currently support the most valuable fishery in the Southern Ocean but it is also part of one of the fastest warming areas on the planet. In order to understand the impact commercial exploitation and climate change the Scotia Sea ecosystem we need to first understand the temporal and spatial functioning of trophic pathways in the system. The aim is to quantify regional and seasonal diets of key species and map the distribution and abundance of these species from phytoplankton and zooplankton groups up to higher predators.

The use of stable isotopes as dietary tracers is based on the principle that isotopic concentrations of consumer diets can be related to those of consumer tissues in a predictable fashion. It has been extensively applied in the investigation of trophic relationships in various marine ecosystems and has been used to determine feeding migrations in numerous species. The stepwise enrichment of both carbon and nitrogen in a predator relative to its prey suggests that the predator will reflect the isotopic composition in the prey and isotope values can be used to identify the trophic position of species in the food web investigated. Additionally  $^{13}\text{C}$  values can successfully be used to identify carbon pathways and sources of primary productivity.

Together with results gathered from fatty acid and conventional gut content studies, stable isotope analysis will allow us to quantify spatial and temporal variability in resource use and energy flow within the Scotia Sea food web. The research will identify key trophic linkages both seasonally and geographically, and will contribute to the development of sustainable management policies for the natural resources in this region.

## **Sampling:**

Whole specimens of invertebrate species were collected from the RTM 25, Bongo and MOCNESS nets during both day and night hauls. Animals were identified, bagged, labelled and frozen at  $-80^{\circ}\text{C}$  (species catalogue see Table 1). Muscle samples of the lateral region of several myctophid species were collected during the first half of the cruise (Stations PS1 – CS4). Samples were individually packed and frozen at  $-80^{\circ}\text{C}$ . The remainder of fish were frozen whole and tissue samples will be taken at BAS at the time when samples are returned to Cambridge and the fish will be processed for stomach content analysis. Particulate organic matter was sampled from shallow CTDs at each station by filtering samples onto glass fibre filters (see cruise report D. Pond). Samples were again stored at  $-80^{\circ}\text{C}$  prior to analysis in the laboratory. To gain insight into the feeding of higher predators both blood and feather samples will be collected at Bird Island and Signy parallel to the timing of the cruise.

**Table 1: Species collected for stable isotope analysis at process, AFI and condensed stations during cruise JR 161.**

| Species                         | PS1 | CS1 | AFI | CS2 | CS3 | CS4 | PS2 | PS3 | CS6 |
|---------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <b>POM</b>                      | X   | X   |     | X   | X   | X   | X   | X   | X   |
| <i>Calycopsis borchgrevinki</i> |     | X   |     | X   |     | X   | X   | X   |     |
| <i>Diphyes sp.</i>              |     | X   | X   | X   |     |     |     |     |     |
| <i>Atolla sp.</i>               | X   |     |     | X   |     | X   | X   | X   | X   |
| <i>Periphylla sp.</i>           | X   | X   |     | X   |     | X   | X   | X   | X   |
| <i>Stygiomedusa gigantea</i>    | X   | X   |     | X   |     | X   |     |     |     |
| <i>Calanoides acutus</i>        | X   | X   |     | X   | X   | X   | X   | X   | X   |
| <i>Calanus propinquus</i>       |     |     |     | X   | X   |     |     |     |     |
| <i>Calanus simillimus</i>       |     |     |     |     |     |     | X   |     | X   |
| <i>Themisto gaudichaudi</i>     |     |     | X   | X   |     |     | X   | X   | X   |
| <i>Rhincalanus gigas</i>        | X   | X   |     |     | X   | X   | X   | X   | X   |
| <i>Euphausia frigida</i>        | X   |     |     |     |     |     | X   | X   | X   |
| <i>Euphausia superba</i>        |     | X   | X   | X   |     | X   | X   | X   |     |
| <i>Euphausia triacantha</i>     | X   |     |     |     |     | X   | X   | X   | X   |
| <i>Thysanoessa sp.</i>          | X   | X   | X   | X   | X   | X   | X   | X   | X   |
| <i>Galiteuthis sp.</i>          |     |     |     | X   |     |     |     |     |     |
| <i>Histioteuthis</i>            | X   |     |     |     |     |     |     |     |     |
| <i>Chaetognata spp.</i>         | X   | X   |     | X   |     | X   | X   | X   | X   |
| <i>Salpa thompsoni</i>          | X   |     |     |     |     | X   | X   | X   | X   |
| <i>Electrona antarctica</i>     | X   | X   |     | X   |     | X   |     |     |     |
| <i>Electrona carlsbergi</i>     | X   |     |     |     |     |     |     |     |     |
| <b>Krefthycthis anderssoni</b>  | X   |     |     |     |     | X   |     |     |     |
| <b>Gymnoscopelus braueri</b>    |     | X   |     |     |     |     |     |     |     |
| <b>Gymnoscopelus nicholsii</b>  |     |     |     | X   |     |     |     |     |     |

# Cruise JR161 – Primary productivity

***Beki Korb, Marina Gordon***

## ***Introduction:***

Fe is a key factor limiting phytoplankton production in HNLC waters of the Southern Ocean. Whilst much of the Southern Ocean is characterized as HNLC type water, there are areas naturally enriched in Fe and highly productive. Within the Scotia Sea the generally easterly flowing ACC crosses a large number of ridges, plateaus and oceanic islands. These bathymetric features may introduce Fe into surface waters through upwelling or mixing with shelf sediments. Indeed some of the most spatially and temporally intense phytoplankton blooms in the Southern Ocean are found in the waters downstream of the island of South Georgia. However, these blooms are largely comprised of diatoms, which in addition to Fe, also require silicic acid for growth. During the austral summer, this macronutrient can become limiting near to South Georgia. Light is another important factor controlling phytoplankton growth. To date few direct measurements of Fe have been made in the Scotia Sea. Thus the exact role of Fe and/or the interactive effects with silicic acid concentrations and light in promoting or preventing primary production in this region is unclear.

## ***Aim:***

Through a collaborative research effort with NOC, we aim to examine the effect that iron, light and silicic acid have on natural phytoplankton populations in the Scotia Sea. We will measure ambient iron, light and silicic acid across a latitudinal gradient covering both areas of open ocean and shelf waters and relate these environmental parameters to differences in primary production rates, phytoplankton biomass, and photosynthetic efficiency. In addition, on deck experiments will be conducted (bioassays) with controlled additions of Fe and light.

## ***Methods and data coverage:***

The iron/bioassay component of this work is covered by the reports of Nielsdottir and Bibby, the macronutrient component, including silicic acid measurements, by Mick Whitehouse. This cruise report will concentrate on primary production, chlorophyll a (biomass) and photosynthetic physiology (as measured by the FRRF).

*Primary production:* Primary production was measured using the radioisotope  $^{14}\text{C}$  (as  $\text{NaHCO}_3$ ) following the standard methods of Korb. This method basically follows the JGOFS protocol and uses an on deck incubator with incubations lasting 24 hours in tubes with 100, 77, 54, 30, 10, 6, 1, and 0% surface irradiance. Trace metal clean techniques were followed. Bottles for incubations were cleaned at BAS (using HCl) and shipped south in plastic bags. Clean water samples were collected using a GoFlo bottle fired at 20m with the exception of the first station whereby clean water was collected using the towfish (see Nielsdotirs report). However, all radioisotope work was carried out in the rad lab and not in the clean container.

Measurements of primary production were also measured as PvsE curves (14C), using the photosynthetron in the rad lab. Incubations lasted for 2 hours.

Primary production rates using the on deck incubators were measured at least once at all CTD Process and Condensed stations (3 times at Process stations 2 and 3). PE curves were made once at all stations and at the end of 2 bioassays (Process stations 1 and 2).

*Chlorophyll a*: At each Processed and Condensed station, a shallow CTD was deployed for collection of chlorophyll *a*. Shallow CTDs were deployed at 3 out of the 4 days of occupation of a Process station and one out of 2 days at a Condensed station. Bottles were fired at nominal depths of 5, 10, 20, 30, 40, 50, 60, 80, 100 and 120 m and at a floating depth determined to be the chlorophyll maxima (from examination of fluorescence data on the downcast). Fluorescence data from the CTD will be examined back at Cambridge and calibrated against the chlorophyll samples collected. PAR data from the shallow CTD cast will also be examined to determine euphotic depths.

In addition, size fractionated chlorophyll *a*, from standard depths of 20 and 100 m as well as from the chlorophyll maxima were measured at all CTD stations mentioned above. Chlorophyll samples were also taken from the ships non-toxic seawater supply when the ship was underway and will be used to calibrate the Oceanlogger fluorescence.

All chlorophyll samples were filtered and then frozen at  $-20\text{ }^{\circ}\text{C}$  and stored until it was convenient to extract and analyse then on the ship.

The PML remote sensing group provided cruise support sending MODIS weekly composites of chlorophyll *a* and sea surface temperature. The images were updated every 3 days.

### ***Photosynthetic physiology***

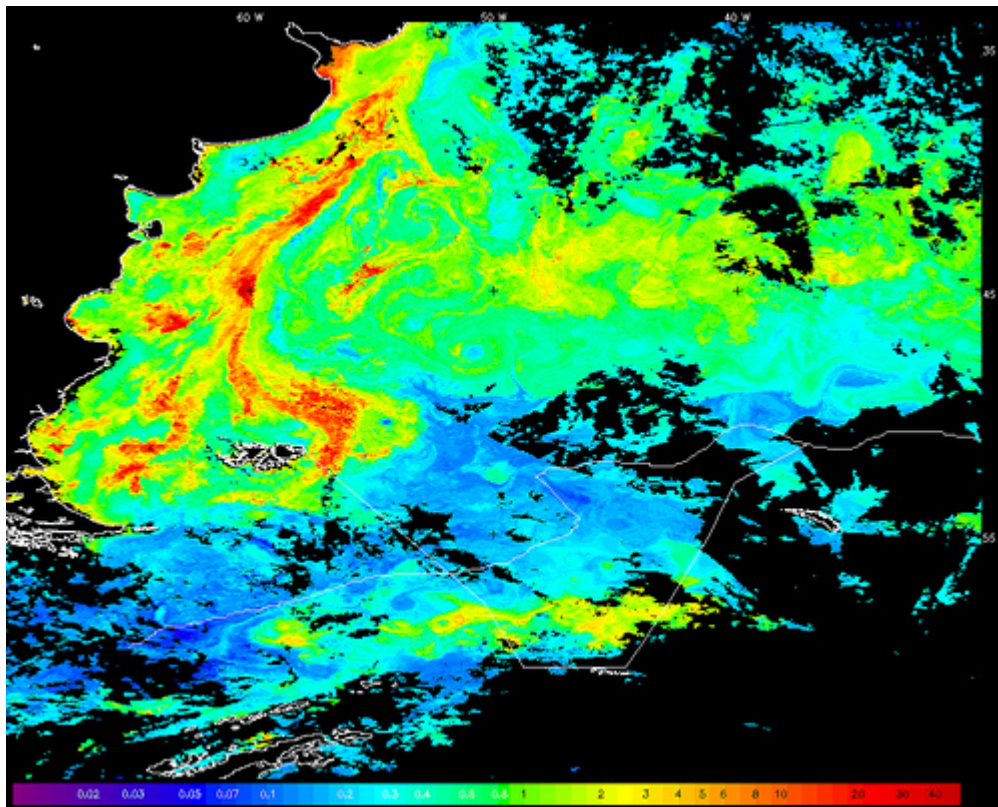
Two Chelsea FRRF's were used during the cruise. The UKORS FRRF was deployed on a frame at each CTD station mentioned above. The BAS FRRF was connected to the ships underway seawater supply during transects. Two types of blanks were performed on both instruments at sea using bucket blanks, with DI water and filtered seawater, and were performed at all gain settings for both the light and dark chambers. An instrument response function was carried out on the UKORS FRRF using a chl *a* standard of  $10\text{ }\mu\text{g}\cdot\text{ml}^{-1}$  in 90% acetone.

*Additonal*: At various time points in the bioassay, water was collected from the incubation bottles by Bibby and samples taken for chlorophyll *a*, POC and Lugols.

At Condensed stations 3 and 4, water samples were taken from the  $100\text{ }\mu\text{m}$  bongo net. The water was added to filtered seawater containing  $f/2$  and cultures were placed in the incubator on the aft deck. When the Polar Front was crossed on the return to the Falklands, the cultures were removed to the cold room. The cultures will be returned to the CCAP in Oban for the potential isolation of new phytoplankton species into culture.

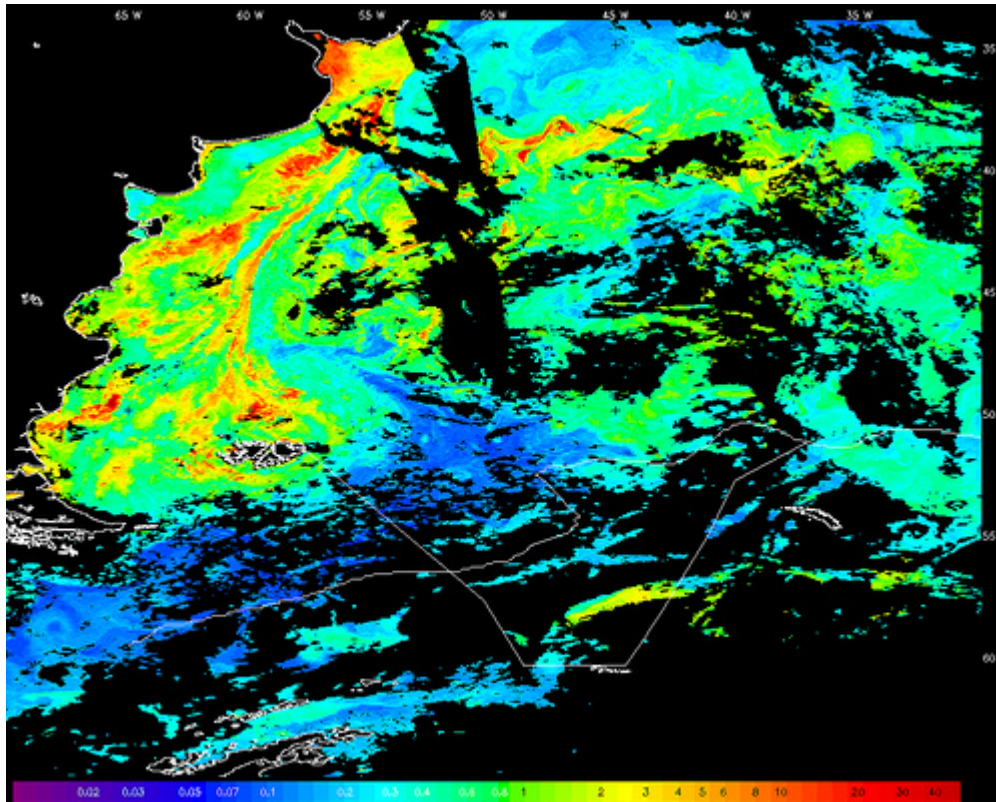
### **Results:**

Full data analysis will be performed back at BAS, Cambridge as many of the data sets are subject to a variety of correction factors, e.g. the chlorophyll standard needs to be calibrated itself on a spectrophotometer. Additionally, the data can only be fully interpreted with the contemporaneous physical oceanographic measurements from the CTD and Oceanlogger. However, from Figure 1 we can see that a fairly intense phytoplankton blooms is located in the region of the southern Scotia Ridge at the beginning of November. This bloom may also be associated with the retreating ice edge in this area. Note the area of high chlorophyll along the western most transect line below the Polar Front, an area previously believed to be low productivity. Figure 1b shows how the bloom along the ridge has retreated during the course of the cruise. A full evaluation of all the data should be completed during summer 2007.



**Figure 1a. MODIS 4km resolution chlorophyll a image, 7 day composite ending the 7<sup>th</sup> November 2006.**





**Figure 1b. MODIS 4km resolution chlorophyll a image, 7 day composite ending the 24<sup>th</sup> November 2006.**

### **Problems**

One of the major problems with the cruise was that we were unable to borrow the UKORS titanium CTD. Instead of one 24 bottle CTD, we had to deploy a 12 bottle CTD twice and collect “clean” water with GoFlo bottles. As noted by Whitehouse, the GoFlo bottle deployment required five people, the depths of water collection were nominal, there is no concurrent oceanographic measurements and the bottles didn’t always close correctly.

At the beginning of the cruise the lab was cleaned out to remove soot or dust particles. However, after this the lab was repeatedly covered with dust/soot from the deckhead vents. It seems pointless to clean bottles etc thoroughly and follow clean techniques if the lab is so badly and regularly contaminated with dirt from the vents.

It was noted that one of the chemical waste drums from the rad lab containing seawater with <sup>14</sup>C leaked whilst being moved to the CTD annex. The leak came from one side of the drum lid, which may have been faulty. Whilst the rad leak from this one drum was contained and did not present a danger to anyone, there may have been other incidences of leaky drums (this was never confirmed to me) which could present a real hazard to those moving the waste drums.

The BAS FRRF died near the very end of the cruise at condensed station 6. The problem most likely lies with the flashcard. Due to the death of the FRRF, an

instrument response function test could not be performed on the instrument whilst at sea.

Internet access was often annoyingly slow. At times, it was difficult to download the satellite images that were sent to me which makes near real time cruise support a bit pointless!

To end this report on a positive note, I would like to say how useful the online event logs were for finding out both event numbers and underway oceanographic parameters e.g. PAR and fluorescence. Well done Nathan and Jeremy!

# Study of phytoplankton response to naturally iron enriched regions of the Scotia Sea

December, 2006

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## **1.0 Overview**

Iron is an essential component of the photosynthetic electron transfer chain and as such iron abundance and phytoplankton abundance are positively correlated. Iron concentrations in the Southern Ocean are generally low owing to the lack of continental derived Aeolian dust inputs. There are however, potential sources of iron into this system – including; seasonal melting sea ice, upwelling, and run-off / dust deposition from islands. The aim of this work, as part of JR-161, is to correlate natural iron abundance with phytoplankton abundance, speciation and productivity with respect to the rest of the Scotia Sea food chain.

## **2.0 Techniques**

### **2.1 Phytoplankton physiology**

Phytoplankton abundance, community structure and physiology are all outputs from the bench top FIRE system (Fluorescence Induction and Relaxation of Emission Spectrometer). This instrument is a development of the FRRF (Fast Repetition Rate Fluorometer) technique that is used widely in biological oceanography. This bench top instrument measures in real time and at high sensitivity a suit of parameters association with the community of phytoplankton. These include:

- **F<sub>m</sub>** – Maximum fluorescence yield – Analogous to Chlorophyll Concentration - (Phytoplankton Abundance).
- **F<sub>v</sub>/F<sub>m</sub>** – The photosynthetic energy conversion efficiency. A measure of the ‘health’ of the phytoplankton community

- **Sigma-PSII** – A measure of the size of the light harvesting antenna association with the photosynthetic reaction centre Photosystem II (PSII)

### 2.1.1 Sampling

The FIRE instrument has been employed continuously on this cruise – measuring surface underway samples both on station and during transects from the uncontaminated sea-water. This has provided information spatial dynamics of phytoplankton physiology during transects and the temporal (diel) dynamics of phytoplankton physiology at stations.

In addition FIRE measurements have been made on discrete (500 ml) samples collected from the niskin rosette during the shallow biological casts. These discrete provided vertical profiles of the abundance and physiology of the phytoplankton community at both condensed and process stations. The physiology of the different size fractions (3, 5, 10 and 20  $\mu\text{m}$  poly-carbonate membrane filters) of the sample collected from the chlorophyll maximum were also performed. This returned information on the size-community structure of the phytoplankton community and the physiology associated with each size fraction.

### 2.2 On-deck Bioassay measurements

A series of on-deck bioassay incubation experiments were conducted at each process station, under controlled temperature and light conditions. The aim of these experiments is to identify the factors limiting phytoplankton growth. Trace metal clean surface water collected using the Go-Flo system or more normally the Tow-Fish were obtained at the start of each process station (such that enough time was available to observe a response). Samples (2 l) were subjected to the conditions summarised tables below, these also highlight the suit of measurements taken in order to characterise the response of the phytoplankton community to the artificially controlled conditions. These experiments will be import demonstrations of conclusions drawn from the sampling of the natural phytoplankton community and nutrient availability in the Scotia Sea.

**Table 1 Conditions of Bioassay Incubation experiments**

| Condition      | 60% of Surface PAR | 60% of Surface PAR + 4 nM FeCl <sub>3</sub> | 30% of Surface PAR | 30% of Surface PAR + 4 nM FeCl <sub>3</sub> |
|----------------|--------------------|---|--------------------|---|
| Bottle Numbers | 1-5                | 6-10  | 11-15              | 16-20                                       |

**Table 2 Summary of Incubation Experiments**

| Station   | Experiment   | Duration | Notes                      |
|---|--------------|----------|----------------------------|
| PS1 - Nominally low – productivity                      | Incubation 1 | 14 days  | Overlap with Signy relief  |
| PS1 Nominally low – productivity                        | Incubation 2 | 12 Days  | Overlap with Signy relief  |
| PS2- South of S. Georgia                                | Incubation 3 | 10 Days  |                            |
| PS3 – North of S. Georgia – Nominally high productivity | Incubation 4 | 8 Days   | Short due to end of cruise |

**Table 3 Sampling summary of incubation experiments**

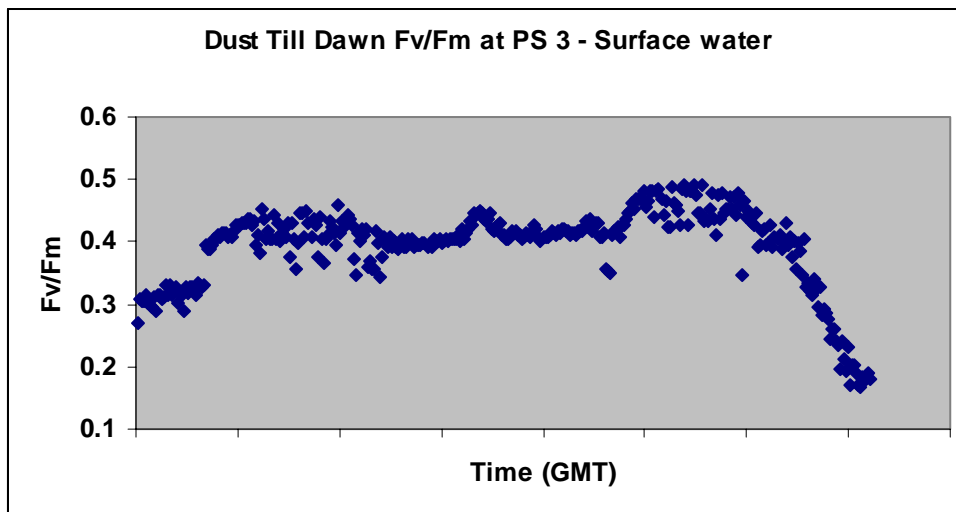
| Time Point   | Sampling   |
|--|--|
| Start of experiment (T0)   | FIRe, Fe, Nutrients, P/E, Chlorophyll, Lugose, POC/PON, HPLC, Flow-Cytometry |
| Daily  | FIRe   |
| Time Series, Two points determined by response as measured by daily FIRe | FIRe, Nutrients, Chlorophyll   |
| End of Experiment (Tend)   | FIRe, Fe, Nutrients, P/E, Chlorophyll, Lugose, POC/PON, HPLC, Flow-Cytometry |

### 3.0 Preliminary Results

#### 3.1 Underway measurements

Underway sampling using the FIRE technique delivers information of the spatial and temporal dynamics of phytoplankton abundance and physiology. An example of which is given in figure 1 which shows the dust till dawn Fv/Fm signal obtained from Process station 3. High Fv/Fm is measured at night indicative of a healthy and nutrient replete phytoplankton; this signal however can be seen to dramatically reduce during the day as a result of quenching by light. Such data obtained both on transects and at each station will be analysed with respect to nutrient concentrations, surface PAR, sea surface temperature, extracted chlorophyll, bathymetry and higher food web structure.

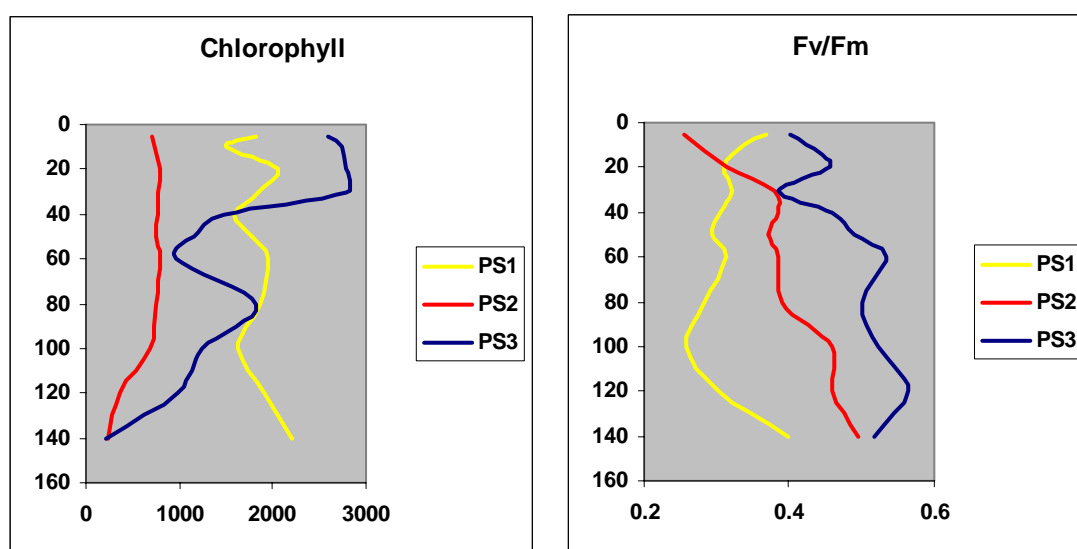
**Figure 1**



### 3.2 Discrete Sampling

Discrete samples were obtained throughout the euphotic zone on all shallow biological CTD's at both condensed stations and process stations. Examples of profiles showing chlorophyll abundance and Fv/Fm at each of the process stations is shown in Figure 2. Process station 3 can be seen to have high phytoplankton abundance in surface waters and elevated Fv/Fm throughout the water column, indicative of a more productive station. Such data from both condensed stations and process stations will be analysed with respect to surface PAR, nutrient availability, phytoplankton species composition, temperature, iron concentrations of higher food web structure.

**Figure 2**



### 4.0 Comments and further work

This work, as part, of JR161, has studied the response of phytoplankton to naturally iron enriched regions of the Scotia sea in early season. It is anticipated that the continuation of this work in 2007 and 2008 will provide an excellent opportunity to study this dynamic at later stages in the season and will reveal the extent to which the phytoplankton / nutrient relationship supports the rest of the Scotia Sea food web.

The localisation of the process stations and condensed stations on this and future cruises is critical in ensuring the sampling of both contrasting and representative regions. In future cruises it is highly recommend that these stations are selected with respect to real-time satellite chlorophyll data and data obtained during the cruise. This is essential to ensure the maximal potential scientific output of such cruises.

Also, the on-deck bioassay incubation experiments provide a valuable demonstration of the limiting nutrients in selected regions of the Scotia Sea and an insight in the response of the phytoplankton community to these inputs. However, owing to the low-temperatures responses can be slow (> 10 days). It would be beneficial if cruise logistics would ensure time for the completion of these experiments. During JR161 the cooling of the bioassay work was achieved by the pumping surface sea water – this is not ideal when the ship is moving through diverse bodies of water and it is recommended that a self contained water cooling system be used in future.

Lastly, the strong diel response of phytoplankton is clear from Figure 1. Sampling of phytoplankton should therefore be conducted at least twice daily (dark and light) and if possible at consistent times, avoiding the highly dynamic dawn and dusk transition.



## **A study of the iron distribution in the Scotia Sea**

December 2006

***Maria C. Nielsdóttir, Tom Bibby and Eric Achterberg***

**National Oceanography Centre, Southampton, SO14 3ZH Southampton**

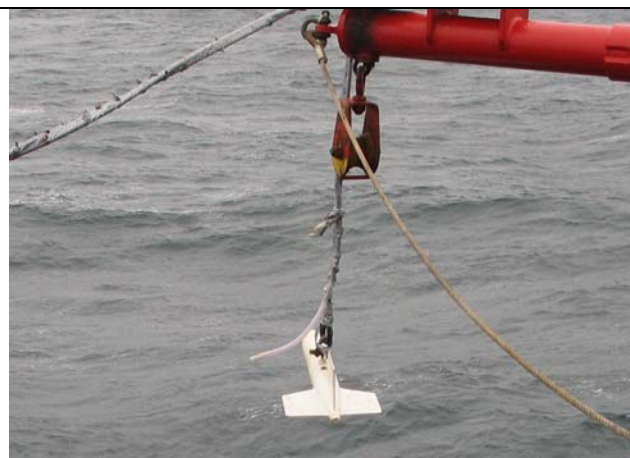
**mcn@noc.soton.ac.uk**

### ***Introduction***

Iron is an essential element for all living organisms and is of major importance for aquatic photosynthetic organism. Due to the insolubility of Fe(III) the concentration of iron in oxygenated seawater is extremely low (<0.5 nM in the open ocean). Iron is supplied to the surface ocean via atmospheric transport of dust and its deposition, as well as by upwelling, entrainment, or mixing of deeper waters relatively rich in nutrients and metals. Furthermore a runoff effect supplying iron from ice, sea ice and brine has been found to contribute significantly to the iron budget in higher latitudes.

### ***Sample method***

**Underway:** Samples were taken from a metal towfish that was towed at the stern on port side of the ship. Tubing went from the fish into the container where it was pumped with a peristaltic pump. See picture 1



Picture 1, torpedo towfish

Underway samples were filtered online through a 0.2 um Sartobran filter. All underway samples were acidified to a pH~1.8 with ultra pure HCl from Fisher.

**Profiles:** At each process station three profiles were collected and one at each condensed station. Samples were taken from 6 General Oceanic bottles at different depths. The bottles were attached to a plastic coated metal wire and the Go-Flo bottles were released with Teflon messengers.

All samples were acidified to a pH~1.8 with ultra pure HCl from Fisher.

### ***Method***

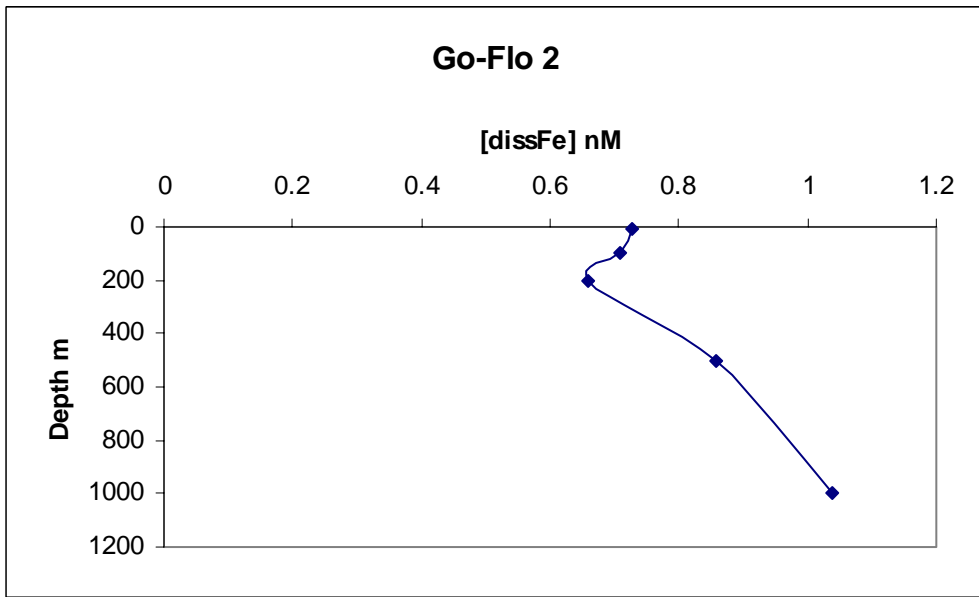
Dissolved iron was measured using the flow-injection chemiluminescence method by Obata (1993). Samples were buffered with ammonium acetate to a pH=4 and pre-concentrated on a resin column during analysis.

### ***Results***

14 Go-Flo profiles were taken and 136 underway samples with the towfish. The samples will undergo further analysis back at NOC.

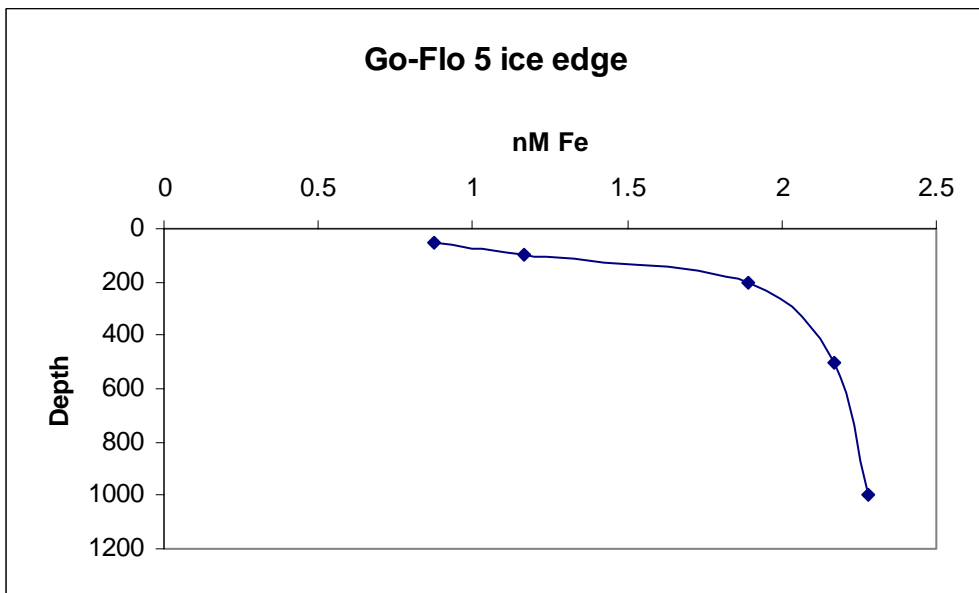
Preliminary data from Process station 1 indicate that this station had higher dissolved Fe concentrations than one would expect for a typical HNLC region.

At process station 1 the dissolved iron concentration were quite high for the region. Ranging from dissolved Fe concentrations from 0.7 nM at surface to about 1 nM at 1000 m. See figure 1.



**Figure 1. Process station 1, day 2.**

At the ice edge condensed station, the dissolved iron concentrations increased both in surface and at depth, which could indicate a run off effect from the ice. See figure 2.



**Figure 2. Condensed station 2, ice edge.**

These are preliminary results and that the values might change after further check and calibration back at NOC.

### ***Recommendations and future work***

The initial results show that the first Process station was not as HNLC condition as planned. Therefore it would be advisable for future cruises that the cruise line would be take into account the latest satellite images.

For future cruises in this region a more cold resistant kind of tubing should be used as the tubing became very brittle in the water and snapped in half when pressure was put on it. Also, gaffa tape is better as use as tape as the grey tape I had was too brittle for the cold weather.

Access to the container should be avoided when the wire for the net comes in again as during the winch time a brush is washing the wire coming in spraying iron water all over the place and onto the container. See picture 2



Picture 2, clean container covered in iron spray.

For future work, it would be a wish to bring at least one more person on the cruise to assist with the iron work and bioassay. This would improve the coverage of underway sampling and having an extra person would mean that a bigger suite of nutrient and light combinations for the bioassay experiments could be done.

### **Equipment**

The clean container: The UKORS clean container was used as a lab.

The back and front door had both big visual gaps. Please see picture 3 and 4. The back door was sealed using silicon gel to avoid water, air and other contaminants to enter the clean space. The front door was left untouched.



The milli-Q system in the clean container had visual algal growth in the pipes and therefore it was decided to use the ships MQ system instead.

During the cruise on the 19.11.06 in the early morning it was noticed that one of the windows facing the afterdeck was cracked. There is no clue what has caused this accident.

The Go-Flos worked very well. Only comment for future cruises would to have a meter counter on the winch.

### ***Acknowledgement***

I would like to thank Dr. Dave Pond for the amazing help with the go-flos. Also, I would like to thank the captain, officers and crew for all their very professional help with the go-flos and not at least the towfish.

## **Copepod Condition Factors.**

### ***Rachael Shreeve***

Depth stratified *Calanoides acutus* samples were taken across the survey area, to look at condition factors and depth distribution within the water column.

The aim for sampling *C. acutus* was to collect 10 stage CV's from each depth horizon sampled with the MOCNESS. These would be placed in pre-weighed tin capsules for carbon and nitrogen elemental analysis and stored at minus 80 oC for transport, and analysis, back in the UK.

MOCNESS hauls were taken at most stations both day and night. The daylight samples were all sorted for samples for CHN and preserved in ethanol, whilst the night time samples were preserved in Formalin. Many depth horizons produced very few, if any, CV *C. acutus*, consequently the samples collected reflect the main distribution of the population. Samples were also not in as good a condition as we are used to with the bongo net, and may cause problems with analysis.

Depths sampled with the MOCNESS were: - 1000 – 750m, 750 – 625 m, 625 – 500, 500 – 375, 375 – 250, 250 – 125 and 125 to the surface. Unfortunately the MOCNESS failed at CS4 so we resorted to using the Multinet. This net has only 5 cod ends so we then sampled the depth horizons: - 1000 – 700m, 700 – 500m, 500 – 400, 400 – 200, 200 – 125m, the top 125m were sampled with the bongo net. We had problems with this net system though, and on most deployments around half the nets failed to actually fire, even though the software indicated all was well. Therefore we are unsure about which depth horizons were sampled with the Multinet, however samples were taken to give some indication of the condition of *C. acutus* at the different sites.

### ***Problems with MOCNESS and Multinet net systems.***

Failure of the MOCNESS system half way through the cruise caused us to substitute this sampling with the Multinet. This system proved to be flakey, possibly linked to the net monitor system has caused problems with collecting samples. It is essential that before next cruise that we have a fully operating system to collect multiple samples on one deployment of plankton that is in good condition. Sea trials during summer 2007 will be essential to test this system out prior to the main cruise.

### ***Krill for Clock genes project.***

2 samples were taken for an initial look at the clock genes. One sample from near the South Orkneys and one to the north of South Georgia. Krill were taken at T0, and heads cut and placed inside a tube that was surround by Ethanol at minus 80 oC, to try and freeze the heads instantly.

### **Samples taken**

| Station (Event) | Depth horizon   | Number/location of sample   |
|-----------------|-----------------|---|
| PS1 (39)        | 375 - 250       | 10 <i>C. acutus</i> . Tray A A1 – A10   |
| PS1 (39)        | 125 - 0         | 10 <i>C. acutus</i> . Tray A B1 – B10   |
| CS1 (81)        | 1000 - 875      | 2 <i>C. acutus</i> Tray A C1 – C2   |
| CS1 (81)        | 875 - 750       | 11 <i>C. acutus</i> Tray A C1 – D1  |
| CS1 (81)        | 750 - 625       | 7 <i>C. acutus</i> Tray A D2 – D8   |
| CS1 (81)        | 625 - 500       | 8 <i>C. acutus</i> Tray A D9 – E4   |
| CS1 (81)        | 500 - 375       | 12 <i>C. acutus</i> Tray A E5 – F4  |
| CS1 (81)        | 375 – 250       | 10 <i>C. acutus</i> Tray A F5 – G2  |
| CS1 (81)        | 250 – 125       | 10 <i>C. acutus</i> Tray A G3 – G12   |
| CS1 (81)        | 125 – 0 m       | 10 <i>C. acutus</i> Tray A H1 – H10   |
| CS1 (82)        | 400 – 0m        | 10 <i>C. acutus</i> from Bongo for comparison with MOCNESS condition Tray B A 1 – A10 |
| CS2 (104)       | 750 - 625       | 10 <i>C. acutus</i> Tray B B1 – B9 and C1   |
| CS2 (104)       | 625 – 500       | 10 <i>C. acutus</i> Tray B C2 – C12   |
| CS3 (132)       | 500 - 375       | 10 <i>C. acutus</i> Tray B D2 – D11   |
| CS3 (132)       | 750 - 625       | 2 <i>C. acutus</i> Tray B E1 – E2   |
| CS3 (132)       | 625 - 500       | 10 <i>C. acutus</i> Tray B E3 – E12   |
| CS3 (132)       | 375 – 250       | 10 <i>C. acutus</i> Tray B F1 – F10   |
| CS3 (132)       | 250 - 135       | 12 <i>C. acutus</i> Tray B F11 – G10  |
| CS3 (132)       | 125 – 0         | 13 <i>C. acutus</i> Tray B G11 – H11  |
| CS4 (153)       | 500 - 375       | 10 <i>C. acutus</i> Tray D A1 – A10   |
| CS4 (153)       | 625 - 500       | 10 <i>C. acutus</i> Tray D B1 – B10   |
| CS4 (153)       | 750 - 625       | 7 <i>C. acutus</i> Tray D C1 – C7   |
| CS4 (153)       | 875 - 750       | 10 <i>C. acutus</i> Tray D D1 – D10   |
| CS4 (153)       | 1000 – 875      | 2 <i>C. acutus</i> Tray D E1 – E2   |
| CS4 (153)       | 375 - 250       | 10 <i>C. acutus</i> Tray D F1 – F10   |
| CS4 (153)       | 250 - 125       | 10 <i>C. acutus</i> Tray D G1 – G10   |
| CS4 (153)       | 125 – 0         | 10 <i>C. acutus</i> Tray D H1 – H10   |
| PS3 (264)       | Unclear (net 1) | 15 <i>C. acutus</i> Tray F A1 – B3  |
| PS3 (272)       | Bongo 400 - 0   | 10 <i>C. acutus</i> Tray L A1 - A1  |
|                 |                 |   |
|                 |                 |   |



## JR161 Krill Studies

**Ryan Saunders, Sophie Fielding, Katrin Schmidt, Gabi Stowasser, Andrew Hirst**

### **Introduction**

Krill (*Euphausia superba*) were collected, analysed and preserved for ongoing BAS studies:

1. Population dynamics: assessment of the length-frequency and maturity status of the Scotia Sea population.
2. Trophic level analysis.
3. Genetic analysis: inter-regional differences throughout the Scotia Sea.
4. Clock gene analysis.
5. Swarm kinship: genetic analysis.
6. Ovarian analysis.

### **Methods**

Samples were taken with an RMT25 net at the condensed and processed stations and during acoustic target fishing events. Length-frequency measurements and sex/maturity status were taken from fresh krill for population dynamical studies. Total length was measured from the front of the eye to the tip of the telson, rounded down to the nearest millimetre. Maturity status was based on the Makarov and Denys scale for juveniles, sub-adults and males. Adult females were classified according to the Cuzin-Roudy and Amsler scale. Samples were preserved for all other krill studies for subsequent laboratory analyses in the UK. Onboard krill sampling protocols are detailed in Table RAS1.

**Table RAS1. Onboard sample preservation protocol for krill.**

| <b>N</b> | <b>Where</b>        | <b>Sample preparation</b>           | <b>Notes</b>                                | <b>Responsible</b> |
|----------|---------------------|-------------------------------------|---|--------------------|
| >200     | Each swarm          | Live                                | Faecal pellet analysis                      | KS                 |
| 10       | Each net or swarm   | Frozen at -80°C                     | T <sub>0</sub> samples for Trophic analysis | GS                 |
| 100      | 1 per station       | 95% ethanol                         | Genetic analysis                            | AH                 |
| 200      | 1 per station       | 10% formaldehyde                    | Ovarian analysis                            | RAS                |
| 200      | Each catch          | Onboard analysis or frozen at -20°C | Length-frequency/maturity                   | RAS                |
| 10       | Where possible      | Dissection to 95% ethanol           | Clock gene analysis                         | RS                 |
| 10*200   | 10 swarms in 1 area | 95% ethanol                         | Kinship genetics                            | SF                 |

### **Data coverage**

A summary of the krill catches analysed/ preserved is shown in Table RAS2, together with station details. Few krill were caught at stations PS1, CS4, CS5 and CS6; therefore, no animals were analysed or preserved for the krill studies. The requisite numbers of krill were preserved for trophic and genetic analysis at each station, and

between 100 and 200 krill per station were retained for ovarian analysis. Onboard length-frequency and maturity measurements were obtained from 100-200 individuals from each net haul. Some, but not all, of these samples were frozen at  $-20^{\circ}\text{C}$ . Dissections for clock gene analyses were collected at PS2 and PS3, and between 100-200 animals were collected from 5 discrete krill swarms for kinship genetics at PS3.

**Table RAS2. Record of krill catches analysed/preserved for krill studies. Target hauls are denoted (\*), and stations where krill were analysed/ preserved are denoted (+).**

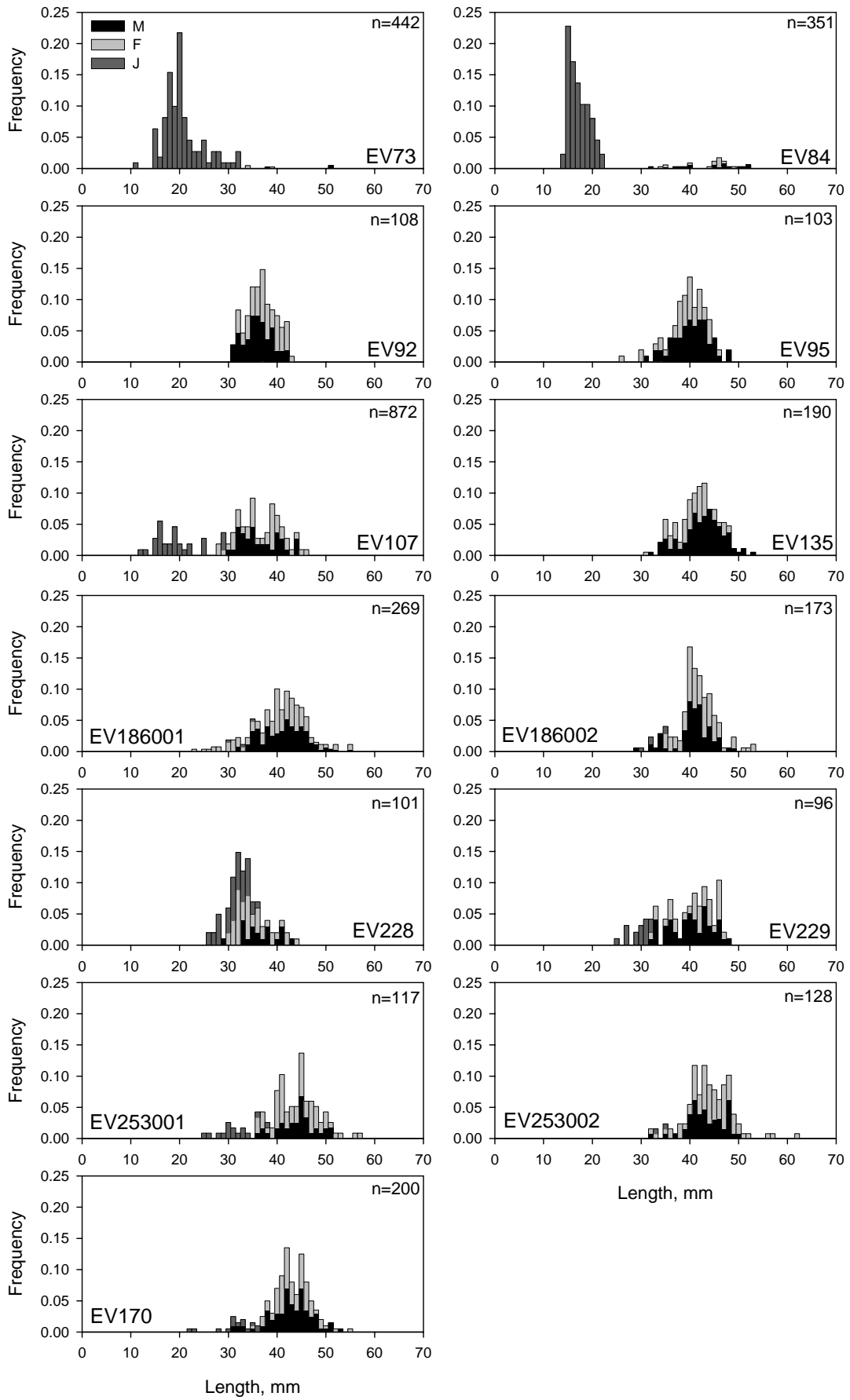
| Date                   | Time  | Station | Event | Net | Depth (m) | Pop. dynamics | Trophic analysis | Genetic analysis | Clock genes | Kinship analysis | Ovarian analysis |
|------------------------|-------|---------|-------|-----|-----------|---------------|------------------|------------------|-------------|------------------|------------------|
| No krill caught at PS1 |       |         |       |     |           |               |                  |                  |             |                  |                  |
| 01/11/2006             | 03:21 | CS1     | 73    | 1   | 980-700   | +             | +                | -                | -           | -                | -                |
| 02/11/2006             | 01:43 | CS1     | 84    | 1   | 400-200   | +             | +                | +                | -           | -                | +                |
| 02/11/2006             | 14:19 | CS1     | 92    | 2   | 200-20    | +             | +                | -                | -           | -                | -                |
| 04/11/2006             | 20:37 | AFI     | 95    | 2   | 100-10    | +             | +                | +                | -           | -                | +                |
| 06/11/2006             | 03:59 | CS2     | 107   | 1*  | 45-30     | +             | +                | +                | -           | -                | +                |
| 09/11/2006             | 02:37 | CS3     | 135   | 2*  | 35-24     | +             | +                | +                | -           | -                | +                |
| No krill caught at CS4 |       |         |       |     |           |               |                  |                  |             |                  |                  |
| No krill caught at CS5 |       |         |       |     |           |               |                  |                  |             |                  |                  |
| 18/11/2006             | 22:15 | PS2     | 186   | 1*  | 26-24     | +             | +                | +                | +           | -                | +                |
| 18/11/2006             | 22:22 | PS2     | 186   | 2*  | 26-25     | +             | +                |                  | -           | -                | -                |
| 23/11/2006             | 01:04 | PS3     | 228   | 1*  | 25-10     | +             | +                | +                | -           | +                | +                |
| 23/11/2006             | 02:36 | PS3     | 229   | 1*  | 30-25     | +             | +                | -                | -           | +                | -                |
| 25/11/2006             | 03:50 | PS3     | 253   | 1   | 400-200   | +             | +                | -                | -           | +                | -                |
| 25/11/2006             | 04:32 | PS3     | 253   | 2   | 200-20    | +             | +                | +                | -           | +                | +                |
| 27/11/2006             | 02:39 | PS3     | 270   | 1*  | 30-15     | +             | +                | +                | +           | +                | +                |

## **Preliminary results**

Relative length-frequency distributions from each net haul where onboard krill measurements were obtained are shown in Figure RAS1. In general, distinct differences in length-frequency distribution and population structure were observed in each net haul. Small, juvenile individuals (15-30 mm) were caught predominantly at sites closest to the ice-edge (CS1 and CS2), whilst krill with a larger body size (30-55 mm) and more advanced state of maturity were evident further north in the open Scotia Sea-South Georgia region. Maturity stage analysis found that almost no adult krill in the survey region were bearing spermatophores, indicating that reproduction had not started at the time of sampling (November).

## **Recommendations**

Comparisons of length-frequency distributions obtained with RMT25 and RMT8 net: possibility of under sampling small krill with RMT25 due to larger mesh size.



**Figure RAS1. Relative length-frequency distribution of krill.**

## Mesozooplankton Sampling

**(Peter Ward, Andrew Hirst and Rachael Shreeve)**

This part of the zooplankton sampling programme was centered around two main objectives which were:

- 1) To describe the vertical distribution of plankton from the surface to 1000 m at each of the stations using the Longhurst-Hardy Plankton recorder (LHPR)
- 2) To sample *Oithona similis* (Copepoda:Cyclopoida) at each station and establish its abundance, population composition (stage structure), fecundity and population mortality in relation to temperature and food. Further, to isolate species stages and undertake grazing experiments using natural seawater obtained from the chlorophyll maximum.

A subsidiary objective was to use passage time to and from Stanley at the beginning and end of the cruise to tow the Continuous Plankton Recorder (CPR) and thus partially satisfy the requirements of the CPR LTMS project for the 2006/07 season.

### **LHPR Studies (Peter Ward)**

It was planned that at each of the stations a day and a night LHPR profile (0-1000 m) would be taken. In the event this proved impossible as the normally reliable system proved extremely temperamental and malfunctioned on a number of occasions. A particularly annoying fault of continuously winding on at some point in its deployment cycle and latterly as soon as the net was lifted from the deck, was traced to fault in the wire. This was re-terminated only for the fault to reoccur and finally be traced to some frayed wiring on the winch slip ring. This fault occasioned the loss of some 4 hauls. Whilst remedying the slip ring problem there still remained a potentially serious problem with 6 of the 13 insofar as there was a mismatch between the number of commands and feedbacks, initiated and received by the deck command unit, and the number of wind-ons (complete revolutions of the gauze supply spool) and hence patches of plankton found on the gauzes. There is still some debate about the root cause of this problem. The number of spool revolutions was always less than the number of commands and feedbacks received. It is therefore seems possible that during its sampling period the magnet in the end cap of the supply spool may have disconnected from the reed-switch causing the next firing command from the deck unit to only move the spool back to its previous position. The disagreements were sometimes relatively trivial but ranged from 5 or so patches out, to in excess of 40. Why this should occur is unknown. It is possible that given the age of the magnets and reed-switches they are weakening and are no longer fit for purpose. Alternatively the method of deployment may be the root cause of the problem. On previous cruises the unit was deployed at around 3.5 knots. Because of the fishing depth required (1000 m) this meant that a ratio of around 3:1 (wire out: net depth) was anticipated. It transpired however that over the years successive re-terminations have reduced the length of the biological wire to something less than 3000 m. It was therefore not

possible to achieve the desired depth at 3.5 kts. We accordingly reduced the ships speed on deployment to 2.0 kts and veered from the winch at 40 m/min which reduced the wire out to depth ratio to around 2:1. It may be that as a result of this new regime the unit is not experiencing a steady flow through the net which is causing the supply spool to 'wobble' as described above. This also suggests that the fault and mismatch is principally occurring on the descent and not on the ascent which is fished at a normal 3.5 kts and hauling rate of 30 m/min. If time allows we plan to check this by undertaking a test deployment to a lesser depth veering and hauling at a constant ships speed of 3.5 kts to see if this remedies the fault.

In the event a total of 17 deployments was made, 4 of which were not cut due to instrument malfunction (see above) and 7 indicated a mismatch between gauzes cut and that indicated by the deck command unit.

With a new net monitor being planned for use on future cruises it is important to ensure that it incorporates a better (more precise) way of disabling the LHPR motor during fishing, rather than further reliance on the reed-switch. It also needs to take into account the requirements to be able to increase the time period that gauzes fish (presently 99 seconds max) as well as incorporating a flow diverter in the cod-end allowing the net to be vented until it is appropriate to switch. A specification needs to be drawn up before work progresses much further on this project.

## ***Oithona similis: mortality rates and role in the Antarctic ecosystem***

***Peter Ward and Andrew Hirst***

### ***Introduction:***

*Oithona* is a ubiquitous genera of cyclopoid copepod which plays an important role as a grazer of microplankton and as a prey item for many fish larvae and other higher predators. *Oithona similis* has been shown to perform coprophagy, and as such is implicated as a potentially important player in modifying vertical flux of faecal material. *Oithona similis* dominate mesozooplankton numbers in Antarctic waters and is an important contributor to zooplankton biomass. Mortality plays a critical role in determining the population dynamics of copepods, and can be as important as growth in determining spatio-temporal patterns of abundance and productivity. Although our knowledge on this species growth and fecundity rates has been progressed in recent years (e.g. Ward & Hirst, in press), without a better understanding of mortality and its controls we will be unable to predict population dynamics of this important species. Although there are some measurements of copepod mortality rates in waters of <math><5^{\circ}\text{C}</math> (Hirst & Kiørboe 2002), these are largely based on rates in cold seasons in temperate regions, as such they may be expected not to necessarily represent Polar waters. There are very few measurements on copepod mortality in the Antarctic Ocean. The objectives of this work were to collect quantitative samples that would allow first assessments of mortality (using a vertical life-table approach) for *Oithona similis* in this region. Our work would also complement previous studies on fecundity and grazing. Our methods are described in detail below.

## **Methods:**

### **Abundance**

At each of the Process (P1 to P3) and Condensed stations (C1 to C6) the 50µm bongo net was hauled vertically from 400 metres, collected samples were preserved in 4% formaldehyde. Details on all net hauls are provided in the Bongo Appendix at the end of this Cruise Report. In addition, collections were made using 10L Niskin bottles on the CTD, with 2 bottles being fired at each of the depths 400m, 300m, 200m, 100m, 50m, and surface. These events are detailed in the CTD Appendix in the Cruise Report (Events and dates were: E27 28/11/06; E86 02/11/06; E109 06/11/06; E161 17/11/06; E195 19/11/06; E245 24/11/06; E286 29/11/06). Each samples was carefully filtered through 50µm mesh and preserved in formaldehyde. Upon return to the laboratory these samples will be used to obtain quantitative estimates of abundance of all stages (egg to adult). We will using stage-specific development times and the abundance estimates in order to determine fecundity and stage-specific mortality rates (using a vertical life-table approach).

### **Grazing**

At each of the stations grazing experiments were also undertaken. Bongo net samples were rapidly sorted and 4 aliquots, each containing 30 *O. similis* (a mixture of CV and CVI females) were isolated in filtered seawater and left in the cool room (1°C) for 24 hours to acclimate. Following this they were filtered and backwashed into 250 ml Duran bottles containing seawater obtained from the chlorophyll maximum not more than one to two hours before the experiment was set up. Three initial 250 ml seawater samples were fixed in 2% lugols iodine, and a further 3 control samples were placed in Duran bottles. These, along with the bottles containing *O. similis* were placed on grazing wheel (approx 1 rev per 90 sec) and incubated for 24 hrs. The experiments were concluded by placing all of the 3 control samples into lugols iodine, as well as three of the bottles containing animals. The remaining bottle containing animals was filtered and the contents inspected under a microscope to establish likely mortality rates during the course of the experiment. The bottles (9 per station) will await counting in the UK.

### **Biomass**

At PS1 and PS2 3 aliquots of 200-250 animals were placed into pre-weighed dried tin capsules. These will be used to determine mean carbon content once in UK.

## **References:**

Ward P, Hirst AG (in press) *Oithona similis* in a high latitude ecosystem: abundance, distribution and temperature limitation of fecundity rates in a sac spawning copepod. Marine Biology  
Hirst AG, Kiørboe T (2002) Mortality of marine planktonic copepods: global rates and patterns. Marine Ecology Progress Series 230: 195-209

### ***CPR tows (Peter Ward and Rachael Shreeve)***

As part of the LTMS CPR project, 3 tows were planned to take place during cruise JR161. An initial tow was made on departure Stanley and continued up to the first Process Station, a distance of some 380 miles. The second and third tows are planned for the journey back to the Falklands commencing on departure of the final station.

## **RMT25 fishing during JR161**

***Ryan Saunders, Sophie Fielding, Katrin Schmidt, Gabi Stowasser, Andrew Hirst, Martin Collins, Peter Enderlein***

### ***Introduction***

The mesopelagic fish and macro-zooplankton are an important part of the foodweb that are not adequately sampled by smaller nets. During the cruise the RMT25 was used to characterise the fish and macro-zooplankton community at each station, to ground truth acoustics with target hauls and to catch krill in surface waters for a range of studies.

### ***Gear***

The RMT25 was rigged with 2 nets, with the release mechanism and downwire net-monitor with flow, temperature, salinity and PAR sensors. In general the RMT 25 performed well. There were two problems with the release mechanism, the first being a failure of the feedback mechanism. The second being when the connection between the shaft and the gear mechanism had worked loose. The RMT nets suffered considerable wear and tear and are now at the end of their working lives.

### ***Catch sorting and processing***

Depth stratified hauls (1000-700; 700-400; 400-200 & 200-surface) were conducted day and night at each of the stations (30 hauls) (see Table X1), with each net open for 35-45 minutes. In addition 20 hauls were undertaken at stations either targeting krill or fish marks identified on the EK60 echosounder or to catch krill in surface waters. In addition 3 hauls were made to catch fish larvae (AFI) over the South Orkneys continental shelf.

For the stratified hauls the total catch was sorted and quantified. Numbers caught and total weight (when > 1 g) was obtained for each species. For some groups specific identification was not possible. Samples were collected from key species for stable isotope analysis and the remainder of the catch, with the exception of the large jellies, was preserved in formalin or ethanol (pteropods and some amphipods only). All data were recorded in an MS Access relational database.

Fish were separated from the rest of the catch and were measured and sexed (using external sexual characters when possible). At stations P1 & C1 stomachs and tissue were sampled and otoliths collected from the most abundant species. At subsequent stations fish were measured, sexed and frozen whole. Bathylagus were all frozen whole from all stations.

### ***Preliminary results***

Details of species caught are given in Tables X2-X6. Over 3000 fish, belonging to 33 species were caught during the cruise (Table X2) with catches dominated by the myctophids (lantern fish) and bathylagids (deep-sea smelts) with the most abundant species being *Krefftichthys anderssoni*, *Electrona antarctica*, *Electrona carlsbergi*, *Protomyctophum bolini*, *Gymnoscopelus braueri* and *Bathylagus* sp. The bathylagids were not always identified to the species level, but most were *Bathylagus antarcticus*.



Length frequency distributions of *Electrona antarctica*, *Electrona carlsbergi* and *Krefftichthys anderssoni* are illustrated in Figure X1.

Few fish were caught during daylight hauls in the top 400 m, indicating that the fish are able to avoid the net during daylight. Daylight target hauls on clear fish marks caught either few or no fish.

Whilst all fish and euphausiids were identified to the species level, it was not possible to identify other faunal groups to the species level. A photographic guide is being developed to make identification easier and provide consistency between cruises and catch sorters.

### ***Recommendations for future cruises***

1. It is essential to carry a full set of spares for the RMT 25 release mechanism and net monitors. Fortunately we were able to remove parts from the RMT8 release to keep the RMT25 system working. With the exception of one haul the net monitor worked reliably with the RMT25, but given the problems that were encountered with other gears, a new net monitoring system is essential.
2. The current set of nets is extremely worn out, with lots of rips that have been hurriedly repaired. We have one spare net, which needs slight adjustment to fit to the bars and a second net is on order. The old nets will be OK as emergency spares.
3. The RMT25 is clearly unable to catch fish in the surface waters during daylight, so to get any idea of fish abundance night time hauls must be used. This may present problems during summer cruises, when darkness is limited and there is pressure from other gears for darkness slots.

**Table X2 Fish**

| Species                           | Weight | Number | Family          |
|-----------------------------------|--------|--------|-----------------|
| Channichthyidae (larvae)          |        | 1      | Channichthyidae |
| Champscephalus gunnari (larvae)   |        | 5      | Channichthyidae |
| Chaenoccephalus aceratus (larvae) |        | 2      | Channichthyidae |
| Electrona antarctica              | 3587   | 614    | Myctophidae     |
| Electrona carlsbergi              | 2263   | 368    | Myctophidae     |
| Electrona sp.                     | 1      | 2      | Myctophidae     |
| Electrona subaspera               | 18     | 1      | Myctophidae     |
| Gymnoscopelus bolini              | 12     | 1      | Myctophidae     |
| Gymnoscopelus braueri             | 2637   | 460    | Myctophidae     |
| Gymnoscopelus fraseri             | 131    | 13     | Myctophidae     |
| Gymnoscopelus nicholsi            | 772.5  | 36     | Myctophidae     |
| Gymnoscopelus opisthopterus       | 237    | 18     | Myctophidae     |
| Gymnoscopelus piabilis            | 155    | 9      | Myctophidae     |
| Gymnoscopelus sp.                 | 2.5    | 2      | Myctophidae     |
| Krefflichthys anderssoni          | 1013   | 705    | Myctophidae     |
| Lampanyctus achirus               | 797    | 53     | Myctophidae     |
| Lampanyctus sp.                   | 2      | 1      | Myctophidae     |
| Protomyctophum andreyseshevi      | 3      | 2      | Myctophidae     |
| Protomyctophum bolini             | 403    | 266    | Myctophidae     |
| Protomyctophum gemmatum           | 7      | 3      | Myctophidae     |
| Protomyctophum luciferum          | 1      | 1      | Myctophidae     |
| Protomyctophum parallelum         | 22     | 26     | Myctophidae     |
| Protomyctophum tenisoni           | 93     | 91     | Myctophidae     |
| Bathylagus antarcticus            | 210    | 54     | Bathylagidae    |
| Bathylagus gracilis               | 10     | 1      | Bathylagidae    |
| Bathylagus sp.                    | 3884   | 345    | Bathylagidae    |
| Benthalbella elongata             | 43     | 2      | Other fish      |
| Benthalbella macropinna           | 122    | 4      | Other fish      |
| Borostomias antarcticus           | 447    | 20     | Stomiidae       |
| Cyclothone sp.                    | 64     | 175    | Gonostomatidae  |
| Cynomacrurus piriei               | 323    | 13     | Macrouridae     |
| Fish larvae indet.                | 1      | 2      | Other fish      |
| Icichthys australis               | 481    | 1      | Other fish      |
| Nansenia antarctica               | 44     | 7      | Other fish      |
| Notolepis coatsi                  | 53     | 4      | Paralepididae   |
| Notolepis sp.                     | 2      | 4      | Paralepididae   |
| Paradiplospinus gracilis          | 724    | 10     | Gemyplidae      |
| Paralepididae                     | 14     | 36     | Paralepididae   |
| Poromitra crassiceps              | 252    | 19     | Melamphidae     |
| Sio nordenskjoldii                | 25     | 2      | Melamphidae     |
| Stomias gracilis                  | 173    | 9      | Stomiidae       |

**Table X3 Amphipods**

| Species               | Number |
|-----------------------|--------|
| Amphipod indet.       | 33     |
| Cylopus sp.           | 79     |
| Cyphocaris anonyx     | 1      |
| Cyphocaris faueri     | 1      |
| Cyphocaris richardi   | 483    |
| Danaella mimonectes   | 1      |
| Eurythenes obesus     | 1      |
| Eurythenes sp.        | 12     |
| Eusirius antarcticus  | 4      |
| Eusirius perdentatus  | 2      |
| Hyperia crassa        | 3      |
| Hyperidae indet.      | 6      |
| Lanceola sayana       | 4      |
| Lanceolidae indet.    | 2      |
| Orchomene sp.         | 1      |
| Orchomene sp. "L"     | 4      |
| Orchomene sp. "S"     | 1      |
| Parandania boeckii    | 292    |
| Parandania gigantea   | 3      |
| Pegohyperia princeps  | 9      |
| Phronima sp.          | 3      |
| Primno macropa        | 142    |
| Scina cf crassicornis | 1      |
| Scina cf incerta      | 1      |
| Scina sp.             | 3      |
| Stenopleura atlantica | 22     |
| Themisto gaudichaudii | 2222   |
| Vibilia antarctica    | 1      |

**Table X4 Mollusca**

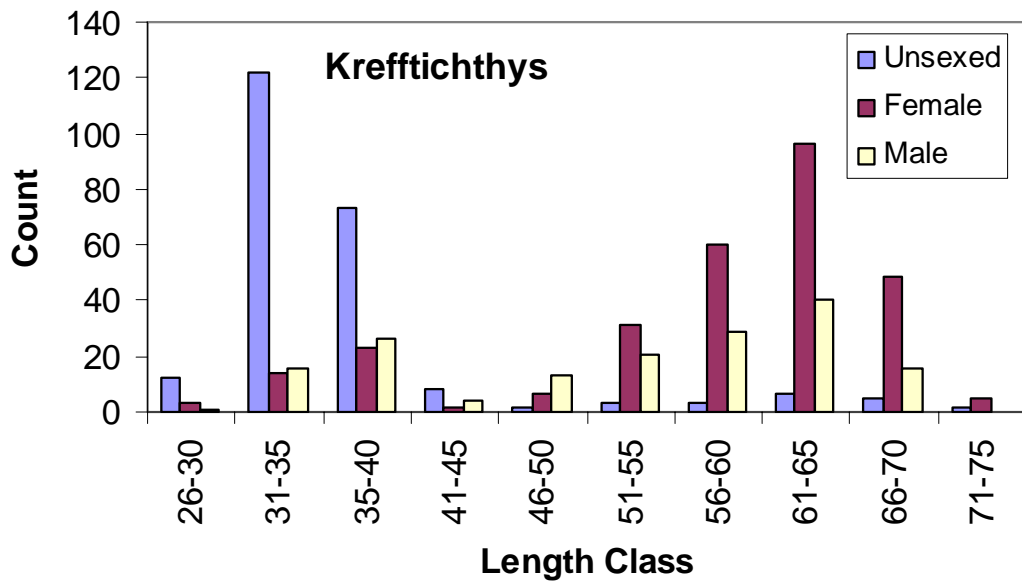
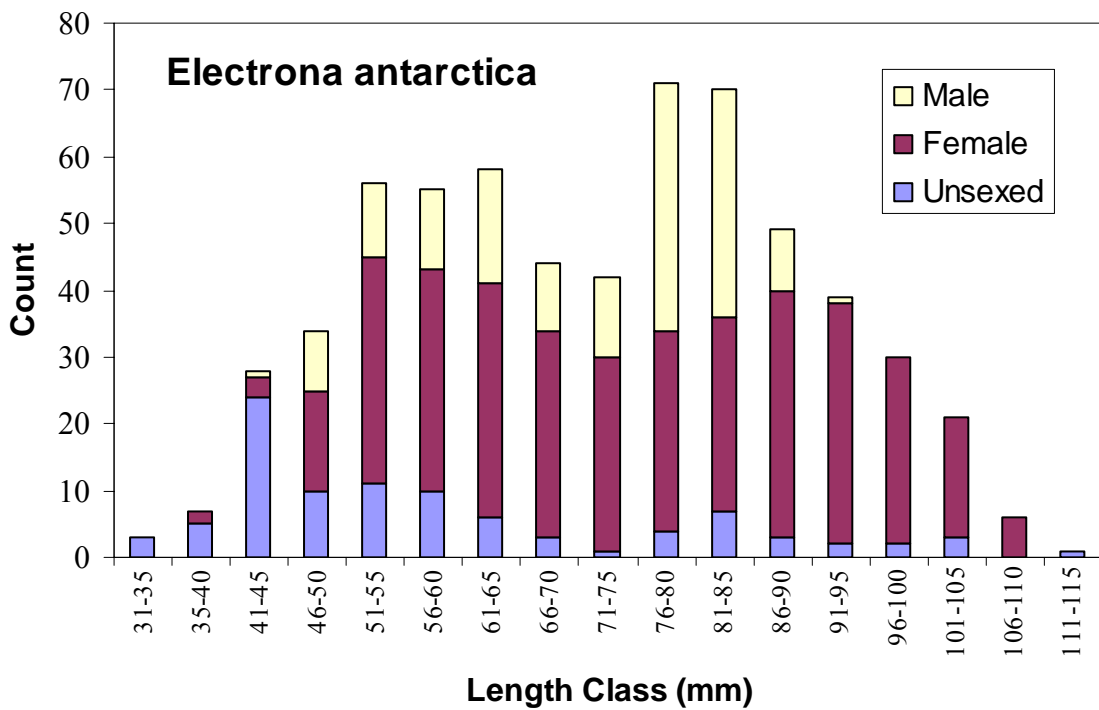
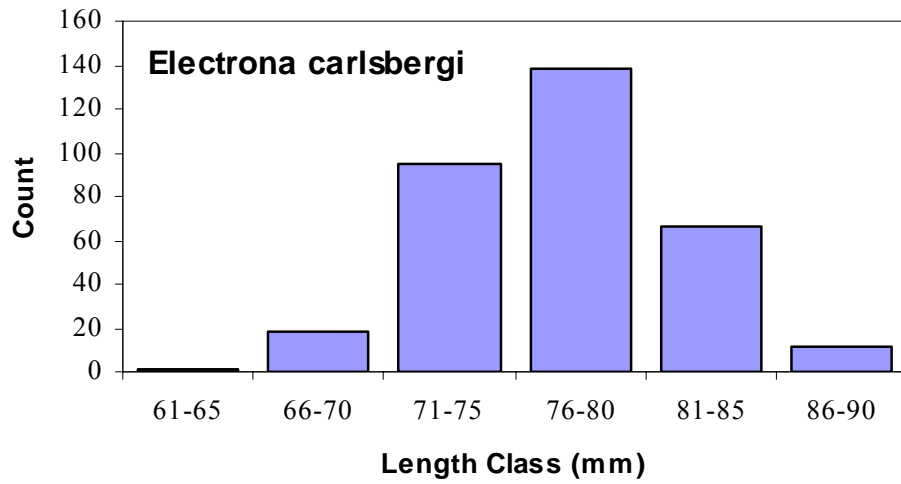
| Species                         | Mass (g) | Number |
|---------------------------------|----------|--------|
| Bathyteuthis abyssicola         | 36       | 6      |
| Cranchiidae indet.              | 83       | 33     |
| Gonatus antarcticus             | 1        | 1      |
| Histioteuthis eltaninae         | 34       | 1      |
| Mastigoteuthis psychrophila     | 126      | 3      |
| Moroteuthis knipovichi          | 69       | 2      |
| Psychroteuthis glacialis        | 7        | 2      |
| Slosarczykovia circumantarctica | 104      | 24     |
| Squid indet.                    | 5        | 3      |
| Clio sp.                        |          | 16     |
| Clione sp.                      |          | 3      |
| Pteropoda indet.                |          | 23     |
| Spongiobranchia sp.             |          | 233    |

**Table X5 Decapods, mysids, euphausiids & ostracods**

| Species                | Mass   | Number |
|------------------------|--------|--------|
| Acanthephyra sp.       | 526    | 80     |
| Decapod larvae Type 1  | 5      | 36     |
| Gennadus sp.           | 684    | 738    |
| Munida gregaria        | 2      | 1      |
| Sergestes sp.          | 35     | 12     |
| Sergestid sp.          | 15.5   | 21     |
| Sergia sp.             | 187.5  | 108    |
| Euphausia frigida      | 143    | 2013   |
| Euphausia superba      | 200729 |        |
| Euphausia triacantha   | 820    | 3591   |
| Euphausia vallentini   | 10.5   | 165    |
| Thysanoessa sp.        | 321.5  | 3414.4 |
| Thysanopoda acutifrons | 3.5    | 6      |
| Gnathophausia sp.      | 82     | 104    |
| Mysid sp "A"           | 1      | 3      |
| Gigantocypris sp.      | 287    | 238    |

**Table X6 Gelatinous zooplankton**

| Species/group                     | Weight  | Number | Group        |
|-----------------------------------|---------|--------|--------------|
| Chaetognaths indet.               | 639     | 1417   | Chaetognaths |
| Atolla wyvillei                   | 7856    | 353    | Cnidaria     |
| Calycopsis borgrevichi            | 725.5   | 384    | Cnidaria     |
| Diphyes sp. 1                     | 835     | 1379   | Cnidaria     |
| Diphyes sp. 2                     | 122     | 379    | Cnidaria     |
| Hydromedusae (clear)              | 1       | 1      | Cnidaria     |
| Hydromedusae (red)                | 182     | 35     | Cnidaria     |
| Hydromedusae indet.               | 27      | 43     | Cnidaria     |
| Nipple medusae                    | 435.5   | 279    | Cnidaria     |
| Periphylla periphylla             | 53932.5 | 213    | Cnidaria     |
| Scyphomedusae (large transparent) | 726     | 1      | Cnidaria     |
| Sibogita sp.                      | 243     | 211    | Cnidaria     |
| Siphonophore indet.               | 141     | 7      | Cnidaria     |
| Stygiomedusa gigantea             | 48157   | 9      | Cnidaria     |
| Beroe sp.                         | 1033    | 6      | Ctenophores  |
| Ctenophora indet.                 | 78      | 12     | Ctenophores  |
| Flatworms indet.                  | 10      | 11     | Flatworms    |
| Tomopteris sp.                    | 57      | 128    | Polychaetes  |
| Vanadis sp.                       | 3       | 3      | Polychaetes  |
| Salpa thompsoni                   | 2077    | 1300   | Salps        |



**Table X1 Details of RMT25 stations during JR161**

| Event | Net | Station | Type       | D or N | Open Date | Open Time | Open Lat | Open Long | Open Wire | Open Depth | Close Date | Close Time | Close Lat | Close Long | Close Wire | Close Depth | Duration | Comments              |  |
|-------|-----|---------|------------|--------|-----------|-----------|----------|-----------|-----------|------------|------------|------------|-----------|------------|------------|-------------|----------|-----------------------|--|
| 41    | 1   | P1      | Target     | Day    | 28-Oct-06 | 21:30     | -57.6762 | -50.3939  | 332       | 201.73     | 28-Oct-06  | 21:56      | -57.6567  | -50.394    | 254        | 107.5       | 25.5     |                       |  |
| 41    | 2   | P1      | Target     | Day    | 28-Oct-06 | 22:05     | -57.6493 | -50.3941  | 170       | 88.06      | 28-Oct-06  | 22:34      | -57.6254  | -50.3971   | 48         | 26.27       | 28.5     |                       |  |
| 42    | 1   | P1      | Stratified | Night  | 29-Oct-06 | 0:24      | -57.632  | -50.4466  | 1895      | 999.29     | 29-Oct-06  | 1:12       | -57.6021  | -50.4678   | 1535       | 685         | 47.6     |                       |  |
| 42    | 2   | P1      | Stratified | Night  | 29-Oct-06 | 1:12      | -57.6017 | -50.4681  | 1520      | 679.07     | 29-Oct-06  | 1:58       | -57.572   | -50.4876   | 816        | 386         | 45.6     | Cod-end lost no catch |  |
| 43    | 1   | P1      | Stratified | Night  | 29-Oct-06 | 3:51      | -57.5134 | -50.5064  | 751       | 391.11     | 29-Oct-06  | 4:25       | -57.488   | -50.5085   | 436        | 192.2       | 33.5     |                       |  |
| 43    | 2   | P1      | Stratified | Night  | 29-Oct-06 | 4:26      | -57.4867 | -50.5087  | 415       | 178.24     | 29-Oct-06  | 4:59       | -57.4615  | -50.5133   | 35         | 21.51       | 32.6     |                       |  |
| 55    | 1   | P1      | Target     | Day    | 29-Oct-06 | 22:29     | -57.7502 | -50.465   | 85        | 58.44      | 29-Oct-06  | 22:49      | -57.7547  | -50.4905   | 154        | 71.48       | 20.6     |                       |  |
| 55    | 2   | P1      | Target     | Day    | 29-Oct-06 | 22:52     | -57.7552 | -50.4933  | 126       | 78.05      | 29-Oct-06  | 23:13      | -57.7598  | -50.518    | 48         | 27.25       | 20.5     |                       |  |
| 56    | 1   | P1      | Stratified | Night  | 30-Oct-06 | 0:13      | -57.7753 | -50.5763  | 1175      | 699        | 30-Oct-06  | 1:01       | -57.7904  | -50.6292   | 855        | 412.5       | 48.7     | Repeat of 42/2        |  |
| 56    | 2   | P1      | Target     | Night  | 30-Oct-06 | 1:02      | -57.7906 | -50.6301  | 844       | 410.83     | 30-Oct-06  | 1:36       | -57.7964  | -50.6683   | 311        | 162         | 33.8     |                       |  |
| 58    | 1   | P1      | Stratified | Day    | 30-Oct-06 | 9:43      | -57.7763 | -50.3472  | 750       | 398.57     | 30-Oct-06  | 10:16      | -57.7628  | -50.3818   | 442        | 200.1       | 33       |                       |  |
| 58    | 2   | P1      | Stratified | Day    | 30-Oct-06 | 10:17     | -57.7624 | -50.3831  | 441       | 199.23     | 30-Oct-06  | 10:49      | -57.7501  | -50.4159   | 49         | 29.31       | 32.6     |                       |  |
| 59    | 1   | P1      | Stratified | Day    | 30-Oct-06 | 12:11     | -57.7078 | -50.4564  | 1668      | 996.54     | 30-Oct-06  | 12:51      | -57.6868  | -50.4661   | 1322       | 703.4       | 39.5     |                       |  |
| 59    | 2   | P1      | Stratified | Day    | 30-Oct-06 | 12:52     | -57.686  | -50.4664  | 1302      | 699.47     | 30-Oct-06  | 13:33      | -57.6634  | -50.4796   | 835        | 401.8       | 40.6     |                       |  |
| 71    | 1   | C1      | Target     | Day    | 31-Oct-06 | 21:37     | -57.4615 | -50.5133  | 35        | 21.51      | 31-Oct-06  | 21:57      | -60.6819  | -48.6985   | 86         | 34.7        | 20.5     |                       |  |
| 71    | 2   | C1      | Target     | Day    | 31-Oct-06 | 21:58     | -60.6812 | -48.6987  | 86        | 39.36      | 31-Oct-06  |            |           |            |            |             |          |                       |  |
| 73    | 1   | C1      | Stratified | Night  | 01-Nov-06 | 3:21      | -60.5001 | -48.7553  | 1917      | 979.97     | 01-Nov-06  | 4:02       | -60.5068  | -48.7535   | 1634       | 700         | 40.9     |                       |  |
| 73    | 2   | C1      | Stratified | Night  | 01-Nov-06 | 4:04      | -60.4669 | -48.7677  | 1551      | 702.02     | 01-Nov-06  | 4:40       | -60.4389  | -48.7841   | 936        | 403.5       | 36.1     |                       |  |
| 84    | 1   | C1      | Stratified | Night  | 02-Nov-06 | 1:43      | -60.5544 | -48.927   | 639       | 402.69     | 02-Nov-06  | 2:19       | -60.5385  | -48.9724   | 419        | 200.1       | 35.8     |                       |  |
| 84    | 2   | C1      | Stratified | Night  | 02-Nov-06 | 2:19      | -60.5385 | -48.9724  | 419       | 200.06     | 02-Nov-06  | 2:55       | -60.5234  | -49.0216   | 33         | 19.6        | 35.8     |                       |  |
| 85    | 1   | C1      | Target     | Night  | 02-Nov-06 | 3:47      | -60.5234 | -49.0216  | 33        | 19.6       | 02-Nov-06  | 4:07       | -60.5075  | -49.1053   | 68         | 27.74       | 20.1     |                       |  |
| 85    | 2   | C1      | Target     | Night  | 02-Nov-06 | 4:07      | -60.5074 | -49.1058  | 68        | 29.5       | 02-Nov-06  | 4:27       | -60.5016  | -49.1338   | 42         | 16.56       | 19.4     |                       |  |

|     |   |     |            |       |           |       |          |          |      |        |           |       |          |          |      |       |      |                     |
|-----|---|-----|------------|-------|-----------|-------|----------|----------|------|--------|-----------|-------|----------|----------|------|-------|------|---------------------|
| 91  | 1 | C1  | Stratified | Day   | 02-Nov-06 | 10:48 | -60.6275 | -48.8185 | 1970 | 994.63 | 02-Nov-06 | 11:38 | -60.6111 | -48.8983 | 1682 | 701.1 | 50.4 |                     |
| 91  | 2 | C1  | Stratified | Day   | 02-Nov-06 | 11:39 | -60.6109 | -48.8992 | 1673 | 699.91 | 02-Nov-06 | 12:33 | -60.5914 | -48.9888 | 990  | 402.2 | 54.6 |                     |
| 92  | 1 | C1  | Stratified | Day   | 02-Nov-06 | 13:45 | -60.574  | -49.1069 | 627  | 404.94 | 02-Nov-06 | 14:19 | -60.572  | -49.1609 | 452  | 203.4 | 33.4 |                     |
| 92  | 2 | C1  | Stratified | Day   | 02-Nov-06 | 14:19 | -60.5719 | -49.1616 | 446  | 200.99 | 02-Nov-06 | 14:57 | -60.5662 | -49.2204 | 33   | 12.78 | 37.5 |                     |
| 95  | 1 | AFI | AFI        | Day   | 04-Nov-06 | 20:06 | -60.7052 | -43.95   | 312  | 202.9  | 04-Nov-06 | 20:37 | -60.6946 | -43.9984 | 238  | 98.45 | 30.4 |                     |
| 95  | 2 | AFI | AFI        | Day   | 04-Nov-06 | 20:37 | -60.6944 | -43.9991 | 238  | 102.37 | 04-Nov-06 | 21:07 | -60.6798 | -44.0491 | 36   | 9.89  | 30.2 |                     |
| 96  | 1 | AFI | AFI        | Day   | 04-Nov-06 | 22:25 | -60.7188 | -43.9416 | 282  | 194.86 | 04-Nov-06 | 22:50 | -60.6987 | -43.9672 | 210  | 97.47 | 24.7 |                     |
| 96  | 2 | AFI | AFI        | Day   | 04-Nov-06 | 22:50 | -60.6983 | -43.9678 | 210  | 100.95 | 04-Nov-06 | 23:15 | -60.6787 | -43.9987 | 27   | 5.77  | 25.4 |                     |
| 98  | 1 | AFI | AFI        | Night | 05-Nov-06 | 1:35  | -60.7324 | -43.9979 | 257  | 182.65 | 05-Nov-06 | 2:00  | -60.715  | -44.0265 | 213  | 102.4 | 25.2 |                     |
| 98  | 2 | AFI | AFI        | Night | 05-Nov-06 | 2:01  | -60.7147 | -44.0271 | 213  | 107.47 | 05-Nov-06 | 2:26  | -60.699  | -44.0599 | 24   | 11.65 | 25.1 |                     |
| 106 | 1 | C2  | Stratified | Night | 06-Nov-06 | 1:49  | -60.4923 | -44.687  | 673  | 402.78 | 06-Nov-06 | 2:24  | -60.4818 | -44.7476 | 432  | 201.9 | 34.8 |                     |
| 106 | 2 | C2  | Stratified | Night | 06-Nov-06 | 2:24  | -60.4816 | -44.7485 | 432  | 202.12 | 06-Nov-06 | 3:00  | -60.4668 | -44.8074 | 31   | 11.65 | 35.5 |                     |
| 107 | 1 | C2  | Target     | Night | 06-Nov-06 | 3:59  | -60.4767 | -44.7447 | 54   | 45.34  | 06-Nov-06 | 4:19  | -60.4691 | -44.7769 | 70   | 32.05 | 20.3 |                     |
| 107 | 2 | C2  | Target     | Night | 06-Nov-06 | 4:20  | -60.469  | -44.7773 | 67   | 31.61  | 06-Nov-06 | 4:34  | -60.464  | -44.8023 | 20   | 4.3   | 14.5 |                     |
| 114 | 1 | C2  | Stratified | Day   | 06-Nov-06 | 11:39 | -60.4335 | -44.5092 | 1803 | 918.57 | 06-Nov-06 | 12:14 | -60.4261 | -44.5638 | 1499 | 695.3 | 35.2 |                     |
| 114 | 2 | C2  | Stratified | Day   | 06-Nov-06 | 12:14 | -60.4261 | -44.5641 | 1496 | 695.94 | 06-Nov-06 | 12:57 | -60.4201 | -44.6286 | 732  | 398.6 | 43.3 |                     |
| 115 | 1 | C2  | Stratified | Day   | 06-Nov-06 | 14:57 | -60.4791 | -44.4862 | 675  | 401.71 | 06-Nov-06 | 15:35 | -60.4581 | -44.5374 | 466  | 198.3 | 37.9 |                     |
| 115 | 2 | C2  | Stratified | Day   | 06-Nov-06 | 15:36 | -60.4575 | -44.5388 | 452  | 198.49 | 06-Nov-06 | 16:11 | -60.4346 | -44.579  | 27   | 9.69  | 35   |                     |
| 117 | 1 | C2  | Target     | Day   | 06-Nov-06 | 21:54 | -60.4258 | -44.6723 | 135  | 95.51  | 06-Nov-06 | 22:10 | -60.4118 | -44.6725 | 109  | 49.41 | 16.7 |                     |
| 117 | 2 | C2  | Target     | Day   | 06-Nov-06 | 22:14 | -60.4088 | -44.6743 | 68   | 44.02  | 06-Nov-06 | 22:25 | -60.4017 | -44.6853 | 40   | 11.31 | 10.6 |                     |
| 118 | 1 | C2  | Stratified | Night | 07-Nov-06 | 0:52  | -60.4315 | -44.3711 | 1585 | 851.68 | 07-Nov-06 | 1:23  | -60.4186 | -44.4147 | 1518 | 702.9 | 31.1 |                     |
| 118 | 2 | C2  | Stratified | Night | 07-Nov-06 | 1:23  | -60.4186 | -44.4147 | 1518 | 702.85 | 07-Nov-06 |       |          |          |      |       |      | net 2 closed?       |
| 123 | 1 | C3  | Target     | Day   | 07-Nov-06 | 21:48 | -59.6788 | -43.9305 | 65   | 47.65  | 07-Nov-06 | 21:56 | -59.6744 | -43.9401 | 95   | 28.62 | 7.7  | Net 1 did not close |
| 123 | 2 | C3  | Target     | Day   | 07-Nov-06 | 21:57 | -59.6736 | -43.9418 | 95   | 32.5   | 07-Nov-06 | 22:00 | -59.699  | -43.9739 | -28  | 0.83  | 2.6  | Did not open        |
| 134 | 1 | C3  | Stratified | Night | 08-Nov-06 | 23:38 | -59.6304 | -44.1404 | 2260 | 988.5  | 09-Nov-06 | 0:18  | -59.6103 | -44.1882 | 1679 | 700.6 | 40   |                     |
| 134 | 2 | C3  | Stratified | Night | 09-Nov-06 | 0:19  | -59.6094 | -44.19   | 1675 | 697.01 | 09-Nov-06 | 0:56  | -59.5909 | -44.2349 | 1013 | 400   | 36.3 |                     |
| 135 | 1 | C3  | Target     | Night | 09-Nov-06 | 2:37  | -59.6079 | -44.1919 | 60   | 47.16  | 09-Nov-06 | 2:57  | -59.5961 | -44.2116 | 82   | 34.51 | 20.2 |                     |



|     |   |    |            |       |           |       |          |          |      |        |           |       |          |          |      |       |        |                         |
|-----|---|----|------------|-------|-----------|-------|----------|----------|------|--------|-----------|-------|----------|----------|------|-------|--------|-------------------------|
| 135 | 2 | C3 | Target     | Night | 09-Nov-06 | 2:58  | -59.5957 | -44.2123 | 80   | 36.66  | 09-Nov-06 | 3:18  | -59.5836 | -44.2327 | 68   | 23.42 | 20.4   |                         |
| 136 | 1 | C3 | Stratified | Night | 09-Nov-06 | 4:07  | -59.5509 | -44.2875 | 685  | 399.74 | 09-Nov-06 | 4:38  | -59.5304 | -44.3196 | 452  | 200.7 | 31.2   |                         |
| 136 | 2 | C3 | Stratified | Night | 09-Nov-06 | 4:38  | -59.5303 | -44.3198 | 447  | 199.67 | 09-Nov-06 | 5:04  | -59.5127 | -44.3461 | 151  | 68.93 | 25.6   | Closed early by mistake |
| 142 | 1 | C3 | Stratified | Day   | 09-Nov-06 | 10:54 | -59.6118 | -44.0918 | 2226 | 993.5  | 09-Nov-06 | 11:33 | -59.5814 | -44.1279 | 1939 | 700.4 | 38.8   |                         |
| 142 | 2 | C3 | Stratified | Day   | 09-Nov-06 | 11:33 | -59.5813 | -44.1282 | 1937 | 700.74 | 09-Nov-06 | 12:23 | -59.5529 | -44.1962 | 1119 | 399.6 | 49.7   |                         |
| 143 | 1 | C3 | Stratified | Day   | 09-Nov-06 | 13:48 | -59.5158 | -44.3235 | 789  | 400.14 | 09-Nov-06 | 14:24 | -59.5018 | -44.3825 | 574  | 197.2 | 36.2   |                         |
| 143 | 2 | C3 | Stratified | Day   | 09-Nov-06 | 14:24 | -59.5016 | -44.3836 | 574  | 202.61 | 09-Nov-06 | 15:00 | -59.4937 | -44.4469 | 36   | 18.37 | 36.1   |                         |
| 157 | 1 | C5 | Stratified | Night | 17-Nov-06 | 0:24  | -57.3829 | -42.6392 | 2319 | 995.56 | 17-Nov-06 | 1:11  | -57.3379 | -42.6498 | 1884 | 700.8 | 47.05  | 1000-700                |
| 157 | 2 | C5 | Stratified | Night | 17-Nov-06 | 1:12  | -57.3371 | -42.6503 | 1873 | 702.7  | 17-Nov-06 | 1:53  | -57.3009 | -42.6724 | 1017 | 399.9 | 41.133 | 700-400                 |
| 159 | 1 | C5 | Stratified | Night | 17-Nov-06 | 4:02  | -57.2846 | -42.7888 | 746  | 398.52 | 17-Nov-06 | 4:37  | -57.3048 | -42.8452 | 541  | 201.5 | 35.1   |                         |
| 159 | 2 | C5 | Stratified | Night | 17-Nov-06 | 4:38  | -57.3051 | -42.846  | 540  | 203.05 | 17-Nov-06 | 5:14  | -57.3213 | -42.9124 | 36   | 14.4  | 35.9   |                         |
| 160 | 1 | C5 | Target     | Dawn  | 17-Nov-06 | 5:49  | -57.3306 | -42.9852 | 90   | 59.91  | 17-Nov-06 | 6:07  | -57.3395 | -43.0179 | 108  | 39.95 | 18.217 |                         |
| 160 | 2 | C5 | Target     | Dawn  | 17-Nov-06 | 6:07  | -57.3396 | -43.0184 | 108  | 41.17  | 17-Nov-06 | 6:26  | -57.3448 | -43.0536 | 57   | 20.97 | 18.217 |                         |
| 185 | 1 | P2 | Target     | Day   | 18-Nov-06 | 20:35 | -55.1522 | -41.0051 | 41   | 26.37  | 18-Nov-06 | 20:46 | -55.1565 | -41.0205 | 44   | 17.54 | 11.567 |                         |
| 185 | 2 | P2 | Target     | Day   | 18-Nov-06 | 20:52 | -55.1582 | -41.0281 | 210  | 123.46 | 18-Nov-06 | 21:13 | -55.1637 | -41.054  | 210  | 101.6 | 20.733 |                         |
| 186 | 1 | P2 | Target     | Dusk  | 18-Nov-06 | 22:15 | -55.1596 | -41.0321 | 33   | 26.27  | 18-Nov-06 | 22:22 | -55.161  | -41.0405 | 58   | 23.82 | 6.4833 | Krill target            |
| 186 | 2 | P2 | Target     | Dusk  | 18-Nov-06 | 22:22 | -55.1611 | -41.0409 | 58   | 26.32  | 18-Nov-06 | 22:38 | -55.1653 | -41.0603 | 58   | 25.24 | 15.467 | Krill target            |
| 199 | 1 | P2 | Stratified | Night | 19-Nov-06 | 23:19 | -55.2073 | -41.3185 | 1938 | 1000   | 20-Nov-06 | 0:04  | -55.2089 | -41.3755 | 1680 | 702.6 | 44.533 | 1000-700 Night          |
| 199 | 2 | P2 | Stratified | Night | 20-Nov-06 | 0:04  | -55.2089 | -41.3756 | 1679 | 702.31 | 20-Nov-06 | 0:53  | -55.2098 | -41.4429 | 980  | 400.5 | 49.817 | 700-400                 |
| 200 | 1 | P2 | Target     | Night | 20-Nov-06 | 1:53  | -55.211  | -41.5125 | 59   | 41.13  | 20-Nov-06 | 2:14  | -55.2117 | -41.5405 | 65   | 27.25 | 21.017 | Krill surface haul      |
| 200 | 2 | P2 | Target     | Night | 20-Nov-06 | 2:14  | -55.2117 | -41.5413 | 65   | 35.09  | 20-Nov-06 | 2:35  | -55.2126 | -41.5684 | 31   | 14.15 | 20.35  | Krill surface haul      |
| 201 | 1 | P2 | Target     | Night | 20-Nov-06 | 3:36  | -55.2136 | -41.553  | 260  | 179.37 | 20-Nov-06 | 3:46  | -55.2127 | -41.5381 | 308  | 149.9 | 9.6833 | Myctophid target        |
| 201 | 2 | P2 | Target     | Night | 20-Nov-06 | 3:52  | -55.212  | -41.5283 | 177  | 101.59 | 20-Nov-06 | 4:02  | -55.211  | -41.5125 | 163  | 76.48 | 10.317 | Myctophid target        |
| 214 | 1 | P2 | Stratified | Night | 21-Nov-06 | 3:17  | -55.26   | -41.1606 | 628  | 399.74 | 21-Nov-06 | 3:52  | -55.2895 | -41.1793 | 481  | 200.9 | 35.25  | 400-200                 |
| 214 | 2 | P2 | Stratified | Night | 21-Nov-06 | 3:53  | -55.2126 | -41.5368 | 475  | 204.37 | 21-Nov-06 | 4:28  | -55.3209 | -41.1984 | 45   | 15.09 | 34.95  | 200-10                  |
| 215 | 1 | P2 | Target     | Dawn  | 21-Nov-06 | 6:09  | -55.2436 | -40.9302 | 153  | 100.22 | 21-Nov-06 | 6:25  | -55.2543 | -40.943  | 97   | 43.82 | 15.917 |                         |
| 215 | 2 | P2 | Target     | Dawn  | 21-Nov-06 | 6:25  | -55.2546 | -40.9434 | 97   | 48.24  | 21-Nov-06 | 6:43  | -55.2664 | -40.9576 | 28   | 10.04 | 17.883 |                         |

|     |   |    |            |       |           |       |          |          |      |        |           |       |          |          |      |       |        |                             |
|-----|---|----|------------|-------|-----------|-------|----------|----------|------|--------|-----------|-------|----------|----------|------|-------|--------|-----------------------------|
| 217 | 1 | P2 | Stratified | Day   | 21-Nov-06 | 12:31 | -55.197  | -41.2866 | 2208 | 999.48 | 21-Nov-06 | 13:19 | -55.2353 | -41.3146 | 1761 | 700.3 | 47.583 | 1000-700 Day                |
| 217 | 2 | P2 | Stratified | Day   | 21-Nov-06 | 13:19 | -55.2361 | -41.3151 | 1749 | 696.38 | 21-Nov-06 | 14:05 | -55.2721 | -41.343  | 969  | 399.1 | 45.25  | 700-400 Day                 |
| 218 | 1 | P2 | Stratified | Day   | 21-Nov-06 | 15:17 | -55.3246 | -41.3857 | 600  | 400.33 | 21-Nov-06 | 15:53 | -55.3516 | -41.4103 | 476  | 202.5 | 35.767 | 400-200 Day                 |
| 218 | 2 | P2 | Stratified | Day   | 21-Nov-06 | 15:53 | -55.352  | -41.4107 | 476  | 205.36 | 21-Nov-06 | 16:31 | -55.3828 | -41.4392 | 33   | 11.16 | 37.133 | 200-10 Day                  |
| 219 | 1 | P2 | Target     | Day   | 21-Nov-06 | 17:36 | -55.3316 | -41.3683 | 458  | 301.96 | 21-Nov-06 | 17:51 | -55.345  | -41.3723 | 435  | 203   | 15.083 | Fish Targets in Daylight    |
| 219 | 2 | P2 | Target     | Day   | 21-Nov-06 | 17:52 | -55.3459 | -41.3726 | 432  | 203.88 | 21-Nov-06 | 18:03 | -55.3568 | -41.3762 | 343  | 145.5 | 11.383 | Fish Targets Daylight       |
| 228 | 1 | P3 | Target     | Night | 23-Nov-06 | 1:04  | -52.8585 | -40.0954 | 37   | 26.86  | 23-Nov-06 | 1:22  | -52.8464 | -40.0856 | 29   | 9.69  | 18.5   |                             |
| 228 | 2 | P3 | Target     | Night | 23-Nov-06 | 1:23  | -52.846  | -40.0851 | 29   | 18.81  | 23-Nov-06 | 1:23  | -52.8459 | -40.0849 | 29   | 17.98 | 0.2167 |                             |
| 229 | 1 | P3 | Target     | Night | 23-Nov-06 | 2:36  | -52.8735 | -40.1042 | 39   | 30.14  | 23-Nov-06 | 2:41  | -52.8703 | -40.1017 | 53   | 26.71 | 4.5667 |                             |
| 229 | 2 | P3 | Target     | Night | 23-Nov-06 | 2:43  | -52.8691 | -40.1009 | 53   | 35.73  | 23-Nov-06 | 2:59  | -52.8691 | -40.1009 | 53   | 35.73 | 16.767 |                             |
| 230 | 1 | P3 | Target     | Night | 23-Nov-06 | 4:18  | -52.8693 | -40.0906 | 49   | 37.3   | 23-Nov-06 | 4:30  | -52.8605 | -40.0862 | 49   | 26.32 | 12.317 | not sorted                  |
| 230 | 2 | P3 | Target     | Night | 23-Nov-06 | 4:30  | -52.8603 | -40.0861 | 49   | 27.64  | 23-Nov-06 | 4:32  | -52.8589 | -40.0854 | 29   | 15.38 | 1.9167 | not sorted                  |
| 253 | 1 | P3 | Stratified | Night | 25-Nov-06 | 3:50  | -53.0431 | -40.5435 | 743  | 397.59 | 25-Nov-06 | 4:31  | -53.0642 | -40.6007 | 415  | 200.7 | 41.133 |                             |
| 253 | 2 | P3 | Stratified | Night | 25-Nov-06 | 4:32  | -53.0676 | -40.6099 | 380  | 153.82 | 25-Nov-06 | 5:08  | -53.0833 | -40.6564 | 37   | 13.66 | 36.183 |                             |
| 265 | 1 | P3 | Stratified | Night | 26-Nov-06 | 4:35  | -52.9243 | -40.3771 | 296  | 201.09 | 26-Nov-06 | 5:10  | -52.9449 | -40.3444 | 40   | 19.99 | 35.5   | 200-0                       |
| 265 | 2 | P3 | Stratified | Night | 26-Nov-06 | 5:17  | -52.9492 | -40.3389 | 109  | 73.44  | 26-Nov-06 | 5:32  | -52.9599 | -40.3259 | 129  | 61.77 | 15.75  | target layer 60-80          |
| 267 | 1 | P3 | Stratified | Day   | 26-Nov-06 | 15:15 | -52.8492 | -40.019  | 1913 | 997.82 | 26-Nov-06 | 16:08 | -52.8963 | -40.0361 | 1711 | 700.3 | 53.317 | 1000-700                    |
| 267 | 2 | P3 | Stratified | Day   | 26-Nov-06 | 16:08 | -52.8966 | -40.0363 | 1705 | 700.15 | 26-Nov-06 | 16:58 | -52.9395 | -40.0582 | 1046 | 400.5 | 49.167 | 700-400                     |
| 270 | 1 | P3 | Target     | Night | 27-Nov-06 | 2:43  | -52.9786 | -40.1071 | 29   | 28.13  | 27-Nov-06 | 2:48  | -52.9822 | -40.1112 | 25   | 15.04 | 5.1167 | krill mark 10 - 20 m        |
| 270 | 2 | P3 | Target     | Night | 27-Nov-06 | 2:49  | -52.9828 | -40.1118 | 25   | 21.46  | 27-Nov-06 | 3:00  | -52.9908 | -40.1201 | 38   | 21.46 | 10.85  |                             |
| 273 | 1 | C6 | Stratified | Night | 27-Nov-06 | 23:43 | -49.9972 | -38.0176 | 2027 | 992.23 | 28-Nov-06 | 0:27  | -50.0271 | -38.0584 | 1734 | 697   | 43.933 | Stratified 1000-700 45 mins |
| 273 | 2 | C6 | Stratified | Night | 28-Nov-06 | 0:28  | -50.0277 | -38.0591 | 1734 | 699.81 | 28-Nov-06 | 1:15  | -50.0643 | -38.0993 | 1000 | 400.6 | 47.45  | 700-400                     |
| 275 | 1 | C6 | Stratified | Night | 28-Nov-06 | 3:21  | -50.1229 | -38.1407 | 683  | 399.65 | 28-Nov-06 | 4:01  | -50.1579 | -38.1625 | 465  | 199   | 40.067 | 400-200                     |
| 275 | 2 | C6 | Stratified | Night | 28-Nov-06 | 4:01  | -50.1583 | -38.1629 | 465  | 201.24 | 28-Nov-06 | 4:41  | -50.1893 | -38.1865 | 34   | 17.2  | 40.183 | 200-15                      |
| 282 | 1 | C6 | Stratified | Day   | 28-Nov-06 | 16:43 | -50.022  | -38.0964 | 707  | 400.19 | 28-Nov-06 | 17:22 | -50.0201 | -38.1392 | 473  | 200.1 | 38.933 | 400-200                     |
| 282 | 2 | C6 | Stratified | Day   | 28-Nov-06 | 17:22 | -50.0201 | -38.1397 | 466  | 199.52 | 28-Nov-06 | 18:02 | -50.0149 | -38.181  | 38   | 16.17 | 40.2   | 200-15                      |
| 283 | 1 | C6 | Stratified | Day   | 28-Nov-06 | 19:58 | -49.9731 | -38.0157 | 1815 | 997.62 | 28-Nov-06 | 20:44 | -49.9513 | -38.0555 | 1726 | 701.3 | 46.383 | 1000-700                    |

|     |   |    |            |     |           |       |          |          |     |        |           |       |          |          |      |       |        |         |
|-----|---|----|------------|-----|-----------|-------|----------|----------|-----|--------|-----------|-------|----------|----------|------|-------|--------|---------|
| 283 | 2 | C6 | Stratified | Day | 28-Nov-06 | 20:44 | -49.9511 | -38.0559 |     | 701.48 | 28-Nov-06 | 21:30 | -49.9279 | -38.099  | 1054 | 398.6 | 45.167 | 700-400 |
| 294 | 1 | C6 | Target     | Day | 30-Nov-06 | 14:40 | -50.0001 | -38.2304 | 379 | 205.55 | 30-Nov-06 | 15:02 | -49.99   | -38.2511 | 483  | 202.1 | 21.95  |         |
| 294 | 2 | C6 | Target     | Day | 30-Nov-06 | 15:02 | -49.9899 | -38.2515 | 483 | 204.37 | 30-Nov-06 | 15:25 | -49.9839 | -38.2764 | 379  | 170   | 22.933 |         |

# **Acoustics Report**

***Sophie Fielding, Peter Enderlein, Martin Collins***

## ***Introduction***

JR161 is the first of three Discovery 2010 cruises running two transects (Stanley to Signy and Signy to South Georgia) across the Scotia Sea. Within these transects there are a series of Process (three) and Condensed (six) stations. During JR161 the three Process stations were undertaken, but the number of Condensed stations was reduced to five as a result of time restrictions (due to a longer than expected Signy relief). Dedicated acoustic transects were run at each of the stations, although the EK60 echosounder was actually run continuously throughout the cruise with relatively few problems (notably a considerable number were ironed out in the preceding cruise JR159), although periods of Doppler log, ADCP bottom tracking mode and swath bathymetry reduced data quality on occasions.

## ***Aim***

Collection of acoustic data to accompany all transects, acoustic surveys, and net tows during the Scotia Sea survey.

Backup and post process the acoustic data

## ***Methods/System specification***

### **Software versions**

Simrad ER60 v. 2.0

Sonardata Echolog 60 v 4.05

Sonardata Echoview v 4.0.75.6342 Live viewing and processing

HASP Dongle BAS3 licensed for base, bathymetry, analysis export, live viewing, school detection and virtual echogram was used to run the echolog and echoview in live viewing mode. It was intended to use the analogue BAS1 HASP, however it appears that the dongle is slightly damaged and the connection is intermittent. Therefore processing of the acoustic data was undertaken using the BAS1 dongle (screwed tightly into a parallel port to get it to work!). It should be noted that the use of this dongle will become increasingly restricted where new computers do not have a parallel port.

The echosounder pc AP10 and the EK60 workstation 2 are integrated into the ship's LAN. ER60 .raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. Echolog was run on workstation 2 and wrote compressed files also directly to the Sun workstation via a Samba connection. On JR159 the network was changed and the Samba software updated. This caused several communication (with the transducers) and logging problems that were eventually solved by IT support. It should be noted though that the newest version of Samba is not compatible with the EK60 and any future changes in software should be done with caution and understanding that an older version may have to be reverted back to for EK60 use.

## Echolog compression settings

Final compression settings used in Echolog for all frequencies:

- 1) Power data only (angle data is still available from the raw files)
- 2) From 0 - 500 m (38 kHz), 0 – 400 (120 kHz) and 0 – 300 (200 kHz) data only (data from deeper is available from the raw files)
- 3) Average samples where both Sv below -100 and TS below 20
- 4) Maximum number of samples to average: 50
- 5) DO NOT use average samples below echosounder detected bottom unless sure of bottom detection

**Note** – echolog was originally setup to average samples where Sv was below -80 dB. This was pointed out on the 26/11/2006 and changed to the above setting of -100 dB. However, given certain warning messages received (logging error warnings), it was decided to not trust the echolog compressed files and instead echozip was used to create ek60 files in post-processing. The settings are given below:

- 1) Power data only
- 2) From 0 – 1000 m (38 kHz), 0 – 400 (120 kHz) and 0 – 300 (200 kHz) data only
- 3) Average samples where both Sv below -100 dB and TS below 20
- 4) Maximum number of samples to average: 50
- 5) DO NOT use average samples below echosounder detected bottom unless sure of bottom detection

Echozip run in windows only allows you to compress one file at a time. However, it can be run on entire folders if run through the command prompt – an example of which is below.

```
C:> Echozip_60 -Z c:\jr61\acoustics\P1_T1
```

where P1\_T1 is the name of a folder. This writes EK60 files from all the raw data files

## File locations

Folders were created to roughly follow transects and stations such that data is contained in folders:

Stanley to P1

P1

P1 to Signy

Signy to P2

P2

P3

C6

Most files are also prefixed with the station/transect name, this needs some clearing up as prefixes were not always changed if no one was watching the echosounder.

All echozip compressed files and ev files were saved onto the L drive in folders by day.

## EK60 (ER60) settings

The EK60 was calibrated immediately prior to JR161 on cruise JR159. Details regarding this calibration can be found in the cruise report for JR159. The following table lists the settings of the EK60 that were obtained during the calibration in Stromness Bay.

| Variable                  | 38 kHz       | 120 kHz      | 200 kHz      |
|---------------------------|--------------|--------------|--------------|
| Ping interval (per sec)   | 2            | 2            | 2            |
| Salinity (PSU)            | 34           | 34           | 34           |
| Temperature (°C)          | 1            | 1            | 1            |
| Sound velocity (m/s)      | 1453         | 1453         | 1453         |
| Mode                      | Active       | Active       | Active       |
| Transducer type           | ES38         | ES120-7      | ES200-7      |
| Transceiver Serial no.    | 009072033fa5 | 00907203422d | 009072033f91 |
| Transducer depth (m)      | 0            | 0            | 0            |
| Absorption coef. (dB/km)  | 10.07        | 26.27        | 39.8         |
| Pulse length (ms)         | 1.024        | 1.024        | 1.024        |
| Max Power (W)             | 2000         | 500          | 300          |
| 2-way beam angle (dB)     | -20.70       | -20.70       | -19.60       |
| Sv transducer gain (dB)   | 24.07        | 21.38        | 22.03        |
| Sa correction (dB)        | -0.63        | -0.39        | -0.31        |
| Angle sensitivity along   | 22           | 21           | 23           |
| Angle sensitivity athwart | 22           | 21           | 23           |
| 3 dB Beam along           | -0.02        | -0.12        | 0.17         |
| 3 dB Beam athwart         | 0            | -0.07        | -0.24        |
| Along offset              | 6.96         | 7.48         | 6.44         |
| Athwart offset            | 6.88         | 7.48         | 6.43         |

The EK60 was run through the SSU for most of the cruise, barring a brief period of swath bathymetry where it was run on internal ping mode to maintain a consistency in ping rate. A new SSU.ini file was created which grouped the EA600, EK60 and ADCP in to the same group, and then each instrument was set as follows:

|       |                   |            |  |
|-------|-------------------|------------|--|
| EA600 | external trigger  | Tx pulse   |  |
| EK60  | external trigger* | Calculated | (Set to 2.5 seconds in ER60 software)                        |
| ADCP  | external trigger  | Tx pulse   | (this setting only works if the bottom tracking mode is off) |

\*note this is not technically true – this set up will work even if the EK60 is in internal trigger mode – why? I do not know.

A 2.5 second ping rate was decided as it gave the ADCP time to ping its full water column depth. This ping rate was maintained for the whole of the cruise. False bottom echoes were accepted, although an investigation into which is more acceptable – changing the ping rate or accepting false bottoms should be undertaken? This setup works fine as long as ADCP bottom track data is not required. When bottom tracking mode is on the EK60 suffers seriously from interference. A major recommendation from this cruise is to obtain a few days on JCR's trials cruise during the summer along

with an ADCP expert and IT support to interface the two instruments together correctly with minimum data loss for both physicists and biologists.

### ***Data processing in echoview***

Post-processing was undertaken in Echoview. Two template EV files were set up, one for use with the net data, the other for use with the acoustic transects – although both had a similar format and the main difference was the depth of data used. The EV file contained the following virtual variables for the 38 kHz, all other frequencies use the same variables apart from the DO resamples\* that are just at 38 kHz.

38 raw – resampled raw data to prevent fractions occurring later

38surf&botbmp – Surface and bottom line mask

38goodbmp – removes bad data

38s&b&gbmp – Combines the surface and bottom mask with the good mask

38-e – raw data masked by the above bitmap

DO resample\* - resample into 1 mean column per ping

DOresample2\* - resample back on to raw grid

DObmp – choose data range that removes dropout

38-e no DO – 38-e with no dropout

noise 38-e – noise level for 38 kHz

38-n – 38-e without noise

38-100m – data resampled onto 100 m grid

EV files were created for each net event and for each acoustic transect. The following procedure was used to create these files:

Using the jr161net or jr161trans template add new files according to the time of the net or transect

View cruise track, making sure that cruise tracks are believable and there isn't too much bad data

Review surface noise and integration stop line

Mark bad data: Start and end, false bottom, interference, drop-out, missed pings. Use automatic detection for various properties (uses the schools detection module from echoview).

EA600 interference detect:

Threshold: -60 dB

Min school length (m): 5

Min school height (m): 2

Min candidate length (m): 2

Min candidate height (m): 0.1

Max vertical linking (m): 2

Max horizontal linking (m): 0.2

ADCP interference detect:

Threshold: -65 dB

Min school length (m): 5

Min school height (m): 10

Min candidate length (m): 2

Min candidate height (m): 0.1

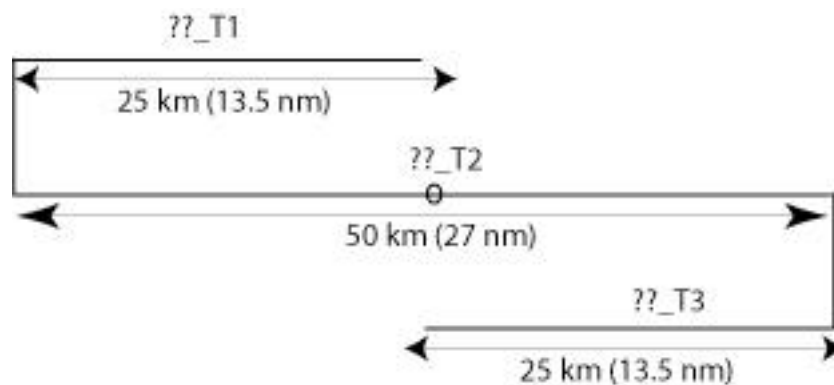
Max vertical linking (m): 2

Max horizontal linking (m): 0.2

Review both 120 and 38 kHz for interference not detected using the automatic detection.

### **Acoustic transects**

Acoustic transects were run at each process or condensed station. The shape of the transect had been discussed in detail in Cambridge, although the direction in which it would be run on board was to be dependant on weather and current conditions. Unfortunately ocean current information was not available in real time and so the decision of survey direction was based on wind conditions and the presence of icebergs. In the future some current information would be useful to make sure that the same water mass was not being repeatedly sampled, especially at site P3 where it was obvious that there was a strong west-east current (as observed by the third officer trying to keep the ship on station). Acoustic transects were run over three legs labelled Station number\_T1, T2 and T3. The first transect was always called T1 independent of where it was started and whether it was a long or short leg (see below) and the long leg was always run upwind unless stated. The optimum was to run three transects at 10 knots, two of 25 km and one of 50 km. Actual transects achieved and any comments are given in acoustic table.



**Figure 1 Theoretical acoustic transect and associated distances**

Underway temperature was plotted during the acoustic transect to examine physical variability around the station site (Figure acoustics 2) and a high degree of change was observed over the relatively short transect lengths. It is highly recommended that for the subsequent cruises the UOR is brought to better elucidate the physical environment around the station.

Predator observations were undertaken during the acoustic transects. This should yield some interesting results and it is important that the predator observer and the acoustician on any future trip interact early on in the cruise.

### **Target fishing**

A degree of RMT25 target fishing was allowed for at each station and was primarily for krill for live incubation experiments. The short period allowed for target fishing and the scarcity in targets at some of the stations resulted in two strategies for target



fishing. The first, traditional, strategy was to head downwind searching for targets. Once found, the ship sails on for ½ to 1 mile more (depending on target depth) and then turns ready to shoot the net. This strategy worked well when there were targets and it was found useful to leave the RMT25 fully cocked whilst searching to enable a prompt deployment. Only at P3 where significant currents were around did the targets move in a different direction from the wind. The large catches of krill during this cruise were all collected using this strategy. The second strategy was to do a night-time surface trawl whether there were targets or not. This strategy worked once at the ice edge, other than that it was normal to bring up empty nets. This was/is a very frustrating task, to maximise opportunity for krill catching it is important that this surface net is undertaken in darkness with time allocated for its undertaking.

Note: there are not enough hours within the current programme to undertake a proper search for targets at each station – especially the low productivity stations where targets were few and far between. It would be very useful if the acoustic transects had time at the beginning of each station so that the probability of encountering targets in the station area can be examined. In addition it was noted several times that there was a high degree of variability around the chosen station sites. A UOR tow combined with the acoustic survey would be an excellent method for determining the small scale variability in the area.

Twenty two target hauls were undertaken in total (Table 2). The targets included myctophid marks, krill swarms and salp layers (Figure acoustics 3).

### ***Problems encountered.***

Interference from the EA600 and ADCP was extremely obvious on the transect out from Stanley to P1. This was due completely to the SSU not being set up correctly. The ADCP was being run in internal mode and the EA600 had not been switched from internal trigger to being controlled by the SSU. Once this was undertaken the acoustic data was exceeding clean all the way to Signy. The main reason, when normally some interference is commented upon, was that the ships Doppler logger was out of commission. The Doppler logger was fixed during the relief of Signy, unfortunately, and since that point there was intermittent interference on the 120 kHz due solely to this instrument. It is highly recommended that there is some dialogue between the scientists and the ships side to examine whether these instruments can be interfaced together.

Key to the success of running biological acoustics with physical current collection is the setting up of the instruments so that neither suffers from interference. This has not been done satisfactorily on board JCR yet. It is highly recommended that a period during the trials cruise is used to set up the instruments correctly so that maximum data coverage can occur during cruises. Trying to do it during a science cruise DOES NOT WORK as people are concerned that they are not getting their data. A method for collecting acoustic data without interference when collecting a combination of ADCP in bottom pinging mode and EK60 data has not been created yet and should be.

### ***Recommendations summary***

- 1) Investigate value of BAS1 Echoview dongle – should we replace parallel port dongle for USB dongle?
- 2) Real-time current information would be useful when deciding what direction to run the acoustic transect in.
- 3) The UOR should be brought on subsequent cruises. It is obvious from the underway TSG that the survey sites are regions of high variability. The vertical structure of this should be investigated.
- 4) The method of searching for targets downwind and then fishing on them upwind worked very well (typically also because of the responsiveness of all the crew and officers onboard – thank you). It is recommended that this method is used in the future.
- 5) The acoustic transects should occur at the beginning of the stations rather than at the end so that the viability of target fishing can be evaluated rather than wasting valuable fishing time doing non-target target fishing or not targeting the right location within the survey area.
- 6) THE ADCP AND EK60 NEED INTERFACING PROPERLY. THIS REQUIRES DEDICATED TIME ON BOARD THE JCR WITH AN ADCP EXPERT, MYSELF AND IT SUPPORT. Until this happens biological and physical data will be compromised.
- 7) A night time slot should be allocated to undertake a shallow RMT tow for live krill experiment catches.
- 8) The Doppler logger of the ship causes interference with the EK60 120 kHz data quality. An investigation into whether the Doppler logger is still required or whether it could be interfaced with the SSU would be desirable. This will be raised by Pete Enderlein in the STEG.

**Figure 2 – SST During the Condensed Stations**

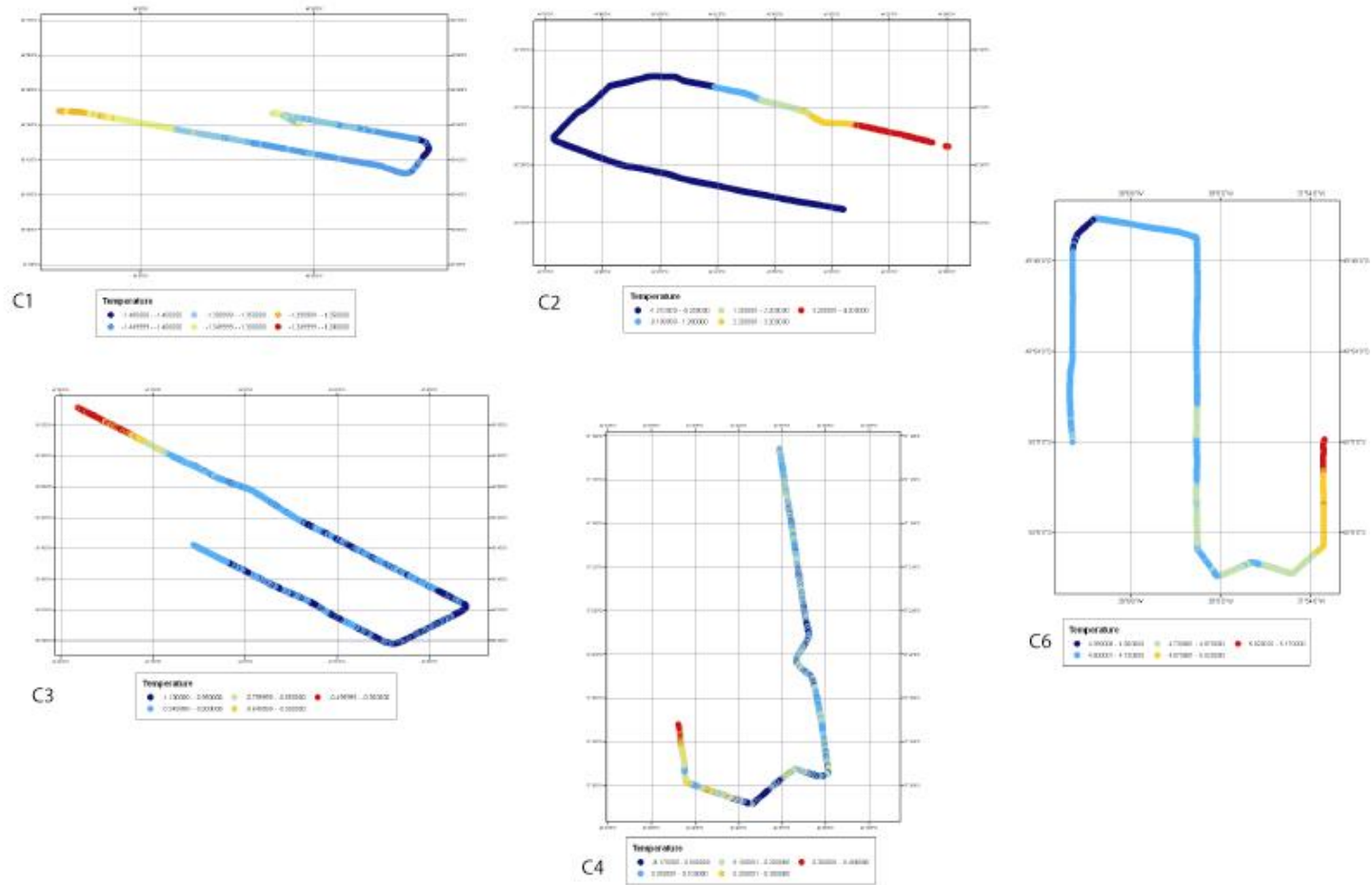


Figure acoustics 2 - Sea surface temperature during the condensed stations acoustic transects

**Figure 2b – SST along acoustic transects**

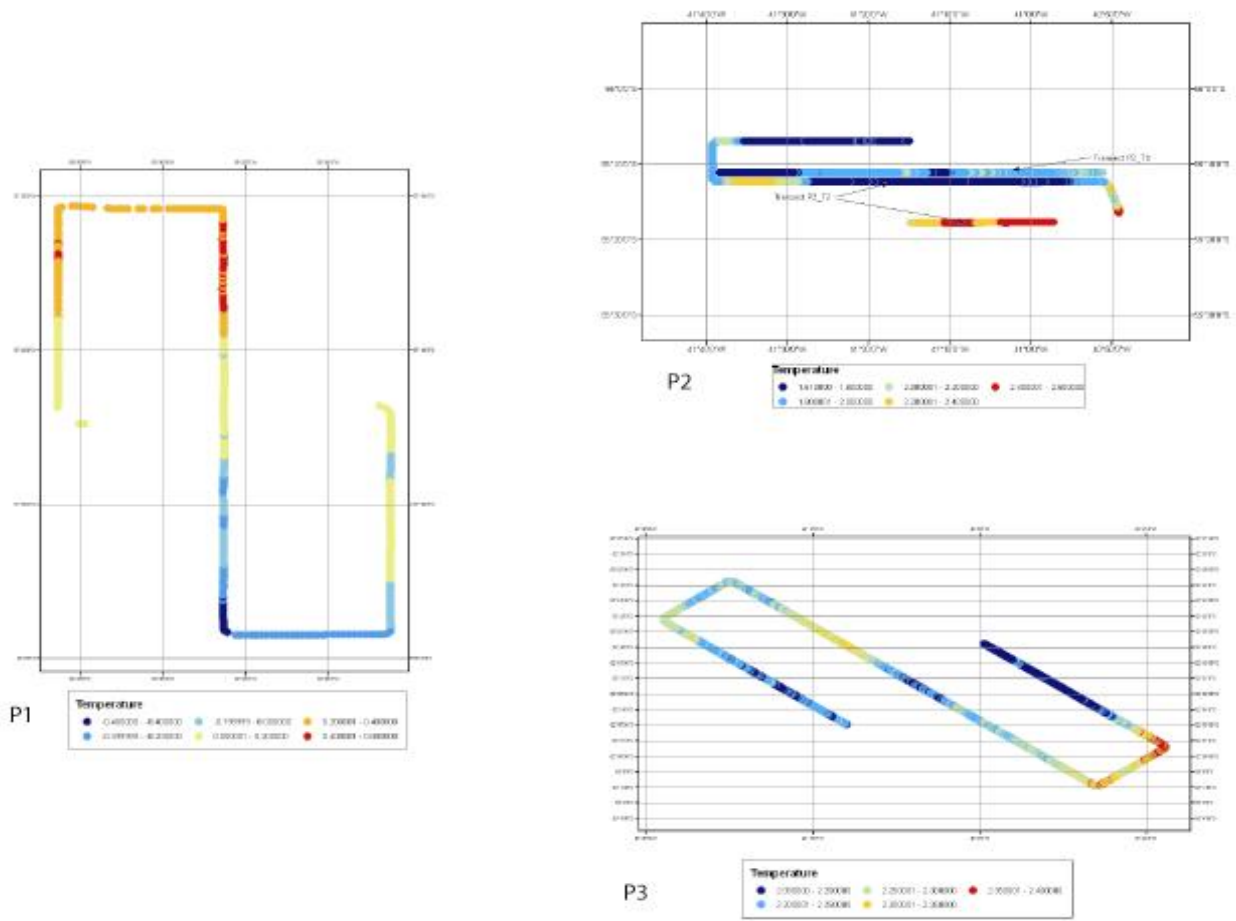


Figure acoustics2b - Sea surface temperature along the acoustic transects at the process stations - note all scales are different

**Acoustic Table 1 – Acoustic transect start and end times**

| Date       | Transect | Time start | Time end | Speed | Bearing | Comment                                 |
|------------|----------|------------|----------|-------|---------|---|
| 30/10/2006 | P1_T1    | 15:06      | 16:26    | 10    | 180     |   |
| 30/10/2006 | P1_T2    | 17:03      | 19:47    | 10    | 0       |   |
| 30/10/2006 | P1_T3    | 20:22      | 21:44    | 10    | 180     |   |
| 02/11/2006 | C1_T1    | 15:51      | 18:34    | 10    | 110     | Downwind due to time constraints        |
| 02/11/2006 | C1_T2    | 19:22      | 20:41    | 10    | 290     | Terminated early due to ice             |
| 06/11/2006 | C2_T1    | 17:16      | 18:35    | 6     | 296     | Terminated early due to ice             |
| 06/11/2006 | C2_T2    | 19:24      | 20:45    | 6     | 116     | Terminated early due to ice             |
| 09/11/2006 | C3_T1    | 16:03      | 18:45    | 10    | 135     |   |
| 09/11/2006 | C3_T2    | 19:21      | 20:42    | 10    | 325     |   |
| 16/11/2006 | C4_T1    | 16:21      | 18:41    | 10    | 175     | Terminated early due to ice             |
| 16/11/2006 | C4_T2    | 19:25      | 19:50    | 10    | 355     | Terminated early to go to fishing point |
| 19/11/2006 | P2_T1    | 14:48      | 16:08    | 10    | 90      |   |
| 19/11/2006 | P2_T2    | 16:44      | 19:30    | 10    | 270     |   |
| 19/11/2006 | P2_T3    | 20:02      | 21:24    | 10    | 90      |   |
| 21/11/2006 | P3_T1    | 07:35      | 10:17    | 5     | 270     | Abandoned due to bad weather            |
| 26/11/2006 | P3_T2    | 07:30      | 08:51    | 10    | 315     |   |
| 26/11/2006 | P3_T3    | 09:29      | 12:11    | 10    | 135     |   |
| 26/11/2006 | P3_T4    | 12:48      | 14:09    | 10    | 315     |   |
| 29/11/2006 | C6_T1    | 09:40      | 10:21    | 10    | 180     |   |
| 29/11/2006 | C6_T2    | 11:24      | 13:58    | 8     | 0       | Terminated early due to ice             |
| 29/11/2006 | C6_T3    | 14:40      | 16:00    | 10    | 180     |   |

## Acoustic Table 2. Target RMT25 hauls

| Date       | Station | Event number | Depth open (m) | Depth closed (m) | Net number | Target description  |
|------------|---------|--------------|----------------|------------------|------------|---|
| 28/10/2006 | P1      | 41           | 200            | 100              | 1          | Myctophid layer 100 – 200 m   |
|            |         |              | 110            | 25               | 2          | Myctophid marks 0 – 100 m   |
| 29/10/2006 | P1      | 55           | 60             | 70               | 1          | No targets  |
|            |         |              | 80             | 20               | 2          | No targets  |
| 31/10/2006 | C1      | 71           | 20             | 35               | 1          | No targets  |
|            |         |              | 40             | 10               | 2          | No targets  |
| 02/11/2006 | C1      | 85           | 20             | 30               | 1          | No targets  |
|            |         |              | 30             | 15               | 2          | No targets  |
| 06/11/2006 | C2      | 107          | 45             | 30               | 1          | Fishing on krill mark at 40 m – not there during tow                                |
|            |         |              | 30             | 4                | 2          | No targets  |
| 06/11/2006 | C2      | 117          | 95             | 50               | 1          | Fishing on krill mark at 80 m – not there during tow                                |
|            |         |              | 44             | 10               | 2          | No targets  |
| 07/11/2006 | C3      | 123          | 50             | 30               | 1          | Fishing on krill mark at 40 m – juvenile krill caught but net didn't close properly |
|            |         |              | 30             | 10               | 2          |   |
| 09/11/2006 | C3      | 135          | 47             | 35               | 1          | No targets  |
|            |         |              | 35             | 24               | 2          | No targets  |
| 17/11/2006 | C4      | 160          | 60             | 40p              | 1          | Fished krill mark 24 m – caught adult krill   |
|            |         |              | 40             | 20               | 2          | No target   |
| 18/11/2006 | P2      | 185          | 25             | 17               | 1          | Fishing on krill mark at 20 m – not there during tow                                |
|            |         |              | 125            | 100              | 2          | Diffuse weak layer – caught salps   |
| 18/11/2006 | P2      | 186          | 25             | 24               | 1          | Krill mark fished – 104 kg  |
|            |         |              | 25             | 25               | 2          | Krill mark fished – 52 kg   |
| 20/11/2006 | P2      | 200          | 40             | 25               | 1          | No target   |
|            |         |              | 35             | 14               | 2          | No target   |
| 20/11/2006 | P2      | 201          | 180            | 150              | 1          | Fish target 225-125 – caught <i>E. carlsbergi</i>                                   |
|            |         |              | 100            | 75               | 2          | Fish target 90-40 – caught <i>E. carlsbergi</i>                                     |
| 21/11/2006 | P2      | 215          | 100            | 45               | 1          | No target   |
|            |         |              | 50             | 10               | 2          | No target   |
| 21/11/2006 | P2      | 219          | 300            | 200              | 1          | Myctophid targets   |
|            |         |              | 200            | 145              | 2          | Myctophid targets   |
| 22/11/2006 | P2      | 222          | 130            | 0                | 1          | Krill target – but not discrete as net didn't close                                 |
| 23/11/2006 | P3      | 228          | 25             | 10               | 1          | Krill target  |
|            |         |              | 20-            | 15               | 2          | No target   |
| 23/11/2006 | P3      | 229          | 30             | 25               | 1          | Krill target  |
|            |         |              | 35             | 35               | 2          | No target   |
| 23/11/2006 | P3      | 230          | 37             | 25               | 1          | No target   |
|            |         |              | 27             | 15               | 2          | Notarget  |
| 26/11/2006 | P3      | 265          | 74             | 61               | 2          | Target 120 kHz layer (not shown in 38 kHz)  |
| 27/11/2006 | P3      | 270          | 30             | 15               | 1          | Small krill mark  |
|            |         |              | 20             | 20               | 2          | Empty water sample discarded  |
| 30/11/2006 | C6      | 294          | 200            | 200              | 1          | Myctophid layer but nothing caught  |
|            |         |              | 200            | 170              | 2          | Myctophid layer but nothing caught  |

# JR161 Predator Observations

***Ewan Wakefield***

## ***Introduction***

As a compliment to other scientific work being carried out during JR161 systematic visual observations of air-breathing predators were made throughout the cruise. Quantitative ship-based surveys of seabirds and marine mammals generally employ a combination of distance sampling and strip-transect surveying (Tasker et al. 1984, Webb & Durinck 1992, Buckland et al. 2001, Camphuysen et al. 2004). Distance sampling relies on obtaining an accurate measure of the distance of the animal from the transect line at the time of detection. This method is usually used to survey marine mammals and birds not in flight while strip transects are used for flying birds. In order to avoid biases caused by the movement of birds through the survey area strip transects are usually subdivided into a series of consecutive boxes. Individuals are recorded at one instant in each box (the 'snapshot' method Webb & Durinck 1992). Although this technique is invaluable for obtaining relative or absolute animal density estimates (van Franeker 1994) it may be more useful for studies of spatial scales of interaction to record all animals encountered within the transect.

An assumption of both the snapshot and of distance sampling methods is that animals are detected before they react to the presence of the survey platform. For most air breathing marine predators however this assumption is poor. Many species of flying seabird for example are attracted to and follow ships. This tendency is especially prevalent in the *Procellariiformes* (Hyrenbach 2001), the dominant group in the Southern Ocean. Further complications occur with diving species, such as penguins and marine mammals, which may move towards or away from the survey vessel whilst submerged. For cetaceans at least this difficulty has recently been surmounted by the use of double platform surveys (Buckland et al. 2004). These rely on a second observer team, which tracks animals' movements in response to the approach of the survey ship. The rate of avoidance or attraction can then be modelled and used to correct the primary observers' results. Similar methods have recently been employed to investigate the avoidance of approaching ships by flying birds (e.g. Borberg et al. 2005). A number of more subjective strategies have also been suggested for identifying which flying birds are following the survey ship, so that these individuals are not over recorded (e.g. Spear et al. 2004).

Despite these complications, abundance estimates of some species of flying seabirds based on at-sea data accord with estimates from colony censuses (Clarke et al. 2003). Furthermore, for the purposes of studies of the distribution of marine predators versus prey or for investigating the effects of environmental correlates, relative rather than absolute abundance may be used (e.g. Ryan & Cooper 1989, Ainley et al. 1993, van Franeker et al. 2002, Woehler et al. 2003, Chapman et al. 2004, Littaye et al. 2004). The assumption implicit in studies taking this approach is that each species reacts in a consistent manner to approaching survey vessels. To my knowledge no one has yet tested this assumption but it seems like a reasonable one.

As well as animal movements and distance a whole host of other covariates may affect the detection rate of air breathing marine predators. These include visibility, sea state, number of observers, ship activity (e.g. fishing vs. steaming) and ship speed. It is essential to record these covariates during surveys so that unwanted variance can be partitioned from variance due to the variables of interest (Buckland et al. 2004). In addition, it is increasingly being recognised that considerable insights can be gained by recording the behaviour of higher predators at sea, for example to identify foraging areas (Veit 1999, Camphuysen & Garthe 2004).

## **Aims**

The aims of the work were to establish the relative abundance and diversity of air breathing predators, both at process and condensed stations and along the ship's track between stations. Amongst other things, this data will be used to characterise the higher predator assemblage at and between stations; investigate spatial cross correlations between higher predators and acoustically detected prey aggregations; <anyone else want to add anything else here?>.

## **Methods**

### **Underway observations**

One observer (Ewan Wakefield) collected data during the cruise, with the assistance of a data recorder (Nick Young or Mike Dunn) during all acoustic transects at process and condensed stations and whenever else possible. There were insufficient observers to use dual platform methods, so while the ship was under way the standard seabirds at sea methodology was used to record seabirds and pinnipeds (Webb & Durinck 1992, Camphuysen et al. 2004). Priority was given to recording species not thought show a marked attraction to or avoidance of ships (pinnipeds and penguins), followed by flying birds and finally (due to the difficulty of detecting them whilst recording other species) cetaceans. Data were collected from one or other of the bridge-wings (eye height 17 m above sea level), the side being chosen and changed if necessary to minimise sun glare and exposure to the prevailing wind. If conditions allowed, a transect 300 m wide (measured from the side of the ship) was surveyed. This was reduced to 200 or 100 m if visibility deteriorated sufficiently; if the sea state became too high to reliably detect animals at its limit or if animal density was too high to record all animals in the transect. Flying birds were recorded when they entered a box with square sides the same length as the transect width, measured from the bridge-wing (figure pred1a). Birds present in the box at times corresponding to 300 m intervals were recorded as present in snapshot. Birds sitting on the water, flightless birds and pinnipeds were recorded in one of five distance bands (A, 0-50 m; B, 50-100 m; C, 100-200 m; D, 200-300 m; E, >300 m) running parallel to the ships track, measured from the side of the ship (figure pred1b). Distances relative to the horizon were checked whenever possible using a simple rangefinder (Heinemann 1981). The range and bearing to cetaceans occurring in a 90° arc running port or starboard from the bow of the ship to the horizon (depending on which bridge-wing was being used) were also recorded. Bearings were measured clockwise from the ship's head using a modified builder's level and ranges were estimated using the rangefinder. Where possible cetaceans sighted on the opposite side of the ship were also recorded but this area was not systematically scanned.

All animals were detected using the naked eye and if necessary identified with the aid of a pair of 10 x 42 Leica Ultravid binoculars. Where there was any ambiguity in identification (for example with prions *Pachyptila* spp.) animals were recorded to genus, or to a lower taxonomic level. Specific and common names follow Shirihai {, 2002 #345}. All data were entered directly into an Access database running on an Itronix Go Book III rugged laptop. The laptop was secured to the bridge-wing combing with a pair of G clamps. The database allowed rapid entry of observations, either using the touch screen or shortcut keys, which were tailored throughout the cruise to reflect the most commonly sighted species. Data entry was standardised and data were automatically checked for common errors by the database. Each observation was automatically time-stamped to the nearest second (UTC), allowing cross reference to data from the ship's telemetry and Ocean Logger systems (for a full explanation of database fields and codes see appendix pred1).

All behaviour indicative of attempted or successful foraging was recorded using a combination of movement, searching and foraging codes adapted in part from Harper et al. (1985) and Camphuysen and Garthe (2004). It was also attempted to identify prey items, although this was rarely possible. Where nothing was recorded it can be assumed that the animal was not actively foraging as the ship passed. Weather conditions (Beaufort wind speed and direction, swell size and direction, sea state,

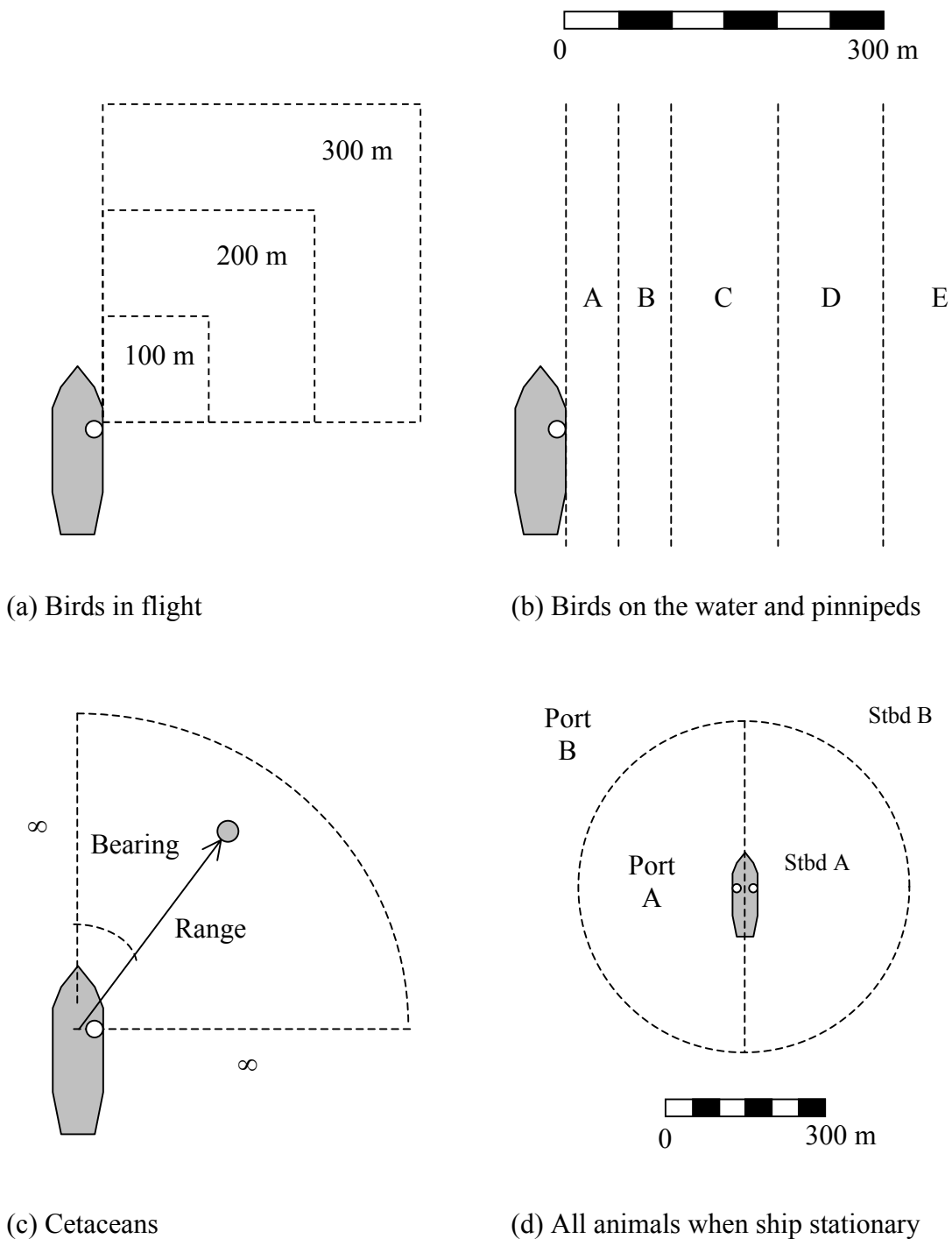


cloud cover and precipitation) were recorded at the start of each observing session and every time they changed. Similarly, the visibility and the amount of sun glare (arc obscured relative to the ship's head) were recorded. Where relevant, sea ice extent was recorded in tenths (World Meteorological Organization 1970).

### **Stationary observations**

During periods when the ship was stationary (at process, condensed and CTD stations) hourly counts of air breathing predators were made from the monkey island (eye height 20 m above sea level). Because it was impossible to obtain instantaneous counts in a 360° arc, counts were made in 180° arcs on either side of the vessel from the port and starboard extremities of the monkey island (from where there is an unobscured view from the bow to the stern). All animals within a radius of 300 m were recorded in band A. It had been intended to record animals in further distance bands. However, it proved impracticable to obtain instantaneous counts beyond 300 m. Hence, only large aggregations of animals or scarce species such as cetaceans beyond this distance were recorded and labelled as being in band B (figure pred1d). In the latter case the range and bearing to the animals relative to the ship's head were also recorded. Before the counts the surveyor spent between 10 minutes and half an hour familiarising himself with the distribution of animals within the vicinity of the ship. Port and starboard counts were then made in close succession and every attempt was made to avoid double counting of animals. For each species of flying bird the percentage of animals in flight at the time of the counts was noted. Following the counts, the behaviour of the majority of individuals of each species was recorded using the suite of codes described for underway observations. Movement categorisation was based on observing three animals of each species if possible for five seconds each (appendix pred1).

In addition to the methods outlined above notes were made of any other observations of interest made whilst not surveying (such as foraging behaviour, unusual species or unusually high numbers of animals).



**Figure pred1.**

Recording areas for air breathing predators observed whilst under way (a, b, c) and stationary (d). White dots indicate surveyor's position on the bridge-wings (a, b, c) and monkey island (d). Underway surveying was carried out from the port or starboard bridge-wing depending upon sun glare and wind direction.

**Data coverage**

Data was recorded whenever possible throughout the cruise. Underway observations were made whilst on passage between sampling stations, with priority being given to periods when the ship was

approaching or leaving stations. However, these periods often occurred during darkness. A total of 146 hours of underway observations were made (table pred1). Underway observations were made during all acoustic transects at process and condensed stations and at other times when the ship was underway, with the exception of periods when the ship was engaged in RMT fishing. Whilst the ship was stationary at sampling stations hourly counts were made from the monkey island. A total of 80 hourly counts were made at 12 stations (table pred2).

**Table pred1. Summary of periods during which underway air breathing predator observations were made during JR161.**

| <b>Transect</b> | <b>Stage of cruise</b>              | <b>From</b>    | <b>To</b>      | <b>Hours on-effort</b> |
|-----------------|-------------------------------------|----------------|----------------|------------------------|
| A               | Stanley to PS1                      | 24/10/06 19:26 | 26/10/06 22:12 | 16.3                   |
| B               | PS1                                 | 27/10/06 19:40 | 30/10/06 21:44 | 13.2                   |
| C               | PS1 to CS1                          | 31/10/06 11:24 | 31/10/06 20:33 | 6.5                    |
| D               | CS1                                 | 01/11/06 13:55 | 02/11/06 20:42 | 9.6                    |
| E               | CS1 to Signy to CS2                 | 03/11/06 09:56 | 04/11/06 19:24 | 12.7                   |
| F               | CS2                                 | 05/11/06 19:35 | 06/11/06 20:46 | 7.3                    |
| G               | CS2 to CS3                          | 07/11/06 13:24 | 07/11/06 20:52 | 3.3                    |
| H               | CS3                                 | 08/11/06 16:19 | 09/11/06 20:44 | 7.8                    |
| I               | Signy to CTD D                      | 15/11/06 11:17 | 15/11/06 20:50 | 7.2                    |
| J               | CS4                                 | 16/11/06 16:23 | 17/11/06 21:19 | 8.7                    |
| K               | PS2                                 | 18/11/06 15:35 | 21/11/06 10:17 | 12.0                   |
| L               | PS2 to PS3                          | 22/11/06 07:47 | 22/11/06 21:25 | 7.5                    |
| M               | PS3 (abandoned due to poor weather) | 23/11/06 15:08 | 23/11/06 16:39 | 1.5                    |
| N               | PS3                                 | 26/11/06 07:35 | 26/11/06 14:10 | 5.1                    |
| O               | PS3 TO CS6                          | 27/11/06 08:35 | 27/11/06 22:00 | 8.7                    |
| P               | CS6                                 | 28/11/06 13:35 | 30/11/06 21:25 | 12.5                   |
| Q               | CS6 TO Stanley                      | 01/12/06 11:16 | 01/12/06 21:15 | 6.0                    |

**Table pred2. Summary of periods during which stationary air breathing predator observations were made during JR161.**

| Station | Database code | From     | To       | Number of scans |
|---------|---------------|----------|----------|-----------------|
| PS1     | A             | 27/10/06 | 29/10/06 | 24              |
| CS1     | B             | 01/11/06 | 01/11/06 | 4               |
| CS2     | C             | 05/11/06 | 05/11/06 | 5               |
| CTD A   | D             | 07/11/06 | 07/11/06 | 2               |
| CTD B   | E             | 07/11/06 | 07/11/06 | 3               |
| CS3     | F             | 08/11/06 | 08/11/06 | 4               |
| CS4     | G             | 16/11/06 | 17/11/06 | 4               |
| PS2     | H             | 18/11/06 | 20/11/06 | 11              |
| CTD I   | I             | 22/11/06 | 22/11/06 | 1               |
| CTDJ    | J             | 22/11/06 | 22/11/06 | 1               |
| PS3     | K             | 23/11/06 | 25/11/06 | 18              |
| CS6     | L             | 28/11/06 | 29/11/06 | 3               |

### **Preliminary Results**

Whilst there was insufficient time to analyse data during the cruise approximate relative abundances of animals recorded whilst underway (table pred3) and at sampling stations (table pred4) are summarised below. These data have not been corrected for the effects of weather, distance, etc. on the detectability of animals and should only serve to illustrate very coarse scale patterns. A total of 39,403 air-breathing predators from at least 61 species were recorded whilst the ship was underway. The most frequently recorded species were cape petrels *Daption capense* and prions *Pachyptila sp.*, both of which are persistent ship followers. A total of 4075 animals from at least 23 species were recorded while the ship was on station, again the most frequently recorded species being cape petrels and prions.

**Table pred3. Standardised sighting rate of air-breathing predators recorded whilst the ship was underway (animals/hour). Total indicates total number of animals seen.**

| Common Name                   | Species                                | Total | Transect |       |       |       |      |       |       |       |
|-------------------------------|--|-------|----------|-------|-------|-------|------|-------|-------|-------|
|                               |  |       | A        | B     | C     | D     | E    | F     | G     | H     |
| Penguin sp.                   |  | 50    | 0.1      | 0.3   | 0.6   | 1.0   | 0.1  | 1.0   | 1.2   | 1.2   |
| King Penguin                  | <i>Aptenodytes patagonicus</i>         | 33    |          |       |       |       |      |       |       |       |
| Emperor Penguin               | <i>Aptenodytes forsteri</i>            | 1     |          |       |       |       | 0.1  |       |       |       |
| Gentoo Penguin                | <i>Pygoscelis papua</i>                | 2     |          |       |       |       | 0.1  |       |       |       |
| Adelie Penguin                | <i>Pygoscelis adeliae</i>              | 85    |          |       |       |       | 6.7  |       |       |       |
| Chinstrap Penguin             | <i>Pygoscelis antarctica</i>           | 1488  | 0.4      | 0.6   | 4.3   |       | 6.8  | 34.1  | 6.4   | 139.1 |
| Crested penguin sp.           | <i>Eudyptes sp.</i>                    | 2     |          |       |       |       |      |       |       |       |
| Wandering albatross sp.       | <i>Diomedea sp.</i>                    | 17    | 1.0      |       |       |       |      |       |       |       |
| Wandering Albatross           | <i>Diomedea exulans</i>                | 92    | 0.7      | 0.3   | 0.6   | 0.1   |      |       |       |       |
| Southern Royal Albatross      | <i>Diomedea epomophora</i>             | 89    | 2.9      |       |       |       |      |       |       |       |
| Northern Royal Albatross      | <i>Diomedea sanfordi</i>               | 5     | 0.2      |       |       |       |      |       |       |       |
| Black-browed Albatross        | <i>Thalassarche melanophrys</i>        | 1450  | 69.3     | 3.0   | 0.6   | 2.3   |      |       |       | 1.8   |
| Grey-headed Albatross         | <i>Thalassarche chrysostoma</i>        | 146   | 2.0      | 2.0   |       |       |      |       |       | 1.5   |
| Light-mantled Sooty Albatross | <i>Phoebastria palpebrata</i>          | 88    | 1.0      | 0.7   |       |       |      |       |       | 0.8   |
| Giant Petrel sp.              | <i>Macronectes sp.</i>                 | 242   | 3.9      | 6.4   | 2.2   | 0.3   |      | 0.4   | 0.9   | 1.5   |
| Southern Giant Petrel         | <i>Macronectes giganteus</i>           | 394   | 3.3      | 9.0   | 2.3   | 3.2   | 1.7  | 2.1   | 0.3   | 0.6   |
| Northern Giant Petrel         | <i>Macronectes halli</i>               | 393   | 0.7      | 1.1   | 1.1   | 0.2   |      |       | 0.3   | 1.7   |
| Southern Fulmar               | <i>Fulmarus glacialisoides</i>         | 1059  | 8.8      | 4.7   | 45.1  | 36.4  | 7.6  | 7.1   | 5.8   | 4.0   |
| Antarctic Petrel              | <i>Thalassoica antarctica</i>          | 260   |          |       | 0.3   | 12.2  | 8.1  | 4.7   | 1.2   |       |
| Cape Petrel                   | <i>Daption capense</i>                 | 17407 | 256.3    | 119.2 | 306.0 | 217.4 | 37.6 | 369.9 | 188.2 | 131.9 |
| Snow Petrel sp.               | <i>Pagodroma sp.</i>                   | 679   |          |       |       | 0.1   | 33.0 | 30.7  |       |       |
| Gadfly petrel sp.             | <i>Pterodroma sp.</i>                  | 1     |          | 0.1   |       |       |      |       |       |       |
| White-headed Petrel           | <i>Pterodroma lessonii</i>             | 3     | 0.1      |       |       |       |      |       |       |       |
| Atlantic Petrel               | <i>Pterodroma incerta</i>              | 71    | 4.4      |       |       |       |      |       |       |       |
| Soft-plumaged Petrel          | <i>Pterodroma mollis</i>               | 102   |          |       |       |       |      |       |       |       |
| Blue Petrel                   | <i>Halobaena caerulea</i>              | 1899  | 20.2     | 28.7  | 7.1   | 0.1   | 0.3  |       | 16.1  | 26.7  |
| Prion sp.                     | <i>Pachyptila sp.</i>                  | 11039 | 12.8     | 28.7  | 10.9  | 5.0   | 0.2  |       | 6.4   | 9.0   |
| Antarctic Prion               | <i>Pachyptila desolata</i>             | 5     | 0.2      | 0.1   |       |       |      |       |       |       |
| Slender-billed Prion          | <i>Pachyptila belcheri</i>             | 12    | 0.5      |       |       |       |      |       |       | 0.3   |
| Fairy Prion                   | <i>Pachyptila turtur</i>               | 6     | 0.2      | 0.1   |       |       |      |       |       | 0.1   |
| White-chinned Petrel          | <i>Procellaria aequinoctialis</i>      | 403   | 1.7      | 4.8   |       | 0.4   |      |       |       | 0.5   |
| Sooty Shearwater              | <i>Puffinus griseus</i>                | 65    | 3.8      |       |       |       |      |       |       |       |
| Storm petrel sp.              |  | 2     | 0.1      | 0.1   |       |       |      |       |       |       |
| Wilson's Storm-petrel         | <i>Oceanites oceanicus</i>             | 542   | 1.6      | 0.4   | 0.5   | 0.4   | 0.1  | 0.3   | 0.9   | 2.7   |
| Grey-backed Storm-petrel      | <i>Oceanites nereis</i>                | 1     |          |       |       |       |      |       |       |       |
| Black-bellied Storm-petrel    | <i>Fregatta tropica</i>                | 395   | 0.3      | 0.3   | 1.4   | 0.7   |      | 0.5   | 4.2   | 3.6   |
| Diving-petrel sp.             | <i>Pelecanoides sp.</i>                | 50    | 0.1      | 0.1   |       | 0.2   |      |       |       |       |
| Blue-eyed shag sp.            | <i>Phalacrocorax sp.</i>               | 7     | 0.4      |       |       |       |      |       |       |       |
| Tern sp.                      | <i>Sterna sp.</i>                      | 5     | 0.2      |       |       |       |      |       | 0.3   | 0.1   |
| Pale-faced Sheathbill         | <i>Chionis alba</i>                    | 6     |          |       |       | 0.4   | 0.1  | 0.1   |       |       |
| Brown skua sp                 | <i>Catharacta sp.</i>                  | 4     |          |       |       |       |      | 0.1   |       |       |
| Subantarctic Skua             | <i>Catharacta antarctica lonnbergi</i> | 20    |          |       | 0.2   | 0.2   |      | 1.1   |       |       |
| Dolphin Gull                  | <i>Larus scoresbii</i>                 | 1     | 0.1      |       |       |       |      |       |       |       |

|                     |                            |    |     |     |  |  |     |     |     |     |     |
|---------------------|----------------------------|----|-----|-----|--|--|-----|-----|-----|-----|-----|
| Kelp Gull           | <i>Larus dominicanus</i>   | 8  | 0.1 | 0.1 |  |  |     | 0.3 |     |     |     |
| Arctic Tern         | <i>Sterna paradisaea</i>   | 6  |     |     |  |  |     | 0.2 |     | 0.4 |     |
| Antarctic Tern      | <i>Sterna vittata</i>      | 14 |     |     |  |  | 0.1 | 0.6 | 0.3 |     | 0.1 |
| South American Tern | <i>Sterna hirundinacea</i> | 2  | 0.1 |     |  |  |     |     |     |     |     |

| Common Name                   | Species                                | Transect |      |       |       |      |       |       |     |     |  |
|-------------------------------|--|----------|------|-------|-------|------|-------|-------|-----|-----|--|
|                               |  | I        | J    | K     | L     | M    | N     | O     | P   | Q   |  |
| Penguin sp.                   |  | 0.8      |      |       |       |      |       |       |     | 0.2 |  |
| King Penguin                  | <i>Aptenodytes patagonicus</i>         |          |      | 1.0   | 1.1   |      |       | 0.9   | 0.2 | 0.3 |  |
| Emperor Penguin               | <i>Aptenodytes forsteri</i>            |          |      |       |       |      |       |       |     |     |  |
| Gentoo Penguin                | <i>Pygoscelis papua</i>                |          |      | 0.1   |       |      |       |       |     |     |  |
| Adelie Penguin                | <i>Pygoscelis adeliae</i>              |          |      |       |       |      |       |       |     |     |  |
| Chinstrap Penguin             | <i>Pygoscelis antarctica</i>           | 0.7      |      |       |       |      |       |       |     |     |  |
| Crested penguin sp.           | <i>Eudyptes sp.</i>                    |          |      |       |       |      |       |       | 0.2 |     |  |
| Wandering albatross sp.       | <i>Diomedea sp.</i>                    |          |      |       |       |      |       | 0.1   |     |     |  |
| Wandering Albatross           | <i>Diomedea exulans</i>                |          | 0.1  | 0.1   | 0.4   | 5.3  | 4.9   | 2.5   | 0.9 | 0.2 |  |
| Southern Royal Albatross      | <i>Diomedea epomophora</i>             |          |      |       |       | 1.3  | 2.4   |       | 2.0 | 0.3 |  |
| Northern Royal Albatross      | <i>Diomedea sanfordi</i>               |          |      |       |       |      |       |       | 0.1 |     |  |
| Black-browed Albatross        | <i>Thalassarche melanophrys</i>        | 0.3      | 0.9  | 3.0   | 1.6   | 4.0  | 21.0  | 2.1   | 3.6 | 1.2 |  |
| Grey-headed Albatross         | <i>Thalassarche chrysostoma</i>        |          |      | 0.8   | 0.1   |      | 4.3   | 2.0   | 1.8 | 0.3 |  |
| Light-mantled Sooty Albatross | <i>Phoebastria palpebrata</i>          | 0.1      | 0.9  | 3.0   | 0.5   |      | 0.2   | 0.3   | 0.2 | 0.2 |  |
| Giant Petrel sp.              | <i>Macronectes sp.</i>                 | 0.4      | 3.0  | 0.4   | 0.1   | 1.3  | 1.8   |       | 1.0 |     |  |
| Southern Giant Petrel         | <i>Macronectes giganteus</i>           | 1.9      | 10.9 | 0.5   | 0.5   | 0.7  | 0.6   | 0.2   | 0.6 |     |  |
| Northern Giant Petrel         | <i>Macronectes halli</i>               |          | 7.4  | 3.4   | 1.6   | 10.0 | 20.8  | 5.1   | 5.0 |     |  |
| Southern Fulmar               | <i>Fulmarus glacialis</i>              | 1.4      |      |       |       |      | 0.4   |       |     |     |  |
| Antarctic Petrel              | <i>Thalassoica antarctica</i>          |          |      |       |       |      |       |       |     |     |  |
| Cape Petrel                   | <i>Daption capense</i>                 | 36.3     | 27.8 | 69.1  | 13.1  | 46.7 | 84.7  | 90.8  | 2.5 |     |  |
| Snow Petrel sp.               | <i>Pagodroma sp.</i>                   |          |      | 1.9   | 0.8   |      | 1.2   |       |     |     |  |
| Gadfly petrel sp.             | <i>Pterodroma sp.</i>                  |          |      |       |       |      |       |       |     |     |  |
| White-headed Petrel           | <i>Pterodroma lessonii</i>             |          |      |       |       |      |       |       | 0.2 |     |  |
| Atlantic Petrel               | <i>Pterodroma incerta</i>              |          |      |       |       |      |       |       |     |     |  |
| Soft-plumaged Petrel          | <i>Pterodroma mollis</i>               |          |      |       |       |      |       |       | 5.9 | 4.7 |  |
| Blue Petrel                   | <i>Halobaena caerulea</i>              | 5.3      | 56.9 | 19.0  | 2.1   |      | 4.1   | 9.0   | 0.2 |     |  |
| Prion sp.                     | <i>Pachyptila sp.</i>                  | 11.0     | 66.9 | 114.6 | 173.7 | 75.3 | 211.6 | 646.2 | 6.0 | 1.7 |  |
| Antarctic Prion               | <i>Pachyptila desolata</i>             |          |      |       |       |      |       |       |     |     |  |
| Slender-billed Prion          | <i>Pachyptila belcheri</i>             | 0.3      |      |       |       |      |       |       |     |     |  |
| Fairy Prion                   | <i>Pachyptila turtur</i>               |          |      |       |       |      |       |       |     |     |  |
| White-chinned Petrel          | <i>Procellaria aequinoctialis</i>      | 0.3      | 2.9  | 1.4   | 7.2   | 12.7 | 13.9  | 5.1   | 4.0 | 3.7 |  |
| Sooty Shearwater              | <i>Puffinus griseus</i>                |          |      |       |       |      |       |       | 0.2 | 0.2 |  |
| Storm petrel sp.              |  |          |      |       |       |      |       |       |     |     |  |
| Wilson's Storm-petrel         | <i>Oceanites oceanicus</i>             | 1.7      | 6.6  | 2.0   | 3.7   |      | 6.7   | 29.1  | 5.4 | 0.3 |  |
| Grey-backed Storm-petrel      | <i>Oceanites nereis</i>                |          |      |       |       |      |       |       | 0.1 |     |  |
| Black-bellied Storm-petrel    | <i>Fregatta tropica</i>                | 4.0      | 2.0  | 2.3   | 4.7   | 2.7  | 5.5   | 13.4  | 5.0 | 0.5 |  |
| Diving-petrel sp.             | <i>Pelecanoides sp.</i>                |          | 0.2  | 1.0   | 1.3   | 0.7  | 2.5   | 0.5   | 0.2 | 0.2 |  |
| Blue-eyed shag sp.            | <i>Phalacrocorax sp.</i>               |          |      |       |       |      |       |       |     |     |  |
| Tern sp.                      | <i>Sterna sp.</i>                      |          |      |       |       |      |       |       |     |     |  |
| Pale-faced Shearbill          | <i>Chionis alba</i>                    |          |      |       |       |      |       |       |     |     |  |
| Brown skua sp                 | <i>Catharacta sp.</i>                  |          | 0.2  |       |       |      |       |       |     | 0.1 |  |
| Subantarctic Skua             | <i>Catharacta antarctica lonnbergi</i> |          | 0.1  |       |       |      | 0.2   | 0.5   | 0.2 |     |  |
| Dolphin Gull                  | <i>Larus scoresbii</i>                 |          |      |       |       |      |       |       |     |     |  |
| Kelp Gull                     | <i>Larus dominicanus</i>               |          |      |       |       |      |       |       |     | 0.2 |  |
| Arctic Tern                   | <i>Sterna paradisaea</i>               |          |      |       |       |      |       |       |     |     |  |
| Antarctic Tern                | <i>Sterna vittata</i>                  | 0.3      |      |       |       |      |       |       |     |     |  |
| South American Tern           | <i>Sterna hirundinacea</i>             |          |      |       |       |      |       |       |     |     |  |
|                               |  |          |      |       |       |      |       |       |     |     |  |
| True seal sp.                 |  |          |      |       |       |      |       |       |     |     |  |
| Leopard Seal                  | <i>Hydrurga leptonyx</i>               |          |      |       |       |      |       |       |     |     |  |

|                           |                                |     |     |     |      |     |      |      |     |     |     |  |  |  |
|---------------------------|--------------------------------|-----|-----|-----|------|-----|------|------|-----|-----|-----|--|--|--|
| Weddell Seal              | <i>Leptonychotes weddellii</i> |     |     |     |      |     |      |      |     |     |     |  |  |  |
| Crabeater Seal            | <i>Lobodon carcinophaga</i>    |     |     |     |      |     |      |      |     |     |     |  |  |  |
| Fur seal sp.              | <i>Arctocephalus sp.</i>       | 1.1 | 6.2 | 7.0 | 19.3 | 8.7 | 35.5 | 11.4 | 3.2 | 0.5 |     |  |  |  |
| Small cetacean sp         |                                |     |     |     |      |     |      |      |     |     |     |  |  |  |
| Long-finned Pilot Whale   | <i>Globicephala melas</i>      |     |     |     |      |     |      | 1.6  |     |     |     |  |  |  |
| Beaked Whale sp.          |                                |     |     |     | 0.1  |     |      |      |     |     |     |  |  |  |
| Southern Bottlenose Whale | <i>Hyperoodon planifrons</i>   |     |     |     |      |     |      |      |     | 0.1 |     |  |  |  |
| Large cetacean sp.        |                                |     | 0.1 | 1.3 |      |     |      | 0.2  |     |     | 0.1 |  |  |  |
| Baleen whale sp.          | <i>Balaenoptera sp.</i>        |     | 0.2 |     |      |     |      |      |     |     |     |  |  |  |
| Minke Whale sp.           | <i>Balaenoptera sp.</i>        |     |     |     |      |     |      |      |     |     |     |  |  |  |
| Fin Whale                 | <i>Balaenoptera physalus</i>   |     |     |     | 1.8  | 0.5 |      |      |     | 0.2 |     |  |  |  |

**Table pred4. Standardised abundance of air-breathing predators recorded within 300 m of the ship whilst the ship was on station (animals/count). 'P' indicates the species was recorded beyond 300 m from the ship.**

| CommonName                    | Species                         | Station |     |      |       |       |      |     |      |       |       |     |      |      |
|-------------------------------|---------------------------------|---------|-----|------|-------|-------|------|-----|------|-------|-------|-----|------|------|
|                               |                                 | PS1     | CS1 | CS2  | CTD A | CTD B | CS3  | CS4 | PS2  | CTD I | CTD J | PS3 | CS6  |      |
| Penguin sp.                   |                                 |         |     | 1.6  |       | 0.3   |      |     |      |       |       |     |      |      |
| Gentoo Penguin                | <i>Pygoscelis papua</i>         |         |     |      |       |       |      |     |      |       |       |     | 0.1  |      |
| Chinstrap Penguin             | <i>Pygoscelis antarctica</i>    |         |     |      | 2.5   |       |      |     |      |       |       |     |      |      |
| Wandering albatross sp.       | <i>Diomedea sp.</i>             |         |     |      |       |       |      |     |      |       |       |     | 0.7  |      |
| Wandering Albatross           | <i>Diomedea exulans</i>         |         |     |      |       |       |      |     | 0.4  | P     |       |     | 1.3  | 2.3  |
| Southern Royal Albatross      | <i>Diomedea epomophora</i>      |         |     |      |       |       |      |     |      |       |       |     | 0.8  | 1.0  |
| Black-browed Albatross        | <i>Thalassarche melanophrys</i> | 2.5     | 0.3 |      |       | 1.0   | 0.3  | 1.0 | 0.9  | 2.0   |       |     | 1.3  | 1.7  |
| Grey-headed Albatross         | <i>Thalassarche chrysostoma</i> | 0.1     |     |      |       |       |      |     |      | 0.5   |       |     | 0.3  | 1.3  |
| Light-mantled Sooty Albatross | <i>Phoebastria palpebrata</i>   | 0.0     |     |      |       |       |      | 0.5 | 0.5  |       |       |     | 0.1  | 0.3  |
| Giant Petrel sp.              | <i>Macronectes sp.</i>          | 5.3     |     |      | 0.5   | P     | 0.5  | 2.3 | 0.5  |       |       |     | 0.7  |      |
| Southern Giant Petrel         | <i>Macronectes giganteus</i>    | 0.9     | 0.5 | 1.0  | 0.5   | 0.7   | 0.5  | 2.0 | 0.1  | 3.0   |       |     | 0.1  | 1.0  |
| Northern Giant Petrel         | <i>Macronectes halli</i>        | 0.3     |     |      |       | 0.3   | 2.5  | 2.0 | 1.6  | 11.0  | 12.0  |     | 9.4  | 11.7 |
| Southern Fulmar               | <i>Fulmarus glacialisoides</i>  | 0.3     | 2.8 | 1.6  | 1.0   | 6.3   | 1.0  |     |      |       |       |     |      |      |
| Antarctic Petrel              | <i>Thalassoica antarctica</i>   |         |     |      | 0.5   | 0.7   |      |     |      |       |       |     |      |      |
| Cape Petrel                   | <i>Daption capense</i>          | 33.7    | 7.5 | 89.8 | 22.0  | 88.0  | 40.0 |     | 21.4 | 11.0  | 14.0  |     | 11.2 | 1.0  |
| Snow Petrel sp.               | <i>Pagodroma sp.</i>            | 0.0     |     |      |       |       |      |     |      |       |       |     |      |      |
| Soft-plumaged Petrel          | <i>Pterodroma mollis</i>        |         |     |      |       |       |      |     |      |       |       |     |      | 0.7  |
| Blue Petrel                   | <i>Halobaena caerulea</i>       | 2.1     |     |      |       | 9.0   | 2.5  | 5.3 | 16.9 |       |       |     | 1.2  |      |
| Prion sp                      | <i>Pachyptila sp.</i>           | 3.8     |     |      |       | 2.7   | 1.0  | 3.0 | 8.9  | 5.0   | 9.0   |     | 14.9 | 1.0  |
| Broad-billed Prion            | <i>Pachyptila vittata</i>       |         |     |      |       | 0.3   |      |     |      |       |       |     |      |      |

|                            |  |     |     |   |     |     |     |     |     |     |     |     |
|----------------------------|--|-----|-----|---|-----|-----|-----|-----|-----|-----|-----|-----|
| Antarctic Prion            | <i>Pachyptila desolata</i>             | 0.3 | 0.3 |   |     |     |     |     |     |     |     |     |
| White-chinned Petrel       | <i>Procellaria aequinoctialis</i>      | 1.5 |     |   | 0.5 | 1.5 | 1.5 | 1.0 | 1.0 | 2.8 | 6.0 |     |
| Wilson's Storm-petrel      | <i>Oceanites oceanicus</i>             | 0.5 |     | P | 0.3 | 0.5 | 2.5 | 1.2 |     | 4.0 | 1.1 | 2.0 |
| Black-bellied Storm-petrel | <i>Fregatta tropica</i>                |     |     | P | 0.3 | 0.3 | 0.3 | 0.5 |     |     | 0.7 | 1.7 |
| Diving-petrel sp           | <i>Pelecanoides sp.</i>                |     |     |   |     |     |     | 0.1 |     |     | 0.2 |     |
| Pale-faced Sheathbill      | <i>Chionis alba</i>                    | 0.5 |     |   |     |     |     | 0.1 |     |     |     |     |
| Subantarctic Skua          | <i>Catharacta antarctica lonnbergi</i> |     |     |   | 1.5 |     | 0.3 |     |     |     |     |     |
| Tern sp.                   | <i>Sterna sp.</i>                      |     |     | P |     |     |     |     |     |     |     |     |
| Arctic Tern                | <i>Sterna paradisaea</i>               | 0.0 |     |   |     |     |     |     |     |     |     |     |
| Fur seal sp.               | <i>Arctocephalus sp.</i>               |     |     |   |     |     |     | 1.5 |     | 1.0 | 0.9 |     |
| Large cetacean sp.         |  |     |     |   |     |     |     | P   |     |     | P   |     |
| Fin Whale                  | <i>Balaenoptera physalus</i>           |     |     | P |     |     |     | P   |     |     | P   |     |

## **Problems encountered and recommendations**

1. The method of counting animals whilst on station was felt to be inadequate because it was only possible to systematically count animals close to the ship. These animals tended to be species that were attracted to the ship (although this tendency could be exploited as a sampling method). They usually congregated around the stern in the prop wash (while in station use of the ship's DP system to hold the vessel head to wind meant there was always some prop wash) or midway along the beam, where the ship's macerators discharged food waste. Counting animals from the stern and bow might have been preferable to counting from the sides as this would give some indication of which animals were attracted to the ship and which were simply passing by. Alternatively, animals in area further from the ship could be counted using binoculars but this method would only be effective in low sea states and good visibility.

2. It was possible at most but not all times for an observer to collect and enter data simultaneously. This was due mainly to the use of the rugged laptop, which was invaluable and performed very well throughout the cruise (although see below). However, at times when the animal density was high a data recorder was necessary in order for the observer not to miss a significant number of animals. Furthermore, because there was only one observer data could not be collected continuously whilst underway. This meant that important features such as fronts were often crossed while no predator data was being collected. An ideal situation would be to have two trained observers working shifts assisted by data recorders drawn from the scientific party or people in transit.

3. The movement codes were over complicated. Flight type could have been more succinctly described as direct, turning or circling.

4. The laptop's touch-screen backlight occasionally switched off unexpectedly making it nearly impossible to use the screen. This seemed to happen if the laptop was left outside in the cold on standby during breaks, etc. Hence, it was always taken inside when not in use. Having spoken to the manufacturers it seems that this is a fault and should be fixed before the laptop is used on another cruise.



5. During underway observations all birds in flight passing through the transect were recorded (with some marked as in snapshot). For some studies this level of detail may be unnecessary and it may be acceptable to record only birds seen in the snapshot counts. Taking this approach would mean more time could be devoted to recording birds' behaviour.

6. Working from the bridge wings was effective and is common practice among predator observers. However, it did at times cause some disruption to the bridge officers. Given that cetacean or air-breathing predator surveys are often undertaken from the *RRS James Clark Ross* it might be worth considering fitting a permanent or removable shelter on the monkey island for observers. Such shelters have apparently been fitted to the *Polar Stern* and other research ships operating in the Southern Ocean.

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## Appendix Pred1. Fields in predator observations database

| Table       | Field       | Description   |
|-------------|-------------|---|
| GeneralData | form_id     | Cruise code & ddmmyy & "_" & transect   |
|             | site        | Cruise code ("SG" throughout JR161)   |
|             | boat        | Ship's name   |
|             | transect    | Letter indicates leg (between or at stations), number indicates day of leg  |
|             | observer    | "EW" Ewan Wakefield throughout cruise   |
|             | date        | Date  |
|             | page        | Not used  |
|             | start_time  | Initial start time at beginning of the day  |
|             | finish_time | Final end time at the end of the day  |
|             | notes       | Concise log of start and end times, activities, etc. during transect  |
|             | CountData   | form_id   |
| observation |             | Observation number  |
| PositionID  |             | Cruise code & ddmmyyhhmmss (used to match records to positions, Ocean Logger data, etc.)  |
| time        |             | Time of observation (UTC)   |
| species     |             | Species or administrative code (see species codes)  |
| age         |             | Age of animal or plumage stage (cy = calendar year for gulls, etc.; type = Gibson plumage index for <i>Exulans</i> spp.): A; Adult; I; Immature ; J; Juvenile ; 1; type I; 2; 2nd cy or type II; 3; 3rd cy or type III; 4; 4th cy or type IV; 5; 5th cy or type V; 6; 6th cy or type VI; 7; 7th cy or type VII; U; Undetermined |
| pl          |             | Plumage, morph or size: W; Winter (non-breeding); S; Summer (breeding); T; Transition; M; Male; F; Female; D; Dark; I; Intermediate; L; Light; E; Eclipse; 1; ½ or less than adult size; 2; over ½ adult size; 3; about same size as adult; U; Undetermined   |
| numbers     |             | Number of animals seen  |
| band        |             | F; bird in flight within the box or A; on water 0-50 m; B; on water 50-100 m; C; on water 100-200 m; D; on water 200-300 m; E; on water >300 m.   |
| dir         |             | Animal's direction of flight of swimming relative to the ship's head  |
| Movement    |             | See movements codes   |
| Search      |             | See searching codes   |
| Forage      |             | Foraging or other behaviour code (see foraging and behaviour codes)   |
| Prey        |             | See prey codes  |

|                    |   |
|--------------------|---|
| radial             | Not used  |
| height             | Not used  |
| grad               | Not used  |
| T                  | 1 = flying bird in snapshot 0 = flying bird not in snapshot   |
| notes              | Any additional notes  |
| OffEastings        | Not used  |
| OffNorthings       | Not used  |
| Range              | Estimated radial distance to cetaceans at time of first sighting (m)  |
| Bearing            | Estimated bearing to cetaceans at time of first sighting relative to ship's head  |
| Ass                | Not used  |
| Lat                | Latitude of ship when animal recorded   |
| Long               | Longitude of ship when animal recorded  |
| Truncation         | Transect width (1; 50 m; 2; 100 m; 3; 200 m; 4; 300 m; 5; 1 km; 6; 5 km; 7; Horizon)  |
| speed              | Ship's speed (knots)  |
| snapshot_interval  | Not used  |
| wind_dir           | True wind direction, estimated by observer  |
| cloud_cover        | Percentage cloud cover estimated by observer  |
| precipitation_type | See precipitation types   |
| wind_sp            | True Beaufort wind speed estimated by observer  |
| wave_hgt           | Significant wave height estimated by observer   |
| sea_ice            | Sea ice concentration in 10ths estimated by observer  |
| swell_direction    | True dominant swell direction estimated by observer   |
| vis                | Visibility (km) estimated by observer. 20 km = beyond the visible horizon   |
| sun_glare_from     | Start of arc obscured by sun glare (deg), clockwise from ship's head  |
| sun_glare_to       | End of arc obscured by sun glare (deg), clockwise from ship's head  |
| temperature        | Subjective temperature category, estimated by observer  |
| pressure           | Not used  |
| direction_scan     | Location of observer and direction of scan (PW; Port bridge wing; SW; Starboard bridge wing; PB; Port inside bridge; SB; Starboard inside bridge) |
| sea_state          | Beaufort sea state estimated by observer  |

|                   |  |
|-------------------|--|
| Base_activity     | Ship's activity (due to communication difficulties this may need check, i.e. instruments or equipment may have been deployed without the observer knowing). 0; no data; 1; non-fishing activity; 2; major fishing activity; 3; steaming between fishing stations; 4; Flaring; 5; steaming between other sampling stations; 6; Seismic Survey; 7; acoustic krill survey; 8; steaming; 9; RMT25; 10; MOCNESS; 11; LHPR.  |
| SpeciesCodes Code | Either: two uppercase letters for bird species (based on BTO codes); three lower case letters for lower taxonomic groupings of birds; three uppercase letters for marine mammals (species or lower grouping); four upper case letters for special codes ("STRT"; start of a surveying session, "STOP"; end of a surveying session, "NOTE"; timed note, "METO"; a metreological observation). Some species may not have had a code allocated, in which case they will simply have a number. |
| CommonName        | Common name following Shirihai (2002)  |
| FuncGroup         | Not presently used   |
| Genus             | Genus following Shirihai (2002)  |
| Species           | Species following Shirihai (2002)  |
| SubSpecies        | Sub-species following Shirihai (2002)  |
| Expected          | 1 = likely to be encountered, 2 = not likely to be encountered (the latter species will produce a warning message if entered into the database)  |
| Type              | BTO; birds identified to species; UNB; birds not identified to species; MAM; marine mammals; NOT; special codes; VES; other vessels (not used on JR161)  |
| VoousNumber       | Approximate taxonomic order  |
| Group             | Group following Shirihai (2002)  |
| Order             | Order following Shirihai (2002)  |
| Status            | Order following Shirihai (2002)  |
| Family            | Family following Shirihai (2002)   |
| BAS_code          | Not presently used   |

## ***Fields in stationary predator observations database***

| Table          | Field   | Description   |
|----------------|---|---|
| GeneralData    | form_id   | Cruise code & ddmmyy & direction_scan & transect  |
|                | site  | Cruise code ("SG" throughout JR161)   |
|                | boat  | Ship's name   |
|                | transect  | Actually refers to scans. Letter indicates station (lettered from A, including CTD stations), number indicates scan (numbered sequentially from 01) |
|                | observer  | "EW" Ewan Wakefield throughout cruise   |
|                | date  | Date  |
|                | direction_scan  | PM; port side of monkey island; SM; starboard side of monkey island   |
|                | page  | Not used  |
|                | start_time  | Time scan started   |
|                | finish_time   | Time scan finished, nominally five minutes after start  |
|                | form_id   | Cruise code & ddmmyy & "_" & transect   |
|                | observation   | Observation number  |
|                | notes   | general notes   |
|                | Truncation  | Not used  |
|                | speed   | Defaults to 0 knots   |
|                | snapshot_interval   | Not used  |
|                | wind_dir  | True wind direction, estimated by observer  |
|                | cloud_cover   | Percentage cloud cover estimated by observer  |
|                | precipitation_type  | See precipitation types   |
|                | wind_sp   | True Beaufort wind speed estimated by observer  |
|                | wave_hgt  | Significant wave height estimated by observer   |
|                | sea_ice   | Sea ice concentration in 10ths estimated by observer  |
|                | swell_direction   | True dominant swell direction estimated by observer   |
|                | vis   | Visibility (km) estimated by observer. 20 km = beyond the visible horizon   |
|                | sun_glare_from  | Start of arc obscured by sun glare (deg), clockwise from ship's head  |
|                | sun_glare_to  | End of arc obscured by sun glare (deg), clockwise from ship's head  |
|                | temperature   | Subjective temperature category, estimated by observer  |
| pressure       | Not used  |   |
| direction_scan | Location of observer and direction of scan (PW; Port bridge wing; SW; Starboard bridge wing; PB; Port inside bridge; SB; Starboard inside bridge) |   |
| sea_state      | Beaufort sea state estimated by observer  |   |

|              |  |   |
|--------------|--|---|
|              | Base_activity  | Ship's activity (due to communication difficulties this may need check, i.e. instruments or equipment may have been deployed without the observer knowing). 0; no data; 1; non-fishing activity; 2; major fishing activity; 3; steaming between fishing stations; 4; Flaring; 5; steaming between other sampling stations; 6; Seismic Survey; 7; acoustic krill survey; 8; steaming; 9; RMT25; 10; MOCNESS; 11; LHPR. |
| CountData    | form_id  | Cruise code & ddmmyy & direction_scan & transect  |
|              | observation  | Automatically numbered  |
|              | PositionID   | Cruise code & ddmmyyhmmss (used to match records to positions, Ocean Logger data, etc.)   |
|              | time   | Defaults to scan start time   |
|              | species  | Species or administrative code (see species codes)  |
|              | age  | Age of animal or plumage stage (cy = calendar year for gulls, etc.; type = Gibson plumage index for <i>Exulans</i> spp.): A; Adult; I; Immature ; J; Juvenile ; 1; type I; 2; 2nd cy or type II; 3; 3rd cy or type III; 4; 4th cy or type IV; 5; 5th cy or type V; 6; 6th cy or type VI; 7; 7th cy or type VII; U; Undetermined   |
|              | pl   | Plumage, morph or size: W; Winter (non-breeding); S; Summer (breeding); T; Transition; M; Male; F; Female; D; Dark; I; Intermediate; L; Light; E; Eclipse; 1; ½ or less than adult size; 2; over ½ adult size; 3; about same size as adult; U; Undetermined   |
|              | numbers  | Total number of animals seen  |
|              | band   | A; within 300 m of the ship's monkey island; B; beyond 300 m from the ship's monkey island  |
|              | dir  | Animal's direction of flight of swimming relative to the ship's head (cetaceans only)   |
|              | Movement   | See movements codes   |
|              | Search   | See searching codes   |
|              | Forage   | Foraging or other behaviour code (see foraging and behaviour codes)   |
|              | Prey   | See prey codes  |
|              | radial   | Not used  |
|              | height   | Not used  |
|              | grad   | Not used  |
|              | T  | Not used  |
|              | notes  | Any additional notes  |
|              | OffEastings  | Not used  |
| OffNorthings | Not used   |   |
| Range        | Estimated radial distance to cetaceans at time of first sighting (m) |   |

|              |  |
|--------------|--|
| Bearing      | Estimated bearing to cetaceans at time of first sighting relative to ship's head |
| Ass          | Not used   |
| Lat          | Latitude of ship when animal recorded  |
| Long         | Longitude of ship when animal recorded   |
| PropFlight   | The percentage of birds in flight  |
| SpeciesCodes | As underway database   |



***Movement, searching, foraging, behaviour and prey codes used in underway and stationary observations databases. Partly based on Harper et al. (1985) and Camphuysen & Garthe (2004).***

| Type          | Sub-type         | Code       | Description                          |  |
|---------------|------------------|------------|--------------------------------------|--|
| Movement      | Diving           | DDD        | Dived/diving direct                  |  |
|               |                  | DDT        | Diving directionless                 |  |
|               | Flight circling  | FT1        | Flight - turns < 90 deg              |  |
|               |                  | FT2        | Flight - turns 90-180 deg            |  |
|               |                  | FT3        | Flight - turns >180 deg              |  |
|               | Flight direct    | FDD        | Flight - direct                      |  |
|               | Flight following | FFS        | Flight following other vessel        |  |
|               |                  | FFF        | Flight following fishing vessel      |  |
|               | Miscellaneous    | BTH        | Bathing                              |  |
|               |                  | CRT        | Courtship display                    |  |
|               |                  | UNW        | Unwell                               |  |
|               |                  | DED        | Dead                                 |  |
|               |                  | SLP        | Apparently asleep                    |  |
|               |                  | Sea/air    | CLA                                  | Landed   |
|               | Sitting on       | CTO        | Took off                             |  |
|               |                  | SOW        | Sitting on the water                 |  |
|               |                  | SOD        | Sitting on driftwood                 |  |
|               |                  | SOI        | Sitting on ice                       |  |
|               |                  | SOF        | Sitting on water by fishing vessel   |  |
|               |                  | SOV        | Sitting on water by other vessel     |  |
|               |                  | SOL        | Sitting on land                      |  |
|               |                  | SOB        | Sitting on buoy                      |  |
|               |                  | Swimming   | SSD                                  | Swim slow - direct   |
|               |                  |            | SUR                                  | At surface, not logging but not moving in any particular direction |
|               | Swimming fast    | SF1        | Swim fast - turns < 90 deg           |  |
|               |                  | SF2        | Swim fast - turns 90-180 deg         |  |
|               |                  | SF3        | Swim fast - turns >180 deg           |  |
|               | Swimming slow    | SS3        | Swim slow - turns >180 deg (milling) |  |
|               |                  | SFD        | Swim fast - direct                   |  |
|               |                  | SS2        | Swim slow - turns 90-180 deg         |  |
|               |                  | SS1        | Swim slow - turns < 90 deg           |  |
|               | Searching        | Unrecorded | U                                    | Unrecorded   |
| Carrying prey |                  | C          | Carrying prey                        |  |
| Feeding       |                  | F          | Seen feeding                         |  |
| No            |                  | 0          | Apparently not searching for prey    |  |
| Unrecorded    |                  | U          | Unrecorded/unclear                   |  |
| Yes           |                  | 1          | Apparently searching for prey        |  |

|            |                   |                  |                                  |   |
|------------|-------------------|------------------|----------------------------------|---|
| Foraging   | Diving            | DDS              | Surface dive (brief)             |   |
|            |                   | DDD              | Diving (type unspecified)        |   |
|            |                   | DDP              | Pursuit dive from surface (full) |   |
|            | Flight feeding    | FPT              | Pattering                        |   |
|            |                   | FAP              | Aerial pursuit                   |   |
|            |                   | FDP              | Dipping                          |   |
|            |                   | FFF              | Flight feeding                   |   |
|            |                   | General foraging | 0                                | Apparently not foraging                   |
|            |                   | 1                | Apparently foraging              |   |
|            | Kleptoparasitism  | KLP              | Kleptoparasitism                 |   |
|            | Marine mammals    | FLU              | Fluke-up dive                    |   |
|            |                   | POR              | Porpoising                       |   |
|            |                   | JUM              | Jumping                          |   |
|            |                   | BLO              | Blowing                          |   |
|            |                   | ASS              | Associating with ship            |   |
|            |                   | SLA              | Tail/flipper slipping            |   |
|            |                   | BOW              | Bow riding                       |   |
|            |                   | SPY              | Spy hopping/bottling             |   |
|            |                   | LOG              | Logging                          |   |
|            |                   | HER              | Herding/concentrating prey       |   |
|            |                   | LOB              | Lobtailing                       |   |
|            |                   | BRE              | Breaching                        |   |
|            |                   | Plunging         | PPP                              | Plunging                                  |
|            |                   |                  | PPU                              | Pursuit plunging (dive from flight)       |
|            |                   |                  | PDP                              | Deep plunging (several metres)            |
|            |                   |                  | PSH                              | Shallow plunging (submerges body length)  |
|            |                   |                  | PSR                              | Surface plunging (doesn't fully submerge) |
|            | SCA               |                  | Scavenging                       |   |
|            | Surface feeding   | SSS              | Surface feeding                  |   |
|            |                   | SFP              | Foot paddling                    |   |
|            |                   | SHY              | Hydroplaning                     |   |
|            |                   | SFL              | Surface filtering                |   |
|            |                   | SSZ              | Surface seizing                  |   |
| SPK        |                   | Surface pecking  |                                  |   |
| Unrecorded |                   | U                | Unrecorded/unclear               |   |
| Prey       |                   | Cephalopod       | SQD                              | Squid sp                                  |
|            | OCT               |                  | Octopus sp                       |   |
|            | Crustacean        | KRL              | Krill sp                         |   |
|            | Fish              | FSH              | Fish sp                          |   |
|            | Jellyfish         | JEL              | Jellyfish sp                     |   |
|            | Salp              | SAL              | Salp sp                          |   |
|            | Unidentified prey | UNP              | Unidentified prey                |   |
|            | Unrecorded        | U                | Unrecorded                       |   |





Engineering Technical Section

# British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

## AME Cruise Report

FAO:

The **BAS AME (electronics) marine scientific instrumentation support engineers**

### Cruise Report Instructions

Richard Bridgeman is the first point of contact for marine scientific instrumentation – any questions email (ribr@bas.ac.uk) or phone him (01223 221407); try Steve Bremner (sfbr, 01223 221416) when Richard not available.

**Before you leave HQ for cruise support, see Richard** for an up to date DVD image of the JCR directories from the M: drive, including the up to date database for locating incidentals and spares – see Richard if you are unfamiliar with this database. The master database will be kept with Richard so **please email/phone Richard with any changes** you think are necessary or keep a log to give to Richard on return; changes made to any copy stored on the ship will be ignored. An incidentals stock check will be attempted annually but if something is getting dangerously low then tell Richard **BEFORE** the end of the cruise.

A brief cruise report checklist is **REQUIRED** for **every cruise** for the instruments AME are responsible for supporting. **Include pertinent notes on fault history and diagnosis at the end of the report even if you have already discussed via email.**

Please log **all** problems or changes made to systems in use while the cruise is underway to your own **log book**.

At the end of the cruise, please fill in the simple checklist attached, briefly describing any problems or changes made to the instrumentation (including intermittent problems, repairs, expansion, changes to software, etc). Tick 'Used?' against all instruments which were used or logged. This is so we can follow up these issues and keep a good history of our instruments.

In order to help us with calibrations and repairs, please note the **serial numbers** of the instruments **ACTUALLY USED** (as listed on the checklist), and also serial numbers of any spares which you swapped or tested due to a fault or fault-finding. Enter any details on the checklist. We now have many spare sensors which are identical except for serial number.

Richard would like to avoid having to run around at the last minute arranging shipment of incidentals, equipment or repairs half way across the planet. If incidentals are getting low, email Richard to order some more; do not wait for them to run out.

Please leave **one copy of the cruise report on the ship in the electronics workshop** for the next support engineer **AND ALSO** either:

- a) Preferably, **email an electronic copy** (or scan in) to Richard and Steve Bremner at BAS, or
- b) Give an electronic copy to Richard and Steve when you return to Cambridge as soon as possible.

**Cruise: Start date:23/10/06 Finish date:03/12/06**

**Name of AME engineer: Mark Preston**

**Name of principle scientist (PSO): Rachael Shreeve**

| <b>Instrument</b>                               | <b>Used ?</b> | <b>Comments</b>   |
|---|---------------|---|
| XBT<br>(aft UIC)<br>(PC, I/F box,<br>handgun)   | ◆             | Spare gun eventually found  |
| Scintillation counter<br>(prep lab)             | ◆             |   |
| AutoSal<br>(labs on upper<br>deck)<br>S/N 63360 |               |   |
| AutoSal<br>(labs on upper<br>deck)<br>S/N 65763 | ◆             | Problems suspected to with the peristaltic pump caused drift and stability problems. To verify that this was the case 68533 was made available. |
| AutoSal<br>(labs on upper<br>deck)<br>S/N 68533 | ◆             | Drift and stability issues followed the BAS pump. Larger diameter pipe for the pump to be supplied.   |
| Portasal<br>S/N 68164                           |               |   |
| Magnetometer<br>STCM1<br>(aft UIC)              | ◆             |   |
|   |               |   |
| AME workshop PC                                 | ◆             | New PC and monitor installed.   |

**GPS, MRU, Gyro**

|   |   |  |
|---|---|--|
| GPS<br>Furuno GP32<br>(bridge – port side)            | ◆ |  |
| DGPS<br>Ashtec ADU5<br>(bridge – port side)           | ◆ |  |
| DGPS, MRU<br>Seatex Seapath<br>(UIC – swath suite)    | ◆ |  |
| DGPS<br>Ashtec Glonass<br>GG24<br>(bridge – starboard | ◆ |  |

|  |   |  |
|--|---|--|
| side)  |   |  |
| Gyro synchro to<br>RS232<br>Navitron NT925HDI<br>(UIC – aft) | ◆ |  |
| TSS HRP<br>(UIC repeater)                                    | ◆ |  |

## ACOUSTIC

| Instrument                                    | Used ? | Comments |
|---|--------|----------|
| ADCP<br>(aft UIC)                             | ◆      |          |
| PES<br>(aft UIC)                              |        |          |
| EM120<br>(for'd UIC)                          | ◆      |          |
| TOPAS<br>(for'd UIC)                          |        |          |
| EPC plotter (used<br>with TOPAS)              |        |          |
| EK60<br>(mid UIC)                             | ◆      |          |
| HP deskjet 1 (used<br>with EK)                |        |          |
| HP deskjet 2 (used<br>with EK)                |        |          |
| SSU<br>(for'd UIC)                            | ◆      |          |
| SVP S/N3298<br>(cage when unused)             |        |          |
| SVP S/N3314<br>(cage when unused)             |        |          |
| 10kHz IOS pinger                              |        |          |
| Benthos 12kHz<br>pinger<br>S/N 1316 + bracket |        |          |
| Benthos 12kHz<br>pinger<br>S/N 1317 + bracket |        |          |
| MORS 10kHz<br>transponder                     |        |          |
| Sonardyne USBL<br>(aft UIC)                   |        |          |



## OCEANLOGGER

| Instrument  | Used ? | Comments |
|---|--------|----------|
| Main logging PC hardware and software                     | ◆      |          |
| Barometer<br>(back of logger rack)<br>#V145002 (7/03)     | ◆      |          |
| Barometer<br>#V145003 (7/03)                              | ◆      |          |
| Barometer<br>#Y2610005                                    |        |          |
| Barometer<br>#W4620001                                    |        |          |
| Air humidity & temp<br>(for'd mast)<br>#15619015          |        |          |
| Air humidity & temp<br>#15619025                          |        |          |
| Air humidity & temp<br>#28552023 (HT1, 7/03)              | ◆      |          |
| Air humidity & temp<br>#18109036 (HT2, 7/03)              | ◆      |          |
| Thermosalinograph<br>SBE45<br>(prep lab)<br>#4524698-0016 |        |          |
| Thermosalinograph<br>SBE45<br># 4532920-0072              |        |          |
| Thermosalinograph<br>SBE45<br>#4524698-0018 (7/04)        | ◆      |          |
| Fluorometer<br>(prep lab)                                 | ◆      |          |
| TIR sensor<br>(pyranometer)<br>(for'd mast)<br>#990684    |        |          |
| TIR sensor<br>#32374 (TIR1, 7/03)                         | ◆      |          |
| TIR sensor<br>#990685                                     |        |          |

|   |   |  |
|---|---|--|
| TIR sensor<br>#011403 (TIR2, 7/03)                    | ◆ |  |
| PAR sensor<br>(for'd mast)<br>#990069                 |   |  |
| PAR sensor<br>#990070                                 |   |  |
| PAR sensor<br>#30335 (PAR1, 7/03)                     | ◆ |  |
| PAR sensor<br># 010224 (PAR2, 7/03)                   | ◆ |  |
| Flow meter<br>(prep room)<br>#45/59462                | ◆ |  |
| Uncontaminated<br>seawater temp<br>(transducer space) | ◆ |  |

**CTD (all kept in cage/ sci hold when not in use)**

| Instrument  | Used ? | Comments  |
|---|--------|---|
| Deck unit 1<br>SBE11plus<br>S/N 11P15759-0458                 | ◆      | Failed mid cast, alarmed briefly, before blowing both input and output fuses. |
| Deck unit 2<br>SBE11plus<br>S/N 11P20391-0502                 | ◆      |   |
| Underwater unit<br>SBE9plus<br>#09P15759-0480<br>Press #67241 |        |   |
| Underwater unit<br>SBE9plus<br>#09P20391-0541<br>Press #75429 |        |   |
| Underwater unit<br>SBE9plus<br>#09P30856-0707<br>Press #89973 |        |   |
| Underwater unit<br>SBE9plus<br>#09P35716-0771<br>Press #93686 | ◆      |   |
| Carousel & pylon<br>SBE32<br>#3215759-0173                    |        |   |
| Carousel & pylon<br>SBE32<br>#0248                            |        |   |
| CTD swivel linkage  | ◆      |   |
| CTD swivel S/N196115  |        |   |
| CTD swivel S/N196111  | ◆      |   |

**CTD contd – C & T & pumps – please state which primary and secondary**

|                                  |        |  |
|----------------------------------|--------|--|
| Temp sensor SBE3plus<br>#03P2191 | ◆<br>S |  |
| Temp sensor SBE3plus<br>#03P2307 |        |  |
| Temp sensor SBE3plus<br>#03P2366 |        |  |
| Temp sensor SBE3plus<br>#03P2679 |        |  |
| Temp sensor SBE3plus<br>#03P2705 |        |  |
| Temp sensor SBE3plus<br>#03P2709 |        |  |
| Temp sensor SBE3plus<br>#03P4235 |        |  |
| Temp sensor SBE3plus<br>#03P4302 | ◆<br>P |  |
| Cond sensor SBE4C<br>#041912     | ◆<br>S |  |
| Cond sensor SBE4C<br>#041913     |        |  |
| Cond sensor SBE4C<br>#042222     |        |  |
| Cond sensor SBE4C<br>#042248     |        |  |
| Cond sensor SBE4C<br>#042255     |        |  |
| Cond sensor SBE4C<br>#042289     |        |  |
| Cond sensor SBE4C<br>#042813     |        |  |
| Cond sensor SBE4C<br>#042875     | ◆<br>P |  |
| Pump SBE5T<br># 51807            | ◆<br>P |  |
| Pump SBE5T                       |        |  |

|                       |        |  |
|-----------------------|--------|--|
| # 51813               |        |  |
| Pump SBE5T<br># 52371 |        |  |
| Pump SBE5T<br># 52395 |        |  |
| Pump SBE5T<br># 52400 |        |  |
| Pump SBE5T<br># 53415 | ◆<br>S |  |

**CTD contd**

| Instrument  | Used ? | Comments |
|---|--------|----------|
| Fluorometer<br>Aquatracka MkIII<br>#088216          |        |          |
| Fluorometer<br>Aquatracka MkIII<br>#088249          | ◆      |          |
| Standards<br>Thermometer<br>SBE35<br>#3515759-0005  | ◆      |          |
| Standards<br>Thermometer<br>SBE35<br># 3527735-0024 |        |          |
| Standards<br>Thermometer<br>SBE35<br># 3535231-0047 |        |          |
| Altimeter PA200<br>#2130.26993                      | ◆      |          |
| Altimeter PA200<br>#2130.27001                      |        |          |
| Transmissometer C-<br>Star<br>#CST-396DR            |        |          |
| Transmissometer C-<br>Star<br>#CST-527DR            |        |          |
| Transmissometer C-<br>Star CST 846DR                |        |          |
| Oxygen sensor SBE43<br>#0242                        |        |          |
| Oxygen sensor SBE43<br>#0245                        |        |          |
| Oxygen sensor SBE43<br>#0620                        |        |          |
| Oxygen sensor SBE43<br>#0676                        | ◆      |          |
| PAR sensor<br>#7235                                 |        |          |
| PAR sensor<br>#7252                                 |        |          |
| PAR sensor<br>#7274                                 | ◆      |          |

|                     |  |  |
|---------------------|--|--|
| PAR sensor<br>#7275 |  |  |
|---------------------|--|--|

|   |  |  |
|---|--|--|
| Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc. |  |  |
|---|--|--|

## AME UNSUPPORTED INSTRUMENTS BUT LOGGED

| Instrument                       | Used ? | Comments |
|----------------------------------|--------|----------|
| EA600<br>(bridge and UIC remote) | ◆      |          |
| Anemometer                       | ◆      |          |
| Gyro                             | ◆      |          |
| DopplerLog                       | ◆      |          |
| EMLog                            | ◆      |          |
| CLAM winch monitoring system     | ◆      |          |

### ***At the end of the cruise, please ensure that:***

- the XBT is left in a suitable state (store in cage if not to be used for a while – do not leave on deck or in UIC as it will get kicked around). Remove all deck cables at end of cruise prior to refit.
- the salinity sample bottles have been washed out and left with deionised water in – please check this otherwise the bottles will build up crud and have to be replaced.
- the CTD is left in a suitable state (washed (including all peripherals), triton + deionised water washed through TC duct, empty syringes put on T duct inlets to keep dust out and stored appropriately). Be careful about freezing before next use – this will damage the C sensors (run through with used standard seawater to reduce the chance of freezing before the next use). Remove all the connector locking sleeves and wash with fresh water. Blank off all unconnected connectors. See the CTD wisdom file for more information. If the CTD is not going to be used for a few weeks, at the end of your cruise please clean all connectors and attach dummy plugs or fit the connectors back after cleaning if they are not corroded.
- the CTD winch slip rings are cleaned if the CTD has been used – this prevents failure through accumulated dirt.
- the SVP is left in a suitable state (washed and stowed). Do not leave this on deck without a cover for any length of time as it rusts. Stow inside at end of cruise.
- all manuals have been returned to the designated drawers and cupboards.
- you clean all the fans listed below every cruise or every month, whichever is the longer.



**Please clean the intake fans on the following machines:**

| <b>Instrument</b>          | <b>Cleaned?</b> |
|----------------------------|-----------------|
| Oceanlogger                | ◆               |
| EM120, TOPAS, NEPTUNE UPSs | ◆               |
| Seatex Seapath             | ◆               |
| Topas tweendeck            | ◆               |
|                            |                 |

## ***Additional notes and recommendations for change / future work***

When working on slip rings it is very important that the cover is installed properly and that the cable that enters the cover is orientated and adjusted properly. At one point in the cruise the net monitor was behaving most erratically, this was eventually traced to the slip rings. The large multi-core wire that enters the cover was placed such that too much of the cable was inside the housing. This meant that over time several of the inner cores gradually rubbed on the rotating slip ring and eventually started to cause an intermittent short.

A 'last look' with a torch and mirror is a good idea before closing the cover after PPM or problems.



## **ICT Report**

### ***JR161: Discovery 2010***

***Dates : 23/10/2006 – 03/12/2006***

### ***PSO: Rachael Shreeve***

Jeremy Robst, [jpro@bas.ac.uk](mailto:jpro@bas.ac.uk)

v1.0

02/12/2006

Ben Tullis, [btull@bas.ac.uk](mailto:btull@bas.ac.uk)

### ***1.0 Personal Computers***

The Chief Officers PC and Surgery PC were replaced with new machines. A few viruses were found during the cruise on various machines, though they were all harmless and were removed.

### ***2.0 Netware***

SP5 applied to JRNA. Some XP clients struggle to find the tree occasionally, especially immediately after powering on. No other problems with Netware.

### ***3.0 Unix***

There were no problems with any of the unix machines. The second v240, JRUB was used as a user accessible machine since it is more powerful than the Sun Blades. This can continue – there is no real need to replace the Blades with anything more powerful at they moment, they can stay as workstations.

Since the old JRUA is now JRUB some licences are tied to JRUB's hosted and so the licence managers run on this machine rather than JRUA, however there is no great need to acquire new licences – both JRUA & JRUB should be normally running.

### ***4.0 SCS Logging System / Data Logging***

The SCS logging system performed reasonably well throughout the cruise, though it is starting to show its age in several areas.

The Ashtech GPS regularly (approx every 5 days) stops outputting heading information and requires power cycling. Many times after the Ashtech is power cycled the SCS begins corrupting the output ACO file and this requires the Data acquisition to be stopped and restarted, causing a

break in data logging and also the retransmission of data to other instruments (e.g GPS to EK60 / XBT).

The Seapath/Seatex GPS appears to be at least as good as the Ashtech for heading, so it may not be necessary to keep restarting the Ashtech, though it would be useful to have the Ashtech data as well for backup purposes.

Data acquisition for all streams needs to be stopped and restarted whenever changes are made to an individual stream or new instruments are added – this is not ideal.

The True wind speed & direction output from the SCS is not working at the moment – although it appears to have been configured identically to previous years. Because investigating the different options requires restarting the SCS it has not been possible to do much investigation during the cruise.

However the SCS True wind calculation suffers when the ship is stationary due to wild fluctuations in the heading sensors (either gyro or GPS) so it may be better to use an external True wind calculation.

A bug was fixed in the ADCP data\_server.pl program which was causing the program to stop outputting GPS information after midnight until the program was restarted. The program can now be run continuously with restarts.

The ADCP VmDAS program needs care when setting up – it logs data to two paths, the primary path & the secondary backup path. Only the essential raw data is logged to the secondary path (from which the intermediate & processed data files can be regenerated). However since the scientists use the intermediate/processed files always have the U: (network) drive as the primary path and the C: drive as the secondary path.

The EA600 had intermittent problems throughout the cruise. It either lost contact with the GPT transceiver – requiring the transceiver to be power cycled (The GPT is in the Gravity Meter room immediately to the right inside the door and the power switch is located on the wall just above the GPT box).

Sometimes the EA600 would stop outputting depth data over the serial port, mostly this just requires the software to be shutdown & restarted, however sometimes the machine on the bridge needs to be power cycled, occasionally repeatedly. The RO (Mike Glostein) is discussing with Simrad.

| Data Acquisition Events  |   |
|--------------------------|---|
| Date / Time              | Event / Reason  |
| 21:57 23/10/2006         | Acquisition Started   |
| 21:21 - 21:30 25/10/2006 | Power outage in UIC/dataprep/Computer office. The UPSes kept the servers going, but some streams were disrupted.                        |
| 21:54 25/10/2006         | Acquisition restarted since the Ashtech was power cycled and the ACO file was corrupted.  |
| 17:31 03/11/2006         | Acquisition restarted to fix corruption in the Ashtech ACO file   |
| 11:05 05/11/2006         | Acquisition restarted to fix corruption in the Ashtech ACO file   |
| 03:55 – 04:30 16/11/2006 | Power outage in UIC/dataprep/Computer room. Too long for UPS to keep servers up, so everything restarted. Most things back up by 05:30. |
| 22:59 16/11/2006         | Acquisition restarted to fix corruption in the Ashtech ACO file   |
| 19:03 21/11/2006         | Acquisition restarted to fix corruption in the Ashtech ACO file   |

## **5.0 Network**

No problems reported.

## **6.0 Other**

An L: drive was created, mapped to /data/cruise/jcr/current/work on the Unix system. This proved a very useful place for the scientists to store documents / images / data etc relevant to the cruise. In this location it is easy to backup with the rest of the cruise data.

The L: drive is mapped through a batch file run from the VP login script in the same manner as the M: & P: drives.

The M: & P: drives were moved to a volume (mediavol) on the FAS270c NetApp Filers and served from JRUA via Samba. JRLB was rebuilt as a virtual machine on JRLVMS1 and continues to run the SlimServer software for the MP3 players in the UIC and Officer & Crew bars.

## **Recommendations**

The SCS is suffering from age (it only just installed on a Windows 2000 machine), and is not a good fit for the way the data logged is used on board. A new data logging system should be investigated, possible for installation in Summer 2007.

The UPS situation in the Computer Office is very poor, both in the capacity and the lack of graceful shutdown ability. This needs to be investigated and proper UPS provisioning provided.

# **Data Management Report**

***Nathan Cunningham***

## ***BASNet***

BASNet is a major improvement for the JCR. It facilitates the use and interaction of the data streams collect in ways that were previously impossible. It opens up the opportunity to undertake scientific projects remotely and allows the unique and valuable nature of the JCR data to be disseminated quickly into the scientific community. For example, the Met. Office are extremely interested in receiving near-real-time data from the ship to input directly into their GCMs and Ocean models. This will mean that the profile of BAS as a unique data provider is increased, and enhanced in many positive ways. Not only being involved in collaborating with external institutions, but getting acknowledge for doing so.

I can not emphasis enough on how this technology is influence the way we work and think about our data.

## ***Near-real-time JCR Data***

### **Project Brief**

#### **Main Points**

- Maintain the requirement for anybody on the ship to get at the data easily.
- Facilitate the viewing, access, retrieval of data from the JCR and Cambridge
- Ensure that a non-specialist interface to the JCR data resource.
- Increase the scientific/data output of the JCR.
- Provide a vital link in the long-term management of LTMS data.

### **Scientific Instrumentation on the JCR**

There is interest and consensus across BSD that access to the JCR data streams in near real-time will offer substantial benefits, efficiencies and productivity to the marine based science being undertaken by the division. In addition, with this further functionality it will help to secure the JCRs reputation as one of the best research ships to accomplish world class Antarctic marine science. This consideration is made with the recent developments on the US research ships, which have started to provide their data in near-real time.

The main impacts are threefold, firstly it will allow the scientist to have an overview of the environmental, oceanographic, discrete equipment and underway data. Secondly, allow the scientist to react to these conditions and suggest alterations to instrument parameters to ensure the best quality data is collected. Finally, dramatically reduce the turn around time of raw data to proceed data can be, especially if the specialist scientist is not on that particular cruise; for example, an oceanographer to process the ADCP data.

With the implementation of near real time data streaming from the JCR it is understood that it is limited by the narrow bandwidth currently available, but with a co-ordinated effort most aspects of

the JCR instrumentation could be summarised and binned into data packets suitable for streaming back. The instruments that are currently logged to the central SCS system could be streamed back immediately as a low priority process over BASnet.

As a proof of concept, targeting instrumentation used by for physical oceanography would be a useful starting point. It is complex enough to cover all the aspects of near real time data streaming by initially targeting three instruments and the underway SCS data. These are the CTD, the ADCP and the XBT data and the following things need to be implemented:

1. Develop the reduced data sets that are suitable for streaming back.
  - a. ADCP – already summaries its data into 2 minute bins.
  - b. CTD – this will output another data stream a reduce level (1-2 seconds) from the default 1/25<sup>th</sup> of a second and provide an initially overview of the cast.
  - c. XBT – produce small ASCII file suitable for streaming back.
2. Develop the interface for streaming back data
  - a. Work closely with PSD project for streaming back Halley data and develop knowledge and information transfer working practice.
3. Scientist/data manager works on streamed data to check that it can be used to
  - a. Provide a succinct overview,
  - b. Enough detail to perform initial analysis and suggest alteration to the collection parameters
  - c. Does improve the turn around time of the raw data and the overall scientific output.

It is important to emphasis that this project should work closely with Peter Kirsch and the Halley data-streaming project.

## **Implementation**

The project was successfully implemented and the proof of concept worked. Data is now streamed back to the UK in near real time. I would like to extend my gratitude to Jeremy Robst, Peter Kirsch, Paul Breen and Dave Judge for all their efforts. This work will help bring about a step change on how BSD can use and interact with the JCR.

## ***Using Google Earth to Visualise Underway Data***

The uptake of Google Earth as a quick and easy data visualisation tools has been good and levels of interest are high. Working with a number of scientist onboard the JCR several useful data discovery products were produced. For example Martin Collins king penguin data was plotted using Google Earth and overlays of sea surface temperature and chlorophyll (from Beki Korb) were combined to help identify where the last polar front process station should be located.

David Judge developed an impressive range of Google Earth tools to help visualise ship data. These tools will be invaluable to how BSD scientist can discover which data sets are of interest. I would like to thank Dave Judge, Peter Kirsch and Paul Breen for all their work, help and support in getting this project of to such an impressive start.

## ***Polar View Project***

Working with Andrew Flemming a number of Polar View products were available for use on the ship. The most impressive is the high quality sea ice images. These were used by the JCR Officers to help inform them of the conditions around Signy. The Polar View Project uses Google Earth as its deliver technology and again will help form the suite of scientific tools utilising BASNet.

## ***Web Based Data Tools***

The event logs and integration tools were updated and widely utilised by all on the ship.





**PRINCIPAL INVESTIGATORS:** Enter the name and address of the Principal Investigators responsible for the data collected on the cruise and who may be contacted for further information about the data. (The letter assigned below against each Principal Investigator is used on pages 2 and 3, under the column heading 'PI', to identify the data sets for which he/she is responsible)

- A. Oceanography. Mike Meredith. BAS
- B. Nutrients. Mick Whitehouse. BAS
- C. Phytoplankton. Rebecca Korb. BAS
- D. Zooplankton – copepods. Pete Ward. BAS
- E. Krill. Geraint Tarling. BAS
- F. Fish. Martin Collins. BAS
- G. High predator observations. Ewan Wakefield. BAS
- H. Sediment trap – biogeochemistry. David Pond. BAS

**MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS**

This section should be used for reporting moorings, bottom mounted gear and drifting systems (both surface and deep) deployed and/or recovered during the cruise. Separate entries should be made for each location (only deployment positions need be given for drifting systems). This section may also be used to report data collected at fixed locations which are returned to routinely in order to construct 'long time series'.

| PI<br><br>See top of page. | APPROXIMATE POSITION |     |     |           |     |     | DATA TYPE<br><br>enter code(s) from list on last page. | DESCRIPTION<br><br>Identify, as appropriate, the nature of the instrumentation the parameters (to be) measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any identifiers given to the site. |
|----------------------------|----------------------|-----|-----|-----------|-----|-----|--|---|
|                            | LATITUDE             |     |     | LONGITUDE |     |     |  |   |
|                            | deg                  | min | N/S | deg       | min | E/W |  |   |
| H                          | 52                   | 43  | 387 | 48        | 08  | 798 | B73  | Sediment trap mooring Deployed 25/11/2006 at Process station 3, in productive waters to the NW of South Georgia.<br>1* Sediment trap at 2000m,<br>1* Acoustic recording package at 200m ,<br>1 * CTD at 500m,<br>1 * ADCP at 2000m,   |
|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
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|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |
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|                            |                      |     |     |           |     |     |  |   |
|                            |                      |     |     |           |     |     |  |   |

### SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).

Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.

Each data set entry should start on a new line – it's description may extend over several lines if necessary.

**NO, UNITS:** for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

| PI         | NO        | UNITS     | DATA TYPE                            | DESCRIPTION   |
|------------|-----------|-----------|--------------------------------------|---|
| see page 2 | see above | see above | Enter code(s) from list on last page | Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken. |
| A          |           |           |                                      | CTD   |
| A          |           |           |                                      | XBT   |
| B          |           |           |                                      | CTD   |
| B          |           |           |                                      | Underway  |
| C          |           |           |                                      | CTD   |
| C          |           |           |                                      | Go flo  |
| C          |           |           |                                      | Underway ships non toxic pumped sea water supply  |
| C          |           |           |                                      | Tow fish  |
| D          |           |           |                                      | Bongo net – vertically hauled   |
| D          |           |           |                                      | LHPR - towed  |
| D          |           |           |                                      | MOCNESS/ Multinet- towed  |
| E          |           |           |                                      | RMT 25. Krill   |
| F          |           |           |                                      | RMT 25. Fish  |
| G          |           |           |                                      | Observations  |
|            |           |           |                                      |   |
|            |           |           |                                      |   |
|            |           |           |                                      |   |
|            |           |           |                                      |   |
|            |           |           |                                      |   |
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|            |           |           |                                      |   |
|            |           |           |                                      |   |
|            |           |           |                                      |   |

**TRACK CHART:**

You are strongly encouraged to submit, with the completed report, an annotated track chart illustrating the route followed and the points where measurements were taken.

Insert a tick (✓) in this box if a track chart is supplied



**GENERAL OCEAN AREA(S):** Enter the names of the oceans and/or seas in which data were collected during the cruise – please use commonly recognised names (see, for example, International Hydrographic Bureau Special Publication No. 23, 'Limits of Oceans and Seas').

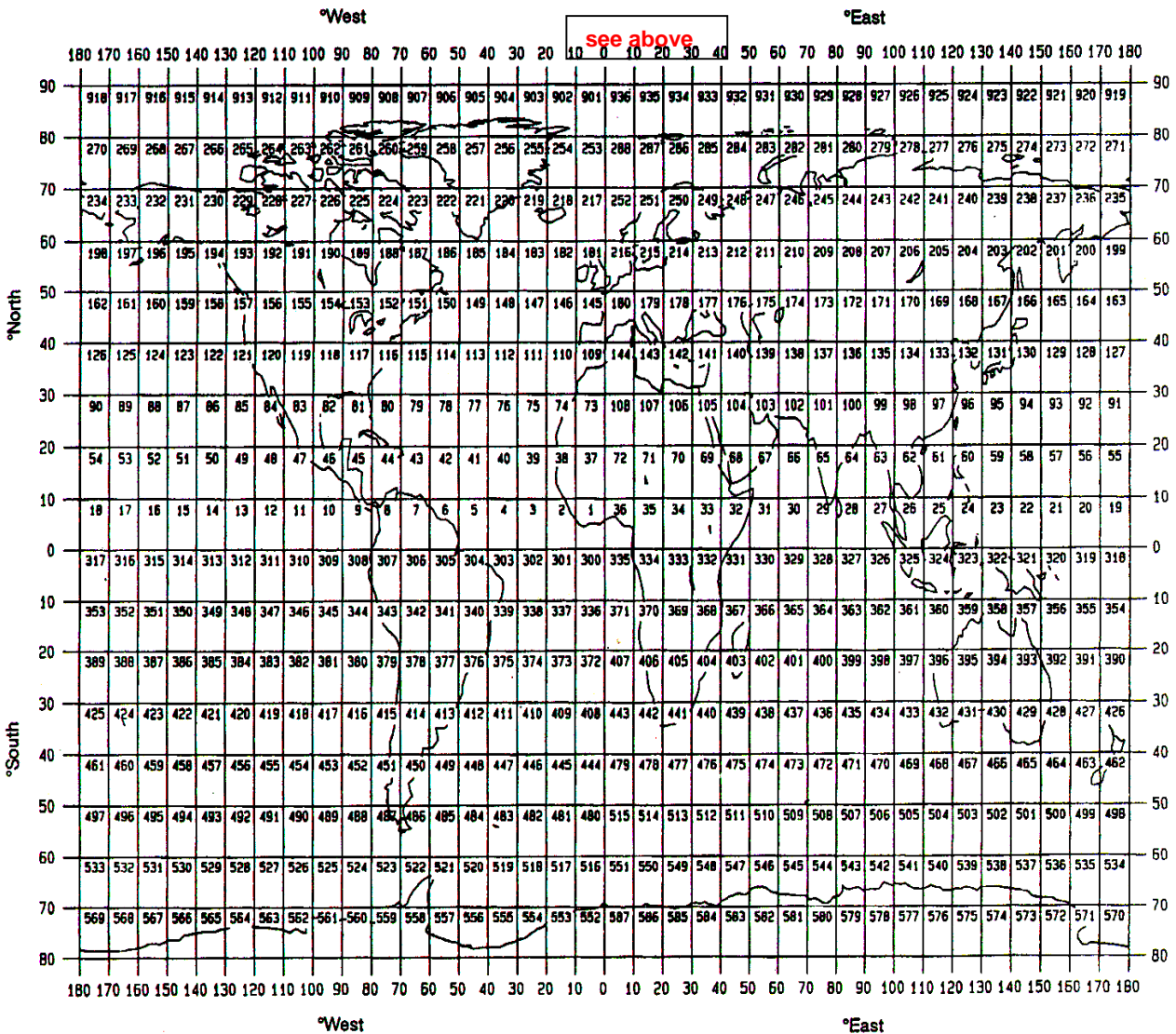
Scotia Sea. Atlantic Sector of the Southern Ocean

**SPECIFIC AREAS:** If the cruise activities were concentrated in a specific area(s) of an ocean or sea, then enter a description of the area(s). Such descriptions may include references to local geographic areas, to sea floor features, or to geographic coordinates.

Please insert here the number of each square in which data were collected from the below given chart

520, 484, 483, 447

**GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED**



THANK YOU FOR YOUR COOPERATION

Please send your completed report without delay to the collating centre indicated on the cover page

## PARAMETER CODES

### METEOROLOGY

|     |                                   |
|-----|-----------------------------------|
| M01 | Upper air observations            |
| M02 | Incident radiation                |
| M05 | Occasional standard measurements  |
| M06 | Routine standard measurements     |
| M71 | Atmospheric chemistry             |
| M90 | Other meteorological measurements |

### PHYSICAL OCEANOGRAPHY

|     |  |
|-----|--|
| H71 | Surface measurements underway (T,S)                      |
| H13 | Bathythermograph   |
| H09 | Water bottle stations                                    |
| H10 | CTD stations   |
| H11 | Subsurface measurements underway (T,S)                   |
| H72 | Thermistor chain   |
| H16 | Transparency (eg transmissometer)                        |
| H17 | Optics (eg underwater light levels)                      |
| H73 | Geochemical tracers (eg freons)                          |
| D01 | Current meters   |
| D71 | Current profiler (eg ADCP)                               |
| D03 | Currents measured from ship drift                        |
| D04 | GEK  |
| D05 | Surface drifters/drifting buoys                          |
| D06 | Neutrally buoyant floats                                 |
| D09 | Sea level (incl. Bottom pressure & inverted echosounder) |
| D72 | Instrumented wave measurements                           |
| D90 | Other physical oceanographic measurements                |

### CHEMICAL OCEANOGRAPHY

|     |   |
|-----|---|
| H21 | Oxygen                                    |
| H74 | Carbon dioxide                            |
| H33 | Other dissolved gases                     |
| H22 | Phosphate                                 |
| H23 | Total - P                                 |
| H24 | Nitrate                                   |
| H25 | Nitrite                                   |
| H75 | Total - N                                 |
| H76 | Ammonia                                   |
| H26 | Silicate                                  |
| H27 | Alkalinity                                |
| H28 | PH  |
| H30 | Trace elements                            |
| H31 | Radioactivity                             |
| H32 | Isotopes                                  |
| H90 | Other chemical oceanographic measurements |

### MARINE CONTAMINANTS/POLLUTION

|     |                                |
|-----|--------------------------------|
| P01 | Suspended matter               |
| P02 | Trace metals                   |
| P03 | Petroleum residues             |
| P04 | Chlorinated hydrocarbons       |
| P05 | Other dissolved substances     |
| P12 | Bottom deposits                |
| P13 | Contaminants in organisms      |
| P90 | Other contaminant measurements |

### MARINE BIOLOGY/FISHERIES

|     |   |
|-----|---|
| B01 | Primary productivity                                  |
| B02 | Phytoplankton pigments (eg chlorophyll, fluorescence) |
| B71 | Particulate organic matter (inc POC, PON)             |
| B06 | Dissolved organic matter (inc DOC)                    |
| B72 | Biochemical measurements (eg lipids, amino acids)     |
| B73 | Sediment traps  |
| B08 | Phytoplankton   |
| B09 | Zooplankton   |
| B03 | Seston  |
| B10 | Neuston   |
| B11 | Nekton  |
| B13 | Eggs & larvae   |
| B07 | Pelagic bacteria/micro-organisms                      |
| B16 | Benthic bacteria/micro-organisms                      |
| B17 | Phytobenthos  |
| B18 | Zoobenthos  |
| B25 | Birds   |
| B26 | Mammals & reptiles                                    |
| B14 | Pelagic fish  |
| B19 | Demersal fish   |
| B20 | Molluscs  |
| B21 | Crustaceans   |
| B28 | Acoustic reflection on marine organisms               |
| B37 | Taggings  |
| B64 | Gear research   |
| B65 | Exploratory fishing                                   |
| B90 | Other biological/fisheries measurements               |

### MARINE GEOLOGY/GEOPHYSICS

|     |   |
|-----|---|
| G01 | Dredge                                    |
| G02 | Grab                                      |
| G03 | Core - rock                               |
| G04 | Core - soft bottom                        |
| G08 | Bottom photography                        |
| G71 | In-situ seafloor measurement/sampling     |
| G72 | Geophysical measurements made at depth    |
| G73 | Single-beam echosounding                  |
| G74 | Multi-beam echosounding                   |
| G24 | Long/short range side scan sonar          |
| G75 | Single channel seismic reflection         |
| G76 | Multichannel seismic reflection           |
| G26 | Seismic refraction                        |
| G27 | Gravity measurements                      |
| G28 | Magnetic measurements                     |
| G90 | Other geological/geophysical measurements |

## Appendix 2. Discovery 2010 Programme Statement



Global Science in the Antarctic Context: Programme Statement

### **DISCOVERY 2010**

Integrating Southern Ocean Ecosystems



#### ***Summary***

The biosphere is the most important component of the earth system for humanity. For earth systems analyses, we know little about the biosphere generally, and least of all about the biological systems of the ocean. There is an urgent need to quantify the role of ocean biological communities in the earth system. ***DISCOVERY 2010*** will undertake an integrated set of field studies, linked to targeted data syntheses and model development to analyse interactions in Southern Ocean ecosystems. The programme will significantly advance the development of global scale models of ocean ecosystems by 2010 and provide the UK required input on conservation science under the Antarctic Treaty.

## **Rationale**

### **The most important challenge in earth systems science: to quantify the role of ocean ecosystems**

For humans, the biosphere is the most important component of the earth system and changes in the biosphere will have the most serious and direct consequences for human communities in the next 20-100 years. Within the biosphere the ocean ecosystem is the least quantified component. We need a step-change in our capacity to predict the dynamics of ocean ecosystems. This requires focussed studies aimed at quantifying and modelling the dynamics of key ocean ecosystems. The large-scale Southern Ocean ecosystem plays a crucial role in earth systems processes, maintains unique biodiversity, is one of the key ocean ecosystems<sup>1-2</sup>. Previous studies have elucidated key biological processes and shown how physical and biological processes interact to generate large-scale variability in Southern Ocean ecosystems<sup>3-12</sup>. What is needed now is the development of integrated analyses and models of the interactions of biological, chemical and physical processes in ocean ecosystems. *DISCOVERY 2010* will develop and integrate previous analyses by undertaking directed data syntheses, field studies and model developments. The ecological analyses and models will be linked with analyses of regional and circumpolar environments to generate ocean scale ecosystem views. The analyses will provide the basis for the development of ecosystem models for more heterogeneous and complex systems in other oceans.

Change is already happening within the oceans and it is already directly affect humanity by modifying the operation of ecosystems on which human communities depend for food, goods and services<sup>1,2,13-15</sup>. These systems also play a crucial role in the global carbon cycle and maintaining biodiversity<sup>1-2</sup>. Current understanding of the operation of ocean ecosystems is extremely limited so there has been little development of a predictive modelling capacity. During the last decade years some useful biogeochemically-based models have been developed, yet these have little realistic biological structure and only encompass the smaller plankton<sup>2</sup>. There is now increasing evidence that such an approach is insufficient. Biological complexity and food-web structure determine key aspects of the way ecosystems function, affecting for example, the capacity to maintain key large predators, the diversity of species supported or the relative efficiency in recycling or exporting carbon<sup>1-2</sup>. Many of the interactions in ecosystems are highly non-linear so without a proper representation of biological systems, and the associated feedback processes, earth system projections will be misleading. The affect of such biological complexity in the food-web on the dynamics is illustrated by observations that rapid and unexpected “regime shifts” in ecosystem structure can occur, apparently in response to gradual changes in the physical environment or through direct human impacts<sup>1</sup>.

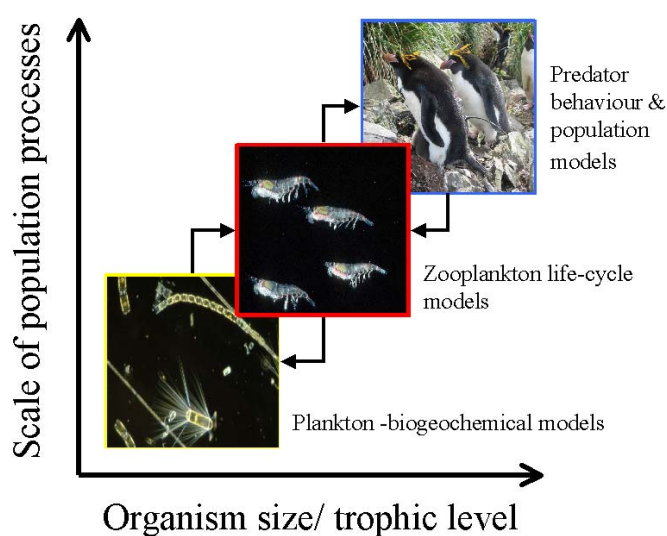
Current analyses and models of ocean ecosystems cannot capture the effects of such complex behaviour generated through the interactive ecosystem. We therefore need to rapidly improve our capacity to analyse and model these systems, a fact further highlighted by realisations that ocean ecosystems cannot be just considered as passive components of the earth system, driven by physical processes. The latest coupled models have shown that the ocean biosphere generates feedbacks that influence the dynamics of the physical system<sup>2</sup>. Developing a capacity to predict the response of ocean ecosystems to environmental variability and change will be crucial in attempts

to develop earth system projections of the future of human environments<sup>1-2</sup>. To develop realistic representations of marine ecosystems in earth system models therefore requires an ecosystem approach examining the physical-biological links that connect regional ecosystems with wider earth system.

## Scientific Issues

Developing representations of oceanic biological systems in earth system models by 2010 is a practical aim, but to do this requires focused effort on ecosystem dynamics in globally important regions that also give a broader scale view of ecosystem operation<sup>1-2</sup>. Several characteristics of Southern Ocean ecosystems make them ideal for the development of ocean scale ecosystem integrations; a necessary prerequisite for global scale analyses. These characteristics include the fact that ecosystem studies in the Southern Ocean are well developed and there is a developing recognition that it is time for regional and large-scale integration<sup>1,3-13</sup> and that in many regions of the Southern Ocean the ecosystem is centred on a single key species<sup>1,4,9,10,11,13</sup>, Antarctic krill (*Euphausia superba* Dana), which is also the target of a major fishery. However, during the last 5 to 10 years, there have been major advances in our understanding of the complexity of the system operation and the importance of alternative pathways<sup>4,6,16</sup>. The importance of these alternative links has yet to be accommodated into analyses and models, but will be important in understanding how ecosystem structure and function are related.

As is being seen elsewhere on the planet, harvesting of living resources has massively disturbed the Southern Ocean ecosystem; further change during the last few decades has also been related to changes in the environment<sup>1,4,6,13,15</sup>. Unique and extensive historical data on the Southern Ocean ecosystem generated by BAS scientists have enabled analyses of variability and change, generating major insights into the dynamics of large-scale systems<sup>2,4,7,8,12</sup>. Large-scale climate effects have already been shown to be crucial in determining some aspects of ecosystem dynamics in the Scotia Sea and more broadly across the Southern Ocean<sup>2,6</sup>. Ocean ecosystem studies at BAS have also shown how local processes in Southern Ocean are linked to large-scale scale physical and biological processes<sup>3-8,12</sup>. Major advances are now possible in understanding the circumpolar operation of the ecosystem. A particular strength in developing this science in the Southern Ocean is the wide geographical coverage of the international scientific community providing the potential to achieve ocean-scale analyses. In the Southern



**Figure 1.** Realistic ecosystem modelling requires taking account of the scale of the biological processes involved which is generally a function of organism size. The schematic illustrates one possible approach linking models that resolve processes over 3 scales appropriate for the smaller plankton, the larger zooplankton and for the larger predators.

Ocean an ecosystem approach to the development of sustainable management procedures is also being pioneered. BAS scientists have had a major role in developing the science underpinning the development of an ecosystem approach under the Antarctic Treaty system through the Convention for Conservation of Antarctic Marine Living Resources (CCAMLR). Maintaining a leading role in the development of CCAMLR science is a requirement of BAS by the UK government through the FCO. The challenge in further developing the ecosystem approach is to include more realistic representations of ocean ecosystems.

The challenge in developing a predictive capacity for ocean ecosystem dynamics is to generate coupled models that include sufficient complexity to represent the system dynamics while maintaining enough simplicity to be able to parameterise and analyse the models. Developing such realistic models is the focus of international research effort and the studies undertaken so far have shown that a range of models and approaches will be required that vary in resolution and complexity so that an assessment can be made of what is a sufficient and appropriate model for a given study<sup>1</sup>. This requires a hierarchical scale-based view of the ecosystem in which the analyses and models developed are appropriate for the scale of biological processes that are of interest<sup>17</sup> (Fig. 1).

### ***Programme Structure***

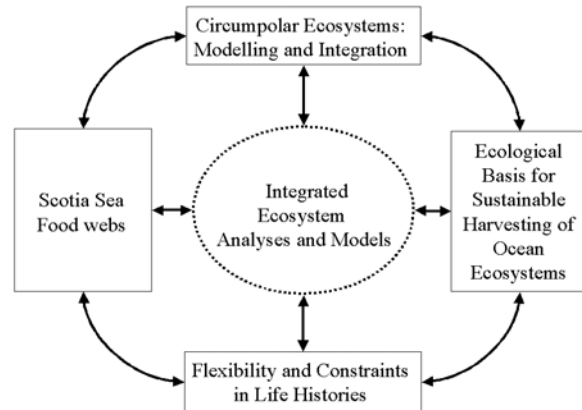
**DISCOVERY 2010** will undertake directed field studies, data syntheses and model development to generate analyses and models of ocean ecosystems. Programme level objectives are:

- *To determine how ocean ecosystem structure and function is related to environmental variability*
- *To develop scale-based analyses and models of ocean ecosystems*
- *To assess the role of the Southern Ocean ecosystem in the global ocean system*

Although centred upon krill in some key regions such as the Scotia Sea and around the coast in the Antarctic Coastal Current, the entire ecosystem is known to involve many other pathways of energy and material flow, for example through copepods and mesopelagic fish. For initial simplicity, our approach in analysing and modelling the ecosystem is to undertake studies that develop the krill-centred view, examining the implications of including more complexity. Our major emphases will be on the role of zooplankton, links to their predators and the environmental connections. This will involve detailed analyses of the life-cycles of key species of plankton, fish, seals and seabirds examining how these are linked to their environment. To examine how the dynamics of these groups are affected by their interactions in an ecosystem, the food-web context for the krill centred interactions will be explored. This will require analyses of the spatial and temporal variability and operation of the food-web with a particular focus on seasonality.



Through targeted studies and collaborations we will develop coupled analyses of the role of zooplankton in lower trophic level systems, in particular we will collaborate to examine the biogeochemical implications of including detailed life-cycles of zooplankton in biogeochemical analyses. Together these studies will allow consideration of the operation of the whole system from end-to-end. To give a context to the more focussed studies we will generate more general descriptions of the whole system by describing the components, their interactions and where possible quantifying their contribution. Through other targeted collaborations we will also examine links between ecosystem structure and biodiversity with a particular focus on the large-scale



**Figure 2.** Modelling will be a central component of the programme and will link the activities in each project.

diversity of zooplankton communities and the importance of diversity in microbial systems. For both the regional Scotia Sea and circumpolar analyses we will undertake targeted analyses and model development building out from the krill. The development of the ecosystem approach to fulfil our CCAMLR commitments will draw on the basic scientific analyses developed elsewhere in the programme, again centred around krill, by including further interactions in the food-web and a more realistic physical environmental basis for the ecosystem. The multidisciplinary science programme will be delivered through 4 integrated projects (Fig. 2).

1. **Flexibility and Constraints in Life Histories (FLEXICON)** will examine how the life-histories of key species are linked to environmental processes.
2. **Scotia Sea Food-Webs (Food-Webs)** will examine the operation of Southern Ocean food-webs building out from the krill centred view.
3. **Ecological Basis for Sustainable Harvesting of Ocean Ecosystems (EBSHOE)** will develop ecosystem approaches to sustainable harvesting which will also provide input into CCAMLR for UK government.
4. **Circumpolar Ecosystems: Integration and Modelling (CEMI)** will examine the large-scale operation of ocean ecosystems by undertaking coupled physical-biological modelling and historical data syntheses building out from krill.

Integration will be an important aspect of the Programme linking the studies undertaken in the individual projects. There will be a modelling component in each Project that will be coordinated across the Programme and closely linked to the field effort. There will be targeted cruises focused on the life-cycles of krill and copepods, and the operation of the food-web centred on krill. Studies at sea will also be linked to year-round studies at Bird Island that allow analyses of how changes in the regional pelagic ecosystem affect higher predator dynamics. This will include recording changes in predator performance, satellite tracking and activity recording linked to environmental observation systems. Broader food-web based analyses will examine seasonal changes in abundance and diet composition. The analyses of temporal and spatial variability will draw on unique long-term datasets on predator foraging and

breeding performance and krill abundance. With such a large-scale programme we cannot undertake all the required analyses in isolation so there will be coordinated collaborative studies targeting aspects where we require further input or expertise (Fig. 3). These collaborations include a range of ongoing externally funded projects and targeted proposals that are being developed under AFI and other international initiatives.

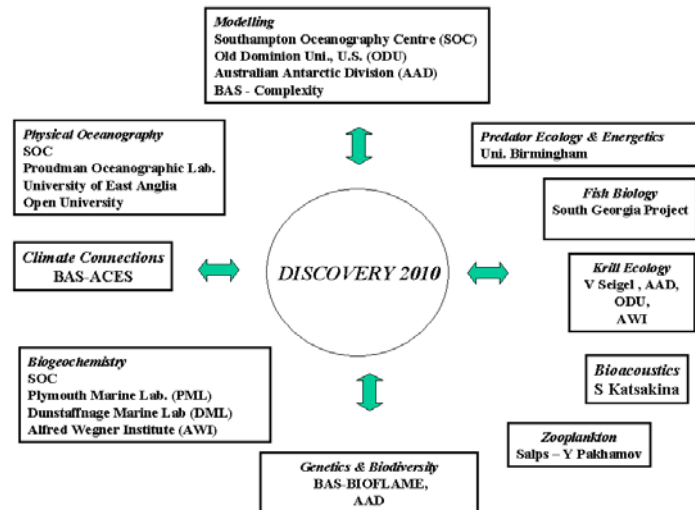


Figure 3. Major collaborations.

### **Leadership and Management**

The PI will direct the integration of the science with a strong model focus in association with the Project Leaders. The PI and PL's will communicate the science to the widest possible audience including generation of primary science papers, input into international programmes, scientific meetings and to the public. To manage the programme the PI will form a steering committee with the Project Leaders, senior members of BSD and a modelling coordinator. The Project Leaders will have responsibility for delivery of the science through the projects.

### **Fit to NERC Strategy and the BAS Global Science in the Antarctic Context Programme**

**DISCOVERY 2010** will be a major contribution to the BAS and NERC strategies providing a leading role in Southern Ocean science on key aspects of ecosystem structure and function in relation to climate and the links to biogeochemical cycles and biodiversity. It will contribute to the development of analyses linking ocean ecosystems into earth system analyses and hence be a timely input to QUEST when it is able to include sufficient biology. The programme will act as a coordinating focus for national capability, be a major contribution to CCAMLR fulfilling BAS commitments to the FCO and UK government. The programme will help lead the development of circumpolar ocean science initiatives as part of the European Polar Board CIRCLE initiative, the International Integrated Circumpolar Climate and Ecosystem Dynamics (ICCED) initiative developing under IGBP IMBER/GLOBEC programmes and the Census of Marine Life (COML) and be a major UK input into the IPY. The circumpolar science initiative is being developed collaboratively with a range of groups with a strong commitment to developing a science programme: Prof Eileen Hofmann (US, ODU), Dr Steve Nicol (Australian Antarctic Division), Prof Uli Bathmann (Germany, AWI). Complementing this effort Dr Murphy is also the lead on the Southern Ocean component of the EUR-OCEANS network of excellence developing in the EU.

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**R.R.S. JAMES CLARK ROSS**  
**BRITISH ANTARCTIC SURVEY**  
*Uncontaminated Sea Water system Events During JR 161*  
*Stanley to Stanley*  
**Via Signy**

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### Appendix 3: Uncontaminated Sea Water system

#### UNCONTAMINATED SEA WATER SYSTEM EVENTS FOR OCTOBER 2006

| DATE<br>TIME LOCAL | TIME<br>GMT      | TIME ZONE | FILTER | PUMP | PROBE<br>POSITION | EVENT                       | REMARKS        | LOCATION<br>CRUISE |
|--------------------|------------------|-----------|--------|------|-------------------|-----------------------------|----------------|--------------------|
| 23/11/2006 00:00   | 23/10/2006 00:00 | GMT -3    | -      | -    | Up                | Water Off                   | Sailed Stanley | Stanley            |
| 24/10/2006 17:32   | 24/11/2006 20:32 | GMT -3    | 1      | 2    | Mid               | Water On                    |                | JR 161             |
| 25/10/2006 08:10   | 25/11/2006 11:10 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 26/10/2006 08:10   | 26/10/2006 11:10 | GMT -3    | 1      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 27/10/2006 08:10   | 27/10/2006 11:10 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 28/10/2006 08:00   | 28/10/2006 11:00 | GMT -3    | 1      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 29/10/2006 08:04   | 29/10/2006 11:04 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 30/10/2006 08:04   | 30/10/2006 11:04 | GMT -3    | 1      | 2    | Mid               | Filter Changeover and Clean |                | JR 161             |
| 30/10/2006 08:06   | 30/10/2006 11:06 | GMT -3    | 1      | 1    | Mid               | Pump Changeover             |                | JR 161             |
| 31/10/2006 08:10   | 31/10/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |                | JR 161             |

#### UNCONTAMINATED SEA WATER SYSTEM EVENTS FOR NOVEMBER 2006

| DATE<br>TIME LOCAL | TIME<br>GMT      | TIME ZONE | FILTER | PUMP | PROBE<br>POSITION | EVENT                          | REMARKS                 | LOCATION<br>CRUISE No |
|--------------------|------------------|-----------|--------|------|-------------------|--------------------------------|-------------------------|-----------------------|
| 01/11/2006 08:10   | 01/11/2006 11:10 | GMT -3    | 1      | 1    | Mid               | Filter Changeover<br>and Clean | Water Off due to<br>Ice | JR 161                |
| 02/11/2006 08:10   | 02/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover<br>and Clean |                         | JR 161                |
| 02/11/2006 08:10   | 03/11/2006 01:00 | GMT -3    | -      | -    | Up                | Water Off                      |                         | JR 161                |
| 03/11/2006 00:00   | 03/11/2006 00:00 | GMT -3    | -      | -    | Up                | Water Off                      |                         | JR 161                |
| 04/11/2006 15:20   | 04/11/2006 18:20 | GMT -3    | 2      | 1    | Mid               | Water On                       |                         | JR 161                |

|                  |                  |        |   |   |     |  |                        |        |
|------------------|------------------|--------|---|---|-----|--|------------------------|--------|
| 05/11/2006 03:00 | 05/11/2006 06:00 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 05/11/2006 08:10 | 05/11/2006 11:10 | GMT -3 | 1 | 2 | Mid | Water On                               | Ice                    | JR 161 |
| 05/11/2006 17:37 | 05/11/2006 20:37 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 05/11/2006 19:20 | 05/11/2006 22:20 | GMT -3 | 1 | 2 | Mid | Water On                               | Ice                    | JR 161 |
| 06/11/2006 08:04 | 06/11/2006 11:04 | GMT -3 | 2 | 2 | Mid | Filter Changeover<br>and Clean<br>Pump |                        | JR 161 |
| 06/11/2006 08:06 | 06/11/2006 11:06 | GMT -3 | 2 | 1 | Mid | Changeover                             |                        | JR 161 |
| 06/11/2006 16:30 | 06/11/2006 19:30 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 06/11/2006 19:04 | 06/11/2006 22:04 | GMT -3 | 2 | 1 | Mid | Water On                               | Ice                    | JR 161 |
| 06/11/2006 23:00 | 07/11/2006 02:00 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 07/11/2006 07:38 | 07/11/2006 10:38 | GMT -3 | 2 | 1 | Mid | Water On                               | Ice                    | JR 161 |
| 08/11/2006 08:10 | 08/11/2006 11:10 | GMT -3 | 1 | 1 | Mid | Filter Changeover<br>and Clean         |                        | JR 161 |
| 09/11/2006 08:10 | 09/11/2006 11:10 | GMT -3 | 2 | 1 | Mid | Filter Changeover<br>and Clean         |                        | JR 161 |
| 09/11/2006 18:38 | 09/11/2006 21:38 | GMT -3 | 2 | 1 | Up  | Probe Position<br>Change               | Probe up due to<br>Ice | JR 161 |
| 09/11/2006 18:42 | 09/11/2006 21:42 | GMT -3 | 2 | 1 | Mid | Probe Position<br>Change               | Cleared Ice            | JR 161 |
| 09/11/2006 22:00 | 10/11/2006 01:00 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 10/11/2006 11:06 | 10/11/2006 14:06 | GMT -3 | 2 | 1 | Mid | Water On                               | Ice                    | JR 161 |
| 10/11/2006 17:15 | 10/11/2006 20:15 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 10/11/2006 19:20 | 10/11/2006 22:20 | GMT -3 | 2 | 1 | Mid | Water On                               | Ice                    | JR 161 |
| 10/11/2006 20:00 | 10/11/2006 23:00 | GMT -3 | - | - | Up  | Water Off                              | Water Off due to       | JR 161 |
| 11/11/2006 18:45 | 11/11/2006 21:45 | GMT -3 | 2 | 1 | Mid | Water On                               | Ice                    | JR 161 |



|                  |                  |        |   |   |     |                             |                      |              |
|------------------|------------------|--------|---|---|-----|-----------------------------|----------------------|--------------|
| 11/11/2006 00:00 | 11/11/2006 20:08 | GMT -3 | - | - | Up  | Water Off                   | Water Off due to Ice | JR 161       |
| 12/11/2006 19:30 | 12/11/2006 22:30 | GMT -3 | 2 | 1 | Up  | Water On                    |                      | JR 161       |
| 12/11/2006 19:45 | 12/11/2006 22:45 | GMT -3 | - | - | Up  | Water Off                   |                      | JR 161       |
| 13/11/2006 11:12 | 13/11/2006 14:12 | GMT -3 | 2 | 1 | Mid | Water On                    |                      | JR 161       |
| 13/11/2006 14:04 | 13/11/2006 17:04 | GMT -3 | - | - | Up  | Water Off                   |                      | JR 161/Signy |
| 14/11/2006 00:00 | 14/11/2006 00:00 | GMT -3 | - | - | Up  | Water Off All Day           |                      | JR 161/Signy |
| 15/11/2006 08:00 | 15/11/2006 11:00 | GMT -3 | 1 | 1 | Mid | Water On                    |                      | JR 161       |
| 16/11/2006 08:10 | 16/11/2006 11:10 | GMT -3 | 2 | 1 | Mid | Filter Changeover and Clean |                      | JR 161       |
| 17/11/2006 08:10 | 17/11/2006 11:10 | GMT -3 | 1 | 1 | Mid | Filter Changeover and Clean |                      | JR 161       |

**UNCONTAMINATED SEA WATER SYSTEM EVENTS FOR NOVEMBER 2006**

| DATE<br>TIME LOCAL | TIME<br>GMT      | TIME ZONE | FILTER | PUMP | PROBE<br>POSITION | EVENT                       | REMARKS | LOCATION<br>CRUISE No |
|--------------------|------------------|-----------|--------|------|-------------------|-----------------------------|---------|-----------------------|
| 18/11/2006 08:10   | 18/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 19/11/2006 08:10   | 19/11/2006 11:10 | GMT -3    | 1      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 20/11/2006 08:02   | 20/11/2006 11:02 | GMT -3    | 1      | 2    | Mid               | Pump Changeover             |         | JR 161                |
| 20/11/2006 08:10   | 20/11/2006 11:10 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 21/11/2006 08:10   | 21/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 22/11/2006 08:10   | 22/11/2006 11:10 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 23/11/2006 08:00   | 23/11/2006 11:00 | GMT -3    | 1      | 2    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 24/11/2006 08:10   | 24/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 25/11/2006 08:00   | 25/11/2006 11:00 | GMT -3    | 1      | 2    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 26/11/2006 08:10   | 26/11/2006 11:10 | GMT -3    | 2      | 2    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 27/11/2006 08:08   | 27/11/2006 11:08 | GMT -3    | 2      | 1    | Mid               | Pump Changeover             |         | JR 161                |
| 27/11/2006 08:10   | 27/11/2006 11:10 | GMT -3    | 1      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 28/11/2006 08:10   | 28/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 29/11/2006 08:10   | 29/11/2006 11:10 | GMT -3    | 1      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |
| 30/11/2006 08:10   | 30/11/2006 11:10 | GMT -3    | 2      | 1    | Mid               | Filter Changeover and Clean |         | JR 161                |

**UNCONTAMINATED SEA WATER SYSTEM EVENTS FOR DECEMBER 2006**

| <b>DATE<br/>TIME LOCAL</b> | <b>TIME<br/>GMT</b> | <b>TIME ZONE</b> | <b>FILTER</b> | <b>PUMP</b> | <b>PROBE<br/>POSITION</b> | <b>EVENT</b>                      | <b>REMARKS</b>          | <b>LOCATION<br/>CRUISE No</b> |
|----------------------------|---------------------|------------------|---------------|-------------|---------------------------|-----------------------------------|-------------------------|-------------------------------|
| 01/12/2006 08:10           | 01/12/2006 11:10    | GMT -3           | 1             | 1           | Mid                       | Filter<br>Changeover<br>and Clean |                         | JR 161                        |
| 02/12/2006 08:10           | 02/12/2006 11:10    | GMT -3           | 2             | 1           | Mid                       | Filter<br>Changeover<br>and Clean |                         | JR 161                        |
| 02/11/2006 22:00           | 03/12/2006 01:00    | GMT -3           | -             | -           | Up                        | Water Off                         |                         | Stanley FI                    |
| 03/12/2006 08:00           | 03/12/2006 11:00    | GMT -3           | -             | -           | Up                        | Water Off                         | Alongside<br>Stanley FI | Stanley FI                    |

## Appendix 4: JR161 Event Log

| Time             | Event Code    | Lat       | Lon       | Comment  |
|------------------|---------------|-----------|-----------|--|
| 29/11/2006 17:52 | 293 BONGO     | -50.0438  | -38.03731 | Gantry Secure hove to till conditions improve  |
| 29/11/2006 17:44 | 293 BONGO     | -50.04321 | -38.03778 | Bongo nets recovered   |
| 29/11/2006 17:28 | 293 BONGO     | -50.04121 | -38.03967 | Bongo nets @ 400m and recovering   |
| 29/11/2006 17:17 | 293 BONGO     | -50.0399  | -38.04144 | Bongo deployed   |
| 29/11/2006 17:12 | 293 BONGO     | -50.03985 | -38.04139 | vessel stopped on D.P. for Bongo deployment  |
| 29/11/2006 16:00 | 292 ACOUSTIC  | -50.00069 | -38.16438 | complete acoustic survey proceeding towards condensed station 6                          |
| 29/11/2006 14:41 | 292 ACOUSTIC  | -49.77718 | -38.16189 | Commence 3rd leg of acoustic transect  |
| 29/11/2006 13:59 | 292 ACOUSTIC  | -49.77552 | -38.02675 | End of 2nd leg of acoustic transect  |
| 29/11/2006 11:24 | 292 ACOUSTIC  | -50.11295 | -38.02579 | Commence 2nd leg of acoustic transect  |
| 29/11/2006 10:21 | 292 ACOUSTIC  | -50.11033 | -37.88615 | Completed first transect. Repositioning for start of second transect.                    |
| 29/11/2006 09:41 | 292 ACOUSTIC  | -49.99966 | -37.88543 | Commenced first transect. Co 180 at 10kts  |
| 29/11/2006 08:50 | ACOUSTIC      | -50.0145  | -37.99898 | Midships gantry secured. Vessel out of DP and repositioning for start of Acoustic Survey |
| 29/11/2006 08:38 | 291 BONGO     | -50.01449 | -37.99899 | Bongo Nets on board.   |
| 29/11/2006 08:37 | 291 BONGO     | -50.01443 | -37.99901 | Bongo Nets at the surface.   |
| 29/11/2006 08:19 | 291 BONGO     | -50.01194 | -37.99905 | Bongo nets @ 400m and recovering   |
| 29/11/2006 08:09 | 291 BONGO     | -50.01067 | -37.99905 | Bongo Nets d   |
| 29/11/2006 08:08 | 290 BONGO     | -50.01038 | -37.99902 | Bongo Nets on board.   |
| 29/11/2006 08:07 | 290 BONGO     | -50.01028 | -37.999   | Bongo Nets at the surface.   |
| 29/11/2006 07:51 | 290 BONGO     | -50.0075  | -37.99897 | Bongo nets @ 400m and recovering   |
| 29/11/2006 07:40 | 290 BONGO     | -50.00544 | -37.99892 | Bongo nets deployed  |
| 29/11/2006 07:36 | 289 CTD       | -50.00544 | -37.99892 | CTD on deck.   |
| 29/11/2006 07:35 | 289 CTD       | -50.00542 | -37.99891 | CTD at the surface.  |
| 29/11/2006 07:27 | 289 CTD       | -50.00543 | -37.99893 | CTD @ 25m Commenced recovery.  |
| 29/11/2006 07:23 | 289 CTD       | -50.00543 | -37.99886 | CTD deployed   |
| 29/11/2006 07:10 | 288 MINIBONGO | -50.00537 | -38.00043 | Mini Bongos on Deck  |

|                  |               |           |           |   |
|------------------|---------------|-----------|-----------|---|
| 29/11/2006 07:09 | 288 MINIBONGO | -50.00517 | -38.00039 | Mini Bongos at the surface  |
| 29/11/2006 06:52 | 288 MINIBONGO | -50.00168 | -38.00003 | Mini Bongos @ 400m and Recovering   |
| 29/11/2006 06:42 | 288 MINIBONGO | -50.00009 | -37.99985 | Mini Bongos Deployed  |
| 29/11/2006 06:37 | 287 CTD       | -50.00007 | -37.99985 | CTD recovered   |
| 29/11/2006 06:19 | 287 CTD       | -50.00009 | -37.99987 | CTD @ 400m and recovering   |
| 29/11/2006 06:08 | 287 CTD       | -50.00008 | -37.99987 | CTD deployed  |
| 29/11/2006 05:51 | 287 CTD       | -50.00042 | -37.99992 | Vessel on D.P. ready to deploy  |
| 29/11/2006 05:44 | 287 CTD       | -50.00042 | -37.99683 | Slowing for Process Station six   |
| 29/11/2006 04:45 | 286 MULTINET  | -49.81172 | -37.94758 | Deck Secure proceeding to condensed process station 6                       |
| 29/11/2006 04:34 | 286 MULTINET  | -49.8132  | -37.94832 | Muli-net recovered  |
| 29/11/2006 04:31 | 286 MULTINET  | -49.8149  | -37.94877 | Multinet @ Surface  |
| 29/11/2006 03:12 | 286 MULTINET  | -49.85681 | -37.95613 | multinet @ 2224m wire out and recovering                                    |
| 29/11/2006 01:57 | 286 MULTINET  | -49.90209 | -37.96785 | Muli-net deployed   |
| 29/11/2006 01:29 | 285 MULTINET  | -49.90744 | -37.96939 | Multinet recovered due to problem with net                                  |
| 29/11/2006 01:23 | 285 MULTINET  | -49.91173 | -37.97089 | Multinet Deployed   |
| 29/11/2006 00:54 | 284 LHPR      | -49.91601 | -37.97224 | LHPR Recovered  |
| 28/11/2006 23:52 | 284 LHPR      | -49.9734  | -37.98694 | LHPR @ 1913m increase speed to 3.5kts                                       |
| 28/11/2006 23:02 | 284 LHPR      | -49.99932 | -37.99988 | LHPR Deployed @ 2.0kts  |
| 28/11/2006 22:15 | 283 RMT-25    | -49.90975 | -38.13458 | RMT 25 on deck. Not feeling very well so repositioning for LHPR deployment! |
| 28/11/2006 22:02 | 283 RMT-25    | -49.91075 | -38.1319  | RMT 25 at the surface   |
| 28/11/2006 20:33 | 283 RMT-25    | -49.95669 | -38.04513 | RMT 25 @ 1879m cable out. Commence hauling                                  |
| 28/11/2006 19:11 | 283 RMT-25    | -49.99484 | -37.98122 | RMT 25 Deployed   |
| 28/11/2006 19:00 | 283 RMT-25    | -50.00474 | -37.97603 | Slowing for RMT 25 deployment   |
| 28/11/2006 18:12 | 282 RMT-25    | -50.01409 | -38.18861 | RMT 25 recovered. Repositioning vessel for next run                         |
| 28/11/2006 18:06 | 282 RMT-25    | -50.01457 | -38.1839  | RMT 25 @ Surface  |
| 28/11/2006 16:48 | 282 RMT-25    | -50.02157 | -38.10134 | RMT 25 @ 740m and recovering  |
| 28/11/2006 16:24 | 282 RMT-25    | -50.0238  | -38.07564 | RMT 25 Deployed @ 2.5kts  |
| 28/11/2006 16:20 | 282 RMT-25    | -50.02398 | -38.07176 | Deploying RMT 25  |
| 28/11/2006 16:15 | 282 RMT-25    | -50.03224 | -38.04852 | Slowing for RMT 25 deployment   |
| 28/11/2006 15:46 | 281 LHPR      | -50.07971 | -38.17571 | LHPR recovered repositioning vessel for RMT 25 deployment.                  |

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|------------------|------------|-----------|--|
| 28/11/2006 15:43 | 281 LHPR   | -50.07943 | -38.1721 LHPR @ surface  |
| 28/11/2006 14:26 | 281 LHPR   | -50.03745 | -38.06201 LHPR @ 2255m cable out                                       |
| 28/11/2006 14:19 | 281 LHPR   | -50.03385 | -38.05201 Increase to 3.5 knots  |
| 28/11/2006 13:23 | 281 LHPR   | -50.01146 | -37.99889 LHPR Deployed @ 2.0kts                                       |
| 28/11/2006 13:17 | LHPR       | -50.01011 | -37.99585 V/L off DP preparing to deploy LHPR                          |
| 28/11/2006 13:11 | 280 FRRF   | -50.01011 | -37.99582 FRRF recovered   |
| 28/11/2006 12:53 | 280 FRRF   | -50.0101  | -37.99588 FRRF @ 150m commence recovery                                |
| 28/11/2006 12:39 | 280 FRRF   | -50.01008 | -37.99594 FRRF deployed  |
| 28/11/2006 12:30 | 279 GO-FLO | -50.01009 | -37.99594 Go-flo recovered   |
| 28/11/2006 12:04 | 279 GO-FLO | -50.00804 | -37.99666 commence recovery of go-flo                                  |
| 28/11/2006 11:50 | 279 GO-FLO | -50.00682 | -37.99699 Go-flo @ depth 1000m bottles triggered bottles triggered     |
| 28/11/2006 11:21 | 279 GO-FLO | -50.0042  | -37.99759 Deploying Go flo first bottle deployed first bottle deployed |
| 28/11/2006 11:09 | 278 CTD    | -50.00418 | -37.99763 CTD Recovered  |
| 28/11/2006 10:45 | 278 CTD    | -50.0042  | -37.99764 CTD @ 140m Commenced recovery. Commenced recovery.           |
| 28/11/2006 10:39 | 278 CTD    | -50.00419 | -37.99763 CTD deployed   |
| 28/11/2006 10:31 | 277 BONGO  | -50.00414 | -37.9977 Bongo Nets on board.  |
| 28/11/2006 10:29 | 277 BONGO  | -50.00398 | -37.99782 Bongo Nets at the surface.                                   |
| 28/11/2006 10:11 | 277 BONGO  | -50.00163 | -37.99922 Bongo nets @ 400m and recovering                             |
| 28/11/2006 10:00 | 277 BONGO  | -50.00065 | -37.99972 Bongo deployed   |
| 28/11/2006 09:55 | 276 CTD    | -50.00065 | -37.99972 CTD on deck.   |
| 28/11/2006 09:53 | 276 CTD    | -50.00066 | -37.99972 CTD at the surface.  |
| 28/11/2006 08:08 | 276 CTD    | -50.00069 | -37.99977 CTD @ 5114m Commencing recovery. Commencing recovery.        |
| 28/11/2006 06:39 | 276 CTD    | -49.9996  | -38.00069 CTD deployed   |
| 28/11/2006 06:31 | 276 CTD    | -49.99962 | -38.0007 Vessel on DP at station for CTD                               |
| 28/11/2006 06:25 | 276 CTD    | -49.9973  | -38.00558 slowing for condensed station six                            |
| 28/11/2006 05:13 | 275 RMT-25 | -50.20243 | -38.19042 Deck Secure proceeding to condensed process station 6        |
| 28/11/2006 04:52 | 275 RMT-25 | -50.19688 | -38.19278 RMT 25 recovered   |
| 28/11/2006 04:44 | 275 RMT-25 | -50.19078 | -38.18775 RMT 25 @ Surface   |
| 28/11/2006 03:36 | 275 RMT-25 | -50.13601 | -38.1485 RMT 25 @ 742m and recovering                                  |
| 28/11/2006 03:00 | 275 RMT-25 | -50.10324 | -38.12951 RMT deployed   |

|                  |            |  |
|------------------|------------|--|
| 28/11/2006 02:53 | RMT-25     | -50.0995 -38.12602 Vessel off DP preparing for RMT deployment  |
| 28/11/2006 02:27 | 274 FRRF   | -50.09875 -38.12643 FRRF recovered   |
| 28/11/2006 02:13 | 274 FRRF   | -50.09651 -38.12861 FRRF @ 150m commence recovery commence recovery  |
| 28/11/2006 02:04 | 274 FRRF   | -50.09557 -38.12909 FRRF deployed  |
| 28/11/2006 02:03 | 274 FRRF   | -50.09557 -38.1291 V/L on DP for FRRF  |
| 28/11/2006 01:51 | 273 RMT-25 | -50.09271 -38.12884 RMT Recovered  |
| 27/11/2006 23:52 | 273 RMT-25 | -50.00273 -38.0256 RMT 25 @ 2126m (cable out)  |
| 27/11/2006 22:50 | 273 RMT-25 | -49.96331 -37.96272 RMT 25 deployed.   |
| 27/11/2006 22:39 | RMT-25     | -49.96056 -37.95161 Turning into wind and reducing speed for RMT 25 deployment.<br>Gantry Secure thruster vents closed moving to Condensed Process station six thruster vents closed moving to Condensed Process station six thruster vents closed moving to |
| 27/11/2006 05:17 |            | -52.90851 -40.10388 Condensed Process station six  |
| 27/11/2006 05:06 | 272 BONGO  | -52.90471 -40.10197 Bongo nets recovered   |
| 27/11/2006 04:49 | 272 BONGO  | -52.90356 -40.10468 Bongo nets @ 400m  |
| 27/11/2006 04:38 | 272 BONGO  | -52.90343 -40.10499 Bongo deployed   |
| 27/11/2006 04:33 | 271 FRRF   | -52.90341 -40.10493 FRRF recovered   |
| 27/11/2006 04:16 | 271 FRRF   | -52.90342 -40.10493 FRRF @ 150m  |
| 27/11/2006 04:05 | 271 FRRF   | -52.90341 -40.10492 FRRF deployed  |
| 27/11/2006 03:59 | 271 FRRF   | -52.9033 -40.10505 Vessel on D.P. ready to deploy  |
| 27/11/2006 03:54 | 271 FRRF   | -52.90202 -40.10961 Slowing for FRRF station   |
| 27/11/2006 03:15 | 270 RMT-25 | -53.00327 -40.13294 Deck Secure proceeding to process station 3  |
| 27/11/2006 03:09 | 270 RMT-25 | -52.99781 -40.12731 RMT 25 recovered   |
| 27/11/2006 03:03 | 270 RMT-25 | -52.99296 -40.12236 RMT 25 @ Surface   |
| 27/11/2006 02:44 | 270 RMT-25 | -52.97964 -40.10841 RMT @ 43m  |
| 27/11/2006 02:42 | 270 RMT-25 | -52.97779 -40.1059 RMT 25 deployed for target fishing  |
| 27/11/2006 02:04 | 269 RMT-25 | -52.98532 -40.11484 RMT Recovered  |
| 26/11/2006 23:59 | 269 RMT-25 | -52.86871 -40.09751 RMT 25 @ 2267m (cable out)   |
| 26/11/2006 22:54 | 269 RMT-25 | -52.8057 -40.08132 RMT 25 Deployed   |
| 26/11/2006 22:40 | RMT-25     | -52.79239 -40.07781 Vessel out of DP and driving ahead for RMT 25 deployment.  |
| 26/11/2006 21:57 | RMT-25     | -52.79192 -40.07764 Vessel stopped on station in D.P. Awaiting RMT 25 deployment.  |

|                  |              |           |           |  |
|------------------|--------------|-----------|-----------|--|
| 26/11/2006 21:50 | RMT-25       | -52.79234 | -40.07772 | Vessel approaching station. Reducing speed.  |
| 26/11/2006 20:26 | RMT-25       | -53.07691 | -40.1167  | Repositioning for RMT 25 deployment  |
| 26/11/2006 20:23 | 268 MULTINET | -53.07403 | -40.11547 | Muti Net on deck.  |
| 26/11/2006 20:21 | 268 MULTINET | -53.07259 | -40.11496 | Multinet @ Surface   |
| 26/11/2006 19:07 | 268 MULTINET | -53.01772 | -40.09454 | Multinet at 1987m and recovering   |
| 26/11/2006 18:09 | 268 MULTINET | -52.976   | -40.08003 | Multinet Deployed @ 2kt  |
| 26/11/2006 18:07 | 268 MULTINET | -52.97409 | -40.0792  | deploying multinet   |
| 26/11/2006 17:33 | 267 RMT-25   | -52.96936 | -40.07653 | RMT 25 recovered   |
| 26/11/2006 17:26 | 267 RMT-25   | -52.9627  | -40.07285 | RMT 25 @ Surface   |
| 26/11/2006 16:59 | 267 RMT-25   | -52.94028 | -40.05868 | Hauling for recovery   |
| 26/11/2006 15:20 | 267 RMT-25   | -52.85337 | -40.02018 | RMT 25 @ 2050m (cable out)   |
| 26/11/2006 14:25 | 267 RMT-25   | -52.8061  | -40.00328 | RMT deployed   |
|                  |              |           |           | End of 3rd transect a/c head to wind and reduce to 2.5knots for RMT deployment a/c |
| 26/11/2006 14:09 | 266 ACOUSTIC | -52.79618 | -39.99039 | head to wind and reduce to 2.5knots for RMT deployment                             |
| 26/11/2006 12:48 | 266 ACOUSTIC | -52.9553  | -39.72734 | Commence 3rd transect  |
| 26/11/2006 12:11 | 266 ACOUSTIC | -53.01755 | -39.83493 | End of 2nd transect  |
| 26/11/2006 09:29 | 266 ACOUSTIC | -52.69937 | -40.36048 | Commenced second transect  |
| 26/11/2006 08:51 | 266 ACOUSTIC | -52.76463 | -40.46207 | Completed first transect. Repositioning for start of second transect.              |
| 26/11/2006 07:30 | 266 ACOUSTIC | -52.92395 | -40.19898 | Commenced first transect. Co 315 at 10kts  |
| 26/11/2006 07:15 | ACOUSTIC     | -52.93759 | -40.17631 | Vessel out of DP and positioning for start of acoustic survey run.                 |
| 26/11/2006 05:52 | 265 ACOUSTIC | -52.97363 | -40.30855 | deck secure proceeding to acoustic survey run                                      |
| 26/11/2006 05:46 | 265 RMT-25   | -52.96975 | -40.31362 | RMT 25 recovered   |
| 26/11/2006 05:38 | 265 RMT-25   | -52.96352 | -40.32156 | RMT 25 @ Surface   |
| 26/11/2006 04:44 | 265 RMT-25   | -52.9295  | -40.36901 | RMT @ 330m   |
| 26/11/2006 04:26 | 265 RMT-25   | -52.91863 | -40.38513 | RMT 25 Deployed @ 2.5kts   |
| 26/11/2006 04:22 | 265 RMT-25   | -52.91602 | -40.38888 | Continue deployment  |
| 26/11/2006 04:10 | 265 RMT-25   | -52.90768 | -40.40031 | Stop deployment due to tangled cod ends  |
| 26/11/2006 04:07 | 265 RMT-25   | -52.90536 | -40.4035  | Re-deploying RMT 25  |
| 26/11/2006 03:45 | 265 RMT-25   | -52.89581 | -40.41687 | RMT 25 recovered   |
| 26/11/2006 03:34 | 265 RMT-25   | -52.88835 | -40.427   | recovering RMT due to fault  |

|                  |              |                     |  |
|------------------|--------------|---------------------|--|
| 26/11/2006 03:30 | 265 RMT-25   | -52.88547 -40.43072 | RMT 25 Deployed @ 2.5kts   |
| 26/11/2006 03:25 | 265 RMT-25   | -52.88207 -40.43587 | Deploying RMT 25   |
| 26/11/2006 03:22 | RMT-25       | -52.88115 -40.43781 | Vessel off DP preparing for RMT deployment   |
| 26/11/2006 02:38 | RMT-25       | -52.88107 -40.43779 | V/L on DP while RMT is prepared  |
| 26/11/2006 02:31 | 264 MULTINET | -52.87845 -40.43765 | Muli-net recovered   |
| 26/11/2006 01:25 | 264 MULTINET | -52.83781 -40.39937 | Multinet at 2034m and recovering   |
| 26/11/2006 00:23 | 264 MULTINET | -52.8035 -40.35264  | Muli-net deployed  |
| 25/11/2006 23:21 | 262 MULTINET | -52.79926 -40.34025 | Muli-net recovered   |
| 25/11/2006 22:34 | 263 TOW-FISH | -52.77937 -40.28921 | Tow fish deployed  |
| 25/11/2006 22:08 | 262 MULTINET | -52.76966 -40.26289 | Multinet at 2178m and recovering   |
| 25/11/2006 21:00 | 262 MULTINET | -52.74138 -40.18687 | Multinet Deployed @2kt   |
| 25/11/2006 20:15 | MULTINET     | -52.72387 -40.14835 | Vessel out of DP and moving clear. Rigging for Multnet deployment.   |
| 25/11/2006 20:09 | 261 MOORING  | -52.72299 -40.14664 | Ship positioned over mooring to confirm position. Vessel then moving off head to wind.                                   |
| 25/11/2006 19:52 | 261 MOORING  | -52.72321 -40.14731 | Rig slipped.   |
| 25/11/2006 19:51 | 261 MOORING  | -52.7232 -40.14729  | Main Buoy in the water.  |
| 25/11/2006 19:48 | 261 MOORING  | -52.72322 -40.14732 | Acoustic Recording Package in the water.   |
| 25/11/2006 19:40 | 261 MOORING  | -52.72323 -40.14731 | Acoustic Recording Package and Main Buoy attached.   |
| 25/11/2006 19:29 | 261 MOORING  | -52.72322 -40.14729 | SBE CTD connected and deployed   |
| 25/11/2006 18:36 | 261 MOORING  | -52.72324 -40.14726 | Trimsin cluster connected & deployed   |
| 25/11/2006 18:30 | 261 MOORING  | -52.72324 -40.14728 | Sediment trap & Aquadoop current meter connected and deployed  |
| 25/11/2006 17:55 | 261 MOORING  | -52.72323 -40.14726 | continue veering   |
| 25/11/2006 17:40 | 261 MOORING  | -52.72321 -40.1473  | stop to rig chain block on kevlar rope to improve lead   |
| 25/11/2006 17:18 | 261 MOORING  | -52.72311 -40.14732 | Acoustic release connected and deployed  |
| 25/11/2006 17:11 | 261 MOORING  | -52.72311 -40.14733 | weights deployed   |
| 25/11/2006 17:09 | 261 MOORING  | -52.72312 -40.14734 | commence mooring deployment  |
| 25/11/2006 16:42 | 261 MOORING  | -52.72307 -40.14716 | vessel stopped on DP stern over deployment pos'n HDG 240T stern over deployment  |
| 25/11/2006 16:27 | 261 MOORING  | -52.72254 -40.14765 | pos'n HDG 240T   |
| 25/11/2006 15:51 | MOORING      | -52.8045 -40.03567  | slowing for mooring site deployment<br>A/C to 323T proceeding towards chosen deployment site (52 43.387S 40 08.798W) (52 |



|                  |               |           |           |   |
|------------------|---------------|-----------|-----------|---|
| 25/11/2006 15:18 | SWATH         | -52.74652 | -40.13887 | A/C to 135T commence second swath run                     |
| 25/11/2006 14:08 | SWATH         | -52.86529 | -40.0881  | v/l off DP commencing swath survey for mooring deployment |
| 25/11/2006 13:59 | 260 MINIBONGO | -52.86527 | -40.08815 | Mini Bongos Recovered                                     |
| 25/11/2006 13:43 | 260 MINIBONGO | -52.86457 | -40.0895  | Mini bongo @ 400m commence hauling                        |
| 25/11/2006 13:42 | 168 TOW-FISH  | -52.8645  | -40.08961 | Tow fish recovered  |
| 25/11/2006 13:27 | 260 MINIBONGO | -52.86364 | -40.09133 | Mini bongo deployed                                       |
| 25/11/2006 13:21 | 259 CTD       | -52.86357 | -40.09131 | CTD Recovered   |
| 25/11/2006 12:39 | 259 CTD       | -52.8636  | -40.0913  | CTD @ 2000m Commencing recovery. Commencing recovery.     |
| 25/11/2006 12:01 | 259 CTD       | -52.86361 | -40.09132 | CTD deployed  |
| 25/11/2006 11:52 | 258 BONGO     | -52.86357 | -40.09139 | Bongo nets recovered                                      |
| 25/11/2006 11:35 | 258 BONGO     | -52.86263 | -40.09241 | Bongo nets @ 400m and recovering                          |
| 25/11/2006 11:24 | 258 BONGO     | -52.86193 | -40.09328 | Bongo nets deployed                                       |
| 25/11/2006 11:18 | 257 CTD       | -52.86193 | -40.09328 | CTD recovered   |
| 25/11/2006 11:08 | 257 CTD       | -52.86193 | -40.09331 | CTD @ 30m and recovering                                  |
| 25/11/2006 11:04 | 257 CTD       | -52.8619  | -40.09331 | CTD Deployed  |
| 25/11/2006 10:52 | 256 FRRF      | -52.86191 | -40.09333 | FRRF on deck.   |
| 25/11/2006 10:51 | 256 FRRF      | -52.86189 | -40.09333 | FRRF at the surface.                                      |
| 25/11/2006 10:39 | 256 FRRF      | -52.8619  | -40.09334 | FRRF @ 150m commence recovery commence recovery           |
| 25/11/2006 10:28 | 256 FRRF      | -52.86192 | -40.0933  | FRRF deployed   |
| 25/11/2006 10:22 | 255 GO-FLO    | -52.86188 | -40.09337 | Go Flo recovered to deck. Setting up for FRRF.            |
| 25/11/2006 10:10 | 255 GO-FLO    | -52.86138 | -40.09404 | Second Go Flo bottle removed                              |
| 25/11/2006 10:02 | 255 GO-FLO    | -52.86103 | -40.0945  | Third Go Flo bottle removed.                              |
| 25/11/2006 09:59 | 255 GO-FLO    | -52.8609  | -40.0947  | Fourth Go Flo bottle removed                              |
| 25/11/2006 09:57 | 255 GO-FLO    | -52.86081 | -40.09479 | Fifth Go Flo bottle removed                               |
| 25/11/2006 09:55 | 255 GO-FLO    | -52.86073 | -40.09488 | Sixth Go Flo bottle removed                               |
| 25/11/2006 09:54 | 255 GO-FLO    | -52.8607  | -40.09495 | Commenced Go Flo recovery                                 |
| 25/11/2006 09:37 | 255 GO-FLO    | -52.85991 | -40.0959  | Go Flo wire at 1000m Trigger weight deployed.             |
| 25/11/2006 09:36 | 255 GO-FLO    | -52.8599  | -40.09593 | Sixth Go Flo bottle attached                              |
| 25/11/2006 09:34 | 255 GO-FLO    | -52.8598  | -40.09601 | Fifth Go Flo bottle attached                              |
| 25/11/2006 09:30 | 255 GO-FLO    | -52.85961 | -40.09624 | Fourth Go Flo bottle attached                             |

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| 25/11/2006 09:27 | 255 GO-FLO | -52.85943 -40.09643 | Third Go Flo bottle attached   |
| 25/11/2006 09:20 | 255 GO-FLO | -52.85911 -40.09679 | Second Go Flo bottle attached.   |
| 25/11/2006 09:08 | 255 GO-FLO | -52.85903 -40.09685 | Go Flo deployed with first bottle  |
| 25/11/2006 08:58 | 254 CTD    | -52.85903 -40.09693 | CTD on deck. Setting up for Go Flo.  |
| 25/11/2006 08:56 | 254 CTD    | -52.85904 -40.09695 | CTD at the surface.  |
| 25/11/2006 08:38 | 254 CTD    | -52.85903 -40.09696 | CTD @ 140m Commenced recovery. Commenced recovery.   |
| 25/11/2006 08:31 | 254 CTD    | -52.85901 -40.09691 | CTD deployed   |
| 25/11/2006 08:18 | CTD        | -52.85862 -40.09601 | Vessel approaching CTD station. Setting up in DP. Midships gantry unlashd.   |
| 25/11/2006 08:08 | CTD        | -52.86429 -40.10138 | Vessel approaching CTD station. Reducing speed and turning.  |
| 25/11/2006 06:00 | 253 RMT-25 | -53.09037 -40.70085 | Deck Secure proceeding to process station 3<br>RMT 25 recovered cod ends recovered with use of Gilson winch cod ends recovered |
| 25/11/2006 05:27 | 253 RMT-25 | -53.0885 -40.67714  | with use of Gilson winch   |
| 25/11/2006 05:11 | 253 RMT-25 | -53.08454 -40.65982 | RMT 25 @ Surface   |
| 25/11/2006 04:00 | 253 RMT-25 | -53.05017 -40.56151 | RMT 25 @ 822m (cable out)  |
| 25/11/2006 03:30 | 253 RMT-25 | -53.03058 -40.51789 | RMT 25 Deployed @ 2.5kts   |
| 25/11/2006 03:25 | 253 RMT-25 | -53.0273 -40.51252  | Deploying RMT 25<br>Midships gantry secured vessel out of D.P. and moving off for RMT 25 deployment.                           |
| 25/11/2006 03:08 | RMT-25     | -53.02538 -40.50542 | vessel out of D.P. and moving off for RMT 25 deployment.   |
| 25/11/2006 02:56 | 252 FRRF   | -53.0231 -40.50078  | FRRF recovered   |
| 25/11/2006 02:40 | 252 FRRF   | -53.02311 -40.50078 | FRRF @ 150m commence recovery commence recovery  |
| 25/11/2006 02:29 | 252 FRRF   | -53.02307 -40.50068 | FRRF deployed  |
| 25/11/2006 02:16 | FRRF       | -53.02308 -40.50067 | V/L on DP for FRRF   |
| 25/11/2006 02:13 | 251 LHPR   | -53.02252 -40.49666 | LHPR Recovered   |
| 25/11/2006 00:51 | 251 LHPR   | -52.97053 -40.38069 | LHPR @ 2290m cable out commence hauling commence hauling   |
| 25/11/2006 00:49 | 251 LHPR   | -52.96923 -40.37846 | Increase to 3.5 knots  |
| 24/11/2006 23:51 | 251 LHPR   | -52.93773 -40.33649 | LHPR Deployed @ 2.0kts   |
| 24/11/2006 23:38 | 250 LHPR   | -52.93247 -40.32457 | LHPR Recovered<br>LHPR @ 2019m increase speed to 3.5kts commence hauling increase speed to 3.5kts                              |
| 24/11/2006 22:25 | 250 LHPR   | -52.895 -40.21484   | commence hauling   |
| 24/11/2006 21:27 | 250 LHPR   | -52.87442 -40.15507 | LHPR Deployed @ 2.0kts   |

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| 24/11/2006 21:23 | LHPR       | -52.87393 -40.1525  | Vessel out of DP and moving off for LHPR re-deployment.<br>Vessel stopped and returned to full auto DP. Awaiting result of investigation into problem |
| 24/11/2006 20:35 | LHPR       | -52.87384 -40.15252 | with LHPR.  |
| 24/11/2006 20:26 | 250 LHPR   | -52.87191 -40.14504 | LHPR on deck for investigation. Ship still moving ahead at 2kts.  |
| 24/11/2006 20:24 | 250 LHPR   | -52.87118 -40.14246 | LHPR deployment aborted returning unit to deck. returning unit to deck.   |
| 24/11/2006 20:22 | 250 LHPR   | -52.87057 -40.14008 | Commenced deployment of LHPR<br>Midships Gantry Secure vessel out of DP and moving off for LHPR deployment. vessel                                    |
| 24/11/2006 20:19 | LHPR       | -52.87018 -40.13891 | out of DP and moving off for LHPR deployment.   |
| 24/11/2006 20:11 | 249 CTD    | -52.87022 -40.13888 | CTD on deck.  |
| 24/11/2006 20:07 | 249 CTD    | -52.87022 -40.13886 | CTD at the surface.   |
| 24/11/2006 18:50 | 249 CTD    | -52.87021 -40.13885 | CTD @ 3733m   |
| 24/11/2006 17:42 | 249 CTD    | -52.87018 -40.13883 | CTD deployed  |
| 24/11/2006 17:30 | 248 GO-FLO | -52.87015 -40.1388  | Go Flo recovered  |
| 24/11/2006 17:01 | 248 GO-FLO | -52.87017 -40.13929 | Commence hauling go-flo   |
| 24/11/2006 16:50 | 248 GO-FLO | -52.87014 -40.13933 | Go flo at depth (500m)  |
| 24/11/2006 16:40 | 248 GO-FLO | -52.87023 -40.13931 | 5th go-flo bottle attached to cable   |
| 24/11/2006 16:38 | 248 GO-FLO | -52.87022 -40.13922 | 4th go-flo bottle attached to cable   |
| 24/11/2006 16:35 | 248 GO-FLO | -52.87023 -40.13922 | 3rd glo-flo bottle attached to cable  |
| 24/11/2006 16:26 | 248 GO-FLO | -52.87021 -40.13926 | 2nd Go Flow bottle attached to the cable  |
| 24/11/2006 16:14 | 248 GO-FLO | -52.87024 -40.13929 | Go Flo deployed with first bottle   |
| 24/11/2006 16:04 | 247 CTD    | -52.87021 -40.13932 | CTD recovered   |
| 24/11/2006 15:53 | 247 CTD    | -52.87023 -40.13923 | CTD @ 30m   |
| 24/11/2006 15:49 | 247 CTD    | -52.87024 -40.13924 | CTD deployed  |
| 24/11/2006 15:25 | 246 BONGO  | -52.87025 -40.13923 | Bongo nets recovered  |
| 24/11/2006 15:20 | 246 BONGO  | -52.87025 -40.13925 | Bongo nets @125m  |
| 24/11/2006 15:16 | 246 BONGO  | -52.87023 -40.13933 | Bongo nets deployed   |
| 24/11/2006 15:09 | 245 CTD    | -52.87022 -40.13933 | CTD recovered   |
| 24/11/2006 14:47 | 245 CTD    | -52.87021 -40.13921 | CTD @ 400m and recovering   |
| 24/11/2006 14:34 | 245 CTD    | -52.87026 -40.13925 | CTD deployed  |
| 24/11/2006 14:25 | 244 FRRF   | -52.87026 -40.13926 | FRRF recovered  |

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| 24/11/2006 14:05 | 244 FRRF      | -52.87023 | -40.13927 | FRRF @ 150m and recovering                                       |
| 24/11/2006 13:51 | 244 FRRF      | -52.87028 | -40.1392  | FRRF Deployed  |
| 24/11/2006 13:46 | 243 CTD       | -52.87025 | -40.13923 | CTD Recovered  |
| 24/11/2006 13:23 | 243 CTD       | -52.87021 | -40.13918 | CTD @ 140m and recovering  |
| 24/11/2006 13:14 | 243 CTD       | -52.87024 | -40.13924 | CTD Deployed   |
| 24/11/2006 13:07 | 242 MINIBONGO | -52.87023 | -40.13924 | Mini Bongos Recovered  |
| 24/11/2006 12:51 | 242 BONGO     | -52.87024 | -40.13928 | Bongo nets @ 400m  |
| 24/11/2006 12:38 | 242 MINIBONGO | -52.87028 | -40.13931 | Mini Bongos Deployed   |
| 24/11/2006 12:35 | 241 CTD       | -52.87023 | -40.13926 | CTD recovered  |
| 24/11/2006 11:50 | 241 CTD       | -52.87031 | -40.13922 | CTD @ 2000m  |
| 24/11/2006 11:12 | 241 CTD       | -52.87028 | -40.1392  | CTD deployed   |
| 24/11/2006 10:51 | CTD           | -52.87028 | -40.13916 | Vessel stopped on station in D.P. Setting up for CTD deployment. |
| 23/11/2006 16:40 | MOORING       | -55.26694 | -41.12083 | Turned on swath for mooring postion                              |
| 23/11/2006 16:39 |               | -52.86811 | -40.36564 | Science suspended due to weather vessel hove to vessel hove to   |
| 23/11/2006 16:35 | 240 ACOUSTIC  | -52.86748 | -40.35793 | Acoustic transect abandoned due to bad weather                   |
| 23/11/2006 15:09 | 240 ACOUSTIC  | -52.87419 | -40.20403 | Start acoustic transect PS3_T1 4-6                               |
| 23/11/2006 14:11 |               | -52.88163 | -40.08742 | Vessel moving off station to head 270 for swath survey           |
| 23/11/2006 13:50 | 239 CTD       | -52.88104 | -40.08784 | CTD Recovered  |
| 23/11/2006 13:08 | 239 CTD       | -52.87766 | -40.08953 | CTD @ 2000m  |
| 23/11/2006 12:31 | 239 CTD       | -52.87573 | -40.09108 | CTD deployed   |
| 23/11/2006 12:20 | 238 BONGO     | -52.87515 | -40.09144 | Bongo nets recovered   |
| 23/11/2006 12:03 | 238 BONGO     | -52.87435 | -40.09211 | Bongo nets @ 400m  |
| 23/11/2006 11:52 | 238 BONGO     | -52.87381 | -40.09271 | Bongo nets deployed  |
| 23/11/2006 11:46 | 237 CTD       | -52.87354 | -40.09297 | CTD recovered  |
| 23/11/2006 11:36 | 237 CTD       | -52.87351 | -40.09299 | CTD @ 30m  |
| 23/11/2006 11:31 | 237 CTD       | -52.8735  | -40.09298 | CTD deployed   |
| 23/11/2006 11:21 | 236 FRRF      | -52.87331 | -40.09309 | FRRF recovered   |
| 23/11/2006 11:02 | 236 FRRF      | -52.87123 | -40.09371 | FRRF @ 150m commence recovery commence recovery                  |
| 23/11/2006 10:51 | 236 FRRF      | -52.87012 | -40.09403 | FRRF deployed  |
| 23/11/2006 10:38 | 235 GO-FLO    | -52.8686  | -40.09452 | Go Flo recovered to deck.  |

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| 23/11/2006 10:25 | 235 GO-FLO | -52.86718 -40.09492 | Second Go Flo bottle removed                             |
| 23/11/2006 10:17 | 235 GO-FLO | -52.86632 -40.09513 | Third Go Flo bottle removed.                             |
| 23/11/2006 10:14 | 235 GO-FLO | -52.866 -40.09523   | Third Go Flo bottle removed.                             |
| 23/11/2006 10:12 | 235 GO-FLO | -52.86578 -40.09532 | Fifth Go Flo bottle removed                              |
| 23/11/2006 10:11 | 235 GO-FLO | -52.86567 -40.09532 | Sixth Go Flo bottle removed                              |
| 23/11/2006 10:09 | 235 GO-FLO | -52.86553 -40.09537 | Commenced recovery of Glo Fo                             |
| 23/11/2006 09:55 | 235 GO-FLO | -52.86398 -40.09583 | Go Flo wire at 1000m Trigger weight deployed.            |
| 23/11/2006 09:54 | 235 GO-FLO | -52.86379 -40.09587 | Sixth Go Flo bottle attached                             |
| 23/11/2006 09:51 | 235 GO-FLO | -52.86357 -40.09594 | Fifth Go Flo bottle attached                             |
| 23/11/2006 09:50 | 235 GO-FLO | -52.86338 -40.09599 | Fourth Go Flo bottle attached                            |
| 23/11/2006 09:46 | 235 GO-FLO | -52.86299 -40.09611 | Third Go Flo bottle attached                             |
| 23/11/2006 09:39 | 235 GO-FLO | -52.86199 -40.09639 | Second Go Flo bottle attached.                           |
| 23/11/2006 09:27 | 235 GO-FLO | -52.86037 -40.09687 | Go Flo deployed with first bottle                        |
| 23/11/2006 09:16 | 234 CTD    | -52.86039 -40.09685 | CTD on deck.   |
| 23/11/2006 09:15 | 234 CTD    | -52.86037 -40.09687 | CTD at the surface.                                      |
| 23/11/2006 08:56 | 234 CTD    | -52.86033 -40.09684 | CTD @ 140m Commenced recovery. Commenced recovery.       |
| 23/11/2006 08:49 | 234 CTD    | -52.86033 -40.09685 | CTD deployed   |
| 23/11/2006 08:41 | 233 BONGO  | -52.86077 -40.09681 | Bongo Nets on board.                                     |
| 23/11/2006 08:40 | 233 BONGO  | -52.86074 -40.09678 | Bongo Nets at the surface.                               |
| 23/11/2006 08:23 | 233 BONGO  | -52.8597 -40.09697  | Bongo nets @400m commenced recovery. commenced recovery. |
| 23/11/2006 08:13 | 233 BONGO  | -52.85889 -40.09685 | Bongo nets deployed                                      |
| 23/11/2006 08:06 | 232 CTD    | -52.85888 -40.09684 | CTD on deck.   |
| 23/11/2006 08:04 | 232 CTD    | -52.85889 -40.09685 | CTD at the surface.                                      |
| 23/11/2006 06:48 | 232 CTD    | -52.85894 -40.09683 | CTD @ 3728m  |
| 23/11/2006 05:41 | 232 CTD    | -52.85886 -40.09707 | CTD deployed   |
| 23/11/2006 05:28 | 231 FRRF   | -52.85899 -40.09721 | FRRF recovered   |
| 23/11/2006 05:14 | 231 FRRF   | -52.85854 -40.09736 | FRRF @ 150m  |
| 23/11/2006 05:05 | 231 FRRF   | -52.85857 -40.09739 | FRRF deployed  |
| 23/11/2006 05:00 | 231 FRRF   | -52.85998 -40.09718 | Slowing for Process Station Three                        |
| 23/11/2006 04:51 | 230 RMT-25 | -52.85001 -40.0797  | Deck Secure proceeding to FRRF station                   |

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| 23/11/2006 04:42 | 230 RMT-25 | -52.8515 -40.08156 RMT 25 recovered  |
| 23/11/2006 04:36 | 230 RMT-25 | -52.85617 -40.08406 RMT @ Surface  |
| 23/11/2006 04:31 | 230 RMT-25 | -52.85957 -40.08572 RMT 25 @ 49m (cable out)   |
| 23/11/2006 03:52 | 230 RMT-25 | -52.88788 -40.09971 RMT 25 Deployed @ 2.5kts   |
| 23/11/2006 03:45 | 230 RMT-25 | -52.8929 -40.10223 Deploying RMT 25  |
| 23/11/2006 03:39 | 230 RMT-25 | -52.88895 -40.10126 Slowing for RMT 25 deployment  |
| 23/11/2006 03:16 | RMT-25     | -52.84867 -40.08505 deck secure moving off to look for targets   |
| 23/11/2006 03:11 | 229 RMT-25 | -52.85033 -40.08674 RMT 25 recovered   |
| 23/11/2006 02:38 | 229 RMT-25 | -52.87269 -40.10358 RMT 25 @ 53m (cable out)   |
| 23/11/2006 02:36 | 229 RMT-25 | -52.87416 -40.10466 RMT 25 deployed  |
| 23/11/2006 02:21 | RMT-25     | -52.87516 -40.10566 Targets identified turn head to wind and prepare for RMT deployment turn head to wind and prepare for RMT deployment |
| 23/11/2006 02:00 | RMT-25     | -52.82821 -40.0669 All secure a/c to run downwind looking for krill targets a/c to run downwind looking for krill targets                |
| 23/11/2006 01:42 | 228 RMT-25 | -52.83486 -40.07409 RMT recovered  |
| 23/11/2006 01:26 | 228 RMT-25 | -52.84443 -40.08351 RMT @ Surface  |
| 23/11/2006 01:17 | 228 RMT-25 | -52.84982 -40.0889 Commence hauling RMT  |
| 23/11/2006 01:06 | 228 RMT-25 | -52.85716 -40.09431 RMT 25 @ 54m (cable out)   |
| 23/11/2006 01:03 | 228 RMT-25 | -52.85938 -40.09604 RMT 25 deployed  |
| 23/11/2006 00:56 | 228 RMT-25 | -52.86356 -40.09849 Commence deploying RMT   |
| 23/11/2006 00:40 |            | -52.86381 -40.10221 Targets identified turn head to wind and prepare for RMT deployment turn head to wind and prepare for RMT deployment |
| 23/11/2006 00:29 |            | -52.85557 -40.09373 Vessel off DP running down wind to search for RMT targets  |
| 22/11/2006 23:44 |            | -52.85578 -40.09382 Weights recovered  |
| 22/11/2006 23:30 |            | -52.8576 -40.09489 Weights @ 500m  |
| 22/11/2006 23:16 |            | -52.8594 -40.09598 V/L moving ahead at 0.5knots on DP. Weights deployed on conducting wire.  |
| 22/11/2006 23:05 |            | -52.86007 -40.09711 V/L on DP @ process station 4  |
| 22/11/2006 22:38 |            | -52.85779 -40.09605 Vessel at Process Station No.3   |
| 22/11/2006 21:37 |            | -52.94286 -40.14645 Ships speed 5 knots  |
| 22/11/2006 21:27 |            | -52.96335 -40.15887 Commenced reducing speed to 5 knots.   |

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| 22/11/2006 20:32 | 227 XBT    | -53.13776 -40.26627 XBT Completed Increasing Speed  |
| 22/11/2006 20:27 | 227 XBT    | -53.14803 -40.27096 XBT Deployed  |
| 22/11/2006 18:28 |            | -53.52243 -40.46603 Deck Secure proceeding to process station 3   |
| 22/11/2006 18:21 | 226 CTD    | -53.52325 -40.46501 CTD recovered   |
| 22/11/2006 17:28 | 226 CTD    | -53.52319 -40.46509 CTD @ 2007m   |
| 22/11/2006 16:49 | 226 CTD    | -53.52308 -40.46506 CTD deployed  |
| 22/11/2006 16:41 | 226 CTD    | -53.52337 -40.46407 Vessel on D.P. ready to deploy  |
| 22/11/2006 16:36 | 226 CTD    | -53.52211 -40.46416 Slowing for CTD station "J"   |
| 22/11/2006 12:34 |            | -54.23816 -40.81356 Vessel moving off station   |
| 22/11/2006 12:30 | 225 CTD    | -54.23814 -40.81356 CTD Recovered   |
| 22/11/2006 11:32 | 225 CTD    | -54.23816 -40.81365 CTD @ 2013m   |
| 22/11/2006 10:54 | 225 CTD    | -54.23815 -40.81363 CTD deployed  |
| 22/11/2006 10:50 |            | -54.23814 -40.81366 Vessel stopped on station in DP midships gantry unlashed. midships gantry unlashed. |
| 22/11/2006 09:04 | 224 XBT    | -54.56465 -40.99199 XBT Completed Increasing Speed  |
| 22/11/2006 08:58 | 224 XBT    | -54.57851 -40.99889 XBT Deployed  |
| 22/11/2006 05:47 |            | -55.20557 -41.2467 Deck Secure proceeding to CTD I Station  |
| 22/11/2006 05:40 | 223 FRRF   | -55.20672 -41.24673 FRRF recovered  |
| 22/11/2006 05:17 | 223 FRRF   | -55.20668 -41.24675 FRRF @ 150m   |
| 22/11/2006 05:04 | 223 FRRF   | -55.20666 -41.24673 FRRF deployed   |
| 22/11/2006 04:57 | 223 FRRF   | -55.20708 -41.24645 Vessel on D.P. ready to deploy  |
| 22/11/2006 04:54 | 223 FRRF   | -55.20708 -41.2433 Slowing for FRRF station   |
| 22/11/2006 04:40 |            | -55.17622 -41.22623 Deck Secure proceeding to process station 2   |
| 22/11/2006 04:30 | 222 RMT-25 | -55.17932 -41.22224 RMT 25 recovered  |
| 22/11/2006 04:13 | 222 RMT-25 | -55.18851 -41.21113 recovering RMT due to fault possible net monitor possible net monitor               |
| 22/11/2006 04:07 | 222 RMT-25 | -55.19136 -41.20702 RMT 25 @ 208m (cable out)   |
| 22/11/2006 03:54 | 222 RMT-25 | -55.19727 -41.19772 RMT 25 Deployed @ 2.5kts  |
| 22/11/2006 03:50 | 222 RMT-25 | -55.19911 -41.19497 Deploying RMT 25  |
| 22/11/2006 03:40 | 222 RMT-25 | -55.2068 -41.18438 Slowing for RMT deployment   |
| 22/11/2006 01:42 | RMT-25     | -55.16308 -41.25328 Run down wind in preparation for RMT 25 target fishing                              |
| 22/11/2006 01:40 |            | -55.16318 -41.25311 Work continuing to rectify LHPR problem. Cable will require retermination           |

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| 22/11/2006 00:20 |              | -55.17597 -41.22564 V/L holding position while work is undertaken to rectify LHPR problem                              |
| 22/11/2006 00:16 | 221 LHPR     | -55.1779 -41.22266 LHPR Recovered<br>LHPR stopped at 605m cable out equipment failure commence recovery equipment      |
| 21/11/2006 23:55 | 221 LHPR     | -55.18783 -41.20785 failure commence recovery  |
| 21/11/2006 23:51 | 221 LHPR     | -55.1898 -41.20503 Resume veering LHPR   |
| 21/11/2006 23:44 | 221 LHPR     | -55.19241 -41.20128 LHPR stopped @ 484m cable out equipment problem equipment problem                                  |
| 21/11/2006 23:31 | 221 LHPR     | -55.19863 -41.19252 LHPR Deployed @ 2.0kts   |
| 21/11/2006 22:10 | LHPR         | -55.29452 -41.2946 Repositioning vessel for LHPR deployment  |
| 21/11/2006 22:06 | 220 MULTINET | -55.29093 -41.29206 Multinet Recovered   |
| 21/11/2006 22:03 | 220 MULTINET | -55.28861 -41.29066 Multinet @ Surface   |
| 21/11/2006 20:49 | 220 MULTINET | -55.23562 -41.25872 Multinet at 1925m and recovering   |
| 21/11/2006 19:43 | 220 MULTINET | -55.19134 -41.2321 Multinet Deployed @ 2kt   |
| 21/11/2006 19:37 |              | -55.19093 -41.22907 Turning vessel and reducing speed for Multinet deployment.   |
| 21/11/2006 18:31 | 219          | -55.38504 -41.38531 Vessel proceeding back to process station  |
| 21/11/2006 18:24 | 219 RMT-25   | -55.3769 -41.38231 RMT Recovered   |
| 21/11/2006 18:17 | 219 RMT-25   | -55.37727 -41.38242 RMT @ Surface  |
| 21/11/2006 17:43 | 219 RMT-25   | -55.33742 -41.36992 RMT 25 @ 495m (cable out)  |
| 21/11/2006 17:24 | 219 RMT-25   | -55.32046 -41.36445 RMT 25 Deployed @ 2.5kts   |
| 21/11/2006 17:18 | 219 RMT-25   | -55.31531 -41.36289 Deploying RMT 25   |
| 21/11/2006 17:17 | 219 RMT-25   | -55.31442 -41.36288 ready to deploy  |
| 21/11/2006 17:14 | 219 RMT-25   | -55.31467 -41.36977 Slowing for RMT deployment   |
| 21/11/2006 16:43 | 218 RMT-25   | -55.39391 -41.45038 Vessel towards process station   |
| 21/11/2006 16:41 | 218 RMT-25   | -55.39201 -41.44839 RMT 25 recovered   |
| 21/11/2006 15:29 | 218 RMT-25   | -55.3326 -41.39283 RMT 25 @ 636m (cable out)   |
| 21/11/2006 15:00 | 218 RMT-25   | -55.31128 -41.37365 RMT 25 deployed  |
| 21/11/2006 14:39 | 217 RMT-25   | -55.30114 -41.36761 RMT 25 recovered   |
| 21/11/2006 12:36 | 217 RMT-25   | -55.20031 -41.28934 RMT 25 @ 2266m (cable out)   |
| 21/11/2006 11:33 | 217 RMT-25   | -55.148 -41.24559 RMT 25 Deployed<br>Completed Acoustic Survey relocating for RMT 25 deployment. relocating for RMT 25 |
| 21/11/2006 10:17 | 216 ACOUSTIC | -55.20621 -41.63975 deployment.  |



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| 21/11/2006 07:35 | 216 ACOUSTIC | -55.20615 | -40.85139 | Commence Acoustic transect on 270T @ 10.0kts                                       |
| 21/11/2006 07:29 |              | -55.2177  | -40.84393 | Turning vessel for start point of Acoustic Survey.                                 |
| 21/11/2006 06:58 |              | -55.27505 | -40.96806 | deck secure proceeding to acoustic survey run                                      |
| 21/11/2006 06:52 | 215 RMT-25   | -55.27238 | -40.9651  | RMT 25 recovered   |
| 21/11/2006 06:46 | 215 RMT-25   | -55.26817 | -40.95986 | RMT 25 @ Surface   |
| 21/11/2006 06:11 | 215 RMT-25   | -55.24501 | -40.93156 | RMT 25 @ 153m (cable out)  |
| 21/11/2006 06:05 | 215 RMT-25   | -55.24056 | -40.92718 | RMT 25 Deployed @ 2.5kts   |
| 21/11/2006 05:59 | 215 RMT-25   | -55.23582 | -40.92272 | Deploying RMT 25   |
| 21/11/2006 05:54 | 215 RMT-25   | -55.233   | -40.9272  | Slowing for RMT deployment   |
| 21/11/2006 04:50 |              | -55.33461 | -41.20376 | deck secure proceeding towards acoustic survey run                                 |
| 21/11/2006 04:38 | 214 RMT-25   | -55.33108 | -41.20453 | RMT 25 recovered   |
| 21/11/2006 04:31 | 214 RMT-25   | -55.32323 | -41.19969 | RMT 25 @ Surface   |
| 21/11/2006 03:29 | 214 RMT-25   | -55.26932 | -41.16689 | RMT 25 @ 714m (cable out)  |
| 21/11/2006 03:00 | 214 RMT-25   | -55.24562 | -41.15184 | RMT 25 Deployed  |
| 21/11/2006 02:50 |              | -55.23961 | -41.14896 | V/L off DP preparing for RMT   |
| 21/11/2006 02:32 | 213 FRRF     | -55.23961 | -41.14891 | FRRF recovered   |
| 21/11/2006 02:13 | 213 FRRF     | -55.23961 | -41.14895 | FRRF @ 150m commence recovery commence recovery                                    |
| 21/11/2006 02:02 | 213 FRRF     | -55.23961 | -41.14916 | FRRF deployed  |
| 21/11/2006 02:00 |              | -55.23964 | -41.14901 | V/L on DP for FRRF   |
| 21/11/2006 01:30 |              | -55.27728 | -41.17763 | LHPR secure a/c to run downwind a/c to run downwind                                |
| 21/11/2006 01:28 | 211 LHPR     | -55.27478 | -41.17731 | LHPR Recovered   |
| 21/11/2006 00:08 | 211 LHPR     | -55.19111 | -41.27729 | LHPR@ 2439m (cable out)  |
| 21/11/2006 00:04 | 211 LHPR     | -55.18744 | -41.28309 | Increase to 3.5 knots  |
| 20/11/2006 23:47 | 212 NEUSTON  | -55.17713 | -41.30252 | Neuston sledge recovered   |
| 20/11/2006 23:10 | 212 NEUSTON  | -55.15544 | -41.34462 | Neuston sledge deployed  |
| 20/11/2006 23:04 | 211 LHPR     | -55.15143 | -41.35178 | LHPR Deployed @ 2.0kts   |
| 20/11/2006 23:00 |              | -55.1497  | -41.35534 | V/L off DP preparing to deploy LHPR  |
| 20/11/2006 21:21 | 210 LHPR     | -55.2927  | -41.08158 | LHPR on deck repositioning vessel for next run. repositioning vessel for next run. |
| 20/11/2006 21:19 | 210 LHPR     | -55.29088 | -41.08513 | LHPR at the surface.   |
| 20/11/2006 20:11 | 210 LHPR     | -55.22736 | -41.20331 | LHPR @ 2050 commence hauling commence hauling                                      |

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| 20/11/2006 20:08 | 210 LHPR     | -55.22481 | -41.20796 | Increase to 3.5 knots   |
| 20/11/2006 19:17 | 210 LHPR     | -55.19647 | -41.26052 | LHPR Deployed @ 2.0kts  |
| 20/11/2006 19:10 |              | -55.1966  | -41.2657  | Vessel turning into wind and reducing speed for LHPR deployment.                      |
| 20/11/2006 18:07 |              | -55.31178 | -41.01233 | Vessel proceeding back to process station   |
| 20/11/2006 17:46 | 209 MULTINET | -55.30559 | -41.03086 | Multinet Recovered  |
| 20/11/2006 17:44 | 209 MULTINET | -55.30465 | -41.03316 | Multinet @ Surface  |
|                  |              |           |           | Recommence hauling electronics not fixed. Hauling for recovery electronics not fixed. |
| 20/11/2006 17:01 | 209 MULTINET | -55.28178 | -41.08724 | Hauling for recovery  |
| 20/11/2006 16:56 | 209 MULTINET | -55.27896 | -41.09365 | Hauling stopped due to problem with electronics for net monitor                       |
| 20/11/2006 16:30 | 209 MULTINET | -55.26415 | -41.12687 | Multinet at 2284m and recovering  |
| 20/11/2006 15:11 | 209 MULTINET | -55.21935 | -41.22666 | Multinet Deployed @ 2kt   |
| 20/11/2006 15:08 | 209 MULTINET | -55.21768 | -41.23057 | Deploying the multinet  |
| 20/11/2006 15:03 |              | -55.21633 | -41.23394 | Vessel moving off station to deploy multinet  |
| 20/11/2006 13:00 |              | -55.21625 | -41.23339 | V/L sat on DP awaiting rigging of mulit net   |
| 20/11/2006 12:55 | 208 BONGO    | -55.21625 | -41.23336 | Bongo nets recovered  |
| 20/11/2006 12:49 | 208 BONGO    | -55.21553 | -41.23384 | Bongo nets @125m commenced recovery. commenced recovery.                              |
| 20/11/2006 12:46 | 208 BONGO    | -55.2153  | -41.23403 | Bongo nets deployed   |
| 20/11/2006 12:38 | 207 CTD      | -55.2153  | -41.23404 | CTD recovered   |
| 20/11/2006 12:26 | 207 CTD      | -55.21529 | -41.23402 | CTD @ 60m   |
| 20/11/2006 12:22 | 207 CTD      | -55.2153  | -41.23402 | CTD deployed  |
| 20/11/2006 12:13 | 206 FRRF     | -55.21532 | -41.23404 | FRRF recovered  |
| 20/11/2006 11:54 | 206 FRRF     | -55.21531 | -41.23404 | FRRF @ 150m commence recovery commence recovery                                       |
| 20/11/2006 11:40 | 206 FRRF     | -55.21528 | -41.23403 | FRRF deployed   |
| 20/11/2006 11:31 | 205 GO-FLO   | -55.21516 | -41.23418 | go-flo recovered  |
| 20/11/2006 11:01 | 205 GO-FLO   | -55.21299 | -41.23689 | commence recovery of go-flo   |
| 20/11/2006 10:46 | 205 GO-FLO   | -55.21162 | -41.23855 | Go Flo wire at 1000m Trigger weight deployed.   |
| 20/11/2006 10:45 | 205 GO-FLO   | -55.21156 | -41.23861 | Sixth Go Flo bottle attached  |
| 20/11/2006 10:43 | 205 GO-FLO   | -55.21135 | -41.23888 | Fifth Go Flo bottle attached  |
| 20/11/2006 10:40 | 205 GO-FLO   | -55.21113 | -41.23918 | Fourth Go Flo bottle attached   |
| 20/11/2006 10:37 | 205 GO-FLO   | -55.21093 | -41.23943 | Third Go Flo bottle attached  |

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| 20/11/2006 10:29 | 205 GO-FLO | -55.21038 -41.2401  | Second Go Flo bottle attached.                            |
| 20/11/2006 10:17 | 205 GO-FLO | -55.21005 -41.24052 | Go-Flo deployed with first bottle.                        |
| 20/11/2006 10:05 | 204 CTD    | -55.21005 -41.24052 | CTD on deck. Setting up for Go Flo.                       |
| 20/11/2006 10:03 | 204 CTD    | -55.21007 -41.24053 | CTD at the surface.                                       |
| 20/11/2006 09:41 | 204 CTD    | -55.21009 -41.24053 | CTD @ 140m Commenced recovery. Commenced recovery.        |
| 20/11/2006 09:33 | 204 CTD    | -55.21009 -41.24053 | CTD deployed  |
| 20/11/2006 09:16 | 203 CTD    | -55.21299 -41.23653 | CTD on deck.  |
| 20/11/2006 09:14 | 203 CTD    | -55.21306 -41.23645 | CTD at the surface.                                       |
| 20/11/2006 08:37 | 203 CTD    | -55.21303 -41.23644 | CTD @ 2000m Commencing recovery. Commencing recovery.     |
| 20/11/2006 07:59 | 203 CTD    | -55.21305 -41.2364  | CTD deployed  |
| 20/11/2006 07:37 | 202 CTD    | -55.21543 -41.23309 | CTD on deck.  |
| 20/11/2006 07:35 | 202 CTD    | -55.21543 -41.23305 | CTD at the surface.                                       |
| 20/11/2006 06:27 | 202 CTD    | -55.21069 -41.24018 | CTD @ 3178m   |
| 20/11/2006 05:28 | 202 CTD    | -55.20673 -41.24668 | CTD deployed  |
| 20/11/2006 05:21 | 202 CTD    | -55.20665 -41.24646 | vessel on auto posn dp @ process station2                 |
| 20/11/2006 05:09 |            | -55.20621 -41.24471 | Slowing for Process Station Two                           |
| 20/11/2006 04:25 |            | -55.20871 -41.47304 | Deck Secure proceeding to process station 2               |
| 20/11/2006 04:17 | 201 RMT-25 | -55.20965 -41.48898 | RMT 25 recovered  |
| 20/11/2006 04:11 | 201 RMT-25 | -55.21022 -41.49908 | RMT 25 @ Surface  |
| 20/11/2006 03:46 | 201 RMT-25 | -55.21269 -41.53811 | RMT 25 @ 306m (cable out)                                 |
| 20/11/2006 03:29 | 201 RMT-25 | -55.2144 -41.56429  | RMT 25 Deployed @ 2.5kts                                  |
| 20/11/2006 03:22 | 201 RMT-25 | -55.21501 -41.57498 | Deploying RMT 25  |
| 20/11/2006 02:50 | 200 RMT-25 | -55.21364 -41.58719 | RMT Recovered   |
| 20/11/2006 01:56 | 200 RMT-25 | -55.21184 -41.54712 | RMT 25 @ 100m (cable out)                                 |
| 20/11/2006 01:51 | 200 RMT-25 | -55.21098 -41.50945 | RMT 25 Deployed   |
| 20/11/2006 01:27 | 199 RMT-25 | -55.20986 -41.49183 | RMT 25 recovered  |
| 19/11/2006 23:26 | 199 RMT-25 | -55.20763 -41.32689 | RMT 25 @ 1975m (cable out)                                |
| 19/11/2006 22:27 | 199 RMT-25 | -55.20644 -41.25129 | RMT 25 Deployed   |
| 19/11/2006 22:21 | 199 RMT-25 | -55.20615 -41.2437  | Vessel out of DP and driving ahead for RMT 25 deployment. |
| 19/11/2006 21:55 |            | -55.20503 -41.23715 | Vessel stopped in DP awaiting RMT 25 deployment.          |

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| 19/11/2006 21:24 | 198 ACOUSTIC | -55.11643 | -41.24543 | Completed transect. Repositioning for RMT 25 deployment.                            |
| 19/11/2006 20:02 | 198 ACOUSTIC | -55.11615 | -41.63987 | Commenced third transect on heading 090   |
| 19/11/2006 19:30 | 198 ACOUSTIC | -55.2061  | -41.63998 | Complete second transect A/C to 000T A/C to 000T                                    |
| 19/11/2006 16:44 | 198 ACOUSTIC | -55.20639 | -40.85192 | Commence 2nd leg of acoustic transect   |
| 19/11/2006 16:08 | 198 ACOUSTIC | -55.29547 | -40.85516 | Complete first transect A/C to 000T A/C to 000T                                     |
| 19/11/2006 14:48 | 198 ACOUSTIC | -55.29673 | -41.24815 | Commence leg 1 of acoustic transect   |
|                  |              |           |           | All secure on deck moving off to begin acoustic survey moving off to begin acoustic |
| 19/11/2006 14:11 |              | -55.22789 | -41.2045  | survey  |
| 19/11/2006 14:03 | 197 BONGO    | -55.22766 | -41.20459 | Bongo nets recovered  |
| 19/11/2006 13:45 | 197 BONGO    | -55.22575 | -41.20497 | Bongo nets @400m commenced recovery. commenced recovery.                            |
| 19/11/2006 13:31 | 197 BONGO    | -55.22377 | -41.20561 | Bongo nets deployed   |
| 19/11/2006 13:29 | 196 BONGO    | -55.2235  | -41.2057  | Bongo nets recovered  |
| 19/11/2006 13:12 | 196 BONGO    | -55.22138 | -41.20637 | Bongo nets @400m commenced recovery. commenced recovery.                            |
| 19/11/2006 13:01 | 196 BONGO    | -55.22037 | -41.20661 | Bongo deployed  |
| 19/11/2006 12:54 | 195 CTD      | -55.22041 | -41.20664 | CTD recovered   |
| 19/11/2006 12:36 | 195 CTD      | -55.22038 | -41.2066  | CTD @ 400m commencing recovery. commencing recovery.                                |
| 19/11/2006 12:24 | 195 CTD      | -55.2204  | -41.20668 | CTD deployed  |
| 19/11/2006 11:58 | 194 CTD      | -55.22037 | -41.20664 | CTD recovered   |
| 19/11/2006 11:39 | 194 CTD      | -55.22034 | -41.2067  | CTD @ 140m Commenced recovery. Commenced recovery.                                  |
| 19/11/2006 11:29 | 194 CTD      | -55.22034 | -41.20675 | CTD deployed  |
| 19/11/2006 11:22 | 193 FRRF     | -55.21981 | -41.20693 | FRRF recovered  |
| 19/11/2006 11:01 | 193 FRRF     | -55.21802 | -41.20768 | FRRF @ 150m commence recovery commence recovery                                     |
| 19/11/2006 10:51 | 193 FRRF     | -55.21764 | -41.2083  | FRRF deployed   |
| 19/11/2006 10:41 | 192 GO-FLO   | -55.21741 | -41.20871 | Go Flo recovered to deck. Setting up for FRRF.                                      |
| 19/11/2006 10:29 | 192 GO-FLO   | -55.21671 | -41.2099  | Second Go Flo bottle removed  |
| 19/11/2006 10:21 | 192 GO-FLO   | -55.21621 | -41.21074 | Third Go Flo bottle removed.  |
| 19/11/2006 10:17 | 192 GO-FLO   | -55.21599 | -41.21115 | Fourth Go Flo bottle removed  |
| 19/11/2006 10:15 | 192 GO-FLO   | -55.21586 | -41.21132 | Fifth Go Flo bottle removed   |
| 19/11/2006 10:13 | 192 GO-FLO   | -55.21575 | -41.21146 | Sixth Go Flo bottle removed   |
| 19/11/2006 10:11 | 192 GO-FLO   | -55.21564 | -41.21175 | Commenced Go Flo recovery   |

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| 19/11/2006 09:54 | 192 GO-FLO  | -55.21464 -41.21344 | Go Flo wire at 1000m Trigger weight deployed.                                       |
| 19/11/2006 09:53 | 192 GO-FLO  | -55.21459 -41.2135  | Sixth Go Flo bottle attached  |
| 19/11/2006 09:51 | 192 GO-FLO  | -55.21448 -41.21379 | Fifth Go Flo bottle attached  |
| 19/11/2006 09:49 | 192 GO-FLO  | -55.21436 -41.21399 | Fourth Go Flo bottle attached   |
| 19/11/2006 09:46 | 192 GO-FLO  | -55.2142 -41.2143   | Third Go Flo bottle attached  |
| 19/11/2006 09:38 | 192 GO-FLO  | -55.21372 -41.21516 | Second Go Flo bottle attached.  |
| 19/11/2006 09:24 | 192 GO-FLO  | -55.21332 -41.21608 | Go-Flo deployed with first bottle.  |
| 19/11/2006 09:07 | 191 CTD     | -55.21335 -41.21608 | CTD on deck. Setting up for Go Flo.   |
| 19/11/2006 09:06 | 191 CTD     | -55.21333 -41.21598 | CTD at the surface.   |
| 19/11/2006 09:04 | 191 CTD     | -55.21332 -41.21606 | Recovering CTD  |
| 19/11/2006 08:58 | 191 CTD     | -55.21332 -41.21604 | CTD at depth 40m  |
| 19/11/2006 08:54 | 191 CTD     | -55.21336 -41.21605 | CTD deployed. One bottle short.   |
| 19/11/2006 08:42 | 191 CTD     | -55.21387 -41.21357 | Broken bottle found on CTD. Deployment held while a new bottle is found and fitted. |
| 19/11/2006 08:15 | 190 CTD     | -55.21503 -41.20891 | CTD on deck   |
| 19/11/2006 08:13 | 190 CTD     | -55.21502 -41.20912 | CTD at the surface.   |
| 19/11/2006 07:34 | 190 CTD     | -55.21476 -41.2128  | CTD @ 2000m Commencing recovery. Commencing recovery.                               |
| 19/11/2006 06:57 | 190 CTD     | -55.21408 -41.21743 | CTD Deployed  |
| 19/11/2006 06:54 | 190 CTD     | -55.214 -41.21791   | Clear to deploy CTD   |
| 19/11/2006 06:37 | 189 CTD     | -55.21352 -41.22125 | CTD Recovered   |
| 19/11/2006 05:30 | 189 CTD     | -55.20908 -41.23557 | CTD @ 3172m and commence recovery   |
| 19/11/2006 04:34 | 189 CTD     | -55.20609 -41.24596 | CTD Deployed  |
| 19/11/2006 04:31 | 189 CTD     | -55.2061 -41.24592  | Clear to deploy CTD   |
| 19/11/2006 04:26 | 188 FRRF    | -55.20608 -41.24596 | FRRF Recovered  |
| 19/11/2006 04:10 | 188 FRRF    | -55.20608 -41.24596 | FRRF @ 150m commence recovery commence recovery                                     |
| 19/11/2006 04:02 | 188 FRRF    | -55.2061 -41.2459   | FRRF deployed   |
| 19/11/2006 03:59 | 188 FRRF    | -55.20618 -41.24576 | Clear to deploy FRRF  |
| 19/11/2006 03:56 |             | -55.20638 -41.24525 | Vessel on station in DP. Midships gantry unlashed.                                  |
| 19/11/2006 03:46 |             | -55.20304 -41.24538 | Vessel slowing for station  |
| 19/11/2006 03:08 | 187 MOCNESS | -55.21069 -41.31152 | Mocness Recovered   |
| 19/11/2006 03:05 | 187 MOCNESS | -55.20995 -41.30718 | Mocness @ Surface   |

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| 19/11/2006 01:51 | 187 MOCNESS   | -55.1952  | -41.2208  | Mocness @ 2376m cable out   | commence hauling     | commence hauling |
| 19/11/2006 00:33 | 187 MOCNESS   | -55.18171 | -41.13068 | Mocness deployed @ 2.0kts   |                      |                  |
| 19/11/2006 00:25 |               | -55.17951 | -41.12466 | Vessel of DP preparing for mocness  |                      |                  |
| 18/11/2006 23:35 |               | -55.17602 | -41.1257  | V/L on DP awaiting de-rigging of RMT and rigging of Mocness                       |                      |                  |
| 18/11/2006 23:26 | 186 RMT-25    | -55.17453 | -41.11836 | RMT Recovered   |                      |                  |
| 18/11/2006 22:41 | 186 RMT-25    | -55.16595 | -41.06349 | RMT 25 at the surface. Gilson winch required to land net on deck.                 |                      |                  |
| 18/11/2006 22:39 | 186 RMT-26    | -55.1655  | -41.06134 | Hauling RMT for recovery  |                      |                  |
| 18/11/2006 22:14 | 186 RMT-25    | -55.15914 | -41.03013 | RMT 25 Deployed   |                      |                  |
| 18/11/2006 22:00 | 186 RMT-25    | -55.15714 | -41.02041 | Turning ship and setting up for RMT 25 deployment                                 |                      |                  |
| 18/11/2006 21:26 | 185 RMT-25    | -55.16775 | -41.07081 | RMT 25 on Deck  |                      |                  |
| 18/11/2006 21:21 | 185 RMT-25    | -55.16626 | -41.06442 | RMT 25 at the surface   |                      |                  |
| 18/11/2006 21:14 | 185 RMT-25    | -55.16399 | -41.05488 | Hauling RMT for recovery  |                      |                  |
| 18/11/2006 20:33 | 185 RMT-25    | -55.15154 | -41.00195 | RMT 25 Deployed   |                      |                  |
| 18/11/2006 20:15 | 185 RMT-25    | -55.14996 | -40.99466 | Turning ship and setting up for RMT 25 deployment                                 |                      |                  |
| 18/11/2006 18:00 |               | -55.24912 | -41.45708 | Vessel heading downwind looking for targets while repairs are made to RMT 25 wire |                      |                  |
| 18/11/2006 17:26 | 184 LHPR      | -55.24189 | -41.43667 | LHPR Recovered  |                      |                  |
| 18/11/2006 16:16 | 184 LHPR      | -55.21803 | -41.31376 | LHPR @ 2017m and commence recovering  |                      |                  |
| 18/11/2006 16:11 | 184 LHPR      | -55.21734 | -41.30616 | Increase to 3.5 knots   |                      |                  |
| 18/11/2006 15:23 | 184 LHPR      | -55.21179 | -41.24517 | LHPR Deployed @ 2.0kts  |                      |                  |
| 18/11/2006 15:20 | 184 LHPR      | -55.2116  | -41.24134 | Deploying LHPR  |                      |                  |
| 18/11/2006 15:15 |               | -55.21109 | -41.24029 | Midships Gantry Secure vessel out of DP and moving off for LHPR deployment.       | vessel               |                  |
| 18/11/2006 15:08 | 183 MINIBONGO | -55.21042 | -41.2406  | Mini Bongos Recovered   |                      |                  |
| 18/11/2006 14:50 | 183 MINIBONGO | -55.20924 | -41.24121 | Mini Bongos @ 400m and Recovering   |                      |                  |
| 18/11/2006 14:38 | 183 MINIBONGO | -55.20842 | -41.24166 | Mini Bongos Deployed  |                      |                  |
| 18/11/2006 14:30 | 181 CTD       | -55.20842 | -41.24165 | CTD recovered   |                      |                  |
| 18/11/2006 13:54 | 181 CTD       | -55.20837 | -41.24172 | Commence hauling CTD  |                      |                  |
| 18/11/2006 13:52 | 182 MOORING   | -55.2084  | -41.24172 | Release test successful hydrophone recovered                                      | hydrophone recovered |                  |
| 18/11/2006 13:49 | 182 MOORING   | -55.20838 | -41.24169 | Hydrophone deployed for acoustic release test                                     |                      |                  |
| 18/11/2006 13:48 | 181 CTD       | -55.20838 | -41.24171 | CTD @ 2000m   |                      |                  |

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| 18/11/2006 13:10 | 181 CTD    | -55.2084 -41.24166 CTD deployed  |
| 18/11/2006 12:58 | 180 BONGO  | -55.20845 -41.24168 Bongo nets recovered                                     |
| 18/11/2006 12:42 | 180 BONGO  | -55.20737 -41.24233 Bongo nets @400m commenced recovery. commenced recovery. |
| 18/11/2006 12:30 | 180 BONGO  | -55.20734 -41.2422 Bongo deployed  |
| 18/11/2006 12:24 | 179 CTD    | -55.20742 -41.24257 CTD recovered  |
| 18/11/2006 12:13 | 179 CTD    | -55.20745 -41.24264 CTD @ 40m  |
| 18/11/2006 12:09 | 179 CTD    | -55.20745 -41.24263 CTD deployed   |
| 18/11/2006 12:00 | 178 FRRF   | -55.20743 -41.24267 FRRF recovered   |
| 18/11/2006 11:44 | 178 FRRF   | -55.20741 -41.24261 FRRF @ 150m commence recovery commence recovery          |
| 18/11/2006 11:32 | 178 FRRF   | -55.20741 -41.24262 FRRF deployed  |
| 18/11/2006 11:23 | 177 GO-FLO | -55.20739 -41.24268 go-flo recovered   |
| 18/11/2006 11:11 | 177 GO-FLO | -55.2074 -41.24282 2nd Go Flow bottle removed                                |
| 18/11/2006 11:04 | 177 GO-FLO | -55.20732 -41.2431 3rd glo-flo bottle removed                                |
| 18/11/2006 11:00 | 177 GO-FLO | -55.20716 -41.24351 Fourth Go Flo bottle removed                             |
| 18/11/2006 10:59 | 177 GO-FLO | -55.20712 -41.24367 Fifth Go Flo bottle removed                              |
| 18/11/2006 10:57 | 177 GO-FLO | -55.20704 -41.24389 Sixth Go Flo bottle removed                              |
| 18/11/2006 10:56 | 177 GO-FLO | -55.207 -41.24402 Commenced recovery of Go Flo                               |
| 18/11/2006 10:39 | 177 GO-FLO | -55.20659 -41.24456 Go Flo wire at 1000m Trigger weight deployed.            |
| 18/11/2006 10:38 | 177 GO-FLO | -55.20655 -41.24462 Sixth Go Flo bottle attached                             |
| 18/11/2006 10:35 | 177 GO-FLO | -55.20636 -41.24466 Fifth Go Flo bottle attached                             |
| 18/11/2006 10:33 | 177 GO-FLO | -55.20625 -41.24469 Fourth Go Flo bottle attached                            |
| 18/11/2006 10:29 | 177 GO-FLO | -55.20607 -41.24474 Third Go Flo bottle attached                             |
| 18/11/2006 10:21 | 177 GO-FLO | -55.20602 -41.24476 Second Go Flo bottle attached.                           |
| 18/11/2006 10:09 | 177 GO-FLO | -55.206 -41.24482 Deploying Go flo with first bottle                         |
| 18/11/2006 09:57 | 176 CTD    | -55.206 -41.24483 CTD on deck  |
| 18/11/2006 09:54 | 176 CTD    | -55.20602 -41.2448 CTD at the surface.                                       |
| 18/11/2006 09:35 | 176 CTD    | -55.20602 -41.24492 CTD @ 140m Commenced recovery. Commenced recovery.       |
| 18/11/2006 09:29 | 176 CTD    | -55.20602 -41.24487 CTD deployed   |
| 18/11/2006 09:18 | 175 BONGO  | -55.2059 -41.2434 Bongo Nets on board.                                       |
| 18/11/2006 09:17 | 175 BONGO  | -55.20589 -41.24347 Bongo Nets at the surface.                               |

|                  |              |           |           |   |   |
|------------------|--------------|-----------|-----------|---|---|
| 18/11/2006 09:00 | 175 BONGO    | -55.20573 | -41.24534 | Bongo nets @400m commenced recovery.              | commenced recovery.                     |
| 18/11/2006 08:49 | 175 BONGO    | -55.20595 | -41.2463  | Bongo nets deployed                               |   |
| 18/11/2006 08:42 | 174 CTD      | -55.20593 | -41.2462  | CTD on deck                                       |   |
| 18/11/2006 08:39 | 174 CTD      | -55.20591 | -41.24626 | CTD at the surface.                               |   |
| 18/11/2006 07:30 | 174 CTD      | -55.20595 | -41.24625 | CTD @ 3187m                                       | Commenced recovery. Commenced recovery. |
| 18/11/2006 06:30 | 174 CTD      | -55.20593 | -41.24617 | CTD Deployed                                      |   |
| 18/11/2006 06:19 | 174 CTD      | -55.20603 | -41.24568 | Vessel on DP at station for CTD                   |   |
| 18/11/2006 06:10 |              | -55.20723 | -41.23555 | Vessel slowing for station                        |   |
| 18/11/2006 03:33 | 173 XBT      | -55.63398 | -41.28847 | XBT Deployed                                      |   |
| 17/11/2006 23:49 |              | -56.22574 | -41.83286 | All secure on deck. Resume transect               |   |
| 17/11/2006 23:38 | 172 XBT      | -56.22087 | -41.82053 | XBT deployed (successful)                         |   |
| 17/11/2006 23:32 | 171 XBT      | -56.22082 | -41.82075 | XBT deployed (failed)                             |   |
|                  |              |           |           | WX Conditions unsuitable for CTD deployment       | deploy XBT then proceed to p2 deploy    |
| 17/11/2006 23:30 |              | -56.22085 | -41.82075 | XBT then proceed to p2                            |   |
| 17/11/2006 23:15 |              | -56.2207  | -41.81425 | V/L on station for CTD deployment                 |   |
| 17/11/2006 21:31 | 170 XBT      | -56.52668 | -42.0399  | XBT Deployed                                      |   |
| 17/11/2006 21:30 | 170 XBT      | -56.52852 | -42.0425  | Clear to deploy XBT                               |   |
| 17/11/2006 19:45 | 169 XBT      | -56.83856 | -42.25856 | XBT Deployed                                      |   |
| 17/11/2006 19:44 | 169 XBT      | -56.8405  | -42.25986 | Clear to deploy XBT                               |   |
| 17/11/2006 18:10 | 168 TOW-FISH | -57.12275 | -42.41609 | Tow fish deployed                                 |   |
| 17/11/2006 18:07 | 168 TOW-FISH | -57.12583 | -42.42042 | Deploying Tow fish                                |   |
| 17/11/2006 18:02 | 168 TOW-FISH | -57.13093 | -42.42725 | Vessel reduce speed to 4kt for towfish deployment |   |
| 17/11/2006 17:55 | 167 XBT      | -57.14053 | -42.44111 | XBT Deployed                                      |   |
| 17/11/2006 17:54 | 167 XBT      | -57.14206 | -42.44318 | Clear to deploy XBT                               |   |
| 17/11/2006 15:40 |              | -57.53236 | -42.67197 | Gantry secured moving off station                 | moving off station                      |
| 17/11/2006 15:34 | 166 CTD      | -57.53236 | -42.67192 | CTD recovered                                     |   |
| 17/11/2006 15:31 | 166 CTD      | -57.53236 | -42.67192 | CTD at Surface                                    |   |
| 17/11/2006 14:29 | 145 TOW-FISH | -57.53233 | -42.67196 | Tow fish recovered                                |   |
| 17/11/2006 14:20 | 166 CTD      | -57.53237 | -42.67197 | CTD stopped @ 3054m                               |   |
| 17/11/2006 13:25 | 166 CTD      | -57.53336 | -42.673   | CTD deployed                                      |   |



|                  |               |           |           |  |
|------------------|---------------|-----------|-----------|--|
| 17/11/2006 13:15 |               | -57.53343 | -42.6731  | V/L on DP for CTD  |
| 17/11/2006 13:03 | 165 LHPR      | -57.5243  | -42.67124 | LHPR Recovered   |
| 17/11/2006 11:58 | 165 LHPR      | -57.46978 | -42.64056 | LHPR @ 1931m cable out commence hauling commence hauling                           |
| 17/11/2006 11:52 | 165 LHPR      | -57.46463 | -42.63641 | Increase to 3.5 knots  |
| 17/11/2006 11:01 | 165 LHPR      | -57.43837 | -42.61703 | LHPR Deployed @ 2.0kts   |
|                  |               |           |           | Midships Gantry Secure vessel out of DP and moving off for LHPR deployment. vessel |
| 17/11/2006 10:56 |               | -57.43632 | -42.61567 | out of DP and moving off for LHPR deployment.                                      |
| 17/11/2006 10:47 | 164 BONGO     | -57.43628 | -42.61564 | Bongo Nets on board.   |
| 17/11/2006 10:46 | 164 BONGO     | -57.43632 | -42.61569 | Bongo Nets at the surface.   |
| 17/11/2006 10:29 | 164 BONGO     | -57.43692 | -42.61625 | Bongo nets @400m commenced recovery. commenced recovery.                           |
| 17/11/2006 10:20 | 164 BONGO     | -57.43813 | -42.61731 | Bongo nets deployed  |
| 17/11/2006 10:13 | 163 CTD       | -57.43812 | -42.61728 | CTD on deck  |
| 17/11/2006 10:11 | 163 CTD       | -57.43813 | -42.61728 | CTD at the surface.  |
| 17/11/2006 10:04 | 163 CTD       | -57.43812 | -42.6173  | CTD at depth (cable out 10m)   |
| 17/11/2006 10:02 | 163 CTD       | -57.43812 | -42.61728 | CTD deployed   |
| 17/11/2006 09:47 | 162 MINIBONGO | -57.43816 | -42.61733 | Mini Bongos on Deck  |
| 17/11/2006 09:46 | 162 MINIBONGO | -57.43816 | -42.6173  | Mini Bongos at the surface   |
| 17/11/2006 09:30 | 162 MINIBONGO | -57.43815 | -42.61729 | Mini Bongos @ 400m and Recovering  |
| 17/11/2006 09:21 | 162 MINIBONGO | -57.43816 | -42.61732 | Mini Bongos Deployed   |
| 17/11/2006 09:16 | 161 CTD       | -57.43815 | -42.61731 | CTD on deck  |
| 17/11/2006 09:15 | 161 CTD       | -57.43814 | -42.61733 | CTD at the surface.  |
| 17/11/2006 08:56 | 161 CTD       | -57.43813 | -42.61733 | CTD @ 400m Commenced recovery. Commenced recovery.                                 |
| 17/11/2006 08:45 | 161 CTD       | -57.43811 | -42.61732 | CTD deployed   |
| 17/11/2006 08:33 |               | -57.43768 | -42.61586 | Vessel approaching station and setting up in DP                                    |
| 17/11/2006 07:02 |               | -57.35985 | -43.11202 | Deck Secure proceeding to CTD E Station  |
| 17/11/2006 06:38 | 160 RMT-25    | -57.35029 | -43.0758  | RMT Recovered  |
| 17/11/2006 06:29 | 160 RMT-25    | -57.34649 | -43.0601  | RMT 25 @ Surface   |
| 17/11/2006 06:05 | 160 RMT-25    | -57.33835 | -43.01331 | RMT 25 @ 140m cable out and commence hauling                                       |
| 17/11/2006 05:46 | 160 RMT-25    | -57.32989 | -42.97868 | RMT 25 Deployed  |
| 17/11/2006 05:42 | 160 RMT-25    | -57.32903 | -42.97107 | Deploying RMT 25   |

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| 17/11/2006 05:23 | 159 RMT-25   | -57.32427 -42.93196 RMT Recovered   |
| 17/11/2006 05:17 | 159 RMT-25   | -57.32189 -42.91633 RMT 25 @ Surface  |
| 17/11/2006 04:15 | 159 RMT-25   | -57.29135 -42.80884 RMT 25 @ 841m cable out and recovering  |
| 17/11/2006 03:42 | 159 RMT-25   | -57.27877 -42.7514 RMT 25 Deployed @ 2.5kts   |
| 17/11/2006 03:33 | 159 RMT      | -57.27587 -42.73376 Clear to deploy RMT   |
| 17/11/2006 03:13 | 158 FRRF     | -57.26863 -42.71573 FRRF recovered  |
| 17/11/2006 02:57 | 158 FRRF     | -57.26866 -42.71575 FRRF @ 150m commence recovery commence recovery                               |
| 17/11/2006 02:48 | 158 FRRF     | -57.26866 -42.71571 FRRF deployed   |
| 17/11/2006 02:40 |              | -57.26863 -42.71567 V/L on DP for FRRF  |
| 17/11/2006 02:33 | 157 RMT-25   | -57.26876 -42.70792 RMT 25 recovered  |
| 17/11/2006 00:33 | 157 RMT-25   | -57.37526 -42.63967 RMT 25 @ 2379m (cable out)  |
| 16/11/2006 23:21 | 157 RMT-25   | -57.4469 -42.62638 RMT Deployed   |
| 16/11/2006 23:15 | 157 RMT-25   | -57.45306 -42.62359 Commence RMT 25 deployment  |
| 16/11/2006 23:00 |              | -57.4654 -42.61276 Turning head to wind and reducing to 2.5kts for RMT 26 deployment.             |
| 16/11/2006 21:10 |              | -57.34114 -42.64286 Vessel stopped in D.P. Rigging for RMT 25 deployment.                         |
| 16/11/2006 19:51 | 156 ACOUSTIC | -57.52701 -42.76992 Broke off Transect  |
| 16/11/2006 19:25 | 156 ACOUSTIC | -57.59765 -42.75663 Resumed Transect on heading 355 @ 10kts.                                      |
| 16/11/2006 18:40 | 156 ACOUSTIC | -57.58483 -42.59693 Complete transect due to ice  |
| 16/11/2006 16:21 | 156 ACOUSTIC | -57.21457 -42.65304 Commence Acoustic transect @ 10.0kts  |
| 16/11/2006 14:58 | 155 MOCNESS  | -57.32874 -42.64098 Mocness recovered   |
| 16/11/2006 13:45 | 155 MOCNESS  | -57.38214 -42.63089 Mocness @ 2089m cable out commence hauling commence hauling                   |
| 16/11/2006 12:35 | 155 MOCNESS  | -57.43283 -42.61892 Mocness deployed @ 2.0kts   |
| 16/11/2006 12:30 | 155 MOCNESS  | -57.43676 -42.61802 Commence mocness deployment   |
| 16/11/2006 12:26 | MOCNESS      | -57.43818 -42.61734 Off station preparing for mocness deployment preparing for mocness deployment |
| 16/11/2006 12:17 | 154 FRRF     | -57.4382 -42.61737 FRRF recovered   |
| 16/11/2006 12:01 | 154 FRRF     | -57.43818 -42.61734 FRRF @ 150m commence recovery commence recovery                               |
| 16/11/2006 11:50 | 154 FRRF     | -57.43815 -42.61736 FRRF deployed   |
| 16/11/2006 11:38 | 153 GO-FLO   | -57.43814 -42.61732 Go-Flo recovered  |
| 16/11/2006 11:10 | 153 GO-FLO   | -57.43815 -42.61733 Commence hauling go-flo   |
| 16/11/2006 10:56 | 153 GO-FLO   | -57.43817 -42.61731 Go-flo @ depth 1000m bottles triggered bottles triggered                      |

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| 16/11/2006 10:26 | 153 GO-FLO   | -57.43814 -42.61728 | Go-Flo deployed   |
| 16/11/2006 10:11 | 152 CTD      | -57.43818 -42.61728 | CTD recovered   |
| 16/11/2006 10:09 | 152 CTD      | -57.43816 -42.61731 | CTD at the surface.   |
| 16/11/2006 09:48 | 152 CTD      | -57.43817 -42.61732 | CTD @ 140m Commenced recovery. Commenced recovery.  |
| 16/11/2006 09:41 | 152 CTD      | -57.43817 -42.61733 | CTD deployed  |
| 16/11/2006 09:29 | 151 BONGO    | -57.43818 -42.61731 | Bongo Nets on board.  |
| 16/11/2006 09:28 | 151 BONGO    | -57.4382 -42.61731  | Bongo Nets at the surface.  |
| 16/11/2006 09:12 | 151 BONGO    | -57.43818 -42.61731 | Bongo nets @400m commenced recovery. commenced recovery.  |
| 16/11/2006 09:03 | 151 BONGO    | -57.43817 -42.61731 | Bongo nets deployed   |
| 16/11/2006 09:00 |              | -57.43831 -42.61738 | Vessel on station in DP midships gantry unlashed. midships gantry unlashed.   |
| 16/11/2006 08:55 |              | -57.43884 -42.61807 | Vessel approaching CTD station. Setting up in DP.   |
| 16/11/2006 07:21 | 150 XBT      | -57.69293 -42.85154 | XBT Deployed  |
| 16/11/2006 05:33 | 149 XBT      | -57.98137 -42.95079 | XBT Deployed  |
| 16/11/2006 01:38 |              | -58.59172 -43.32988 | All secure on deck moving off station moving off station  |
| 16/11/2006 01:24 | 148 CTD      | -58.5917 -43.32983  | CTD recovered   |
| 16/11/2006 00:25 | 148 CTD      | -58.59169 -43.3298  | Resumed recovery of CTD   |
| 16/11/2006 00:15 | 148 CTD      | -58.59168 -43.32979 | Stop hauling CTD @ 2822m cable out due to compressed air supply problem   |
| 16/11/2006 00:10 | 148 CTD      | -58.59166 -43.32982 | Acoustic release test unsuccessful continue hauling CTD continue hauling CTD<br>CTD stopped @3000m Hydrophone deployed for acoustic release test Hydrophone |
| 15/11/2006 23:53 | 148 CTD      | -58.59167 -43.32982 | deployed for acoustic release test  |
| 15/11/2006 23:49 | 148 CTD      | -58.59168 -43.32983 | CTD @ 3034m   |
| 15/11/2006 22:55 | 148 CTD      | -58.59172 -43.32988 | CTD deployed  |
| 15/11/2006 22:46 |              | -58.59201 -43.32998 | Vessel on station in DP. Midships gantry unlashed.  |
| 15/11/2006 20:45 | 147 XBT      | -58.87658 -43.51152 | XBT Deployed  |
| 15/11/2006 17:09 | 146 XBT      | -59.54518 -43.96823 | XBT Deployed  |
| 15/11/2006 12:40 | 145 TOW-FISH | -60.02219 -45.37481 | V/L back to 12 knots  |
| 15/11/2006 12:35 | 145 TOW-FISH | -60.02758 -45.39854 | Tow fish deployed increase speed increase speed   |
| 15/11/2006 12:30 | 145 TOW-FISH | -60.02953 -45.40843 | v/l @ 4 knots commence tow fish deployment  |
| 15/11/2006 12:25 | TOW-FISH     | -60.03348 -45.42655 | Commence slowing for Tow Fish deployment  |
| 09/11/2006 20:42 | 144 ACOUSTIC | -59.74473 -44.18406 | End of CS3 Transect 2   |

|                  |               |           |           |  |
|------------------|---------------|-----------|-----------|--|
| 09/11/2006 19:21 | 144 ACOUSTIC  | -59.90306 | -43.86844 | Start of CS3 Transect 2  |
| 09/11/2006 18:45 | 144 ACOUSTIC  | -59.83855 | -43.74638 | Complete first transect A/C to 225T A/C to 225T                                  |
| 09/11/2006 17:24 | 144 ACOUSTIC  | -59.67681 | -44.05561 | passing condensed station  |
| 09/11/2006 16:03 | 144 ACOUSTIC  | -59.52129 | -44.37309 | commence acoustic transect on 135T @ 10.0kts                                     |
| 09/11/2006 15:30 | 143 RMT-25    | -59.49627 | -44.50029 | deck secure proceeding to acoustic survey run                                    |
| 09/11/2006 15:15 | 143 RMT-25    | -59.49573 | -44.47504 | RMT 25 recovered   |
| 09/11/2006 14:00 | 143 RMT-25    | -59.51101 | -44.34245 | RMT 25 @ 875m (cable out)  |
| 09/11/2006 13:27 | 143 RMT-25    | -59.52513 | -44.29033 | RMT deployed   |
| 09/11/2006 13:13 | 143 RMT-25    | -59.5313  | -44.26666 | Commence RMT 25 deployment   |
| 09/11/2006 13:00 | 142 RMT-25    | -59.53535 | -44.25422 | RMT 25 recovered   |
| 09/11/2006 09:55 | 142 RMT-25    | -59.66625 | -44.05962 | RMT 25 Deployed  |
| 09/11/2006 09:43 |               | -59.67581 | -44.05417 | Midships gantry secured vessel out of D.P. and moving off for RMT 25 deployment. |
| 09/11/2006 09:24 | 141 BONGO     | -59.6758  | -44.05422 | vessel out of D.P. and moving off for RMT 25 deployment.                         |
| 09/11/2006 09:23 | 141 BONGO     | -59.67585 | -44.05434 | Bongo Nets on board.   |
| 09/11/2006 09:07 | 141 BONGO     | -59.67669 | -44.05611 | Bongo Nets at the surface.   |
| 09/11/2006 08:57 | 141 BONGO     | -59.67741 | -44.05691 | Bongo nets @400m commenced recovery. commenced recovery.                         |
| 09/11/2006 08:56 | 140 BONGO     | -59.6774  | -44.05698 | Bongo nets deployed  |
| 09/11/2006 08:55 | 140 BONGO     | -59.67741 | -44.05697 | Bongo Nets on board.   |
| 09/11/2006 08:40 | 140 BONGO     | -59.67852 | -44.05822 | Bongo Nets at the surface.   |
| 09/11/2006 08:29 | 140 BONGO     | -59.67852 | -44.05822 | Bongo nets @400m commenced recovery. commenced recovery.                         |
| 09/11/2006 08:23 | 140 BONGO     | -59.67915 | -44.0589  | Bongo nets deployed  |
| 09/11/2006 08:23 | 139 CTD       | -59.67868 | -44.05867 | CTD on deck  |
| 09/11/2006 08:22 | 139 CTD       | -59.67863 | -44.05863 | CTD at the surface.  |
| 09/11/2006 08:21 | 139 CTD       | -59.67859 | -44.05861 | Commenced hauling CTD  |
| 09/11/2006 08:13 | 139 CTD       | -59.67848 | -44.05851 | CTD @ 30m.   |
| 09/11/2006 08:09 | 139 CTD       | -59.6785  | -44.05851 | CTD deployed   |
| 09/11/2006 08:02 | 138 MINIBONGO | -59.67814 | -44.05806 | Mini Bongos on Deck  |
| 09/11/2006 08:01 | 138 MINIBONGO | -59.67821 | -44.05811 | Mini Bongos at the surface   |
| 09/11/2006 07:45 | 138 MINIBONGO | -59.67942 | -44.05925 | Mini Bongos @ 400m and Recovering  |
| 09/11/2006 07:35 | 138 MINIBONGO | -59.67995 | -44.05978 | Mini Bongos Deployed   |

|                  |             |   |
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| 09/11/2006 07:30 | 137 CTD     | -59.67995 -44.05982 CTD on deck   |
| 09/11/2006 07:28 | 137 CTD     | -59.67996 -44.05975 CTD at the surface.   |
| 09/11/2006 07:15 | 137 CTD     | -59.67993 -44.05975 CTD @ 400m commencing recovery. commencing recovery.  |
| 09/11/2006 07:00 | 137 CTD     | -59.67994 -44.05977 CTD deployed  |
| 09/11/2006 06:49 | 137 CTD     | -59.67994 -44.05973 Vessel on D.P. ready to deploy  |
| 09/11/2006 06:38 | 137 CTD     | -59.6742 -44.05467 Slowing for CTD Deployment   |
| 09/11/2006 05:25 | 136 RMT-25  | -59.50013 -44.36374 Deck Secure proceeding to condensed process station 3   |
| 09/11/2006 05:19 | 136 RMT-25  | -59.5028 -44.36057 RMT 25 recovered   |
| 09/11/2006 04:17 | 136 RMT-25  | -59.54434 -44.29817 RMT 25 @ 769m (cable out)   |
| 09/11/2006 03:49 | 136 RMT-25  | -59.5633 -44.26847 RMT 25 Deployed @ 2.5kts   |
| 09/11/2006 03:44 | 136 RMT-25  | -59.56696 -44.26288 Deploying RMT 25  |
| 09/11/2006 03:34 | 135 RMT-25  | -59.57357 -44.25108 RMT 25 recovered  |
| 09/11/2006 03:24 | 135 RMT-25  | -59.58006 -44.23904 RMT 25 @ Surface  |
| 09/11/2006 02:45 | 135 RMT-25  | -59.60373 -44.19914 RMT 25 @ 82m (cable out)  |
| 09/11/2006 02:35 | 135 RMT-25  | -59.60917 -44.19012 RMT deployed<br>All secure aft a/c to run downwind in preparation for redeploy a/c to run downwind in |
| 09/11/2006 01:50 |             | -59.56306 -44.29456 preparation for redeploy  |
| 09/11/2006 01:36 | 134 RMT-25  | -59.56921 -44.28591 RMT 25 recovered  |
| 08/11/2006 23:39 | 134 RMT-25  | -59.62978 -44.14189 RMT 25 @ 2277m (cable out)  |
| 08/11/2006 22:36 | 134 RMT-25  | -59.65979 -44.04981 RMT 25 Deployed   |
| 08/11/2006 22:24 | RMT-25      | -59.66402 -44.04499 Turn into wind and reducing speed for RMT 25 deployment.  |
| 08/11/2006 20:19 | 133 LHPR    | -59.49737 -44.35849 LHPR on deck. Rigging aft deck for RMT 25 target fishing.   |
| 08/11/2006 20:18 | 133 LHPR    | -59.49799 -44.35707 LHPR @ surface  |
| 08/11/2006 19:11 | 133 LHPR    | -59.5417 -44.25359 LHPR @ 1967m increase speed to 3.5kts increase speed to 3.5kts   |
| 08/11/2006 18:20 | 133 LHPR    | -59.56886 -44.21105 LHPR Deployed @ 2.0kts  |
| 08/11/2006 18:18 | 133 LHPR    | -59.56972 -44.20976 Deploying LHPR @ 2.0kts   |
| 08/11/2006 17:40 | 132 MOCNESS | -59.58689 -44.18693 Mocness recovered setting up LHPR setting up LHPR   |
| 08/11/2006 16:20 | 132 MOCNESS | -59.63824 -44.13841 Mocness @ 2302m wire out  |
| 08/11/2006 15:00 | 132 MOCNESS | -59.67877 -44.06323 Mocness deployed @ 2.0kts   |
| 08/11/2006 14:55 |             | -59.67989 -44.05958 Gantry secured vessel out of DP and moving off for Mocness deployment. vessel out of                  |

DP and moving off for Mocness deployment.

|                  |             |           |           |   |   |
|------------------|-------------|-----------|-----------|---|---|
| 08/11/2006 14:18 | 131 FRRF    | -59.6799  | -44.0596  | FRRF recovered  |   |
| 08/11/2006 14:03 | 131 FRRF    | -59.6799  | -44.05957 | FRRF @ 150m   | commence recovery commence recovery     |
| 08/11/2006 13:50 | 131 FRRF    | -59.67993 | -44.05953 | FRRF deployed   |   |
| 08/11/2006 13:40 | 130 GO-FLO  | -59.67991 | -44.05957 | Go flow recovered   |   |
| 08/11/2006 12:54 | 130 GO-FLO  | -59.67995 | -44.05958 | Go-flo @ depth 1000m  | bottles triggered bottles triggered     |
| 08/11/2006 12:24 | 130 GO-FLO  | -59.67991 | -44.05957 | Commence deployment of Go Flow                              |   |
| 08/11/2006 12:10 | 129 CTD     | -59.6799  | -44.05959 | CTD recovered   |   |
| 08/11/2006 11:48 | 129 CTD     | -59.67989 | -44.05964 | CTD @ 140m  |   |
| 08/11/2006 11:41 | 129 CTD     | -59.67989 | -44.05957 | CTD deployed  |   |
| 08/11/2006 11:28 | 128 BONGO   | -59.67992 | -44.05959 | Bongo nets recovered  |   |
| 08/11/2006 11:12 | 128 BONGO   | -59.68014 | -44.05978 | Bongo nets @400m  | commenced recovery. commenced recovery. |
| 08/11/2006 11:02 | 128 BONGO   | -59.68011 | -44.05977 | Bongo nets deployed   |   |
| 08/11/2006 10:54 | 127 CTD     | -59.68011 | -44.05978 | CTD on deck   |   |
| 08/11/2006 10:52 | 127 CTD     | -59.68013 | -44.05978 | CTD at the surface.   |   |
| 08/11/2006 09:26 | 127 CTD     | -59.68015 | -44.05982 | CTD @ 4038m   | Commenced recovery. Commenced recovery. |
| 08/11/2006 08:02 | 127 CTD     | -59.6801  | -44.0599  | CTD deployed  |   |
| 08/11/2006 07:50 |             | -59.68062 | -44.05683 | Vessel in D.P. Midships gantry unlashed.                    |   |
| 08/11/2006 07:40 |             | -59.66032 | -44.07518 | Vessel approaching CTD station. Reducing speed and turning. |   |
| 08/11/2006 07:00 | 126 MOCNESS | -59.57682 | -44.23497 | Deck Secure proceeding to DP station                        |   |
| 08/11/2006 06:47 | 126 MOCNESS | -59.58582 | -44.21967 | Mocness recovered   |   |
| 08/11/2006 06:43 | 126 MOCNESS | -59.58835 | -44.21561 | Mocness @ surface   |   |
| 08/11/2006 05:24 | 126 MOCNESS | -59.634   | -44.14099 | Mocness @ 2290m cable out                                   | commence hauling commence hauling       |
| 08/11/2006 04:05 | 126 MOCNESS | -59.67383 | -44.05825 | Mocness deployed @ 2.0kts                                   |   |
| 08/11/2006 04:00 | 126 MOCNESS | -59.67586 | -44.05224 | Deploying Mocness   |   |
| 08/11/2006 03:56 | MOCNESS     | -59.67658 | -44.04995 | moving off station for Mocness deployment                   |   |
| 08/11/2006 03:47 | 125 FRRF    | -59.67658 | -44.05001 | FRRF recovered  |   |
| 08/11/2006 03:30 | 125 FRRF    | -59.67661 | -44.04993 | FRRF @ 150m   |   |
| 08/11/2006 03:18 | 125 FRRF    | -59.67663 | -44.04991 | FRRF deployed   |   |
| 08/11/2006 03:12 | 125 FRRF    | -59.67698 | -44.04957 | Vessel on DP for FRRF deployment                            |   |

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| 08/11/2006 03:05 | 125 FRRF     | -59.67614 -44.04548 | Slowing for FRRF station   |
| 08/11/2006 01:39 | 124 LHPR     | -59.6227 -44.21443  | LHPR Recovered<br>LHPR @ 2376m increase speed to 3.5kts commence hauling increase speed to 3.5kts  |
| 08/11/2006 00:21 | 124 LHPR     | -59.67312 -44.08158 | commence hauling   |
| 07/11/2006 23:19 | 124 LHPR     | -59.70065 -44.00924 | LHPR deployed @ 2.5kts   |
| 07/11/2006 22:15 | 123 RMT-25   | -59.66499 -43.95855 | RMT 25 on deck. Not feeling very well so repositioning for LHPR deployment!  |
| 07/11/2006 22:04 | 123 RMT-25   | -59.66944 -43.94991 | RMT 25 @ Surface   |
| 07/11/2006 21:56 | 123 RMT-25   | -59.67444 -43.94004 | RMT 25 @ 95m (cable out)   |
| 07/11/2006 21:46 | 123 RMT-25   | -59.67999 -43.92774 | RMT 25 Deployed  |
| 07/11/2006 21:19 | 123 RMT-25   | -59.67158 -43.94589 | Repositioning for RMT 25 deployment  |
| 07/11/2006 20:57 |              | -59.71334 -43.87638 | Turning back into wind. Speed 10kts.   |
| 07/11/2006 20:47 |              | -59.72698 -43.91631 | Turning towards the north est to run across the wind.<br>Vessel passing through Condensed Station No.3. Turning and running down wind. Speed     |
| 07/11/2006 20:07 |              | -59.68262 -44.05469 | 10kts.   |
| 07/11/2006 18:26 |              | -59.94623 -44.21405 | Moving off station   |
| 07/11/2006 18:10 | 122 TOW-FISH | -59.94577 -44.2147  | Tow fish deployed  |
| 07/11/2006 18:04 |              | -59.94574 -44.21471 | midships gantry secure   |
| 07/11/2006 18:02 | 122 TOW-FISH | -59.94575 -44.21471 | deploying tow fish Gantry Secure hove to till conditions improve   |
| 07/11/2006 17:57 | 121 CTD      | -59.94573 -44.21468 | CTD recovered Bongo nets recovered   |
| 07/11/2006 16:13 | 121 CTD      | -59.94163 -44.23121 | CTD @ 4668m and recovering Bongo nets @ 400m and recovering  |
| 07/11/2006 14:49 | 121 CTD      | -59.94072 -44.23487 | CTD deployed Bongo deployed  |
| 07/11/2006 14:39 |              | -59.94095 -44.23329 | Vessel on DP for CTD vessel stopped on D.P. for Bongo deployment<br>Gantry lashed moving off station moving off station complete acoustic survey |
| 07/11/2006 13:17 |              | -60.11105 -44.4873  | proceeding towards condensed station 6   |
| 07/11/2006 13:09 | 120 CTD      | -60.11017 -44.48918 | CTD recovered Commence 3rd leg of acoustic transect  |
| 07/11/2006 11:15 | 120 CTD      | -60.10283 -44.51985 | CTD @ 5079m End of 2nd leg of acoustic transect  |
| 07/11/2006 09:44 | 120 CTD      | -60.09786 -44.53339 | CTD deployed Commence 2nd leg of acoustic transect<br>Vessel stopped in D.P. midships gantry unlashed. Completed first transect.                 |
| 07/11/2006 09:38 |              | -60.09787 -44.53338 | Repositioning for start of second transect.  |
| 07/11/2006 09:23 |              | -60.12839 -44.51293 | Vessel clear of ice. Commenced first transect. Co 180 at 10kts   |
| 07/11/2006 06:33 | 119 MOCNESS  | -60.39974 -44.49772 | Deck Secure proceeding to CTD A station Midships gantry secured. Vessel out of DP  |

and repositioning for start of Acoustic Survey

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| 07/11/2006 06:19 | 119 MOCNESS  | -60.39772 | -44.48771 | Mocness recovered  | Bongo Nets on board.   |
| 07/11/2006 06:14 | 119 MOCNESS  | -60.39628 | -44.48096 | Mocness @ surface  | Bongo Nets at the surface.   |
| 07/11/2006 05:07 | 119 MOCNESS  | -60.37723 | -44.38527 | 400m and recovering  | Mocness @ 1993m cable out commence hauling commence hauling Bongo nets @ |
| 07/11/2006 03:59 | 119 MOCNESS  | -60.36138 | -44.2965  | Mocness deployed @ 2.0kts  | Bongo Nets d   |
| 07/11/2006 03:54 | 119 MOCNESS  | -60.36123 | -44.28954 | Deploying Mocness  | Bongo Nets on board.   |
| 07/11/2006 03:49 | 119 MOCNESS  | -60.36449 | -44.28825 | slowing for Mocness deployment                                       | Bongo Nets at the surface.   |
| 07/11/2006 02:36 | 118 RMT-25   | -60.41171 | -44.54394 | RMT 25 recovered. Repositioning vessel for mocness deployment        | Bongo nets @ 400m  |
| 07/11/2006 01:05 | 118 RMT-25   | -60.42316 | -44.38548 | and recovering   |  |
| 07/11/2006 00:09 | 118 RMT-25   | -60.44744 | -44.30547 | RMT 25 @ 1724m (cable out)   | Bongo nets deployed  |
| 07/11/2006 00:01 | 118 RMT-25   | -60.44933 | -44.2927  | RMT 25 Deployed  | CTD on deck.   |
| 06/11/2006 22:33 | 117 RMT-25   | -60.39564 | -44.69137 | Commence RMT 25 deployment   | CTD at the surface.  |
| 06/11/2006 22:28 | 117 RMT-25   | -60.39941 | -44.68738 | RMT 25 on Deck repositioning for next run.                           | repositioning for next run. CTD @ 25m                                    |
| 06/11/2006 22:00 | 117 RMT-25   | -60.42118 | -44.67202 | Commenced recovery.  |  |
| 06/11/2006 21:49 | 117 RMT-25   | -60.43021 | -44.67368 | RMT 25 on surface  | CTD deployed   |
| 06/11/2006 21:42 | 117 RMT-25   | -60.43351 | -44.68032 | RMT 25 @ 184m (cable out)  | Mini Bongos on Deck  |
| 06/11/2006 20:45 | 116 ACOUSTIC | -60.3849  | -44.49683 | RMT 25 Deployed  | Mini Bongos at the surface   |
| 06/11/2006 19:24 | 116 CTD      | -60.32376 | -44.73921 | Reduce Speed for deployment of RMT 25                                | Mini Bongos @ 400m and Recovering  |
| 06/11/2006 19:05 | 116 CTD      | -60.33298 | -44.79531 | End of transect - A/C to run back up transect for RMT target fishing | Mini Bongos  |
| 06/11/2006 18:33 | 116 CTD      | -60.38084 | -44.83746 | Deployed   |  |
| 06/11/2006 17:16 | 116 ACOUSTIC | -60.43883 | -44.59006 | A/C 116  | CTD recovered  |
| 06/11/2006 16:21 | 115 RMT-25   | -60.43004 | -44.59114 | A/C 065  | CTD @ 400m and recovering  |
| 06/11/2006 16:12 | 115 RMT-25   | -60.4343  | -44.57946 | A/c to 026T  | CTD deployed   |
| 06/11/2006 15:07 | 115 RMT-25   | -60.47433 | -44.49848 | Commence acoustics transect  | on course 296T @ 6.0 kts due to ice and viz on course                    |
| 06/11/2006 14:39 | 115 RMT-25   | -60.49091 | -44.46345 | 296T @ 6.0 kts due to ice and viz Vessel on D.P.                     | ready to deploy  |
| 06/11/2006 14:11 | 115 RMT-25   | -60.46799 | -44.49561 | RMT 25 recovered   | Slowing for Process Station six  |
|                  |              |           |           | RMT 25 @ Surface   | Deck Secure proceeding to condensed process station 6                    |
|                  |              |           |           | RMT 25 @ 760m (cable out)  | Muli-net recovered   |
|                  |              |           |           | RMT Deployed   | Multinet @ Surface   |
|                  |              |           |           | Commence RMT 25 deployment   | multinet @ 2224m wire out and recovering                                 |



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| 06/11/2006 13:27 | 114 RMT-25    | -60.40881 -44.66374 | RMT recovered a/c to run downwind to reposition for next deployment a/c to run downwind to reposition for next deployment Multi-net deployed                               |
| 06/11/2006 11:41 | 114 RMT-25    | -60.43309 -44.5123  | Stop veering RMT 1823m cable out 1823m cable out Multinet recovered due to problem with net  |
| 06/11/2006 10:51 | 114 RMT-25    | -60.45309 -44.43474 | RMT 25 Deployed Multinet Deployed  |
| 06/11/2006 10:35 |               | -60.4548 -44.41529  | Vessel turning and reducing speed for RMT 25 deployment. LHPR Recovered  |
| 06/11/2006 09:56 |               | -60.43197 -44.60628 | Midships Gantry Secure vessel out of DP and positioning for RMT 25 deployment vessel out of DP and positioning for RMT 25 deployment LHPR @ 1913m increase speed to 3.5kts |
| 06/11/2006 09:53 | 113 BONGO     | -60.43196 -44.60628 | Bongo Nets on board. LHPR Deployed @ 2.0kts  |
| 06/11/2006 09:51 | 113 BONGO     | -60.43198 -44.60621 | Bongo Nets at the surface. RMT 25 on deck. Not feeling very well so repositioning for LHPR deployment!   |
| 06/11/2006 09:35 | 113 BONGO     | -60.43212 -44.60537 | Bongo nets @400m commenced recovery. commenced recovery. RMT 25 at the surface   |
| 06/11/2006 09:24 | 113 BONGO     | -60.43225 -44.60464 | Bongo nets deployed RMT 25 @ 1879m cable out. Commence hauling   |
| 06/11/2006 09:23 | 112 BONGO     | -60.43224 -44.60462 | Bongo Nets on board. RMT 25 Deployed   |
| 06/11/2006 09:22 | 112 BONGO     | -60.43225 -44.60459 | Bongo Nets at the surface. Slowing for RMT 25 deployment   |
| 06/11/2006 09:06 | 112 BONGO     | -60.43224 -44.60457 | Bongo nets @400m commenced recovery. commenced recovery. RMT 25 recovered. Repositioning vessel for next run   |
| 06/11/2006 08:56 | 112 BONGO     | -60.43215 -44.6045  | Deployed Bongo Nets RMT 25 @ Surface   |
| 06/11/2006 08:52 |               | -60.43224 -44.60437 | Vessel repositioned and in DP RMT 25 @ 740m and recovering   |
| 06/11/2006 08:42 | RMT-25        | -60.4381 -44.61934  | Repositioning Vessel away from Ice Bergs. RMT 25 Deployed @ 2.5kts   |
| 06/11/2006 08:25 | 111 CTD       | -60.43816 -44.61925 | CTD deployed Deploying RMT 25  |
| 06/11/2006 08:05 | 110 MINIBONGO | -60.43878 -44.61985 | Mini Bongos on Deck Slowing for RMT 25 deployment  |
| 06/11/2006 08:04 | 110 MINIBONGO | -60.43875 -44.61968 | Mini Bongos at the surface LHPR recovered repositioning vessel for RMT 25 deployment.  |
| 06/11/2006 07:49 | 110 MINIBONGO | -60.43905 -44.61749 | Mini Bongos @ 400m and Recovering LHPR @ surface   |
| 06/11/2006 07:39 | 110 MINIBONGO | -60.43929 -44.61606 | Mini Bongos Deployed LHPR @ 2255m cable out  |
| 06/11/2006 07:31 | 109 CTD       | -60.4394 -44.6162   | CTD on deck Increase to 3.5 knots  |
| 06/11/2006 07:29 | 109 CTD       | -60.43952 -44.61627 | CTD at the surface. LHPR Deployed @ 2.0kts   |
| 06/11/2006 07:12 | 109 CTD       | -60.44015 -44.61662 | CTD @ 400m V/L off DP preparing to deploy LHPR   |
| 06/11/2006 07:02 | 109 CTD       | -60.44016 -44.61662 | CTD deployed FRRF recovered  |

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|                  |             |                     | Deck Secure proceeding to condensed process station 2 | FRRF @ 150m   | commence   |
| 06/11/2006 06:09 | 108 FRRF    | -60.48999 -44.71972 | recovery  |   |  |
| 06/11/2006 06:03 | 108 FRRF    | -60.48998 -44.71977 | FRRF recovered  | FRRF deployed                                       |  |
| 06/11/2006 05:48 | 108 FRRF    | -60.48998 -44.71974 | FRRF @ 150m   | commence recovery                                   | commence recovery Go-flo recovered               |
| 06/11/2006 05:33 | 108 FRRF    | -60.48998 -44.7198  | FRRF deployed   | commence recovery of go-flo                         |  |
|                  |             |                     | Vessel on DP for FRRF deployment                      | Go-flo @ depth 1000m                                | bottles triggered bottles                        |
| 06/11/2006 05:25 | 108 FRRF    | -60.48997 -44.71909 | triggered   |   |  |
| 06/11/2006 05:20 | 108 FRRF    | -60.48696 -44.71587 | Slowing for FRRF station                              | Deploying Go flo                                    | first bottle deployed first bottle deployed      |
| 06/11/2006 04:55 | 107 RMT-25  | -60.45876 -44.82167 | Deck Secure proceeding to FRRF station                | CTD Recovered                                       |  |
| 06/11/2006 04:46 | 107 RMT-25  | -60.46073 -44.82073 | RMT 25 recovered                                      | CTD @ 140m  | Commenced recovery. Commenced recovery.          |
| 06/11/2006 04:04 | 107 RMT-25  | -60.47473 -44.75138 | RMT 25 @ 76m (cable out)                              | CTD deployed  |  |
| 06/11/2006 03:58 | 107 RMT-25  | -60.4774 -44.74206  | RMT 25 Deployed                                       | Bongo Nets on board.                                |  |
| 06/11/2006 03:53 | 107 RMT-25  | -60.47976 -44.73386 | Deploying RMT 25                                      | Bongo Nets at the surface.                          |  |
| 06/11/2006 03:44 | 107 RMT-25  | -60.47805 -44.73739 | Slowing for RMT deployment                            | Bongo nets @ 400m                                   | and recovering                                   |
| 06/11/2006 03:10 | 106 RMT-25  | -60.46187 -44.82622 | RMT 25 recovered                                      | Bongo deployed                                      |  |
| 06/11/2006 01:54 | 106 RMT-25  | -60.49101 -44.6958  | RMT 25 @ 729m (cable out)                             | CTD on deck.  |  |
| 06/11/2006 01:30 | 106 RMT-25  | -60.49864 -44.64882 | RMT 25 deployed                                       | CTD at the surface.                                 |  |
|                  |             |                     | Commence deployment of RMT 25                         | CTD @ 5114m   | Commencing recovery.                             |
| 06/11/2006 01:23 | 106 RMT-25  | -60.50119 -44.63524 | Commencing recovery.                                  |   |  |
| 06/11/2006 00:20 | 105 LHPR    | -60.43489 -44.87974 | LHPR Recovered  | CTD deployed  |  |
|                  |             |                     | LHPR cable @1032m                                     | stop veering  | increase to 3.5knots commence hauling stop       |
| 05/11/2006 23:44 | 105 LHPR    | -60.45407 -44.79847 | veering Vessel on DP at station for CTD               | commence hauling                                    |  |
| 05/11/2006 23:16 | 105 LHPR    | -60.46542 -44.75633 | LHPR Deployed @ 2.0kts                                | slowing for condensed station six                   |  |
|                  |             |                     | Commence LHPR deployment                              | Deck Secure proceeding to condensed process station |  |
| 05/11/2006 23:13 | 105 LHPR    | -60.46674 -44.75115 | 6   |   |  |
| 05/11/2006 20:36 | 104 MOCNESS | -60.35293 -44.59445 | Mocness on deck. Moving vessel to next location.      | RMT 25 recovered                                    |  |
| 05/11/2006 20:33 | 104 MOCNESS | -60.35399 -44.59194 | Mocness @ surface                                     | RMT 25 @ Surface                                    |  |
| 05/11/2006 19:55 | 104 MOCNESS | -60.37674 -44.56051 | Commenced hauling Mocness                             | RMT 25 @ 742m                                       | and recovering                                   |
| 05/11/2006 19:32 | 104 MOCNESS | -60.38402 -44.53341 | Mocness @ 1022m cable out                             | RMT deployed  |  |
|                  |             |                     | Mocness deployed                                      | increasing to 0.7kts                                | increasing to 0.7kts Vessel off DP preparing for |
| 05/11/2006 18:55 | 104 MOCNESS | -60.3903 -44.51951  | RMT deployment  |   |  |

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| 05/11/2006 18:52 | 104 MOCNESS | -60.39037 -44.51906 | Deploying Mocness @ 0.3 kts FRRF recovered<br>Vessel on D.P. ready to deploy Mocness @ 0.3 Kts FRRF @ 150m commence  |
| 05/11/2006 18:48 | 104 MOCNESS | -60.39049 -44.51842 | recovery commence recovery   |
| 05/11/2006 15:57 | 103 FRRF    | -60.41924 -44.67735 | FRRF recovered FRRF deployed   |
| 05/11/2006 15:37 | 103 FRRF    | -60.41926 -44.67734 | FRRF deployed V/L on DP for FRRF   |
| 05/11/2006 15:28 | 102 GO-FLO  | -60.41924 -44.67733 | Go flow recovered RMT Recovered  |
| 05/11/2006 14:54 | 102 GO-FLO  | -60.41924 -44.67738 | commence recovery of go-flo RMT 25 @ 2126m (cable out)   |
| 05/11/2006 14:39 | 102 GO-FLO  | -60.41926 -44.67736 | Go-flo @ depth 1000m bottles triggered bottles triggered RMT 25 deployed.<br>Commence deployment of Go Flow Turning into wind and reducing speed for RMT 25                              |
| 05/11/2006 14:09 | 102 GO-FLO  | -60.41901 -44.67886 | deployment.<br>CTD recovered Gantry Secure thruster vents closed moving to Condensed Process<br>station six thruster vents closed moving to Condensed Process station six thruster vents |
| 05/11/2006 13:54 | 101 CTD     | -60.41895 -44.67932 | closed moving to Condensed Process station six   |
| 05/11/2006 13:31 | 101 CTD     | -60.41897 -44.67931 | CTD @ 140m Commenced recovery. Commenced recovery. Bongo nets recovered  |
| 05/11/2006 13:24 | 101 CTD     | -60.41895 -44.67932 | CTD deployed Bongo nets @ 400m   |
| 05/11/2006 13:03 | 100 BONGO   | -60.41897 -44.6793  | Bongo nets recovered Bongo deployed  |
| 05/11/2006 12:46 | 100 BONGO   | -60.41896 -44.67929 | Bongo nets @ 400m FRRF recovered   |
| 05/11/2006 12:34 | 100 BONGO   | -60.4189 -44.67927  | Bongo nets deployed FRRF @ 150m  |
| 05/11/2006 12:25 | 99 CTD      | -60.41905 -44.67833 | CTD recovered FRRF deployed  |
| 05/11/2006 11:48 | 99 CTD      | -60.42041 -44.67092 | CTD @ 1175m Vessel on D.P. ready to deploy   |
| 05/11/2006 11:22 | 99 CTD      | -60.42027 -44.66969 | CTD deployed Slowing for FRRF station<br>v/l on DP awaiting daylight to proceed to condensed station awaiting daylight to  |
| 05/11/2006 02:55 |             | -60.70616 -44.06887 | proceed to condensed station Deck Secure proceeding to process station 3   |
| 05/11/2006 02:33 | 98 RMT-25   | -60.70631 -44.06863 | RMT recovered RMT 25 recovered   |
| 05/11/2006 01:48 | 98 RMT-25   | -60.72356 -44.01167 | Commence hauling RMT RMT 25 @ Surface  |
| 05/11/2006 01:42 | 98 RMT-25   | -60.72782 -44.00517 | Stop veering RMT 309m cable out 309m cable out RMT @ 43m   |
| 05/11/2006 01:28 | 98 RMT-25   | -60.73798 -43.98893 | RMT deployed RMT 25 deployed for target fishing  |
| 05/11/2006 01:22 | 98 RMT-25   | -60.74259 -43.98161 | Commence deployment of RMT 25 RMT Recovered  |
| 05/11/2006 01:07 | 97 NEUSTON  | -60.74925 -43.97441 | Neuston sledge recovered RMT 25 @ 2267m (cable out)  |
| 05/11/2006 00:48 | 97 NEUSTON  | -60.76248 -43.96107 | Neuston sledge deployed RMT 25 Deployed  |
| 05/11/2006 00:27 | 97 NEUSTON  | -60.77128 -43.94671 | A/C head to wind prepare for Neuston net deployment prepare for Neuston net  |

deployment Vessel out of DP and driving ahead for RMT 25 deployment.

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| 05/11/2006 00:24 | 97 NEUSTON  | -60.7082 -44.06808  | Neuston net deployed                                | Vessel stopped on station in D.P. Awaiting RMT 25 deployment.                  |
| 04/11/2006 23:24 | 96 RMT-25   | -60.67146 -44.00826 | RMT recovered                                       | Vessel approaching station. Reducing speed.                                    |
| 04/11/2006 23:18 | 96 RMT-25   | -60.67702 -44.00127 | Net on surface                                      | Repositioning for RMT 25 deployment  |
| 04/11/2006 22:30 | 96 RMT-25   | -60.7331 -43.94441  | RMT 25 @ 327m (cable out)                           | Muti Net on deck.  |
| 04/11/2006 22:16 | 96 RMT-25   | -60.6706 -44.00926  | RMT 25 Deployed                                     | Multinet @ Surface   |
| 04/11/2006 21:16 | 95 RMT-25   | -60.67538 -44.06455 | RMT on deck. Repositioning vessel for next drive.   | Multinet at 1987m and recovering   |
| 04/11/2006 21:11 | 95 RMT-25   | -60.67821 -44.05461 | RMT @ Surface                                       | Multinet Deployed @ 2kt  |
| 04/11/2006 20:11 | 95 RMT-25   | -60.70382 -43.95695 | RMT 25 @ 363m (cable out)                           | deploying multinet   |
| 04/11/2006 19:57 | 95 RMT-25   | -60.70838 -43.93408 | Deployed RMT 25                                     | RMT 25 recovered   |
| 04/11/2006 19:35 | 94 NEUSTON  | -60.71128 -43.89745 | Neuston Net clear on deck                           | RMT 25 @ Surface   |
| 04/11/2006 19:34 | 94 NEUSTON  | -60.71111 -43.89573 | Neuston Net clear of the water                      | Hauling for recovery   |
| 04/11/2006 19:27 | 94 NEUSTON  | -60.70991 -43.88366 | Deployed Neuston Net                                | RMT 25 @ 2050m (cable out)   |
| 02/11/2006 20:41 | 93 RMT-25   | -60.56866 -48.60874 | Terminated transect due to proximity of ice bergs   | RMT deployed   |
|                  |             |                     | Passing through start position for 290 transect     | End of 3rd transect a/c head to wind and reduce to 2.5knots for RMT deployment |
| 02/11/2006 19:22 | 93 RMT-25   | -60.64073 -48.20576 | RMT deployment                                      |  |
| 02/11/2006 19:07 | 93 RMT-25   | -60.67247 -48.17112 | A/C to 290 for next transect                        | Commence 3rd transect  |
| 02/11/2006 18:34 | 93 ACOUSTIC | -60.73258 -48.26631 | Complete first transect                             | A/C to 020T A/C to 020T End of 2nd transect                                    |
| 02/11/2006 15:51 | 93 ACOUSTIC | -60.57326 -49.11994 | Commence Acoustic transect on course 110T @ 10.0kts | Commenced second transect  |
| 02/11/2006 15:07 | 92 RMT-25   | -60.56374 -49.23573 | RMT 25 recovered                                    | Completed first transect. Repositioning for start of second transect.          |
|                  |             |                     | RMT 25 @ 694m (cable out) commence hauling          | commence hauling Commenced first   |
| 02/11/2006 14:01 | 92 RMT-25   | -60.57294 -49.13016 | transect. Co 315 at 10kts                           |  |
| 02/11/2006 13:27 | 92 RMT-25   | -60.57611 -49.07714 | RMT Deployed  | Vessel out of DP and positioning for start of acoustic survey run.             |
| 02/11/2006 13:22 | 92 RMT-25   | -60.57689 -49.069   | Commence deployment of RMT 25                       | deck secure proceeding to acoustic survey run                                  |
| 02/11/2006 13:09 | 91 RMT-25   | -60.5795 -49.04936  | RMT recovered                                       | RMT 25 recovered   |
| 02/11/2006 13:02 | 91 RMT-25   | -60.5818 -49.03688  | RMT on surface                                      | RMT 25 @ Surface   |
| 02/11/2006 12:35 | 91 RMT-27   | -60.59097 -48.99076 | Hauling RMT for recovery                            | RMT @ 330m   |
| 02/11/2006 11:02 | 91 RMT-25   | -60.62313 -48.83965 | Commence hauling RMT                                | RMT 25 Deployed @ 2.5kts   |
| 02/11/2006 10:55 | 91 RMT-25   | -60.62533 -48.82921 | RMT 25 @ 2073m (cable out)                          | Continue deployment  |

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| 02/11/2006 09:54 | 91 RMT-25    | -60.64292 -48.72767 | RMT 25 Deployed                          | Stop deployment due to tangled cod ends  |
|                  |              |                     |  | Gantry secured vessel out of DP and moving off for RMT 25 deployment. vessel out of  |
| 02/11/2006 09:37 |              | -60.64751 -48.70066 | DP and moving off for RMT 25 deployment. | Re-deploying RMT 25  |
| 02/11/2006 09:31 | 90 BONGO     | -60.6475 -48.70063  | Bongo Nets on board.                     | RMT 25 recovered   |
| 02/11/2006 09:29 | 90 BONGO     | -60.64749 -48.70065 | Bongo Nets at the surface.               | recovering RMT due to fault  |
|                  |              |                     | Bongo nets @400m commenced recovery.     | commenced recovery. RMT 25 Deployed @  |
| 02/11/2006 09:13 | 90 BONGO     | -60.6475 -48.70065  | 2.5kts                                   |  |
| 02/11/2006 09:02 | 90 BONGO     | -60.64752 -48.70063 | Bongo nets deployed                      | Deploying RMT 25   |
| 02/11/2006 09:00 | 89 BONGO     | -60.64751 -48.70063 | Bongo Nets on board.                     | Vessel off DP preparing for RMT deployment   |
| 02/11/2006 08:59 | 89 BONGO     | -60.64752 -48.70063 | Bongo Nets at the surface.               | V/L on DP while RMT is prepared  |
| 02/11/2006 08:44 | 89 BONGO     | -60.64751 -48.70063 | Bongo nets @400m commenced recovery.     | commenced recovery. Multi-net recovered  |
| 02/11/2006 08:33 | 89 BONGO     | -60.64754 -48.70064 | Bongo nets deployed                      | Multinet at 2034m and recovering   |
| 02/11/2006 08:29 | 88 CTD       | -60.64753 -48.70063 | CTD on deck                              | Muli-net deployed  |
| 02/11/2006 08:26 | 88 CTD       | -60.64755 -48.70064 | CTD at the surface.                      | Muli-net recovered   |
| 02/11/2006 08:25 | 88 CTD       | -60.64753 -48.70068 | CTD @ 40m                                | Commenced recovery. Commenced recovery. Tow fish deployed                            |
| 02/11/2006 08:20 | 88 CTD       | -60.64752 -48.70065 | CTD deployed                             | Multinet at 2178m and recovering   |
| 02/11/2006 07:55 | 87 MINIBONGO | -60.64752 -48.70069 | Mini Bongos @ 400m and Recovering        | Multinet Deployed @2kt   |
|                  |              |                     | Deploying Mini Bongo Nets                | Vessel out of DP and moving clear. Rigging for Multnet                               |
| 02/11/2006 07:44 | 87 MINIBONGO | -60.64752 -48.70065 | deployment.                              | CTD on deck Ship positioned over mooring to confirm position. Vessel then moving off |
|                  |              |                     |  | head to wind.  |
| 02/11/2006 07:38 | 86 CTD       | -60.64752 -48.70065 | CTD at the surface.                      | Rig slipped.   |
| 02/11/2006 07:35 | 86 CTD       | -60.64751 -48.70065 | Commenced CTD recovery                   | Main Buoy in the water.  |
| 02/11/2006 07:19 | 86 CTD       | -60.64753 -48.70066 | CTD @ 400m                               | Acoustic Recording Package in the water.   |
| 02/11/2006 07:18 | 86 CTD       | -60.64753 -48.70061 | CTD @ 400m                               | Acoustic Recording Package and Main Buoy attached.                                   |
| 02/11/2006 07:07 | 86 CTD       | -60.64752 -48.70063 | CTD deployed                             | Acoustic Recording Package and Main Buoy attached.                                   |
| 02/11/2006 06:58 | 86 CTD       | -60.64755 -48.70045 | Vessel on D.P. ready to deploy           | SBE CTD connected and deployed   |
| 02/11/2006 04:51 | 85 RMT-25    | -60.49292 -49.14841 | Deck Secure proceeding to DP station     | Trimsin cluster connected & deployed   |
| 02/11/2006 04:38 | 85 RMT-25    | -60.49593 -49.1465  | RMT 25 recovered                         | Sediment trap & Aquadoop current meter connected and deployed                        |
| 02/11/2006 04:30 | 85 RMT-25    | -60.50021 -49.13692 | RMT 25 @ Surface                         | continue veering   |
| 02/11/2006 03:58 | 85 RMT-25    | -60.51016 -49.08978 | RMT 25 @ 100m (cable out)                | stop to rig chain block on kevlar rope to improve lead                               |
| 02/11/2006 03:45 | 85 RMT-25    | -60.51502 -49.06797 | RMT 25 Deployed                          | Acoustic release connected and deployed  |

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| 02/11/2006 03:41 | 85 RMT-25  | -60.51638 -49.06186 | Deploying RMT 25 weights deployed<br>RMT 25 recovered scientists off for 20' meal break scientists off for 20' meal break  |
| 02/11/2006 03:04 | 84 RMT-25  | -60.52038 -49.03595 | commence mooring deployment<br>Commence hauling RMT vessel stopped on DP stern over deployment pos'n HDG   |
| 02/11/2006 01:55 | 84 RMT-25  | -60.54959 -48.94243 | 240T stern over deployment pos'n HDG 240T  |
| 02/11/2006 01:46 | 84 RMT-25  | -60.55322 -48.93079 | Stop veering RMT 690m cable out 690m cable out slowing for mooring site deployment<br>RMT deployed A/C to 323T proceeding towards chosen deployment site (52 43.387S |
| 02/11/2006 01:26 | 84 RMT-25  | -60.56156 -48.90379 | 40 08.798W) (52 43.387S 40 08.798W)<br>Deployment delayed problem with net release gear problem with net release gear A/C  |
| 02/11/2006 01:18 | 84 RMT-25  | -60.56478 -48.89291 | to 135T commence second swath run<br>Commence deployment of RMT 25 v/l off DP commencing swath survey for mooring  |
| 02/11/2006 01:14 | 84 RMT-25  | -60.56657 -48.88714 | deployment   |
| 02/11/2006 00:32 | 83 MOCNESS | -60.57435 -48.86484 | Mocness recovered Mini Bongos Recovered<br>Mocness @ 2116m cable out commence hauling commence hauling Mini bongo @  |
| 01/11/2006 23:18 | MOCNESS    | -60.60666 -48.78137 | 400m commence hauling  |
| 01/11/2006 22:05 | 83 MOCNESS | -60.64666 -48.7032  | Mocness deployed Tow fish recovered  |
| 01/11/2006 22:00 |            | -60.64843 -48.69697 | Vessel out of DP moving off for Mocness deployment. Mini bongo deployed<br>Midships Gantry Secure awaiting Mocness deployment. awaiting Mocness deployment.          |
| 01/11/2006 21:36 |            | -60.64843 -48.69703 | CTD Recovered<br>Bongo nets recovered CTD @ 2000m Commencing recovery. Commencing  |
| 01/11/2006 21:29 | 82 BONGO   | -60.64843 -48.69702 | recovery.  |
| 01/11/2006 21:27 | 82 BONGO   | -60.64842 -48.69701 | Bongo Nets at the surface. CTD deployed<br>Bongo nets @400m commenced recovery. commenced recovery. Bongo nets   |
| 01/11/2006 21:12 | 82 BONGO   | -60.64844 -48.69696 | recovered  |
| 01/11/2006 21:00 | 82 BONGO   | -60.64837 -48.69716 | Bongo nets deployed Bongo nets @ 400m and recovering   |
| 01/11/2006 20:54 |            | -60.64836 -48.69704 | Vessel on station in DP. Bongo nets deployed   |
| 01/11/2006 20:50 |            | -60.64871 -48.69615 | Vessel setting up in DP. Midships gantry unlashd. CTD recovered  |
| 01/11/2006 19:40 | CTD        | -60.50768 -48.77213 | Repositioning vessel for Bongo Net deployment. CTD @ 30m and recovering  |
| 01/11/2006 19:36 | 81 MOCNESS | -60.50801 -48.76787 | Mocness recovered CTD Deployed   |
| 01/11/2006 19:33 | 81 MOCNESS | -60.50983 -48.76715 | Mocness @ surface FRRF on deck.<br>Mocness @ 2145m cable out commence hauling commence hauling FRRF at the   |
| 01/11/2006 18:21 | 81 MOCNESS | -60.55997 -48.73785 | surface.   |

|                  |            |           |           |   |                                   |   |                              |
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| 01/11/2006 17:05 | 81 MOCNESS | -60.61132 | -48.72558 | Mocness deployed                            | FRRF @ 150m                       | commence recovery                           | commence recovery            |
| 01/11/2006 17:02 | 81 MOCNESS | -60.61353 | -48.72444 | Deploying Mocness                           | FRRF deployed                     |   |                              |
|                  |            |           |           | V/L head to wind and 2Kts through the water | ready to deploy                   | Go Flo recovered to deck.                   |                              |
| 01/11/2006 16:54 | 81 MOCNESS | -60.61904 | -48.72183 | Setting up for FRRF.                        |                                   |   |                              |
| 01/11/2006 16:50 | 81 MOCNESS | -60.61726 | -48.71641 | slowing for Mocness deployment              | Second Go Flo bottle removed      |   |                              |
| 01/11/2006 15:57 | 80 LHPR    | -60.54377 | -48.75435 | LHPR Recovered                              | Third Go Flo bottle removed.      |   |                              |
| 01/11/2006 15:53 | 80 LHPR    | -60.54821 | -48.75496 | LHPR @ surface                              | Fourth Go Flo bottle removed      |   |                              |
|                  |            |           |           | LHPR cable @1961m                           | stop veering                      | increase to 3.5knots                        | commence hauling             |
| 01/11/2006 14:47 | 80 LHPR    | -60.62112 | -48.74346 | veering                                     | Fifth Go Flo bottle removed       | commence hauling                            |                              |
| 01/11/2006 13:54 | 80 LHPR    | -60.64778 | -48.70302 | LHPR Deployed @ 2.0kts                      | Sixth Go Flo bottle removed       |   |                              |
| 01/11/2006 13:47 | 80 LHPR    | -60.64926 | -48.69765 | V/L off DP preparing for LHPR deployment    | Commenced Go Flo recovery         |   |                              |
| 01/11/2006 13:18 | 79 FRRF    | -60.6494  | -48.69766 | FRRF recovered                              | Go Flo wire at 1000m              | Trigger weight deployed.                    |                              |
| 01/11/2006 13:02 | 79 FRRF    | -60.64938 | -48.69765 | FRRF @ 150m                                 | commence recovery                 | commence recovery                           | Sixth Go Flo bottle attached |
| 01/11/2006 12:51 | 79 FRRF    | -60.64932 | -48.69758 | FRRF deployed                               | Fifth Go Flo bottle attached      |   |                              |
| 01/11/2006 12:45 | 78 GO-FLO  | -60.64937 | -48.6976  | Go-flo recovered                            | Fourth Go Flo bottle attached     |   |                              |
| 01/11/2006 12:13 | 78 GO-FLO  | -60.64936 | -48.69749 | commence recovery of go-flo                 | Third Go Flo bottle attached      |   |                              |
|                  |            |           |           | Go-flo @ depth 1000m                        | bottles triggered                 | bottles triggered                           | Second Go Flo bottle         |
| 01/11/2006 12:00 | 78 GO-FLO  | -60.64927 | -48.69746 | attached.                                   |                                   |   |                              |
| 01/11/2006 11:26 | 78 GO-FLO  | -60.64927 | -48.69743 | Commence deployment of Go-flo               | Go Flo deployed with first bottle |   |                              |
| 01/11/2006 11:13 | 77 CTD     | -60.64925 | -48.69743 | CTD recovered to deck                       | CTD on deck.                      | Setting up for Go Flo.                      |                              |
| 01/11/2006 10:54 | 77 CTD     | -60.64923 | -48.69744 | CTD @ 140m                                  | Commenced recovery.               | Commenced recovery.                         | CTD at the surface.          |
| 01/11/2006 10:48 | 77 CTD     | -60.64923 | -48.69745 | CTD deployed                                | CTD @ 140m                        | Commenced recovery.                         | Commenced recovery.          |
| 01/11/2006 10:39 | 76 BONGO   | -60.64926 | -48.69745 | Bongo Nets at the surface.                  | CTD deployed                      |   |                              |
|                  |            |           |           | Bongo Nets on board.                        | Vessel approaching CTD station.   | Setting up in DP.                           | Midships                     |
| 01/11/2006 10:36 | 76 BONGO   | -60.64926 | -48.69745 | gantry unlashed.                            |                                   |   |                              |
|                  |            |           |           | Bongo nets @400m                            | commenced recovery.               | commenced recovery.                         | Vessel approaching           |
| 01/11/2006 10:20 | 76 BONGO   | -60.64868 | -48.69727 | CTD station.                                | Reducing speed and turning.       |   |                              |
| 01/11/2006 10:11 | 76 BONGO   | -60.64834 | -48.69705 | Bongo nets deployed                         | Deck Secure                       | proceeding to                               | process station 3            |
|                  |            |           |           | CTD on deck                                 | RMT 25 recovered                  | cod ends recovered with use of Gilson winch | cod                          |
| 01/11/2006 10:03 | 75 CTD     | -60.64833 | -48.69704 | ends recovered with use of Gilson winch     |                                   |   |                              |
| 01/11/2006 10:01 | 75 CTD     | -60.64834 | -48.69707 | CTD at the surface.                         | RMT 25 @ Surface                  |   |                              |

|                  |           |                     |   |  |
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| 01/11/2006 09:20 | 75 CTD    | -60.6483 -48.69703  | CTD @ depth 1650m. Commencing recovery  | RMT 25 @ 822m (cable out)  |
| 01/11/2006 08:48 | 75 CTD    | -60.64834 -48.697   | CTD deployed  | RMT 25 Deployed @ 2.5kts   |
| 01/11/2006 08:42 |           | -60.64836 -48.69695 | Vessel on station in DP. Midships gantry unlashd. Deploying RMT 25  |  |
|                  |           |                     | Approaching revised position. Setting up in DP Midships gantry secured vessel out of D.P. and moving off for RMT 25 deployment. vessel out of D.P. and moving off for RMT |  |
| 01/11/2006 08:39 |           | -60.64845 -48.69662 | 25 deployment.  |  |
| 01/11/2006 08:18 | FFRF      | -60.62372 -48.67202 | Revised position of CTD deployment due to proximity of ice.   | FFRF recovered   |
|                  |           |                     | Gantry Secure moving to Condensed Process station one   | moving to Condensed  |
| 01/11/2006 06:38 | 74 FRRF   | -60.42583 -48.77746 | Process station one FRRF @ 150m   | commence recovery commence recovery                              |
| 01/11/2006 06:30 | 74 FRRF   | -60.42586 -48.77748 | FRRF recovered  | FRRF deployed  |
| 01/11/2006 06:12 | 74 FRRF   | -60.42598 -48.77752 | FRRF @ 150m   | V/L on DP for FRRF   |
| 01/11/2006 06:03 | 74 FRRF   | -60.42596 -48.77746 | FRRP deployed   | LHPR Recovered   |
|                  |           |                     | V/I on Auto Position DP ready to deploy FRRF LHPR @ 2290m cable out commence  |  |
| 01/11/2006 05:56 | 74 FRRF   | -60.42595 -48.77751 | hauling   | commence hauling   |
| 01/11/2006 05:50 | 74 FRRF   | -60.42619 -48.78359 | Slowing for FRRF station  | Increase to 3.5 knots  |
| 01/11/2006 05:32 | 73 RMT-25 | -60.40529 -48.80015 | Deck Secure proceeding to FRRF station  | LHPR Deployed @ 2.0kts   |
| 01/11/2006 05:15 | 73 RMT-25 | -60.40913 -48.80232 | RMT 25 recovered  | LHPR Recovered   |
|                  |           |                     | RMT 25 @ Surface  | LHPR @ 2019m increase speed to 3.5kts commence hauling           |
| 01/11/2006 05:07 | 73 RMT-25 | -60.41563 -48.79732 | increase speed to 3.5kts  | commence hauling   |
| 01/11/2006 03:39 | 73 RMT-25 | -60.48624 -48.75872 | RMT 25 @ 1917m  | wire out wire out LHPR Deployed @ 2.0kts                         |
| 01/11/2006 02:31 | 73 RMT-25 | -60.53885 -48.74578 | RMT 25 deployed   | Vessel out of DP and moving off for LHPR re-deployment.          |
|                  |           |                     | Commence deployment of RMT 25 Vessel stopped and returned to full auto DP.  |  |
| 01/11/2006 02:24 | 73 RMT-25 | -60.54471 -48.74413 | Awaiting result of investigation into problem with LHPR.  |  |
| 01/11/2006 01:21 | 72 LHPR   | -60.57278 -48.7471  | LHPR Recovered  | LHPR on deck for investigation. Ship still moving ahead at 2kts. |
|                  |           |                     | Stop veering LHPR 1834m cable out increase to 3.5knots commence recovery increase   |  |
| 01/11/2006 00:21 | LHPR      | -60.63023 -48.70728 | to 3.5knots LHPR deployment aborted   | returning unit to deck. returning unit to deck.                  |
| 31/10/2006 23:33 | 72 LHPR   | -60.65986 -48.69972 | LHPR Deployed @ 2.0kts  | Commenced deployment of LHPR                                     |
|                  |           |                     | Commence deployment of LHPR Midships Gantry Secure vessel out of DP and moving  |  |
| 31/10/2006 23:31 | 72 LHPR   | -60.66104 -48.70008 | off for LHPR deployment.  | vessel out of DP and moving off for LHPR deployment.             |
| 31/10/2006 22:38 | LHPR      | -60.65092 -48.70434 | Repositioning vessel for LHPR deployment  | CTD on deck.   |
| 31/10/2006 22:35 | CTD       | -60.65345 -48.70368 | Condenced Station Position Fixed @ 60 39.9'S 048 42.1'W   | CTD at the surface.  |
| 31/10/2006 22:31 | 71 RMT-25 | -60.65663 -48.70299 | RMT 25 on Deck  | CTD @ 3733m  |



|                  |             |           |           |   |  |
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| 31/10/2006 22:20 | 71 RMT-25   | -60.66495 | -48.70193 | Commence Recovery of RMT  | CTD deployed   |
| 31/10/2006 21:48 | 71 RMT-25   | -60.68968 | -48.69487 | RMT 25 @ 119m (cable out)   | Go Flo recovered   |
| 31/10/2006 21:33 | 71 RMT-25   | -60.70181 | -48.68686 | RMT 25 Deployed   | Commence hauling go-flo  |
| 31/10/2006 21:22 |             | -60.70792 | -48.68256 | Vessel out of DP moving off for RMT 25 deployment.                | Go flo at depth (500m)   |
| 31/10/2006 20:40 |             | -60.70789 | -48.6829  | Vessel set up in DP   | 5th go-flo bottle attached to cable  |
| 31/10/2006 20:33 | GO-FLO      | -60.70782 | -48.68288 | Commenced reducing speed.   | 4th go-flo bottle attached to cable  |
| 31/10/2006 20:22 | 62 TOW-FISH | -60.68641 | -48.75951 | Tow Fish on deck  | 3rd glo-flo bottle attached to cable   |
|                  |             |           |           | Approaching ice edge. Commenced recovering Tow Fish               | 2nd Go Flow bottle attached  |
| 31/10/2006 20:19 | 62 GO-FLO   | -60.67933 | -48.7765  | to the cable  |  |
| 31/10/2006 19:19 | 70 XBT      | -60.54237 | -49.06845 | XBT Deployed  | Go Flo deployed with first bottle  |
| 31/10/2006 17:13 | 69 XBT      | -60.13637 | -49.20936 | XBT Deployed  | CTD recovered  |
| 31/10/2006 14:32 | 68 XBT      | -59.73592 | -49.46991 | XBT Deployed  | CTD @ 30m  |
| 31/10/2006 11:45 | 67 XBT      | -59.36034 | -49.65833 | 1st XBT failed  | XBT redeployed XBT redeployed CTD deployed   |
| 31/10/2006 11:40 | 67 XBT      | -59.34041 | -49.66815 | XBT deployed  | Bongo nets recovered   |
| 31/10/2006 09:34 | 66 XBT      | -58.9249  | -49.87587 | XBT Deployed  | Bongo nets @125m   |
| 31/10/2006 07:35 | 65 XBT      | -58.53883 | -50.0599  | XBT Deployed  | Bongo nets deployed  |
| 31/10/2006 05:08 | 64 XBT      | -58.1239  | -50.22527 | XBT Deployed  | CTD recovered  |
|                  |             |           |           | All secure on deck complete process station 1. A/C to 166 degrees | increase to 10 knots heading towards CS1 complete process station 1. A/C to 166 degrees CTD @ 400m and |
| 31/10/2006 02:16 |             | -57.66249 | -50.38754 | recovering  | heading towards CS1  |
| 31/10/2006 01:50 | 63 MOCNESS  | -57.66893 | -50.39983 | Mocness recovered   | CTD deployed   |
| 31/10/2006 00:46 | 63 MOCNESS  | -57.70472 | -50.41985 | Mocness @ 1835m cable out   | commence hauling commence hauling FRRF recovered   |
| 30/10/2006 23:44 | 63 MOCNESS  | -57.73039 | -50.43437 | Mocness deployed  | FRRF @ 150m and recovering   |
| 30/10/2006 23:40 | 63 MOCNESS  | -57.74168 | -50.43655 | Commence mocness deployment                                       | FRRF Deployed  |
|                  |             |           |           | Vessel off DP preparing for mocness deployment                    | preparing for mocness deployment   |
| 30/10/2006 23:38 |             | -57.74235 | -50.4366  | CTD Recovered   |  |
| 30/10/2006 23:30 | 62 TOW-FISH | -57.74229 | -50.4367  | Tow fish deployed   | CTD @ 140m and recovering  |
| 30/10/2006 23:06 | 61 GO-FLO   | -57.74229 | -50.43674 | go-flo recovered  | CTD Deployed   |
| 30/10/2006 22:53 | 61 GO-FLO   | -57.74233 | -50.43669 | Go flo at depth (50m)   | Mini Bongos Recovered  |
| 30/10/2006 22:52 | 61 GO-FLO   | -57.74231 | -50.43674 | Deploying Go flo (six bottles together)                           | Bongo nets @ 400m  |
| 30/10/2006 22:34 |             | -57.74227 | -50.43678 | Vessel on station in DP. Midships gantry unlashd.                 | Mini Bongos Deployed   |

|                  |             |           |           |  |
|------------------|-------------|-----------|-----------|--|
| 30/10/2006 22:18 | 60 ACOUSTIC | -57.74613 | -50.44049 | Completed transect. CTD recovered  |
| 30/10/2006 21:44 | 60 ACOUSTIC | -57.74232 | -50.60632 | Commenced leg six of Transect course 270 course 270 CTD @ 2000m  |
| 30/10/2006 20:19 | 60 ACOUSTIC | -57.51149 | -50.59725 | Commenced leg five of Transect course 180 course 180 CTD deployed  |
| 30/10/2006 19:47 | 60 ACOUSTIC | -57.51701 | -50.43993 | Commenced leg four of Transect course 270 course 270 Vessel stopped on station in D.P. Setting up for CTD deployment.  |
| 30/10/2006 17:03 | 60 ACOUSTIC | -57.9675  | -50.43943 | commence leg 3 of transect course 000T course 000T Turned on swath for mooring position  |
| 30/10/2006 16:26 | 60 ACOUSTIC | -57.96545 | -50.27084 | Complete first transect A/C to 270T A/C to 270T Science suspended due to weather vessel hove to vessel hove to   |
| 30/10/2006 15:06 | 60 ACOUSTIC | -57.74169 | -50.27047 | Commence Acoustic transect on 180T @ 12.0kts Acoustic transect abandoned due to bad weather  |
| 30/10/2006 14:16 | RMT-25      | -57.63832 | -50.49445 | RMT secure A/C and increase speed to relocate to start of acoustic transect A/C and increase speed to relocate to start of acoustic transect Start acoustic transect PS3_T1 4-6                    |
| 30/10/2006 14:05 | 59 RMT-25   | -57.64543 | -50.48976 | RMT 25 recovered Vessel moving off station to head 270 for swath survey  |
| 30/10/2006 13:34 | 59 CTD      | -57.66298 | -50.47979 | Hauling for recovery CTD Recovered   |
| 30/10/2006 12:22 | 59 RMT-25   | -57.70161 | -50.45936 | Commence hauling RMT CTD @ 2000m   |
| 30/10/2006 12:18 | 59 RMT-25   | -57.70424 | -50.4582  | Stop veering RMT 1731m cable out 1731m cable out CTD deployed  |
| 30/10/2006 11:24 | 59 RMT-25   | -57.73566 | -50.44222 | RMT 25 deployed Bongo nets recovered   |
| 30/10/2006 11:20 | 59 RMT-25   | -57.73819 | -50.44079 | Commence deployment of RMT 25 Bongo nets @ 400m  |
| 30/10/2006 11:00 | 58 RMT-25   | -57.74649 | -50.4258  | RMT 25 recovered Bongo nets deployed   |
| 30/10/2006 10:52 | 58 RMT-25   | -57.74943 | -50.41779 | RMT 25 @ Surface CTD recovered   |
| 30/10/2006 09:53 | 58 RMT-25   | -57.77226 | -50.35788 | Commence Recovery of RMT CTD @ 30m   |
| 30/10/2006 09:43 | 58 RMT-25   | -57.7764  | -50.34698 | RMT 25 @ 750m (cable out) CTD deployed   |
| 30/10/2006 09:21 | 58 RMT-25   | -57.78544 | -50.32191 | RMT 25 Deployed FRRF recovered   |
| 30/10/2006 09:11 | RMT-25      | -57.78559 | -50.32151 | All ready on deck. Vessel out of DP and working up to speed for RMT 25 deployment. FRRF @ 150m commence recovery commence recovery   |
| 30/10/2006 07:47 |             | -57.78986 | -50.31066 | Vessel on station in DP awaiting RMT 25 deployment FRRF deployed   |
| 30/10/2006 07:32 | RMT-25      | -57.78973 | -50.30812 | Approaching RMT 25 deployment position. Setting up in DP to await deployment. Go Flo recovered to deck.  |
| 30/10/2006 05:19 | RMT-25      | -57.71413 | -50.56711 | Deck secure proceeding 5' downwind of Process station ready for RMT25 deployment at 0600 proceeding 5' downwind of Process station ready for RMT25 deployment at 0600 Second Go Flo bottle removed |

|                  |              |                     |  |   |
|------------------|--------------|---------------------|--|---|
| 30/10/2006 05:06 | 57 LHPR      | -57.71614 -50.56774 | LHPR Recovered   | Third Go Flo bottle removed.  |
| 30/10/2006 05:04 | 57 LHPR      | -57.71707 -50.56468 | LHPR @ surface   | Third Go Flo bottle removed.<br>LHPR @ 1854m increase speed to 3.5kts increase speed to 3.5kts Fifth Go Flo bottle                  |
| 30/10/2006 04:02 | 57 LHPR      | -57.73512 -50.46758 | removed  |   |
| 30/10/2006 03:15 | 57 LHPR      | -57.74377 -50.43228 | LHPR Deployed @ 2.0kts                                 | Sixth Go Flo bottle removed   |
| 30/10/2006 03:07 | 57 LHPR      | -57.74759 -50.43161 | Slowing for LHPR deployment                            | Commenced recovery of Glo Fo<br>All secure on deck a/c to run back to process station a/c to run back to process station            |
| 30/10/2006 02:07 |              | -57.80074 -50.69754 | Go Flo wire at 1000m                                   | Trigger weight deployed.  |
| 30/10/2006 01:53 | 56 RMT-25    | -57.7991 -50.68837  | RMT recovered  | Sixth Go Flo bottle attached  |
| 30/10/2006 00:33 | 56 RMT-25    | -57.78165 -50.59807 | Commence hauling RMT                                   | Fifth Go Flo bottle attached  |
| 30/10/2006 00:15 | 56 RMT-25    | -57.77588 -50.57856 | Stop veering RMT 1175m cable out                       | 1175m cable out Fourth Go Flo bottle attached   |
| 29/10/2006 23:41 | 56 RMT-25    | -57.76618 -50.54229 | RMT 25 Deployed  | Third Go Flo bottle attached  |
| 29/10/2006 23:34 | 56 RMT-25    | -57.76419 -50.53501 | Commence deployment of RMT 25                          | Second Go Flo bottle attached.  |
| 29/10/2006 23:23 | 55 RMT-25    | -57.76248 -50.53007 | RMT 25 recovered                                       | Go Flo deployed with first bottle   |
| 29/10/2006 23:05 | 55 RMT-25    | -57.75783 -50.50813 | RMT 25 heaved up to 100m (cable out)                   | CTD on deck.  |
| 29/10/2006 22:40 | 55 RMT-25    | -57.75774 -50.50776 | RMT 25 @ 154m (cable out)                              | CTD at the surface.   |
| 29/10/2006 22:25 | 55 RMT-25    | -57.74909 -50.45961 | RMT 25 Deployed  | CTD @ 140m Commenced recovery. Commenced recovery.<br>Midships Gantry Secure vessel out of DP and positioning for RMT 25 deployment |
| 29/10/2006 22:00 |              | -57.74462 -50.43041 | vessel out of DP and positioning for RMT 25 deployment | CTD deployed  |
| 29/10/2006 21:55 | 54 MINIBONGO | -57.74461 -50.43042 | Mini Bongos Recovered                                  | Bongo Nets on board.  |
| 29/10/2006 21:54 | 54 MINIBONGO | -57.74456 -50.43064 | Mini Bongos at the surface                             | Bongo Nets at the surface.<br>Mini Bongos @ 400m and Recovering Bongo nets @400m commenced recovery.                                |
| 29/10/2006 21:32 | 54 MINIBONGO | -57.74303 -50.43559 | commenced recovery.                                    |   |
| 29/10/2006 21:19 | 54 MINIBONGO | -57.74252 -50.43721 | Deploying Mini Bongo                                   | Bongo nets deployed   |
| 29/10/2006 21:06 |              | -57.74209 -50.43785 | Vessel on station in DP. Midships gantry unlashd.      | CTD on deck.  |
| 29/10/2006 20:56 |              | -57.74456 -50.44589 | Approaching Process Station 1. Setting up in DP        | CTD at the surface.   |
| 29/10/2006 20:22 | 53 LHPR      | -57.75878 -50.59927 | LHPR @ surface   | CTD @ 3728m<br>LHPR recovered repositioning vessel for Mini Bongo deployment. repositioning vessel                                  |
| 29/10/2006 20:22 | 53 LHPR      | -57.75878 -50.59927 | for Mini Bongo deployment.                             | CTD deployed  |
| 29/10/2006 19:03 | 53 LHPR      | -57.74219 -50.43792 | LHPR cable out 2394m                                   | Commenced recovery FRRF recovered   |
| 29/10/2006 17:56 | 53 LHPR      | -57.74271 -50.43657 | Deploying LHPR   | FRRF @ 150m   |

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| 29/10/2006 17:47 |           | -57.74535 -50.37731 gantry secure increasing speed for LHPR deployment increasing speed for LHPR deployment FRRF deployed   |
| 29/10/2006 17:42 | 52 CTD    | -57.74548 -50.37999 CTD recovered Slowing for Process Station Three   |
| 29/10/2006 17:03 | 52 CTD    | -57.74548 -50.39012 CTD @ 2000m Deck Secure proceeding to FRRF station  |
| 29/10/2006 16:25 | 52 CTD    | -57.74546 -50.39957 CTD deployed RMT 25 recovered   |
| 29/10/2006 15:45 | 52 CTD    | -57.74551 -50.39951 CTD deployment delayed due to wire jumping off drum RMT @ Surface   |
| 29/10/2006 15:38 | 51 BONGO  | -57.74542 -50.40011 Bongo nets recovered RMT 25 @ 49m (cable out)   |
| 29/10/2006 15:09 | 51 BONGO  | -57.74483 -50.40952 Bongo nets @400m RMT 25 Deployed @ 2.5kts   |
| 29/10/2006 14:58 | 51 BONGO  | -57.74448 -50.41352 Bongo nets deployed Deploying RMT 25  |
| 29/10/2006 14:51 | 50 CTD    | -57.74442 -50.41391 CTD recovered Slowing for RMT 25 deployment   |
| 29/10/2006 14:41 | 50 CTD    | -57.74428 -50.41574 CTD @ 60m deck secure moving off to look for targets  |
| 29/10/2006 14:37 | 50 CTD    | -57.74422 -50.41623 CTD deployed RMT 25 recovered   |
| 29/10/2006 14:24 | 49 FRRF   | -57.74459 -50.41174 FRRF recovered RMT 25 @ 53m (cable out)   |
| 29/10/2006 14:09 | 49 FRRF   | -57.74438 -50.41433 FRRF @ 150m RMT 25 deployed   |
| 29/10/2006 13:59 | 49 FRRF   | -57.74422 -50.41688 FRRF deployed Targets identified turn head to wind and prepare for RMT deployment<br>turn head to wind and prepare for RMT deployment<br>go-flo recovered All secure a/c to run downwind looking for krill targets a/c to run |
| 29/10/2006 13:46 | 48 GO-FLO | -57.74475 -50.41194 downwind looking for krill targets  |
| 29/10/2006 13:16 | 48 GO-FLO | -57.74433 -50.41937 Commence recovery of go-flo RMT recovered   |
| 29/10/2006 12:58 | 48 GO-FLO | -57.74394 -50.42448 Go-flow @ depth 1000m bottles triggered bottles triggered RMT @ Surface   |
| 29/10/2006 12:27 | 48 GO-FLO | -57.74344 -50.43338 Go-Flo deployed Commence hauling RMT  |
| 29/10/2006 12:15 | 47 CTD    | -57.74375 -50.4283 CTD recovered RMT 25 @ 54m (cable out)   |
| 29/10/2006 11:57 | 47 CTD    | -57.74349 -50.43164 CTD @ 140m RMT 25 deployed  |
| 29/10/2006 11:50 | 47 CTD    | -57.74337 -50.43282 CTD deployed Commence deploying RMT<br>Bongo nets recovered Targets identified turn head to wind and prepare for RMT  |
| 29/10/2006 11:41 | 46 BONGO  | -57.74396 -50.429 deployment turn head to wind and prepare for RMT deployment   |
| 29/10/2006 11:24 | 46 BONGO  | -57.74304 -50.43412 Bongo nets @400m Vessel off DP running down wind to search for RMT targets  |
| 29/10/2006 11:14 | 46 BONGO  | -57.74227 -50.43785 Bongo nets deployed Weights recovered   |
| 29/10/2006 11:05 | 45 CTD    | -57.74209 -50.4386 CTD recovered Weights @ 500m<br>CTD at deph (cable out 4063m). Commenced recovery. V/I moving ahead at 0.5knots  |
| 29/10/2006 09:38 | 45 CTD    | -57.74209 -50.43858 on DP. Weights deployed on conducting wire.   |

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| 29/10/2006 08:28 | 45 CTD    | -57.74217 -50.43854 CTD deployed V/L on DP @ process station 4  |
| 29/10/2006 08:21 |           | -57.74218 -50.43857 Vessel on station in DP. Vessel at Process Station No.3   |
| 29/10/2006 08:12 |           | -57.74224 -50.43672 Midships gantry unlashed Ships speed 5 knots  |
| 29/10/2006 08:11 |           | -57.74224 -50.43648 knots.<br>Approaching Process Station 1. Setting up in DP Commenced reducing speed to 5 knots.<br>Gantry Secure moving to Process station one moving to Process station one XBT                             |
| 29/10/2006 06:41 |           | -57.49888 -50.51263 Completed Increasing Speed  |
| 29/10/2006 06:34 | 44 FRRF   | -57.49924 -50.51195 FRRF recovered XBT Deployed   |
| 29/10/2006 06:16 | 44 FRRF   | -57.49925 -50.51193 FRRF @ 150m Deck Secure proceeding to process station 3   |
| 29/10/2006 06:03 | 44 FRRF   | -57.49927 -50.51194 FRRF deployed CTD recovered   |
| 29/10/2006 05:56 | 44 FRRF   | -57.49947 -50.51164 Vessel on DP for FRRF deployment CTD @ 2007m  |
| 29/10/2006 05:51 | 44 FRRF   | -57.49884 -50.50664 Slowing for FRRF station CTD deployed   |
| 29/10/2006 05:31 | 43 RMT-25 | -57.44501 -50.51752 Deck Secure proceeding to DP station Vessel on D.P. ready to deploy   |
| 29/10/2006 05:11 | 43 RMT-25 | -57.45288 -50.51519 RMT Recovered Slowing for CTD station "J"   |
| 29/10/2006 05:02 | 43 RMT-25 | -57.45943 -50.5141 RMT 25 @ Surface Vessel moving off station   |
| 29/10/2006 03:58 | 43 RMT-25 | -57.50876 -50.50677 RMT 25 @ 766m CTD Recovered<br>Bridge Informed by U.I.C. that RMT will be deployed till 0200 then vessel to proceed in direction of Process Station one stopping at 0300 for deployment of FRRF then vessel |
| 29/10/2006 03:41 | RMT-25    | -57.49923 -50.51194 to proceed in direction of Process Station one CTD @ 2013m  |
| 29/10/2006 03:30 | 43 RMT-25 | -57.53066 -50.50526 RMT 25 Deployed CTD deployed<br>Deploying RMT Vessel stopped on station in DP midships gantry unlashed. midships  |
| 29/10/2006 03:24 | 43 RMT-25 | -57.53512 -50.50532 gantry unlashed.  |
| 29/10/2006 02:38 | 42 RMT-25 | -57.54536 -50.50589 RMT Recovered XBT Completed Increasing Speed  |
| 29/10/2006 02:26 | 42 RMT-25 | -57.55389 -50.49981 RMT 25 @ Surface XBT Deployed   |
| 29/10/2006 00:32 | 42 RMT-25 | -57.627 -50.4497 Commence hauling Deck Secure proceeding to CTD I Station   |
| 29/10/2006 00:24 | 42 RMT-25 | -57.63226 -50.44641 Stop veering out cable at 1895m FRRF recovered  |
| 28/10/2006 23:31 | 42 RMT-25 | -57.66753 -50.42721 RMT 25 Deployed FRRF @ 150m   |
| 28/10/2006 22:43 | 41 RMT-25 | -57.61767 -50.39899 RMT 25 recovered. Repositioning vessel for next run FRRF deployed   |
| 28/10/2006 22:37 | 41 RMT-25 | -57.62293 -50.39765 RMT 25 @ Surface Vessel on D.P. ready to deploy   |
| 28/10/2006 22:32 | 41 RMT-25 | -57.62744 -50.39676 RMT 25 commenced recovery Slowing for FRRF station  |
| 28/10/2006 21:32 | 41 RMT-25 | -57.67511 -50.39387 Stopped veering out cable at 338m. Deck Secure proceeding to process station 2  |

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| 28/10/2006 21:18 | 41 RMT-25  | -57.68598 -50.39344 | RMT 25 Deployed RMT 25 recovered<br>Midships Gantry Secure vessel out of DP and positioning for RMT 25 deployment<br>vessel out of DP and positioning for RMT 25 deployment recovering RMT due to fault |
| 28/10/2006 21:01 |            | -57.6957 -50.39106  | possible net monitor possible net monitor   |
| 28/10/2006 20:56 | 40 CTD     | -57.6955 -50.39173  | CTD recovered RMT 25 @ 208m (cable out)   |
| 28/10/2006 20:54 | 40 CTD     | -57.69543 -50.39199 | CTD at the surface. RMT 25 Deployed @ 2.5kts  |
| 28/10/2006 20:49 | 40 CTD     | -57.69519 -50.3926  | CTD at depth (40m) commenced recovery commenced recovery Deploying RMT 25   |
| 28/10/2006 20:44 | 40 CTD     | -57.69505 -50.39287 | CTD deployed Slowing for RMT deployment<br>Vessel on station in DP. Midships gantry unlashed. Run down wind in preparation for  |
| 28/10/2006 20:40 |            | -57.6794 -50.39387  | RMT 25 target fishing<br>Mocness recovered Repositioning Vessel for CTD deployment Repositioning Vessel for<br>CTD deployment Work continuing to rectify LHPR problem. Cable will require               |
| 28/10/2006 19:52 | 39 MOCNESS | -57.63762 -50.36547 | retermination<br>Mocness @ surface V/L holding position while work is undertaken to rectify LHPR  |
| 28/10/2006 19:50 | 39 MOCNESS | -57.68296 -50.39369 | problem   |
| 28/10/2006 18:44 | 39 MOCNESS | -57.68132 -50.37961 | Mocness @ 1952m and hauling LHPR Recovered<br>Mocness deployed LHPR stopped at 605m cable out equipment failure commence  |
| 28/10/2006 17:34 | 39 MOCNESS | -57.72223 -50.38383 | recovery equipment failure commence recovery  |
| 28/10/2006 17:30 | 39 MOCNESS | -57.725 -50.3836    | Deploying Mocness Resume veering LHPR<br>Mocness recovered LHPR stopped @ 484m cable out equipment problem equipment  |
| 28/10/2006 17:24 | 38 MOCNESS | -57.72854 -50.38368 | problem   |
| 28/10/2006 17:18 | 38 MOCNESS | -57.73306 -50.38358 | Recovering Mocness No readings No readings LHPR Deployed @ 2.0kts   |
| 28/10/2006 17:17 | 38 MOCNESS | -57.73384 -50.38347 | Mocness deployed Repositioning vessel for LHPR deployment   |
| 28/10/2006 17:13 | 38 MOCNESS | -57.73645 -50.38365 | Deploying Mocness Multinet Recovered<br>Gantry Lashed preparing to deploy mocness preparing to deploy mocness Multinet @  |
| 28/10/2006 17:07 |            | -57.7398 -50.38369  | Surface   |
| 28/10/2006 16:58 | 37 CTD     | -57.74121 -50.38464 | CTD recovered Multinet at 1925m and recovering  |
| 28/10/2006 16:40 | 37 CTD     | -57.74132 -50.38998 | CTD @ 400m Multinet Deployed @ 2kt  |
| 28/10/2006 16:29 | 37 CTD     | -57.74138 -50.39249 | CTD deployed Turning vessel and reducing speed for Multinet deployment.   |
| 28/10/2006 15:51 | 36 CTD     | -57.74178 -50.40053 | CTD recovered Vessel proceeding back to process station   |
| 28/10/2006 14:23 | 36 CTD     | -57.74215 -50.4085  | CTD@ depth 4099m cable out RMT Recovered  |
| 28/10/2006 13:10 | 36 CTD     | -57.74289 -50.4218  | CTD deployed RMT @ Surface  |

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| 28/10/2006 12:33 | 35 CTD    | -57.74288 -50.42182 CTD recovered to deck RMT 25 @ 495m (cable out)   |
| 28/10/2006 12:10 | 35 CTD    | -57.7429 -50.4218 CTD stopped @140m RMT 25 Deployed @ 2.5kts  |
| 28/10/2006 12:02 | 35 CTD    | -57.7429 -50.4218 CTD deployed Deploying RMT 25   |
| 28/10/2006 11:41 | 34 FRRF   | -57.74289 -50.42174 FRRF recovered ready to deploy  |
| 28/10/2006 11:27 | 34 FRRF   | -57.74287 -50.42386 Commence recovery of FRRF Slowing for RMT deployment  |
| 28/10/2006 11:16 | 34 FRRF   | -57.74273 -50.42543 FRRF deployed Vessel towards process station  |
| 28/10/2006 11:06 | 33 GO-FLO | -57.74266 -50.42599 Go flow recovered RMT 25 recovered  |
| 28/10/2006 10:36 | 33 GO-FLO | -57.74189 -50.43121 Commence Recovery of Go-Flo RMT 25 @ 636m (cable out)   |
| 28/10/2006 10:20 | 33 GO-FLO | -57.74196 -50.43355 Go-Flo at depth (1000m) RMT 25 deployed   |
| 28/10/2006 09:55 | 33 GO-FLO | -57.74241 -50.43807 Vessel tracking in DP to maintain lead on the Go-Flo wire RMT 25 recovered  |
| 28/10/2006 09:51 | 33 GO-FLO | -57.74236 -50.43831 Go-Flo deployed RMT 25 @ 2266m (cable out)  |
| 28/10/2006 09:36 | 32 CTD    | -57.74238 -50.43838 CTD recovered RMT 25 Deployed<br>CTD at the surface. Completed Acoustic Survey relocating for RMT 25 deployment.                                  |
| 28/10/2006 09:35 | 32 CTD    | -57.74237 -50.43837 relocating for RMT 25 deployment.<br>Resumed recovery of CTD direct to deck. Commence Acoustic transect on 270T @                                 |
| 28/10/2006 08:31 | 32 CTD    | -57.74226 -50.43837 10.0kts<br>CTD recovery held. Problem with the CTD (cable out 3820m) Turning vessel for start   |
| 28/10/2006 08:18 | 32 CTD    | -57.74224 -50.43836 point of Acoustic Survey.<br>CTD at depth (cable out 4065m) Commencing recovery deck secure proceeding to   |
| 28/10/2006 08:11 | 32 CTD    | -57.74217 -50.43839 acoustic survey run   |
| 28/10/2006 07:00 | 32 CTD    | -57.74218 -50.43842 CTD deployed RMT 25 recovered   |
| 28/10/2006 06:44 | 31 FRRF   | -57.74205 -50.43814 FRRF recovered RMT 25 @ Surface   |
| 28/10/2006 06:24 | 31 FRRF   | -57.74137 -50.43646 FRRF @ 150m RMT 25 @ 153m (cable out)   |
| 28/10/2006 06:16 | 31 FRRF   | -57.74101 -50.43557 FRRF deployed RMT 25 Deployed @ 2.5kts  |
| 28/10/2006 06:09 | 31 FRRF   | -57.74101 -50.43556 V/I on Auto Position DP ready to deploy FRRF Deploying RMT 25   |
| 28/10/2006 06:00 | 31 FRRF   | -57.74246 -50.44123 Slowing for Process Station One Slowing for RMT deployment<br>Deck Secure proceeding to DP station deck secure proceeding towards acoustic survey |
| 28/10/2006 04:43 |           | -57.65328 -50.13435 run   |
| 28/10/2006 04:18 | 30 LHPR   | -57.66153 -50.16789 LHPR Recovered RMT 25 recovered   |
| 28/10/2006 04:14 | 30 LHPR   | -57.66383 -50.17481 LHPR @ surface RMT 25 @ Surface   |
| 28/10/2006 02:35 | 30 RMT-25 | -57.72621 -50.37216 Commence hauling RMT 25 @ 714m (cable out)  |

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| 28/10/2006 02:34 | 30 RMT-25    | -57.72671 | -50.37424 | Stop veering out cable at 2808m RMT 25 Deployed  |
| 28/10/2006 01:20 | 30 RMT-25    | -57.76551 | -50.53438 | LHPR Deployed V/L off DP preparing for RMT   |
| 28/10/2006 00:10 | 29 RMT-25    | -57.7537  | -50.3561  | RMT 25 recovered to deck due to fault with a wire FRRF recovered   |
| 28/10/2006 00:00 | 29 RMT-25    | -57.75306 | -50.34204 | RMT 25 Deployed FRRF @ 150m commence recovery commence recovery  |
| 27/10/2006 22:54 |              | -57.73108 | -50.35153 | Turning back towards the East FRRF deployed  |
| 27/10/2006 21:10 |              | -57.74134 | -50.11534 | Turning back towards the west one mile north of east bound track V/L on DP for FRRF  |
| 27/10/2006 21:00 |              | -57.73692 | -50.16156 | Steaming North for one mile LHPR secure a/c to run downwind a/c to run downwind<br>RMT deployment aborted due to technical problems. Vessel reversed course and<br>increased speed to 5kts for fish finding while repairs made to the RMT LHPR |
| 27/10/2006 19:32 | 29 RMT-25    | -57.74856 | -50.37249 | Recovered<br>Vessel Head to wind @ 2.5Kts ready to deploy RMT ready to deploy RMT LHPR@  |
| 27/10/2006 18:55 | 29 RMT-25    | -57.7493  | -50.3289  | 2439m (cable out)  |
| 27/10/2006 18:40 |              | -57.74926 | -50.36774 | Vessel moving off station Increase to 3.5 knots  |
| 27/10/2006 18:22 |              | -57.74862 | -50.36464 | Midships Gantry Secure rigging RMT wire rigging RMT wire Neuston sledge recovered  |
| 27/10/2006 18:13 | 28 MINIBONGO | -57.74849 | -50.37193 | Mini Bongos Recovered Neuston sledge deployed  |
| 27/10/2006 17:52 | 28 MINIBONGO | -57.74695 | -50.38033 | Mini Bongos @ 400m and Recovering LHPR Deployed @ 2.0kts   |
| 27/10/2006 17:37 | 28 MINIBONGO | -57.74549 | -50.38536 | Mini Bongos Deployed V/L off DP preparing to deploy LHPR<br>Mini Bongos Recovered LHPR on deck repositioning vessel for next run.  |
| 27/10/2006 17:32 | 27 MINIBONGO | -57.74522 | -50.3873  | repositioning vessel for next run.   |
| 27/10/2006 17:15 | 27 MINIBONGO | -57.74409 | -50.3931  | Mini Bongos @ 400m and Recovering LHPR at the surface.   |
| 27/10/2006 17:02 | 27 MINIBONGO | -57.74296 | -50.3978  | Mini Bongos Deployed LHPR @ 2050 commence hauling commence hauling   |
| 27/10/2006 16:53 | 26 CTD       | -57.74297 | -50.39991 | CTD recovered Increase to 3.5 knots  |
| 27/10/2006 16:10 | 26 CTD       | -57.74303 | -50.41022 | CTD @ 2000m LHPR Deployed @ 2.0kts   |
| 27/10/2006 15:32 | 26 CTD       | -57.74302 | -50.42025 | CTD deployed Vessel turning into wind and reducing speed for LHPR deployment.  |
| 27/10/2006 15:19 | 25 BONGO     | -57.74294 | -50.42358 | Bongo nets recovered from 400m Vessel proceeding back to process station   |
| 27/10/2006 14:50 | 25 BONGO     | -57.74267 | -50.43003 | Bongo nets deployed Multinet Recovered   |
| 27/10/2006 14:49 | 24 BONGO     | -57.74266 | -50.43025 | Bongo nets recovered from 400m Multinet @ Surface<br>Commence recovery of bongo nets Recommence hauling electronics not fixed. Hauling   |
| 27/10/2006 14:31 | 24 BONGO     | -57.74254 | -50.43478 | for recovery electronics not fixed. Hauling for recovery   |
| 27/10/2006 14:20 | 24 BONGO     | -57.74247 | -50.43674 | Bongo nets deployed Hauling stopped due to problem with electronics for net monitor  |
| 27/10/2006 14:14 | 23 CTD       | -57.74243 | -50.4375  | CTD recovered Multinet at 2284m and recovering   |



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| 27/10/2006 14:01 | 23 CTD      | -57.74245 -50.43754 CTD stopped at 20m Multinet Deployed @ 2kt  |
| 27/10/2006 13:57 | 23 CTD      | -57.74246 -50.43748 CTD deployed Deploying the multinet   |
| 27/10/2006 13:55 | 23 CTD      | -57.74246 -50.43748 Clear to deploy CTD Vessel moving off station to deploy multinet  |
| 27/10/2006 13:45 | 22 FRRF     | -57.74284 -50.43359 FRRF recovered V/L sat on DP awaiting rigging of multinet   |
| 27/10/2006 13:28 | 22 FRRF     | -57.74285 -50.4336 Commence recovery of FRRF Bongo nets recovered   |
| 27/10/2006 13:10 | 22 FRRF     | -57.74282 -50.43382 FRRF deployed Bongo nets @125m commenced recovery. commenced recovery.  |
| 27/10/2006 12:56 | 21 GO-FLO   | -57.74347 -50.42523 go-flo recovered Bongo nets deployed  |
| 27/10/2006 12:15 | 21 GO-FLO   | -57.74289 -50.43034 commence recovery of go-flo CTD recovered   |
| 27/10/2006 11:56 | 21 GO-FLO   | -57.74247 -50.43423 6th go-flo bottle attached to cable CTD @ 60m   |
| 27/10/2006 11:53 | 21 GO-FLO   | -57.7424 -50.4348 5th go-flo bottle attached to cable CTD deployed  |
| 27/10/2006 11:50 | 21 GO-FLO   | -57.74235 -50.43545 4th go-flo bottle attached to cable FRRF recovered<br>3rd go-flo bottle attached to cable FRRF @ 150m commence recovery commence    |
| 27/10/2006 11:46 | 21 GO-FLO   | -57.74225 -50.43626 recovery  |
| 27/10/2006 11:36 | 21 GO-FLO   | -57.74211 -50.43784 2nd Go Flow bottle attached to the cable FRRF deployed  |
| 27/10/2006 11:20 | 21 GO-FLO   | -57.74202 -50.43838 Commence deployment of Go Flow go-flo recovered   |
| 27/10/2006 10:57 | 20 CTD      | -57.74202 -50.43837 CTD recovered commence recovery of go-flo   |
| 27/10/2006 10:55 | 20 CTD      | -57.74202 -50.43837 CTD at the surface. Go Flo wire at 1000m Trigger weight deployed.   |
| 27/10/2006 10:41 | 20 CTD      | -57.74202 -50.43837 CTD Commenced recovery Commenced recovery Sixth Go Flo bottle attached  |
| 27/10/2006 10:39 | 20 CTD      | -57.74201 -50.4384 CTD at depth (cable out 140m) Fifth Go Flo bottle attached   |
| 27/10/2006 10:33 | 20 CTD      | -57.74198 -50.43838 CTD deployed Fourth Go Flo bottle attached  |
| 27/10/2006 09:42 | 19 CTD      | -57.74201 -50.43837 CTD recovered Third Go Flo bottle attached  |
| 27/10/2006 09:40 | 19 CTD      | -57.74202 -50.43835 CTD at the surface. Second Go Flo bottle attached.<br>CTD at depth (cable out 4050m) Commencing recovery Go-Flo deployed with first |
| 27/10/2006 08:11 | 19 CTD      | -57.74202 -50.43835 bottle.   |
| 27/10/2006 06:59 | 19 CTD      | -57.74201 -50.43835 CTD deployed CTD on deck. Setting up for Go Flo.  |
| 27/10/2006 06:26 | 18 FRRF     | -57.74197 -50.43806 FRRF recovered from 120m CTD at the surface.  |
| 27/10/2006 06:18 | 18 FRRF     | -57.74197 -50.43811 FRRF deployed CTD @ 140m Commenced recovery. Commenced recovery.  |
| 27/10/2006 06:05 | 18 FRRF     | -57.74216 -50.43781 Vessel on DP for FRRF deployment CTD deployed   |
| 27/10/2006 05:51 | 17 TOW-FISH | -57.75106 -50.40468 Towed Fish recovered proceeding to DP station proceeding to DP station CTD on deck.   |
| 27/10/2006 05:39 | 17 TOW-FISH | -57.75568 -50.38854 recovering Towed Fish CTD at the surface.   |

|                  |             |           |           |   |
|------------------|-------------|-----------|-----------|---|
|                  |             |           |           | Slowing to recover Towed Fish CTD @ 2000m Commencing recovery. Commencing             |
| 27/10/2006 05:36 | 17 TOW-FISH | -57.75633 | -50.38717 | recovery.   |
| 27/10/2006 03:21 | 16 MOCNESS  | -57.73076 | -50.50701 | Mocness recovered CTD deployed  |
| 27/10/2006 03:17 | 16 MOCNESS  | -57.73057 | -50.50261 | Mocness @ surface CTD on deck.  |
| 27/10/2006 02:45 | 16 MOCNESS  | -57.73047 | -50.4698  | Commence recovery of mocness CTD at the surface.                                      |
| 27/10/2006 02:44 | 16 MOCNESS  | -57.73044 | -50.46861 | Stopped veering mocness cable at 1000m CTD @ 3178m                                    |
| 27/10/2006 02:27 | 17 TOW-FISH | -57.7305  | -50.451   | Tow fish deployed CTD deployed  |
| 27/10/2006 02:02 | 16 MOCNESS  | -57.72809 | -50.42646 | Mocness deployed vessel on auto posn dp @ process station2                            |
|                  |             |           |           | Alter course head to swell reduce speed to 2kt and prepare for deployment of Mocness  |
| 27/10/2006 00:54 | 16 MOCNESS  | -57.72455 | -50.34996 | head to swell Slowing for Process Station Two   |
|                  |             |           |           | Rochester Cable tests completed increasing speed and altering course for Process      |
| 26/10/2006 20:44 |             | -57.13095 | -51.17834 | Station 1. Deck Secure proceeding to process station 2                                |
|                  |             |           |           | CPR recovered to deck. Commencing load and conductivity test on Rochester Cable.      |
| 26/10/2006 20:08 | 3 CPR       | -57.013   | -51.54339 | RMT 25 recovered  |
| 26/10/2006 20:02 | 3 CPR       | -57.01297 | -51.57041 | Commenced recovering CPR RMT 25 @ Surface   |
|                  |             |           |           | Turning vessel to run with the sea and reducing speed for CPR recovery. RMT 25 @      |
| 26/10/2006 19:58 |             | -57.12294 | -51.19002 | 306m (cable out)  |
| 26/10/2006 11:47 | 2 MAGNET    | -56.20563 | -54.4992  | Magnetometer recovered RMT 25 Deployed @ 2.5kts                                       |
| 26/10/2006 11:40 | 2 MAGNET    | -56.20237 | -54.48801 | commence recovery of magnetometer Deploying RMT 25                                    |
|                  |             |           |           | XBT Aborted resuming track towards XBT10 position. resuming track towards XBT10       |
| 25/10/2006 21:12 | 15 XBT      | -54.78682 | -53.77049 | position. RMT Recovered   |
| 25/10/2006 19:39 | 15 XBT      | -54.78548 | -53.7712  | XBT Deployed RMT 25 @ 100m (cable out)  |
| 25/10/2006 19:35 | 15 XBT      | -54.54975 | -53.88036 | Altering into weather for XBT deployment. RMT 25 Deployed                             |
|                  |             |           |           | Essential Deck/Sci work completed. Vessel A/C towards XBT10 position. RMT 25          |
| 25/10/2006 19:10 |             | -54.49177 | -53.90282 | recovered   |
|                  |             |           |           | Vessel A/C down weather to allow essential deck/ Sci work deck/ Sci work RMT 25 @     |
| 25/10/2006 16:25 |             | -54.54581 | -54.55138 | 1975m (cable out)   |
| 25/10/2006 15:49 | 14 XBT      | -54.44743 | -54.6566  | Vessel @ 11.5kts RMT 25 Deployed  |
|                  |             |           |           | XBT Failed increasing speed to 11.5 kts increasing speed to 11.5 kts Vessel out of DP |
| 25/10/2006 15:38 | 14 XBT      | -54.43491 | -54.68534 | and driving ahead for RMT 25 deployment.  |
| 25/10/2006 15:36 | 14 XBT      | -54.43486 | -54.69009 | XBT Deployed Vessel stopped in DP awaiting RMT 25 deployment.                         |
| 25/10/2006 15:32 | 13 XBT      | -54.43454 | -54.69992 | XBT Failed Completed transect. Repositioning for RMT 25 deployment.                   |

|                  |        |                     |                                       |   |
|------------------|--------|---------------------|---------------------------------------|---|
| 25/10/2006 15:31 | 13 XBT | -54.43437 -54.70245 | XBT Deployed                          | Commenced third transect on heading 090                                 |
| 25/10/2006 15:27 | 13 XBT | -54.43315 -54.71309 | transect A/C to 000T                  | A/C to 000T Complete second   |
| 25/10/2006 13:15 |        | -54.18342 -54.96832 | Vessel @ 11.5kts                      | Commence 2nd leg of acoustic transect                                   |
| 25/10/2006 13:10 | XBT    | -54.17477 -54.98149 | Complete first transect               | A/C to 000T A/C to 000T   |
| 25/10/2006 13:03 | 12 XBT | -54.17338 -55.0006  | XBT failed                            | Commence leg 1 of acoustic transect                                     |
| 25/10/2006 13:00 | 12 XBT | -54.17277 -55.00898 | XBT deployed                          | All secure on deck moving off to begin acoustic survey moving off to    |
| 25/10/2006 12:56 | 11 XBT | -54.17193 -55.02046 | XBT failed                            | Bongo nets recovered  |
| 25/10/2006 12:53 | 11 XBT | -54.17125 -55.02884 | XBT deployed                          | Bongo nets @400m commenced recovery. commenced recovery.                |
| 25/10/2006 12:45 |        | -54.16611 -55.05284 | a/c to run down swell                 | reduce speed reduce speed Bongo nets deployed                           |
| 25/10/2006 11:18 |        | -53.94488 -55.33986 | v/l at 11.5 knots                     | Bongo nets recovered  |
| 25/10/2006 11:14 | 10 XBT | -53.93824 -55.34935 | XBT deployed                          | Bongo nets @400m commenced recovery. commenced recovery.                |
| 25/10/2006 11:04 | 9 XBT  | -53.93118 -55.36006 | XBT Failed                            | Bongo deployed  |
| 25/10/2006 11:00 | 9 XBT  | -53.93074 -55.36069 | XBT Deployed                          | CTD recovered   |
| 25/10/2006 10:54 | 9      | -53.913 -55.38507   | Slowing to 6.0 kts for XBT deployment | CTD @ 400m commencing recovery.   |
| 25/10/2006 09:26 | 8      | -53.69288 -55.66072 | Vessel @ 11.5kts                      | CTD deployed  |
| 25/10/2006 09:23 | 8 XBT  | -53.68535 -55.67051 | XBT Completed Increasing Speed        | CTD recovered   |
| 25/10/2006 09:19 | 8 XBT  | -53.69039 -55.66401 | XBT Completed Increasing Speed        | CTD @ 140m Commenced recovery.  |
| 25/10/2006 09:10 | 8 XBT  | -53.66799 -55.69425 | XBT Deployed                          | CTD deployed  |
| 25/10/2006 09:05 | 8      | -53.66041 -55.70395 | Slowing to 6.0 kts for XBT deployment | FRRF recovered  |
| 25/10/2006 07:35 | 7      | -53.70041 -55.65162 | Vessel @ 11.5kts                      | FRRF @ 150m commence recovery commence recovery                         |
| 25/10/2006 07:28 | 7 XBT  | -53.42418 -56.00729 | XBT Failed                            | increasing speed to 11.5 kts increasing speed to 11.5 kts FRRF deployed |
| 25/10/2006 07:22 | 7 XBT  | -53.45386 -55.97062 | XBT Deployed                          | Go Flo recovered to deck. Setting up for FRRF.                          |
| 25/10/2006 07:17 | 6 XBT  | -53.41461 -56.0198  | XBT Failed                            | Second Go Flo bottle removed  |
| 25/10/2006 07:14 | 6 XBT  | -53.45044 -55.97498 | XBT Deployed                          | Third Go Flo bottle removed.  |
| 25/10/2006 07:10 | 6      | -53.4048 -56.03353  | Slowing to 6.0 kts for XBT deployment | Fourth Go Flo bottle removed  |
| 25/10/2006 05:45 | 5      | -53.19355 -56.30502 | Vessel @ 11.5kts                      | Fifth Go Flo bottle removed   |

| Time             | Event    | Lat       | Lon       | Description  |
|------------------|----------|-----------|-----------|--|
| 25/10/2006 05:37 | 5 XBT    | -53.17804 | -56.32597 | bottle removed   |
| 25/10/2006 05:26 | 5 XBT    | -53.16354 | -56.34411 | XBT Deployed Commenced Go Flo recovery                             |
| 25/10/2006 05:23 | 4 XBT    | -53.15998 | -56.34842 | XBT Failed Go Flo wire at 1000m Trigger weight deployed.           |
| 25/10/2006 05:20 | 4 XBT    | -53.15617 | -56.35302 | XBT Deployed Sixth Go Flo bottle attached                          |
| 25/10/2006 05:12 | 4        | -53.14354 | -56.36778 | Slowing to 6.0 kts for XBT deployment Fifth Go Flo bottle attached |
| 24/10/2006 20:54 | 3 CPR    | -51.72058 | -57.58259 | CPR deployed to 60m Fourth Go Flo bottle attached                  |
| 24/10/2006 20:46 | 3 CPR    | -51.70105 | -57.60213 | CPR deployed Third Go Flo bottle attached                          |
| 24/10/2006 20:41 | 2 MAGNET | -51.69041 | -57.6149  | Magnetometer deployed to 200m Second Go Flo bottle attached.       |
| 24/10/2006 20:33 | 2 MAGNET | -51.67691 | -57.63011 | Magnetometer deployed Go-Flo deployed with first bottle.           |
| 24/10/2006 20:14 | 1 CTD    | -51.66645 | -57.64222 | CTD recovered CTD on deck. Setting up for Go Flo.                  |
| 24/10/2006 20:10 | 1 CTD    | -51.66764 | -57.64292 | CTD at Depth (30m) CTD at the surface.                             |
| 24/10/2006 20:05 | 1 CTD    | -51.66825 | -57.64303 | Trial deployment of CTD Recovering CTD                             |



## Appendix 5: JR152 & JR159 Cruise Report

27/09/06-20/10/06

**David Pond**

### **Introduction**

During the 3 weeks prior to JR161 the JCR was primarily engaged in logistical duties with limited time allocated to science activities. Forty eight hours were allocated to AFI16-16 for larval fish sampling using the RMT8 and neuston net. A further 6 days were allocated to mooring deployments, the western core box and acoustic calibrations. A PCO<sub>2</sub> analyser was also operated during this leg of the cruise. Sea conditions were generally rough during the 3 weeks and science time was lost from all science activities.

### **Non-toxic pumped seawater sampling**

**David Pond**

During passage from Montivideo samples were taken from the ships non-toxic pumped seawater supply. Large volume filtrations 100-125 litres were taken for PCB analysis and smaller volume filtrations taken for stable isotope (<sup>13</sup>C and <sup>15</sup>N) and fatty acid analysis (Table1).

Details of samples taken form the non-toxic pumped sea water filtrations for fatty acid, stable isotope and PCB analysis.

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| DP Event | Date       | Time (ship) | Lat      | Long     | N°<br>carbouys | Salinity | Temp | Fluor. |
|----------|------------|-------------|----------|----------|----------------|----------|------|--------|
| PCB1     | 29/09/2006 | 20:25       | 40 02.50 | 56 04.43 | 4              | -        | -    | -      |
| PCB2     | 30/11/2006 | 05:11       | 41 44.65 | 56 17.02 | 5              | 34.04    | 5.15 | 1.00   |
| PCB3     | 30/11/2006 | 10:30       | 42 52.58 | 56 25.50 | 5              | 34.02    | 7.29 | 0.43   |
| PCB4     | 30/09/2006 | 16:10       | 44 03.52 | 56 34.57 | 5              | 34.00    | 7.31 | 0.40   |
| PCB5     | 30/11/2006 | 22:11       | 45 19.41 | 56 44.53 | 5              | 34.07    | 7.43 | 0.65   |
| PCB6     | 01/11/2006 | 04:11       | 46 31.85 | 56 54.32 | 4              | 34.03    | 7.18 | 1.58   |
| PCB7     | 01/10/2006 | 01:12       | 47 40.68 | 57 03.79 | 4              | 34.03    | 5.7  | 0.47   |
| PCB8     | 01/10/2006 | 16:00       | 48 50.87 | 57 13.47 | 5              | 34.02    | 5.61 | 0.41   |
| PCB9     | 13/10/2006 | 10:20       | 53 19 60 | 39 35 11 | 5              | 33.92    | 0.58 | 0.36   |

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## ***Report on pCO<sub>2</sub> activities***

***Nick Hardman-Mountford , Elizabeth Jones***

### ***Introduction***

This report describes the implementation of pCO<sub>2</sub> (partial pressure of carbon dioxide) monitoring on James Clark Ross (JCR) during cruise JR152/159 during 3-21 October 2006. A Natural Environment Research Council (NERC) Capital Equipment Grant to CASIX covered the provision and temporary installation of the pCO<sub>2</sub> system on JCR. The pCO<sub>2</sub> system was built by the engineering company Dartcom. Participation in the cruise was through an Antarctic Funding Initiative (AFI) Collaborative Gearing Scheme (CGS) bid (CGS8/28). This funded sending Nick Hardman-Mountford (CASIX-PML, pCO<sub>2</sub> instrument expert) and Elizabeth Jones (CASIX-UEA, pCO<sub>2</sub> researcher) on the first scientific voyage of JCR with this instrument, with the aims of a) providing validation data for British Antarctic Survey (BAS) modeling activities over the long-term, b) tailoring the system to JCR for use in specific Southern Ocean conditions (e.g. large diatoms, sea ice), c) to train BAS and shipside in the necessary procedures for future near-autonomous operation.

Expectations prior to departure were that PML would install the instrument in Immingham prior to the ship's departure south. BAS would ensure the necessary NMEA and ancillary data streams were output to the instrument and that e-mail communications for the instrument were established. It was also intended that the instrument would run with basic shipside support (Deck Engineer) on the leg south to gain important data from the Atlantic Ocean. Mark Preston (BAS) would then take over science support of the instrument at first port of embarkation for scientific personnel.

The instrument was successfully installed in Immingham, although the NMEA/ancillary data streams and e-mail communications were not working adequately on departure from Immingham. Jeremy Robst (BAS) endeavoured to implement these during the leg south (departure 4<sup>th</sup> Sep 2006) but these were not implemented by the time of a major incident with the instrument on the 22<sup>nd</sup> Sep, at which point the instrument was turned off to await repair in Stanley. Therefore, the repair of the instrument has become the primary goal of this trip. The prior stated aims have also all been achieved as best possible.

### ***Summary of problems and actions taken to recover system performance***

#### **Flooding of valve tray gas loop**

##### **Initial assessment**

Analysis of the data file from the leg south showed a short-lived spike in pCO<sub>2</sub> on 12 Sep, coinciding with a quick clean of the equilibrator by the Deck Engineer. This in itself may not be indicative of a problem. On 14<sup>th</sup> Sep humidity in the equilibrator cycle began to increase and reached 100% on 15<sup>th</sup> Sep. This would have triggered an alarm, but no metatext record is entered for this event. pCO<sub>2</sub> values were reduced due

to the high humidity. The software was closed and restarted on 21<sup>st</sup> Sep although the reasons for this are not specified. The high humidity and low pCO<sub>2</sub> continued until 22<sup>nd</sup> Sep when another quick clean took place. Both pCO<sub>2</sub> and pressure values jumped at this point, 10-fold in the case of pCO<sub>2</sub>. At this point Dartcom were contacted and the system turned off. The changes in the equilibrator cycle were reflected in the other cycles to a lesser degree.

Initial inspection of the valve tray showed water had got into the valve tray via the equilibrator-in gas line. The marine air and equilibrator pumps were still working. Attempts to blow out some of the water through the V3 vent valve were initially unsuccessful, suggesting this valve could be stuck. However, it continued to make the right noises when turned on and off and further attempts showed this valve to be working properly. All the other valves were working properly.

### **Causes**

Water in the valve tray was fresh, not saline, so the flooding appears to have happened when the equilibrator was filled up for cleaning. Inspection of data for the leg south showed problems to have occurred following cleaning of the equilibrator (12<sup>th</sup> and 22<sup>nd</sup> Sep). This suggests that the equilibrator was overfilled, allowing water to push all the way through the gas lines and explains the high humidity and pCO<sub>2</sub> values on all readings.

### **Actions taken**

To attempt to dry out the valve tray components, the filters and various bits of tubing were disconnected and dried out using a low oven (40-60°C). A peristaltic pump was used to suck water out of the solenoid valve manifold, humidity sensor housings, LICOR and other sections of the gas loop, until thoroughly dry. A hairdryer was used to dry the humidity sensor.

Following this action, the LICOR was still not providing absorption output values so, in reference to the manual, the optical bench was taken apart for cleaning. The interior was covered in dry salts so was cleaned with a 50% ethanol solution, clean cotton swabs and lens tissues. This was not entirely effective, although it allowed some tarnishing of the gold and scratches (presumably from dried salts) to be identified. A second clean with a high-grade solvent cleaner (designed for electronic systems) improved the reflectivity of the gold tube, source and receptor ends.

Once all components were cleaned and dry, tubing was refitted. For the most part existing tubing and collars/clamps were reused, although a new length was required between the Swagelok T-piece and the input air filter, as this had been damaged during removal. Some new collars and clamps were also fitted. The tray was pressurized to 1.6 bar using the nitrogen standard and left overnight with the input pressure turned off. Reduction in pressure was negligible. Joints were also tested with Snoop and no leaks were found.

Recalibration of the LICOR was undertaken using software provided by LICOR. The zero for CO<sub>2</sub> was calculated using the nitrogen standard and the span gas used for CO<sub>2</sub> was the 450ppm standard as this gave the least variable reading (actual value used was 449.03ppm, as provided by UEA calibration of gases). The nitrogen gas was also



used to zero the H<sub>2</sub>O channel but marine air had to be used as the span gas because this allowed a positive dew point to be entered (the LICOR calibration software can only take positive dewpoints although the LICOR itself can read negative dewpoints). Dewpoints were calculated from relative humidity and temperature in the loop using the Magnus formulae (obtained from UK National Physical Laboratory website [http://www.npl.co.uk/thermal/faqs\\_humidity.html#dewpoint](http://www.npl.co.uk/thermal/faqs_humidity.html#dewpoint)). Recalibration was attempted after both the initial and second cleans.

Overnight operation of the LICOR following the initial clean showed an increasing trend in pCO<sub>2</sub> although H<sub>2</sub>O values remained stable. The low LICOR pressure values also showed an increasing trend. The second clean and recalibration appeared to reduce the high frequency variability on the pCO<sub>2</sub> readings but did not fix the increasing trend in pCO<sub>2</sub> or pressure. Breathing into the valve tray and around joints produced no CO<sub>2</sub> spikes, suggesting no leaks in the tray.

Ultimately, the problem with the LICOR could not be solved during the cruise. However, post-processing corrections applied to data collected between leaving KEP (9 Oct) and arrival in Stanley (20 Oct) may provide useable data for some of this period (data from after the 18<sup>th</sup> Oct appears to be best). Dartcom/PML have provided a replacement LICOR and filters, sent out with personnel for the next leg (JR161).

Swagelok taps were sent out from PML and UEA to be fitted to the gas lines in the top of the equilibrator. These will be closed during future cleaning to prevent water getting through the lines.

Dartcom are looking into a retrospective modification to the dryer design, allowing a flood reservoir to be fitted to the input gas lines.

The cleaning schedule has been amended to avoid this problem reoccurring.

## **Flow and LICOR pressure readings**

### **Initial assessment**

In addition to the other LICOR and valve tray problems, barometric pressure readings from the LICOR and flow meter readings were found to be extremely low (2-300mb and 3-7 sccm, respectively) when the system was restarted in Stanley.

### **Causes**

These problems were probably caused by over-pressurisation of the valve tray, although the point at which this occurred is not apparent from the data files.

### **Actions taken**

Mark Preston replaced the flow meter with a new unit provided by Dartcom. The LICOR was replaced with a new unit provided by Dartcom/PML on return to Stanley.

### **Final state**

Flow meter working properly.

### **Low 250 ppm CO<sub>2</sub> standard**

#### **Initial assessment**

The regulator on the 250ppm cylinder showed only 100 bar remaining, i.e. 100 bar had been used. The other two cylinders had used 10-20 bar each. This suggests a leak but no leak was identified on the cylinder or regulator. The pressure in this cylinder did not drop significantly during the cruise.

#### **Causes**

The cause of this problem is uncertain, but was probably a leak that has been fixed.

#### **Actions taken**

The cylinder and regulator were tested for leaks. No further actions were taken with respect to the fitting. Replacement standards for all gases were ordered from PML to be sent from the UK on RRS Ernest Shackleton and then transferred to JCR. If these are not required they can be returned to PML for use on other pCO<sub>2</sub> systems or retained by BAS for next season (to be discussed).

### **Final state**

The regulator and cylinder appear to be functioning properly, but need to be monitored.

### **Lack of NMEA/Ancillary data stream**

#### **Initial assessment**

Jeremy Robst (IT support) was aware of the need to provide an NMEA/ancillary data feed to the pCO<sub>2</sub> system but had not been able to implement this during the leg south. He logged a metatext message that these were 'to do' on 3<sup>rd</sup> Sep. Jeremy was not aware that underway NMEA (including GPS) and ancillary data were required during the leg south, so these were not logged by the ship. Therefore no ancillary data concurrent with pCO<sub>2</sub> data exists prior to this cruise.

#### **Causes**

During the cruise, attempts to provide the NMEA and ancillary data strings were held up because BAS data output strings do not normally have a check sum term.

#### **Actions taken**

Contact with Dartcom established the checksum was needed. This was then implemented by Jeremy Robst for the BAS strings.

The GPS string coordinates need the number of satellites to be output for the data to be logged in preference to the Iridium, when Iridium is showing zero.

## **Final state**

GPS co-ordinates, ancillary data and some NMEA data are now being received by the pCO<sub>2</sub> system and logged, where appropriate.

## **Lack of e-mail communications**

### **Initial assessment**

Attempts during the leg south to e-mail data from the pCO<sub>2</sub> system via the ship's mailserver were unsuccessful. Jeremy Robst was not able to fix this prior to this cruise. During the cruise it was found that the pCO<sub>2</sub> system would e-mail only the first address of the three listed, that it would do this for every record rather than waiting for a buffer to fill up and that attempts to change the mailserver or input a new DNS server would hang the system.

### **Causes**

The probable cause of the mail only being sent to the first address was identified as being the structure of the e-mail addresses. All three e-mail addresses were surrounded by angle brackets and separated by semi-colons, as follows:

```
<pco2@pml.ac.uk;colin@dartcom.co.uk;jpro@bas.ac.uk>
```

The BAS sendmail system interprets this as an attempt to use a routing address format. When sending multiple addresses BAS use the format:

```
<pco2@pml.ac.uk> , <colin@dartcom.co.uk> , <jpro@bas.ac.uk>
```

Note the angle brackets are around individual addresses, not the whole list. Also, addresses are separated by a comma, according to the RFC, but most e-mail systems accept either a comma or semicolon, including BAS systems. Section 3.4 of RFC2822 has details (<http://www.faqs.org/rfcs/rfc2822.html>).

### **Actions taken**

Dartcom were contacted with these details to determine any changes to the source code that were necessary. This is not straightforward because the routine used by Dartcom has been used successfully for many other applications over many years.

An interim solution was provided by Jeremy Robst: the pCO<sub>2</sub> system sends an e-mail to a single onboard e-mail address which then concatenates the mime output into one file and sends it out to other e-mail recipients every 6 hours.

## **Final state**

The interim on-board system is working properly. A software upgrade by Dartcom is pending.

## **Dryer blockage**

### **Initial assessment**

During testing of the valve tray, it was noticed that the marine air line was blocked.

### **Causes and actions taken**

This was initially thought to be caused by the input filter to the line being frozen, so this was defrosted and an inverted funnel fitted to the input to prevent water accumulating at the narrow aperture of the filter input. However, this was found not to be the cause of the problem. The blockage was then traced to the dryer. Turning off the dryer for a while released the blockage and quite a bit of water was pumped from the dryer reservoir. It appears that the dryer was frozen, perhaps from being left in cooling mode when the pCO<sub>2</sub> system control screen was changed from automatic to manual operation. Gas lines were disconnected from the dryer and all water was removed from the dryer before turning the dryer back on. The dryer gradually reduced the humidity of the marine air and equilibrators gases, but with a much lower efficiency than before. Rebooting the live pCO<sub>2</sub> software fixed this problem and caused the dryer to work efficiently again.

The problem repeated on 18<sup>th</sup> Oct during normal operation. The marine air lines into and then out from the dryer were systematically disconnected to check that this was where the blockage could be found. The system was then powered down, the equilibrators in and out gas lines to/from the dryer were disconnected (to prevent any water ingress when the dryer was turned off) and the whole system was left to stand for 2 hours, allowing time for the dryer to thaw out. The system was then powered up and the dryer pump operated in manual mode to empty the water reservoirs (although nothing was found in these). Finally, when satisfied that there was no water in the dryer, all the gas lines to the dryer were reconnected and the system switched back to automatic operation. This procedure should be followed if the problem recurs.

### **Final state**

The dryer is working properly.

While continued running in manual mode for testing the system may have caused the dryer to freeze up the first time, this is not certain and was certainly not the case the second time. Prolonged system testing is unusual away from Dartcom, however, modifications to the control system are required so that the dryer is not left either cooling or turned off for prolonged periods, e.g. while systems are being tested. The former could cause freezing and the latter could allow water ingress to the valve tray.

### ***Other activities***

During the cruise, Mark Preston was trained in the day-to-day scientific support of the instrument, including equilibrators cleaning procedures.

Elizabeth Jones supplemented the pCO<sub>2</sub> data obtained with water samples for dissolved inorganic carbon (DIC) and total alkalinity (TA). These were taken from the ship's non-toxic underway seawater supply and fixed with mercuric chloride for analysis back at UEA. Samples were taken coincident with CTD stations in the

western core box and every 6 hours along the transect from South Georgia to Stanley, with a higher frequency of every 3 hours in the vicinity of the Polar Front.

Remote sensing support was provided to the cruise by the NERC Earth Observation Data Service (NEODAS), hosted at PML. Composites of SST and chlorophyll data from satellite were provided every 2-3 days (see Fig. 1). Cloud covered much of the area of work, but information on the position of the Polar Front and areas of bloom developed off South Georgia was useful.

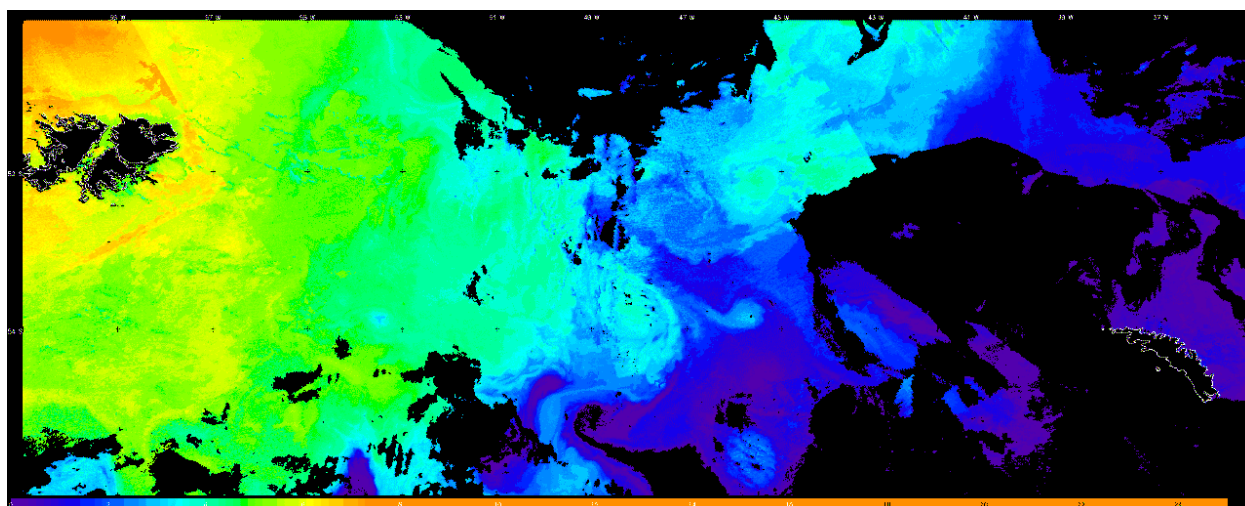


Fig. 1. SST composite from MODIS Aqua for the period 26 Sep to 2 Oct 2006, showing the position of the Polar Front between the Falklands (left) and South Georgia (right). Provided by NEODAS.

## ***Lessons learned***

### **Communication is the key to successful operations.**

Breakdown in communication at a number of points, both technical and personal, have been behind a number of the problems encountered. If near-real time (NRT) e-mail communications between the pCO<sub>2</sub> system and Dartcom/PML had been established on departure from Immingham, the water ingress problems could have been spotted earlier and the severe damage to the system potentially avoided. A gap in the communication of the need for ship's underway data logging meant that valuable data collected by the pCO<sub>2</sub> instrument on the leg south cannot be processed to the highest possible standards. Conversely, good communications between the ship, PML and Dartcom during this cruise have allowed for many of the problems encountered to be adequately dealt with and repairs made where necessary. Good communications between the ship and Dartcom/PML, by telephone and e-mail, must be maintained if this trial is to succeed.

### **Training of pCO<sub>2</sub> system operators is essential.**

Another contributing factor to the problems encountered has been the lack of adequate training so far. This was looked into and accepted as not feasible before the cruise, but must be prioritised for the future. Simon Wright (shipside, Deck Engineer) was given very basic level training before departure from Immingham, which he passed on to Doug Trevy (shipside, Deck Engineer) when the crew changed over. Mark Preston

has been trained in operation of the system for this season during this cruise but should attend further training at Dartcom if he is to be responsible for the instrument over future seasons. Ideally, more than one responsible person needs to be trained so operations are not dependent on one person and it would also be useful if both BAS technical personnel and the ship's Deck Engineers could be trained.

### **Appropriate spare parts should be kept on board**

Expense precludes providing a full set of spare parts for each pCO<sub>2</sub> system, but provision of a basic set of Swagelok fittings, tubing, Snoop leak detector, filters and regulator as a minimum has proved useful on this cruise. Spare gas cylinders should also be provided in future (these have been ordered). Other (small) parts can be transported by scientific personnel heading south, as has been undertaken during the changeover between this cruise and JR161.

### **Major risks to the system are water ingress and over-pressurisation.**

These risks are well known and the diagnostic sensors in the tray have worked adequately in alerting to these. These failure modes are the most likely to cause full system shutdown so must be avoided at all costs. Any evidence of these must be treated with the utmost urgency.

### **Southern Ocean specific problems**

So far, the harsh Southern Ocean environment has not caused significant problems for the instrument. The freezing-up of the marine air line may be partly attributable to negative air temperatures, but this has only been a minor issue and appropriate procedures have been established to deal with it. The cruise has not encountered blockage by large diatoms but these may become an issue later in the season. It has also not been exposed to the lowest temperatures or sea ice. Ongoing assessment of these possible issues needs to be undertaken throughout the season.

### **Conclusion**

Despite a difficult start, the operation of the pCO<sub>2</sub> system throughout this cruise has been broadly successful, although with provisos to data quality. Good communication between the ship and PML/Dartcom appear to be the key to successful implementation of the trial throughout the season, so these must be maintained at all times.

## **Gene Flow in Antarctic Fishes (AF16-16):**

**Jenny Rock, Bill Hutchinson (leg 1); Martin Collins, leg 2**

This research examines the influence of oceanographic processes, bathymetry and life history variation on dispersal and gene flow in two Antarctic fishes (*Champscephalus gunnari*, *Notothenia rossii*) that differ in the distribution of eggs and larvae and longevity. Molecular markers (microsatellites and mtDNA) are being used to characterise population structure at both circumpolar and regional geographic scales, which will then be compared with predictions from oceanographic models.

### **Objectives**

Broadly, to quantify the degree of population genetic structuring, larval dispersal, and influence of oceanography on two fish species with contrasting life histories. Specifically for **JR 152**, to sample aggregations of *C. gunnari* and *N. rossii* larvae for genetic analysis to test dispersal patterns predicted by oceanographic modelling.

Sampling will occur:

- a) at a coarse-scale level across the Scotia Sea, including the area between the southern and northern extremes (South Orkneys and South Georgia/Shag Rocks, respectively) and between South Georgia and Shag Rocks themselves;
- b) at a fine-scale level along the coast of South Georgia, e.g. comparing NW with NE waters, and N coast with SW coast.

### **Work at sea to date (20-10-06; end of first leg of cruise)**

To collect larval fish of both species, two types of fishing gear are prepared for use: the Neuston net and RMT8 net. Due to weather conditions and other constraints of sampling time, to date we have been unable to deploy the neuston net. The RMT8 (rigged with paired nets) has been deployed a total of seven times. Six of these deployments involved fishing each of the paired nets sequentially for approximately 30 minutes each at depths ranging from 20-90 m; the 7th deployment had to be aborted due to poor weather after only a few minutes fishing. Deployments were made onto or over shelf waters, generally between 100-250 m, and occurred in two locations: Royal Bay (54.30 S, 36.0 W) and Shag Rocks (53.40 S, 41.0 W).

Due to previously mentioned constraints, nets were deployed at suboptimal times (daylight hours) and due to weather conditions were limited to depths greater than 20 m (which is also considered suboptimal for sampling larval aggregations). Catch was extremely low for larvae, as well as for pelagic crustaceans such as krill and amphipods.

At Royal Bay two larvae were caught at depths of between 30-50 m, both of these were identified as *Chaenocephalus aceratus*. At Shag Rocks 5 larvae and two eggs were caught. One larvae, captured at approximately 30 m depth was identified as the target species *C. gunnari* and measured 33mm total length. Three larvae were identified as putative *Patagonotothen larseni* (these identifications will be confirmed

using molecular methods) with total lengths ranging from 27-33 mm. One larvae was significantly damaged by the net and will be identified by molecular methods, as will the two eggs.

A further 24 h of fishing time remains allocated to JR152 for the second leg of the cruise, to be carried out by Martin Collins.



## Acoustic Report

**Peter Enderlein, Sophie Fielding, Nathan Cunningham, Mark Preston**

### Introduction:

The EK60 has been run routinely on the JCR since 2003. Detailed operating instructions can be found in either the cruise reports of JR96, JR100 and JR116 or within the operating protocols that can be found on the EK60 computing machines. The EK60 was run continuously throughout this cruise with a 2 second ping rate, although logging of the data was not continuous due to network issues and the running of the swath bathymetry system.

### SSU settings

During the passage from Stanley to South Georgia, the swath bathymetry (EM120) system was switched on and run through the SSU grouped with the EA500. The EM120 was set to active, whilst the EA500 was passive and time usage was calculated. The EK60 maintained a 2 second ping rate and was independent of the SSU. Interference from the EM120 is obvious.

During the Western Core Box the EK60 and EA500 were run together through the SSU, the EM120 and ADCP was switched off. Mode was EM EA&EK TO. The EM120 trigger was off. The EA500 was in active mode and set to external trigger by the bridge, the SSU trigger was on and time usage was set to Tx Pulse. The EK60 trigger was on and the time usage was calculated. Ping control by the ER60 software was set to 2 seconds. The bridge was asked to turn off the bridge Doppler logger to prevent shelf interference. All other ships echosounders, apart from the EA500, should be turned off if the Captain is willing.

A new group on the SSU has been established in order to undertake combined EK60, EA500 and ADCP measurements at a frequency acceptable to both the biologists and physicists (note the WCB needs a minimum of a 2 second ping rate for the EK60).

| Survey for?                | Mode           | Group            |            |                   |            |                                |              |         |            |                                |              |
|----------------------------|----------------|------------------|------------|-------------------|------------|--------------------------------|--------------|---------|------------|--------------------------------|--------------|
|                            |                | EM120            |            | EA600             |            | EK60                           |              | TOPAS   |            | ADCP                           |              |
|                            |                | Trigger          | Time usage | Trigger           | Time usage | Trigger                        | Time usage   | Trigger | Time usage | Trigger                        | Time usage   |
| Swath bathymetry           | EM&EA EK TO AD | Active, external | Calculated | Passive, external | Calculated | Active, internal, interference | User defined | x       | x          | Active, internal, interference | User defined |
| Biology/EK60               | EM EK&EA TO AD | Off              | x          | Active, external  | TX pulse   | Active, external               | Calculated   | x       | x          | x                              | X            |
| Physics/ADCP               | EM EK EA TO AD | Off              | Off        | Off               | Off        | Off                            | Off          | x       | x          | Active, internal               | User defined |
| Biology/physics compromise | EM EA&EK&AD TO | Off              | Off        | Active, external  | Tx Pulse   | Active, external               | Calculated   | x       | x          | Active&, external              | Tx pulse     |

\* EM = EM120 swath bathymetry, EA = EA500 bathymetry, EK = EK60 biological echosounder, TO = Topas sub bottom profiler, AD = ADCP Acoustic Doppler Current Profiler.

& Check ADCP setup file CX1,3 Bottom tracking mode off

As yet, no method has been created to run the ADCP within the core box survey. However, it should be possible within the new group setting of EM EA&EK&AD TO. There will likely have to be a compromise from the physicists regarding bottom pinging (not necessarily compatible with the SSU), but a dedicated time is required onboard the ship to really establish compatible instruments and correct settings. A recommendation would be to use the ships trials after refit to undertake on-shelf/off-shelf transects in a dedicated time allocation.

### **General narrative:**

The Western Core Box (WCB) acoustic survey was run in the normal west to east direction. W1.1 was started at 08:57 GMT 13 October 2006 at the southern end, all XBTs were successfully undertaken. The sea was calm (!) and there was little dropout on transect W1.1 or W1.2. Immediately after the end of W1.2 transect 3 RMT8 net hauls were undertaken. The first (Event 9), was fished returning back off shelf along the transect W1.2 on small marks between 130 and 150 m. The catch consisted predominantly of salps. The second net (Event 10) was undertaken near the beginning of transect W1.1 on a strong deep scattering layer that was present at the beginning of the WCB survey. The net was fished at a depth of ~265 m and returned with 6 myctophid fish and a few euphausiids – predominantly *Euphausia triacantha*. Unfortunately this sample was disposed of before further investigation could be made. The third net undertaken on the first WCB day (Event 11) was close to the surface between 0 and 20 m, unfortunately the mark originally expected to be fished had disappeared. This net event brought up only a few euphausiids and was not kept. A shallow and a deep CTD were undertaken overnight before the second transect commenced at 09:00 14 October 2006. The weather deteriorated rapidly over the period of W2.1 and W2.2 (far more in keeping with typical WCB weather!) and neither nets or CTDs were undertaken after the transects had finished. At this point, with the weather forecast in hand, it was decided to abort the WCB and run for shelter.

### **EK60 settings and operation:**

#### **Software versions, hardware**

Simrad ER60 v. 2.0

Sonardata Echolog 60 v 4.05

Sonardata Echoview v 4.0.75.6342 Live viewing and processing

HASP Dongle BAS3 licensed for base, bathymetry, analysis export, live viewing, school detection and virtual echogram was used to run the echolog and echoview in live viewing mode. It was intended to use the analogue BAS1 HASP, however it appears that the dongle is slightly damaged and the connection is intermittent. Therefore processing of the WCB data was undertaken using the BAS1 dongle (screwed tightly into a parallel port to get it to work!).

The echosounder pc AP10 and the EK60 workstation 2 are integrated into the ship's LAN. ER60 .raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. Echolog was run on workstation 2 and wrote compressed files also directly to the Sun workstation via a Samba connection.

### Echolog compression settings

Final compression settings used in Echolog for all frequencies:

- 6) Power data only (angle data is still available from the raw files)
- 7) From 0 to 300 m data only (data from deeper is available from the raw files)
- 8) Average samples where both Sv below -100 and TS below -20
- 9) Maximum number of samples to average: 50
- 10) DO NOT use average samples below echosounder detected bottom unless sure of bottom detection

### Data processing

Data processing utilised the WCBtemp.ev template that is on the Echoview workstation. Dropout and interference was removed, data were averaged into 100 sec intervals horizontally and 3 m vertical bins. Krill biomass estimates were calculated assuming a TS of -39 dB per Kg for Antarctic krill (NOTE – this value was not calculated using in situ length data and may be subject to validation). The average biomass for the two transects was calculated to be 25 gm<sup>-2</sup>.

### EK60 (ER60) settings

| Variable                  | 38 kHz       | 120 kHz      | 200 kHz      |
|---------------------------|--------------|--------------|--------------|
| Ping interval (per sec)   | 2            | 2            | 2            |
| Salinity (PSU)            | 34           | 34           | 34           |
| Temperature (°C)          | 1            | 1            | 1            |
| Sound velocity (m/s)      | 1453         | 1453         | 1453         |
| Mode                      | Active       | Active       | Active       |
| Transducer type           | ES38         | ES120-7      | ES200-7      |
| Transceiver Serial no.    | 009072033fa5 | 00907203422d | 009072033f91 |
| Transducer depth (m)      | 0            | 0            | 0            |
| Absorption coef. (dB/km)  | 10.07        | 26.27        | 39.8         |
| Pulse length (ms)         | 1.024        | 1.024        | 1.024        |
| Max Power (W)             | 2000         | 500          | 300          |
| 2-way beam angle (dB)     | -20.70       | -20.70       | -19.60       |
| Sv transducer gain (dB)   | 24.07        | 21.38        | 22.03        |
| Sa correction (dB)        | -0.63        | -0.39        | -0.31        |
| Angle sensitivity along   | 22           | 21           | 23           |
| Angle sensitivity athwart | 22           | 21           | 23           |
| 3 dB Beam along           | -0.02        | -0.12        | 0.17         |

|                          |      |       |       |
|--------------------------|------|-------|-------|
| <b>3 dB Beam athwart</b> | 0    | -0.07 | -0.24 |
| <b>Along offset</b>      | 6.96 | 7.48  | 6.44  |
| <b>Athwart offset</b>    | 6.88 | 7.48  | 6.43  |

### ***CTD operations***

The CTD was successfully deployed at 2 stations.

### ***Problems:***

During the transect from Stanley to South Georgia the EK60 38 kHz signal was extremely noisy. This feature was also noted during cruise JR129 and was discovered to have been solve by replacing the 38 kHz GPT (Serial No. 00907203400b). This process was undertaken during this cruise also. The serial number of the 38 kz GPT being used during this season is 009072033fa5

Echolog appeared to be extremely temperamental this trip and stalled regularly if used to compress files in real time, although live viewing could be run permanently if no compression was used. Ultimately, Jeremy discovered that there was a problem with new Samba software Ver. 3.0.23c loaded onto the Sun server. Reloading the older version (Ver. 2.2.12) fixed the problem and normal Echolog saving could resume.

Both the EK60 main processor and the EK60 workstation computers were networked differently this cruise – onto a more secure network. There were some teething problems after this that were fixed by Jeremy Robst actually.

A comcontainer.exe error arose on several occasions with the ER60 software, crashing the EK60 echosounder. This seems to arise when there is a conflict between the SSU and the EK60 and requires the power cycling of the EK60 and turning the trigger off on the SSU.

### ***Calibration:***

An acoustic calibration was carried out in Stromness Harbour, South Georgia between the 13 and 14<sup>th</sup> October 2006. Standard EK60 calibration procedures were undertaken for a calibration of each transducer as documented for previous cruises on the 13 October 2006. Each frequency was calibrated (with the other frequencies switched off) with standard copper spheres and a pulse duration of 1.024 ms. All unnecessary ships noise was turned off and ships discharge over the side was ceased. A CTD was conducted prior to the start of the calibration and sound velocity calculated using Francois and Garrison (1989) for the depth of the target (Temperature = 1°C, Salinity = 33.75, Sound velocity = 1453). Slightly different from previous calibrations was the requirement to undertake at least 300 points per calibration (this was to examine the controls on a good calibration). The 120 kHz target appeared to have some noise above it as viewed in the echogram and it was decided to repeat this calibration during the next set of calibrations.

On the 14<sup>th</sup> October a second calibration was undertaken, in a similar manner, but on this occasion all frequencies were left on during calibration (except for the 120 kHz repeat). At a first look it appears that there is little difference between calibration values and that it may be possible to undertake future calibrations within conditions

more similar to survey conditions (i.e. noise left on as well as all transducers left on). During the 38 kHz calibration a tungsten carbide sphere was also hung under the transducers (below the copper sphere). The EK60 settings after calibration are given above, these were implemented on the 14th October 2006.

Calibration details are as follows for each frequency. The following filenames were uploaded as the calibration constants. Cal38khz\_061006\_mod, cal\_07100\_120khzalone\_mod, cal200khz\_20061006\_cal

### 38 kHz calibration

```
# Calibration Version 1.0.0.9
#
# Date: 2006-10-06
#
# Comments:
#
# Reference Target:
# TS -33.80 dB Min. Distance 22.00
m
# TS Deviation 3.0 dB Max. Distance 28.00
m
#
# Transducer: ES38 Serial No. 0090720335
# Frequency 38000 Hz Beamtype
Split
# Gain 24.24 dB Two Way Beam Angle -20.7
dB
# Athw. Angle Sens. 22.00 Along. Angle Sens.
22.00
# Athw. Beam Angle 6.91 deg Along. Beam Angle 6.94
deg
# Athw. Offset Angle 0.03 deg Along. Offset Angle -0.03
deg
# SaCorrection -0.64 dB Depth 0.00
m
#
# Transceiver: GPT 38 kHz 009072033fa5 1 ES38
# Pulse Duration 1.024 ms Sample Interval 0.186
m
# Power 2000 W Receiver Bandwidth 2.43
kHz
#
# Sounder Type:
# EK60 Version ComSounder
#
# TS Detection:
# Min. Value -50.0 dB
# Max. Beam Comp. 6.0 dB Min. Echolength 80
%
# Max. Phase Dev. 8.0 Max. Echolength 180
%
#
# Environment:
# Absorption Coeff. 10.1 dB/km Sound Velocity 1453.0
m/s
#
# Beam Model results:
```

```

#   Transducer Gain      = 24.07 dB           SaCorrection           = -0.63
dB
#   Athw. Beam Angle     = 6.88 deg           Along. Beam Angle       = 6.96
deg
#   Athw. Offset Angle   = 0.00 deg           Along. Offset Angle     =-0.02
deg
#
#   Data deviation from beam model:
#   RMS =      0.14 dB
#   Max =      0.47 dB No. =    129 Athw. = -2.9 deg Along =  0.2
deg
#   Min =     -0.44 dB No. =    147 Athw. =  0.5 deg Along = -4.8
deg
#
#   Data deviation from polynomial model:
#   RMS =      0.10 dB
#   Max =      0.42 dB No. =    129 Athw. = -2.9 deg Along =  0.2
deg
#   Min =     -0.24 dB No. =    229 Athw. =  1.4 deg Along =  2.7
deg
#
#   Data:
#   No.      Time      Distance  TS-c    TS-u      Athw.    Along    Sa
#           [m]       [dB]     [dB]     [deg]    [deg]
# [m2/nm2]
#
  1  19:25:12.35  24.85  -34.22  -34.24     0.03     0.16    3088
  2  19:25:49.35  24.85  -34.14  -34.17    -0.03     0.22    3078
  3  19:26:02.35  24.85  -34.09  -34.20    -0.22     0.35    3093
  4  19:27:33.37  24.86  -34.50  -34.52     0.23    -0.10    2922
  5  19:27:37.38  24.87  -34.56  -34.64     0.35    -0.29    2864
  6  19:27:45.37  24.93  -34.65  -35.08     0.74    -0.61    2679
  7  19:27:47.37  24.94  -34.57  -35.12     0.80    -0.74    2619
  8  19:27:50.38  24.95  -34.49  -35.48     1.06    -0.99    2382
  9  19:27:51.38  24.96  -34.62  -35.66     1.06    -1.06    2275
 10  19:27:58.38  24.98  -34.15  -36.30     1.50    -1.50    1936
 11  19:28:02.38  24.98  -34.14  -36.19     1.50    -1.44    1980
 12  19:28:07.37  25.00  -34.12  -37.62     1.89    -1.95    1403
 13  19:28:15.37  25.02  -34.10  -39.23     2.27    -2.40     958
 14  19:28:16.38  25.03  -34.08  -39.47     2.34    -2.46     902
 15  19:28:25.38  25.04  -34.22  -41.87     2.78    -2.97     530
 16  19:28:30.38  25.03  -33.90  -40.46     2.59    -2.72     717
 17  19:28:47.39  25.01  -34.45  -43.27     3.17    -3.04     379
 18  19:29:11.38  25.17  -34.31  -40.56     2.21    -2.91     708
 19  19:29:22.39  25.14  -34.36  -38.65     1.82    -2.40    1120
 20  19:29:25.38  25.13  -34.63  -38.53     1.76    -2.27    1156
 21  19:29:30.38  25.17  -34.29  -37.64     1.38    -2.27    1387
 22  19:29:36.41  25.22  -33.87  -36.68     0.99    -2.21    1685
 23  19:29:42.40  25.31  -34.61  -36.93     0.48    -2.14    1682
 24  19:29:46.40  25.35  -34.61  -36.71     0.16    -2.08    1712
 25  19:29:50.40  25.38  -34.18  -36.18    -0.22    -2.02    1891
 26  19:29:57.41  25.43  -34.15  -36.48    -0.67    -2.08    1791
 27  19:30:03.40  25.53  -34.14  -36.55    -1.05    -1.95    1757
 28  19:30:09.40  25.58  -33.74  -36.82    -1.50    -2.02    1588
 29  19:30:14.40  25.62  -33.97  -37.79    -1.95    -2.02    1311
 30  19:30:24.40  25.71  -33.97  -38.37    -2.33    -1.89    1141
 31  19:30:25.41  25.72  -33.97  -38.40    -2.40    -1.82    1120
 32  19:30:29.40  25.76  -33.60  -38.92    -2.71    -1.89     966
 33  19:30:35.40  25.80  -33.76  -40.46    -3.23    -1.82     698
 34  19:30:39.40  25.88  -34.04  -41.66    -3.48    -1.89     531
 35  19:30:41.40  25.91  -33.94  -41.91    -3.61    -1.82     490

```

|      |             |       |        |        |       |       |      |
|------|-------------|-------|--------|--------|-------|-------|------|
| 36   | 19:30:50.41 | 25.92 | -33.65 | -42.79 | -3.99 | -1.63 | 395  |
| 37   | 19:30:52.41 | 25.92 | -33.62 | -43.05 | -4.12 | -1.44 | 373  |
| 38   | 19:30:56.40 | 25.90 | -34.09 | -44.31 | -4.38 | -1.12 | 282  |
| 39   | 19:30:57.41 | 25.90 | -34.25 | -44.66 | -4.44 | -0.99 | 262  |
| 40   | 19:31:04.41 | 25.88 | -34.40 | -46.37 | -4.82 | -0.55 | 181  |
| 41   | 19:31:10.40 | 25.80 | -34.65 | -46.30 | -4.76 | -0.48 | 185  |
| 42   | 19:31:17.40 | 25.76 | -34.04 | -43.63 | -4.31 | -0.48 | 326  |
| 43   | 19:31:23.40 | 25.71 | -34.23 | -42.21 | -3.93 | -0.48 | 472  |
| 44   | 19:31:29.40 | 25.61 | -33.74 | -40.10 | -3.48 | -0.61 | 761  |
| 45   | 19:31:35.40 | 25.57 | -33.52 | -38.60 | -3.10 | -0.61 | 1062 |
| 46   | 19:31:38.40 | 25.54 | -33.83 | -38.17 | -2.84 | -0.67 | 1204 |
| 47   | 19:31:42.40 | 25.50 | -34.12 | -37.73 | -2.59 | -0.61 | 1373 |
| 48   | 19:31:43.40 | 25.44 | -34.16 | -37.63 | -2.52 | -0.67 | 1437 |
| 49   | 19:31:47.41 | 25.42 | -34.10 | -36.99 | -2.27 | -0.74 | 1565 |
| 50   | 19:31:53.41 | 25.38 | -33.97 | -35.86 | -1.76 | -0.80 | 2053 |
| 51   | 19:31:58.41 | 25.33 | -34.36 | -35.64 | -1.37 | -0.80 | 2237 |
| 52   | 19:32:04.41 | 25.23 | -34.18 | -34.99 | -0.99 | -0.80 | 2524 |
| 53   | 19:32:11.41 | 25.18 | -34.41 | -34.96 | -0.61 | -0.86 | 2568 |
| 54   | 19:32:16.41 | 25.13 | -34.28 | -34.59 | -0.16 | -0.80 | 2909 |
| 55   | 19:32:27.41 | 25.06 | -34.42 | -34.95 | 0.10  | -1.06 | 2653 |
| 56   | 19:32:34.41 | 25.03 | -34.00 | -35.09 | -0.03 | -1.50 | 2479 |
| 57   | 19:32:47.41 | 24.96 | -34.14 | -36.81 | -0.16 | -2.34 | 1750 |
| 58   | 19:32:50.42 | 24.93 | -34.25 | -37.56 | -0.22 | -2.59 | 1501 |
| 59   | 19:32:51.41 | 24.88 | -34.21 | -37.85 | -0.22 | -2.72 | 1421 |
| 60   | 19:32:58.42 | 24.85 | -33.84 | -38.80 | -0.29 | -3.17 | 1081 |
| 61   | 19:33:06.41 | 24.81 | -33.85 | -40.38 | -0.48 | -3.61 | 756  |
| 62   | 19:33:12.41 | 24.75 | -34.23 | -41.44 | -0.86 | -3.74 | 621  |
| 63   | 19:33:14.41 | 24.75 | -34.43 | -42.57 | -0.80 | -4.00 | 478  |
| 64   | 19:33:16.42 | 24.75 | -34.58 | -44.19 | -0.61 | -4.38 | 327  |
| 65   | 19:33:18.42 | 24.69 | -34.44 | -44.64 | -0.67 | -4.51 | 299  |
| 66   | 19:33:39.42 | 24.63 | -34.34 | -44.95 | -0.16 | -4.64 | 263  |
| 67   | 19:33:45.42 | 24.58 | -34.84 | -45.46 | 0.23  | -4.64 | 241  |
| 68   | 19:33:56.43 | 24.49 | -34.18 | -43.38 | 0.16  | -4.32 | 393  |
| 69   | 19:34:00.44 | 24.47 | -33.95 | -41.33 | -0.16 | -3.87 | 616  |
| 70   | 19:34:18.43 | 24.49 | -33.56 | -38.70 | -0.16 | -3.23 | 1161 |
| 71   | 19:34:28.43 | 24.56 | -34.10 | -40.78 | 0.29  | -3.68 | 729  |
| 72   | 19:34:33.44 | 24.58 | -34.08 | -42.05 | 0.55  | -4.00 | 531  |
| 73   | 19:34:36.43 | 24.60 | -34.55 | -43.38 | 0.74  | -4.19 | 387  |
| 74   | 19:34:38.43 | 24.61 | -34.41 | -44.12 | 0.86  | -4.38 | 323  |
| 75   | 19:34:40.44 | 24.62 | -34.18 | -44.87 | 1.06  | -4.57 | 270  |
| 76   | 19:34:47.44 | 24.66 | -34.42 | -44.20 | 1.31  | -4.32 | 313  |
| 77   | 19:34:53.43 | 24.68 | -34.28 | -42.43 | 1.44  | -3.87 | 494  |
| 78   | 19:34:57.43 | 24.75 | -34.37 | -41.67 | 1.50  | -3.61 | 578  |
| 79   | 19:34:58.44 | 24.76 | -34.42 | -41.29 | 1.50  | -3.49 | 627  |
| 80   | 19:35:04.43 | 24.80 | -34.18 | -39.92 | 1.57  | -3.10 | 839  |
| 81   | 19:35:35.44 | 24.87 | -34.02 | -36.37 | 1.44  | -1.70 | 1926 |
| 82   | 19:35:54.44 | 24.97 | -34.40 | -35.38 | 1.31  | -0.61 | 2416 |
| 83   | 19:36:00.44 | 25.01 | -34.54 | -35.45 | 1.38  | -0.16 | 2315 |
| 84   | 19:36:11.45 | 25.00 | -34.15 | -34.85 | 1.18  | 0.22  | 2678 |
| * 85 | 19:36:20.44 | 24.94 | -35.19 | -36.44 | 1.57  | 0.29  | 1943 |
| * 86 | 19:36:25.45 | 24.86 | -33.24 | -35.03 | 1.89  | 0.29  | 2590 |
| 87   | 19:36:31.45 | 24.82 | -34.36 | -37.09 | 2.34  | 0.29  | 1618 |
| 88   | 19:36:39.45 | 24.75 | -34.23 | -37.90 | 2.72  | 0.22  | 1407 |
| 89   | 19:36:40.45 | 24.69 | -34.31 | -38.33 | 2.85  | 0.16  | 1293 |
| 90   | 19:36:43.44 | 24.68 | -33.80 | -38.77 | 3.17  | 0.16  | 1120 |
| 91   | 19:36:45.45 | 24.66 | -33.71 | -39.11 | 3.29  | 0.22  | 1013 |
| 92   | 19:36:49.44 | 24.64 | -34.09 | -40.36 | 3.55  | 0.16  | 771  |
| 93   | 19:36:54.45 | 24.59 | -34.54 | -41.52 | 3.74  | 0.29  | 608  |
| 94   | 19:36:57.44 | 24.56 | -34.43 | -42.65 | 4.06  | 0.22  | 474  |
| 95   | 19:36:58.44 | 24.55 | -34.62 | -43.34 | 4.19  | 0.09  | 409  |
| 96   | 19:37:00.45 | 24.50 | -34.48 | -44.03 | 4.38  | 0.03  | 344  |

|      |             |       |        |        |       |       |      |
|------|-------------|-------|--------|--------|-------|-------|------|
| 97   | 19:37:41.46 | 24.47 | -34.45 | -42.92 | 4.12  | -0.23 | 427  |
| 98   | 19:37:46.46 | 24.44 | -34.07 | -41.79 | 3.93  | -0.35 | 563  |
| 99   | 19:37:50.45 | 24.41 | -34.69 | -42.29 | 3.87  | -0.67 | 510  |
| 100  | 19:37:56.46 | 24.32 | -34.62 | -42.21 | 3.81  | -1.06 | 539  |
| 101  | 19:38:01.46 | 24.32 | -34.37 | -42.93 | 4.00  | -1.31 | 460  |
| 102  | 19:38:30.47 | 24.38 | -34.79 | -43.56 | 4.00  | -1.50 | 390  |
| 103  | 19:38:58.47 | 24.31 | -34.11 | -40.42 | 3.49  | -0.86 | 790  |
| 104  | 19:39:08.46 | 24.30 | -34.07 | -39.58 | 3.29  | -0.61 | 950  |
| 105  | 19:39:12.48 | 24.29 | -33.76 | -38.57 | 3.10  | -0.35 | 1177 |
| 106  | 19:39:25.47 | 24.25 | -33.96 | -36.86 | 2.34  | 0.67  | 1805 |
| 107  | 19:39:26.48 | 24.25 | -33.91 | -36.57 | 2.21  | 0.73  | 1927 |
| 108  | 19:39:46.47 | 24.28 | -33.89 | -35.78 | 1.76  | 0.86  | 2250 |
| 109  | 19:39:51.47 | 24.31 | -34.24 | -35.55 | 1.38  | 0.86  | 2429 |
| 110  | 19:39:57.47 | 24.41 | -34.05 | -34.91 | 0.99  | 0.86  | 2821 |
| 111  | 19:40:01.48 | 24.45 | -34.23 | -34.95 | 0.55  | 1.05  | 2732 |
| 112  | 19:40:02.47 | 24.45 | -34.14 | -34.76 | 0.48  | 0.99  | 2835 |
| 113  | 19:40:07.47 | 24.49 | -34.45 | -35.05 | 0.16  | 1.05  | 2668 |
| 114  | 19:40:12.47 | 24.58 | -34.17 | -34.81 | -0.29 | 1.05  | 2895 |
| 115  | 19:40:14.47 | 24.60 | -34.18 | -34.79 | -0.41 | 0.99  | 2854 |
| 116  | 19:40:18.48 | 24.64 | -33.87 | -34.81 | -0.73 | 1.12  | 2773 |
| 117  | 19:40:22.48 | 24.67 | -33.94 | -35.24 | -1.05 | 1.18  | 2443 |
| 118  | 19:40:30.48 | 24.76 | -34.27 | -36.16 | -1.50 | 1.18  | 2083 |
| 119  | 19:40:34.48 | 24.81 | -33.97 | -36.51 | -1.88 | 1.18  | 1864 |
| 120  | 19:40:40.48 | 24.85 | -34.10 | -37.65 | -2.33 | 1.24  | 1403 |
| 121  | 19:40:46.48 | 24.95 | -34.15 | -38.75 | -2.71 | 1.31  | 1128 |
| 122  | 19:40:52.47 | 25.01 | -33.80 | -40.05 | -3.23 | 1.44  | 800  |
| 123  | 19:40:53.48 | 25.02 | -33.96 | -40.50 | -3.29 | 1.50  | 716  |
| 124  | 19:40:56.48 | 25.04 | -34.16 | -41.56 | -3.55 | 1.50  | 563  |
| 125  | 19:41:04.48 | 25.05 | -33.74 | -41.27 | -3.61 | 1.44  | 605  |
| 126  | 19:41:10.48 | 25.06 | -33.84 | -39.63 | -3.23 | 0.99  | 902  |
| 127  | 19:41:12.47 | 25.06 | -34.11 | -39.38 | -3.10 | 0.86  | 974  |
| 128  | 19:41:15.48 | 25.12 | -34.22 | -38.56 | -2.84 | 0.61  | 1180 |
| 129  | 19:41:48.49 | 25.05 | -33.05 | -37.42 | -2.91 | 0.16  | 1486 |
| 130  | 19:41:58.49 | 25.03 | -33.98 | -37.45 | -2.59 | 0.16  | 1425 |
| 131  | 19:42:03.49 | 24.99 | -34.05 | -36.74 | -2.27 | 0.16  | 1745 |
| 132  | 19:42:10.49 | 24.88 | -33.92 | -35.65 | -1.82 | 0.09  | 2306 |
| 133  | 19:42:14.50 | 24.85 | -33.97 | -35.05 | -1.44 | 0.03  | 2511 |
| 134  | 19:42:20.50 | 24.81 | -34.54 | -35.07 | -0.99 | -0.03 | 2603 |
| *135 | 19:42:25.65 | 24.70 | -34.95 | -35.15 | -0.61 | -0.03 | 2689 |
| 136  | 19:42:44.65 | 24.64 | -34.48 | -34.50 | -0.03 | -0.23 | 2972 |
| 137  | 19:42:51.65 | 24.59 | -34.44 | -34.64 | -0.22 | -0.61 | 2960 |
| 138  | 19:42:59.65 | 24.49 | -34.40 | -35.02 | -0.41 | -1.06 | 2670 |
| 139  | 19:43:04.65 | 24.46 | -34.00 | -34.98 | -0.67 | -1.25 | 2694 |
| 140  | 19:43:09.64 | 24.43 | -34.28 | -35.65 | -0.73 | -1.50 | 2354 |
| 141  | 19:43:13.65 | 24.38 | -33.90 | -35.63 | -1.12 | -1.50 | 2450 |
| 142  | 19:43:28.61 | 24.27 | -33.97 | -37.46 | -1.31 | -2.34 | 1527 |
| 143  | 19:43:31.61 | 24.26 | -33.90 | -38.25 | -1.24 | -2.72 | 1290 |
| 144  | 19:43:40.61 | 24.25 | -33.96 | -39.38 | -1.05 | -3.17 | 995  |
| 145  | 19:43:42.61 | 24.26 | -33.92 | -39.49 | -0.99 | -3.23 | 970  |
| 146  | 19:44:00.61 | 24.29 | -34.21 | -42.13 | -0.35 | -4.00 | 516  |
| 147  | 19:44:13.61 | 24.36 | -35.17 | -46.75 | 0.48  | -4.83 | 189  |
| 148  | 19:44:47.58 | 24.23 | -33.68 | -38.35 | -1.50 | -2.72 | 1282 |
| 149  | 19:44:49.58 | 24.23 | -33.88 | -38.38 | -1.50 | -2.65 | 1273 |
| 150  | 19:45:08.58 | 24.12 | -33.74 | -40.12 | -1.82 | -3.17 | 862  |
| 151  | 19:45:09.58 | 24.12 | -33.47 | -40.15 | -1.88 | -3.23 | 847  |
| 152  | 19:45:18.58 | 24.13 | -33.88 | -41.20 | -1.63 | -3.55 | 676  |
| 153  | 19:45:21.58 | 24.18 | -34.02 | -41.77 | -1.44 | -3.74 | 608  |
| 154  | 19:45:31.58 | 24.25 | -33.88 | -42.80 | -1.63 | -4.00 | 453  |
| 155  | 19:45:34.59 | 24.27 | -33.74 | -42.65 | -1.95 | -3.87 | 461  |
| 156  | 19:45:45.55 | 24.27 | -33.50 | -41.58 | -2.33 | -3.42 | 592  |
| 157  | 19:45:51.55 | 24.25 | -34.01 | -41.66 | -2.65 | -3.04 | 588  |



|     |             |       |        |        |       |       |      |
|-----|-------------|-------|--------|--------|-------|-------|------|
| 158 | 19:45:52.55 | 24.24 | -33.97 | -41.62 | -2.71 | -2.97 | 594  |
| 159 | 19:45:57.54 | 24.23 | -33.77 | -41.29 | -2.97 | -2.65 | 651  |
| 160 | 19:46:00.55 | 24.22 | -33.77 | -41.16 | -3.16 | -2.34 | 679  |
| 161 | 19:46:19.55 | 24.26 | -33.36 | -39.35 | -3.16 | -1.44 | 996  |
| 162 | 19:46:21.55 | 24.27 | -33.49 | -39.06 | -3.10 | -1.25 | 1049 |
| 163 | 19:46:50.51 | 24.47 | -33.69 | -37.53 | -2.65 | 0.67  | 1472 |
| 164 | 19:46:51.51 | 24.46 | -33.81 | -37.28 | -2.52 | 0.61  | 1565 |
| 165 | 19:46:55.51 | 24.43 | -34.31 | -37.16 | -2.27 | 0.61  | 1660 |
| 166 | 19:47:02.51 | 24.32 | -34.07 | -35.95 | -1.82 | 0.54  | 2240 |
| 167 | 19:47:11.51 | 24.31 | -34.14 | -35.65 | -1.56 | 0.67  | 2386 |
| 168 | 19:47:22.51 | 24.44 | -34.07 | -36.37 | -1.50 | 1.50  | 1973 |
| 169 | 19:47:23.51 | 24.45 | -33.88 | -36.29 | -1.44 | 1.63  | 2002 |
| 170 | 19:47:27.50 | 24.47 | -33.65 | -36.42 | -1.37 | 1.88  | 1904 |
| 171 | 19:47:33.50 | 24.50 | -34.03 | -37.64 | -1.31 | 2.33  | 1496 |
| 172 | 19:47:40.51 | 24.60 | -33.89 | -38.59 | -1.12 | 2.84  | 1190 |
| 173 | 19:47:45.47 | 24.64 | -33.75 | -39.55 | -1.05 | 3.23  | 928  |
| 174 | 19:47:46.48 | 24.65 | -33.78 | -39.73 | -0.99 | 3.29  | 883  |
| 175 | 19:47:53.48 | 24.65 | -33.78 | -41.06 | -1.24 | 3.61  | 652  |
| 176 | 19:47:56.47 | 24.64 | -33.78 | -42.29 | -1.50 | 3.87  | 495  |
| 177 | 19:48:00.48 | 24.63 | -33.77 | -42.92 | -1.63 | 3.99  | 428  |
| 178 | 19:48:04.47 | 24.62 | -33.95 | -44.71 | -1.88 | 4.31  | 287  |
| 179 | 19:48:05.47 | 24.62 | -33.95 | -45.06 | -1.95 | 4.38  | 263  |
| 180 | 19:48:16.47 | 24.58 | -34.16 | -43.60 | -2.01 | 3.93  | 380  |
| 181 | 19:48:27.47 | 24.50 | -33.94 | -43.93 | -2.33 | 3.93  | 352  |
| 182 | 19:48:28.48 | 24.49 | -33.97 | -44.31 | -2.40 | 3.99  | 318  |
| 183 | 19:48:36.47 | 24.57 | -34.27 | -45.24 | -2.71 | 3.99  | 263  |
| 184 | 19:49:04.44 | 24.31 | -33.74 | -41.49 | -0.99 | 3.80  | 616  |
| 185 | 19:49:10.45 | 24.27 | -33.82 | -41.32 | -0.61 | 3.80  | 636  |
| 186 | 19:49:18.44 | 24.23 | -33.88 | -40.12 | -0.41 | 3.48  | 859  |
| 187 | 19:49:24.45 | 24.13 | -33.97 | -39.00 | -0.54 | 3.10  | 1150 |
| 188 | 19:49:27.44 | 24.12 | -33.81 | -38.15 | -0.67 | 2.84  | 1349 |
| 189 | 19:49:30.45 | 24.10 | -33.69 | -37.50 | -0.67 | 2.65  | 1528 |
| 190 | 19:49:36.45 | 24.06 | -34.15 | -36.96 | -0.80 | 2.20  | 1792 |
| 191 | 19:49:50.45 | 24.10 | -33.68 | -37.12 | -1.50 | 2.14  | 1660 |
| 192 | 19:49:55.41 | 24.14 | -34.05 | -38.39 | -1.88 | 2.27  | 1335 |
| 193 | 19:50:03.41 | 24.27 | -33.76 | -39.13 | -2.40 | 2.27  | 1046 |
| 194 | 19:50:07.40 | 24.30 | -33.85 | -40.16 | -2.78 | 2.27  | 832  |
| 195 | 19:50:08.40 | 24.30 | -33.72 | -40.32 | -2.84 | 2.33  | 803  |
| 196 | 19:50:23.41 | 24.32 | -34.31 | -38.49 | -2.33 | 1.69  | 1266 |
| 197 | 19:50:24.41 | 24.38 | -34.22 | -38.05 | -2.27 | 1.56  | 1407 |
| 198 | 19:50:40.41 | 24.31 | -33.90 | -41.93 | -3.16 | 2.59  | 560  |
| 199 | 19:50:42.40 | 24.31 | -33.64 | -42.16 | -3.23 | 2.71  | 532  |
| 200 | 19:50:53.41 | 24.32 | -33.97 | -44.21 | -3.55 | 3.03  | 339  |
| 201 | 19:51:06.37 | 24.28 | -33.80 | -42.07 | -3.03 | 2.84  | 532  |
| 202 | 19:51:12.37 | 24.22 | -33.83 | -40.82 | -2.59 | 2.78  | 731  |
| 203 | 19:51:16.37 | 24.13 | -34.09 | -40.22 | -2.27 | 2.71  | 864  |
| 204 | 19:51:22.37 | 24.09 | -34.02 | -39.32 | -1.82 | 2.71  | 1015 |
| 205 | 19:51:25.37 | 24.07 | -34.16 | -38.90 | -1.56 | 2.65  | 1138 |
| 206 | 19:51:38.37 | 23.91 | -34.11 | -37.52 | -0.54 | 2.52  | 1549 |
| 207 | 19:51:50.37 | 23.91 | -34.00 | -36.66 | -0.22 | 2.27  | 1885 |
| 208 | 19:51:52.37 | 23.92 | -33.88 | -36.11 | -0.16 | 2.08  | 2143 |
| 209 | 19:51:57.37 | 23.93 | -33.87 | -35.59 | 0.23  | 1.82  | 2450 |
| 210 | 19:52:04.35 | 23.94 | -34.24 | -35.34 | 0.67  | 1.31  | 2655 |
| 211 | 19:52:40.34 | 24.20 | -34.24 | -36.19 | 0.55  | 1.88  | 2188 |
| 212 | 19:52:43.34 | 24.22 | -33.80 | -36.35 | 0.67  | 2.14  | 2064 |
| 213 | 19:52:46.35 | 24.24 | -33.96 | -36.93 | 0.67  | 2.33  | 1778 |
| 214 | 19:52:51.35 | 24.28 | -33.67 | -37.62 | 0.67  | 2.71  | 1486 |
| 215 | 19:52:57.34 | 24.31 | -34.08 | -39.43 | 0.80  | 3.16  | 1003 |
| 216 | 19:53:02.34 | 24.40 | -33.70 | -40.43 | 0.93  | 3.55  | 801  |
| 217 | 19:53:07.30 | 24.44 | -33.57 | -41.57 | 1.06  | 3.87  | 598  |
| 218 | 19:53:09.30 | 24.45 | -33.56 | -42.05 | 1.06  | 3.99  | 531  |

|     |             |       |        |        |       |       |      |
|-----|-------------|-------|--------|--------|-------|-------|------|
| 219 | 19:53:13.31 | 24.48 | -33.31 | -43.61 | 1.31  | 4.38  | 372  |
| 220 | 19:53:21.30 | 24.46 | -33.67 | -44.15 | 1.50  | 4.38  | 327  |
| 221 | 19:53:22.30 | 24.45 | -33.84 | -44.13 | 1.57  | 4.31  | 330  |
| 222 | 19:53:26.31 | 24.42 | -33.82 | -44.77 | 1.89  | 4.38  | 290  |
| 223 | 19:53:31.30 | 24.39 | -33.91 | -44.59 | 1.89  | 4.31  | 308  |
| 224 | 19:53:36.30 | 24.31 | -33.60 | -42.77 | 1.89  | 3.93  | 468  |
| 225 | 19:53:38.30 | 24.30 | -34.00 | -42.60 | 1.82  | 3.80  | 479  |
| 226 | 19:53:43.30 | 24.27 | -33.78 | -40.79 | 1.63  | 3.42  | 720  |
| 227 | 19:53:48.31 | 24.23 | -33.71 | -39.35 | 1.50  | 3.03  | 1029 |
| 228 | 19:53:49.30 | 24.22 | -33.97 | -39.53 | 1.44  | 3.03  | 993  |
| 229 | 19:53:54.31 | 24.13 | -34.31 | -38.72 | 1.38  | 2.65  | 1226 |
| 230 | 19:54:07.27 | 24.09 | -34.10 | -37.75 | 1.50  | 2.27  | 1471 |
| 231 | 19:54:12.27 | 24.10 | -33.81 | -37.52 | 1.89  | 2.01  | 1536 |
| 232 | 19:54:15.27 | 24.10 | -33.90 | -37.39 | 2.02  | 1.76  | 1573 |
| 233 | 19:54:19.27 | 24.11 | -33.82 | -37.57 | 2.34  | 1.50  | 1540 |
| 234 | 19:54:20.27 | 24.12 | -34.16 | -37.75 | 2.34  | 1.37  | 1478 |
| 235 | 19:54:27.27 | 24.11 | -34.11 | -38.42 | 2.72  | 1.18  | 1239 |
| 236 | 19:54:33.27 | 24.06 | -34.14 | -39.72 | 3.17  | 1.18  | 949  |
| 237 | 19:54:38.26 | 24.02 | -34.55 | -41.33 | 3.55  | 1.12  | 669  |
| 238 | 19:54:45.26 | 23.92 | -33.97 | -42.61 | 4.06  | 1.05  | 480  |
| 239 | 19:54:49.27 | 23.90 | -33.91 | -41.86 | 3.74  | 1.56  | 577  |
| 240 | 19:54:53.27 | 23.92 | -34.30 | -43.40 | 4.19  | 0.99  | 398  |
| 241 | 19:54:59.27 | 23.93 | -34.41 | -44.17 | 4.38  | 0.73  | 344  |
| 242 | 19:55:00.27 | 23.93 | -34.52 | -44.75 | 4.51  | 0.54  | 300  |
| 243 | 19:55:14.23 | 23.88 | -34.49 | -44.05 | 4.38  | -0.23 | 350  |
| 244 | 19:55:20.23 | 23.83 | -34.77 | -44.25 | 4.32  | -0.80 | 344  |
| 245 | 19:55:22.23 | 23.83 | -34.72 | -44.45 | 4.38  | -0.74 | 329  |
| 246 | 19:55:43.23 | 23.74 | -34.01 | -39.58 | 3.29  | 0.67  | 973  |
| 247 | 19:55:45.23 | 23.73 | -34.21 | -39.26 | 3.10  | 0.80  | 1051 |
| 248 | 19:56:03.23 | 23.74 | -33.72 | -38.95 | 2.65  | 1.95  | 1153 |
| 249 | 19:56:07.24 | 23.76 | -34.04 | -39.78 | 2.72  | 2.14  | 980  |
| 250 | 19:56:10.23 | 23.83 | -34.23 | -40.50 | 2.72  | 2.40  | 838  |
| 251 | 19:56:13.23 | 23.85 | -33.88 | -41.19 | 2.78  | 2.78  | 702  |
| 252 | 19:56:19.20 | 23.90 | -33.60 | -42.39 | 2.97  | 3.16  | 512  |
| 253 | 19:56:26.20 | 23.92 | -33.65 | -42.78 | 3.17  | 3.10  | 472  |
| 254 | 19:56:31.20 | 23.91 | -33.60 | -43.81 | 3.74  | 2.84  | 365  |
| 255 | 19:56:33.20 | 23.91 | -34.05 | -44.15 | 3.87  | 2.59  | 339  |
| 256 | 19:56:40.20 | 23.83 | -34.22 | -44.52 | 4.06  | 2.33  | 329  |
| 257 | 19:56:41.21 | 23.84 | -34.05 | -43.43 | 3.87  | 2.20  | 415  |
| 258 | 19:56:44.20 | 23.73 | -34.07 | -45.64 | 4.51  | 2.01  | 243  |
| 259 | 19:56:46.20 | 23.73 | -34.16 | -43.57 | 4.12  | 1.56  | 392  |
| 260 | 19:56:48.21 | 23.66 | -34.65 | -45.73 | 4.51  | 1.63  | 248  |
| 261 | 19:56:52.20 | 23.64 | -34.52 | -44.93 | 4.44  | 1.24  | 302  |
| 262 | 19:57:01.20 | 23.65 | -34.47 | -41.92 | 3.81  | 0.80  | 602  |
| 263 | 19:58:01.16 | 24.27 | -33.91 | -35.22 | -0.22 | 1.56  | 2610 |
| 264 | 19:58:02.17 | 24.27 | -34.04 | -35.23 | -0.16 | 1.50  | 2590 |
| 265 | 19:58:27.12 | 24.24 | -34.27 | -34.95 | -0.73 | 0.86  | 2812 |
| 266 | 19:58:43.13 | 24.13 | -34.08 | -34.34 | -0.16 | 0.67  | 3280 |
| 267 | 19:58:54.13 | 24.05 | -34.34 | -34.75 | 0.67  | 0.61  | 2999 |
| 268 | 19:59:08.13 | 24.03 | -34.48 | -35.77 | 1.63  | -0.03 | 2391 |
| 269 | 19:59:10.12 | 24.06 | -34.44 | -35.65 | 1.57  | -0.23 | 2420 |
| 270 | 19:59:13.13 | 24.02 | -34.48 | -36.78 | 2.14  | -0.35 | 1912 |
| 271 | 19:59:21.13 | 23.95 | -34.50 | -37.28 | 2.34  | -0.48 | 1754 |
| 272 | 19:59:26.13 | 23.92 | -34.36 | -38.02 | 2.65  | -0.67 | 1381 |
| 273 | 20:00:04.11 | 23.63 | -35.31 | -47.19 | 4.83  | -0.93 | 179  |
| 274 | 20:00:10.11 | 23.57 | -34.78 | -46.44 | 4.76  | -1.06 | 214  |
| 275 | 20:00:30.10 | 23.74 | -34.44 | -40.46 | 3.36  | -1.06 | 812  |
| 276 | 20:00:35.07 | 23.82 | -34.48 | -38.97 | 2.91  | -0.86 | 1182 |
| 277 | 20:00:41.06 | 23.76 | -34.25 | -39.33 | 3.04  | -1.12 | 1094 |
| 278 | 20:00:46.07 | 23.74 | -34.25 | -39.30 | 2.85  | -1.57 | 1063 |
| 279 | 20:00:53.06 | 23.75 | -33.98 | -38.79 | 2.65  | -1.76 | 1203 |

|     |             |       |        |        |       |       |      |
|-----|-------------|-------|--------|--------|-------|-------|------|
| 280 | 20:00:56.07 | 23.76 | -34.22 | -38.63 | 2.40  | -1.89 | 1299 |
| 281 | 20:01:06.07 | 23.84 | -34.45 | -40.22 | 2.72  | -2.21 | 871  |
| 282 | 20:01:08.06 | 23.85 | -34.14 | -40.65 | 2.91  | -2.34 | 780  |
| 283 | 20:01:30.06 | 23.89 | -34.32 | -41.07 | 3.17  | -2.08 | 696  |
| 284 | 20:01:52.03 | 23.84 | -34.71 | -42.76 | 3.81  | -1.50 | 480  |
| 285 | 20:02:06.03 | 23.87 | -34.69 | -44.27 | 4.06  | -1.95 | 333  |
| 286 | 20:02:13.03 | 23.80 | -35.01 | -43.61 | 3.74  | -2.08 | 411  |
| 287 | 20:02:15.03 | 23.81 | -35.08 | -45.17 | 3.93  | -2.53 | 285  |
| 288 | 20:02:16.03 | 23.76 | -34.79 | -45.35 | 4.00  | -2.65 | 275  |
| 289 | 20:02:19.03 | 23.74 | -34.56 | -44.59 | 3.81  | -2.72 | 316  |
| 290 | 20:02:23.02 | 23.74 | -34.78 | -46.02 | 4.00  | -2.97 | 226  |
| 291 | 20:02:31.02 | 23.87 | -35.01 | -45.25 | 3.55  | -3.17 | 265  |
| 292 | 20:02:32.03 | 23.88 | -34.57 | -44.63 | 3.49  | -3.17 | 305  |
| 293 | 20:02:41.00 | 24.02 | -35.22 | -46.69 | 3.49  | -3.68 | 190  |
| 294 | 20:02:43.00 | 24.02 | -34.91 | -44.26 | 3.04  | -3.36 | 334  |
| 295 | 20:02:45.00 | 24.06 | -34.44 | -44.05 | 2.91  | -3.55 | 344  |
| 296 | 20:02:48.00 | 24.09 | -34.58 | -46.57 | 3.29  | -4.00 | 190  |
| 297 | 20:03:00.00 | 24.08 | -34.00 | -42.30 | 2.59  | -3.36 | 510  |
| 298 | 20:03:25.99 | 23.94 | -34.31 | -35.70 | 0.93  | -1.44 | 2425 |
| 299 | 20:03:45.97 | 24.05 | -34.43 | -34.90 | 0.99  | -0.16 | 2885 |
| 300 | 20:04:04.96 | 24.09 | -33.96 | -35.28 | 1.25  | 1.05  | 2578 |
| 301 | 20:04:10.96 | 24.08 | -34.00 | -35.45 | 0.80  | 1.50  | 2508 |
| 302 | 20:04:19.97 | 24.08 | -33.75 | -36.54 | -0.03 | 2.33  | 1947 |
| 303 | 20:04:58.92 | 24.28 | -33.72 | -40.02 | -1.50 | 3.23  | 848  |
| 304 | 20:05:01.93 | 24.30 | -33.88 | -40.93 | -1.88 | 3.29  | 697  |
| 305 | 20:05:46.92 | 24.42 | -34.10 | -43.52 | -1.44 | 4.12  | 386  |
| 306 | 20:06:01.90 | 24.32 | -33.96 | -42.92 | -0.92 | 4.12  | 462  |
| 307 | 20:06:02.90 | 24.23 | -34.04 | -43.54 | -0.41 | 4.31  | 389  |
| 308 | 20:06:04.90 | 24.24 | -34.00 | -42.63 | -0.16 | 4.12  | 482  |
| 309 | 20:06:11.90 | 24.24 | -34.18 | -43.97 | -0.41 | 4.38  | 353  |
| 310 | 20:06:13.90 | 24.27 | -34.23 | -45.41 | -0.92 | 4.63  | 247  |
| 311 | 20:06:24.90 | 24.19 | -34.31 | -44.60 | -0.16 | 4.50  | 317  |
| 312 | 20:06:36.90 | 24.24 | -34.10 | -45.88 | -0.03 | 4.82  | 226  |
| 313 | 20:06:49.90 | 24.19 | -34.47 | -46.30 | 0.42  | 4.82  | 215  |
| 314 | 20:07:00.86 | 24.13 | -34.30 | -45.54 | 0.48  | 4.70  | 254  |
| 315 | 20:07:07.86 | 24.09 | -33.94 | -43.40 | 0.35  | 4.31  | 398  |
| 316 | 20:07:12.86 | 24.09 | -33.90 | -42.41 | 0.67  | 4.06  | 501  |
| 317 | 20:07:15.86 | 24.11 | -33.60 | -41.53 | 0.55  | 3.93  | 620  |
| 318 | 20:07:23.86 | 24.07 | -33.82 | -39.80 | 0.35  | 3.42  | 928  |
| 319 | 20:07:26.86 | 24.05 | -34.07 | -39.05 | 0.48  | 3.10  | 1114 |
| 320 | 20:07:36.86 | 24.08 | -34.03 | -38.72 | 0.03  | 3.03  | 1183 |
| 321 | 20:07:46.86 | 24.12 | -34.01 | -37.29 | 0.23  | 2.52  | 1644 |
| 322 | 20:08:14.82 | 23.92 | -34.54 | -34.71 | 0.35  | 0.48  | 3001 |
| 323 | 20:10:06.76 | 23.90 | -34.10 | -35.55 | -0.54 | -1.63 | 2455 |
| 324 | 20:13:45.65 | 24.31 | -33.97 | -39.28 | -0.09 | 3.23  | 1051 |
| 325 | 20:14:34.62 | 24.13 | -33.84 | -41.43 | -0.03 | 3.87  | 654  |
| 326 | 20:15:03.62 | 24.37 | -34.38 | -45.00 | -1.56 | 4.38  | 284  |
| 327 | 20:15:17.62 | 24.47 | -34.03 | -45.99 | -2.33 | 4.44  | 210  |
| 328 | 20:16:30.55 | 24.66 | -34.17 | -44.54 | -2.84 | 3.74  | 289  |
| 329 | 20:16:34.54 | 24.65 | -33.76 | -42.60 | -2.52 | 3.48  | 453  |
| 330 | 20:16:57.55 | 24.76 | -34.15 | -36.36 | -0.99 | 1.82  | 1997 |
| 331 | 20:18:27.52 | 25.01 | -34.08 | -34.36 | -0.67 | 0.22  | 2979 |
| 332 | 20:18:39.48 | 25.00 | -34.42 | -34.84 | -0.86 | -0.23 | 2692 |
| 333 | 20:25:20.28 | 24.57 | -34.71 | -35.09 | 0.61  | -0.67 | 2716 |

### 120 kHz calibration

```
# Calibration Version 1.0.0.9
#
# Date: 2006-10-07
#
# Comments:
```

```

# just 120 kHz
#
# Reference Target:
# TS -40.40 dB Min. Distance 24.00
m
# TS Deviation 3.0 dB Max. Distance 28.00
m
#
# Transducer: ES120-7 Serial No. 907203422
# Frequency 120000 Hz Beamtype
Split
# Gain 20.24 dB Two Way Beam Angle -20.7
dB
# Athw. Angle Sens. 21.00 Along. Angle Sens.
21.00
# Athw. Beam Angle 7.73 deg Along. Beam Angle 7.71
deg
# Athw. Offset Angle -0.04 deg Along. Offset Angle -0.17
deg
# SaCorrection -0.38 dB Depth 0.00
m
#
# Transceiver: GPT 120 kHz 00907203422d 1 ES120-7
# Pulse Duration 1.024 ms Sample Interval 0.186
m
# Power 500 W Receiver Bandwidth 3.03
kHz
#
# Sounder Type:
# EK60 Version ComSounder
#
# TS Detection:
# Min. Value -50.0 dB
# Max. Beam Comp. 6.0 dB Min. Echolength 80
%
# Max. Phase Dev. 8.0 Max. Echolength 180
%
#
# Environment:
# Absorption Coeff. 26.3 dB/km Sound Velocity 1453.0
m/s
#
# Beam Model results:
# Transducer Gain = 21.38 dB SaCorrection = -0.39
dB
# Athw. Beam Angle = 7.48 deg Along. Beam Angle = 7.48
deg
# Athw. Offset Angle =-0.07 deg Along. Offset Angle=-0.12
deg
#
# Data deviation from beam model:
# RMS = 0.19 dB
# Max = 0.50 dB No. = 220 Athw. = -1.3 deg Along = -3.0
deg
# Min = -0.73 dB No. = 228 Athw. = -0.6 deg Along = -5.3
deg
#
# Data deviation from polynomial model:
# RMS = 0.15 dB
# Max = 0.37 dB No. = 83 Athw. = 4.4 deg Along = -2.8
deg

```



|     |             |       |        |        |       |       |     |
|-----|-------------|-------|--------|--------|-------|-------|-----|
| 54  | 12:20:58.97 | 25.17 | -38.59 | -42.46 | 3.05  | -0.37 | 461 |
| 55  | 12:21:02.98 | 25.20 | -38.97 | -43.63 | 3.32  | -0.70 | 350 |
| 56  | 12:21:12.97 | 25.22 | -38.40 | -43.33 | 3.46  | -0.10 | 376 |
| 57  | 12:21:16.98 | 25.27 | -38.16 | -43.34 | 3.52  | 0.30  | 371 |
| 58  | 12:21:19.97 | 25.29 | -38.24 | -43.36 | 3.46  | 0.57  | 366 |
| 59  | 12:21:20.97 | 25.29 | -37.97 | -43.34 | 3.52  | 0.71  | 367 |
| 60  | 12:21:26.97 | 25.36 | -38.20 | -44.19 | 3.59  | 1.24  | 298 |
| 61  | 12:21:30.98 | 25.37 | -38.30 | -44.73 | 3.59  | 1.64  | 264 |
| 62  | 12:21:35.97 | 25.36 | -37.59 | -44.67 | 3.59  | 2.11  | 273 |
| 63  | 12:21:41.97 | 25.38 | -37.79 | -45.68 | 3.59  | 2.58  | 216 |
| 64  | 12:21:46.98 | 25.40 | -37.98 | -47.14 | 3.66  | 3.12  | 153 |
| 65  | 12:21:53.03 | 25.41 | -37.72 | -48.16 | 3.72  | 3.59  | 121 |
| 66  | 12:22:05.02 | 25.49 | -37.90 | -48.94 | 4.12  | 3.38  | 100 |
| 67  | 12:22:10.02 | 25.53 | -38.08 | -49.41 | 4.46  | 3.05  | 90  |
| 68  | 12:22:11.02 | 25.54 | -38.26 | -49.55 | 4.53  | 2.92  | 86  |
| 69  | 12:22:18.02 | 25.52 | -38.20 | -49.02 | 4.59  | 2.51  | 98  |
| 70  | 12:22:23.02 | 25.50 | -38.51 | -48.18 | 4.46  | 2.05  | 119 |
| 71  | 12:22:28.03 | 25.48 | -38.57 | -47.89 | 4.53  | 1.58  | 127 |
| 72  | 12:22:32.02 | 25.42 | -38.46 | -47.12 | 4.46  | 1.11  | 153 |
| 73  | 12:22:34.03 | 25.41 | -38.45 | -46.78 | 4.39  | 0.97  | 167 |
| 74  | 12:22:38.02 | 25.41 | -38.04 | -46.17 | 4.39  | 0.64  | 190 |
| 75  | 12:22:43.02 | 25.42 | -38.03 | -45.97 | 4.39  | 0.10  | 200 |
| 76  | 12:22:47.02 | 25.40 | -38.30 | -45.98 | 4.33  | -0.23 | 200 |
| 77  | 12:22:52.02 | 25.39 | -38.76 | -46.53 | 4.33  | -0.70 | 174 |
| 78  | 12:22:57.06 | 25.38 | -38.80 | -46.80 | 4.33  | -1.17 | 163 |
| 79  | 12:23:03.06 | 25.31 | -38.70 | -46.82 | 4.26  | -1.64 | 164 |
| 80  | 12:23:06.06 | 25.30 | -38.24 | -47.47 | 4.46  | -2.04 | 141 |
| 81  | 12:23:08.06 | 25.30 | -38.80 | -47.21 | 4.19  | -2.11 | 149 |
| 82  | 12:23:10.06 | 25.29 | -38.64 | -48.38 | 4.46  | -2.44 | 115 |
| 83  | 12:23:14.06 | 25.27 | -38.23 | -48.25 | 4.39  | -2.78 | 120 |
| 84  | 12:23:19.06 | 25.22 | -39.30 | -49.47 | 4.26  | -3.11 | 91  |
| 85  | 12:23:25.06 | 25.27 | -39.10 | -50.55 | 4.46  | -3.45 | 70  |
| 86  | 12:23:42.06 | 25.35 | -39.95 | -51.89 | 4.86  | -2.98 | 51  |
| 87  | 12:23:44.06 | 25.36 | -39.45 | -51.33 | 4.93  | -2.78 | 58  |
| 88  | 12:23:51.06 | 25.38 | -39.44 | -50.46 | 4.93  | -2.11 | 71  |
| 89  | 12:23:55.06 | 25.42 | -38.88 | -49.55 | 4.93  | -1.77 | 87  |
| 90  | 12:23:57.06 | 25.40 | -38.84 | -49.29 | 4.93  | -1.50 | 92  |
| 91  | 12:23:58.06 | 25.40 | -38.96 | -49.11 | 4.86  | -1.44 | 96  |
| 92  | 12:24:01.11 | 25.41 | -38.82 | -48.75 | 4.86  | -1.10 | 106 |
| 93  | 12:24:02.11 | 25.41 | -38.83 | -49.02 | 4.93  | -1.10 | 99  |
| 94  | 12:24:06.11 | 25.46 | -39.92 | -49.93 | 4.93  | -0.63 | 80  |
| 95  | 12:24:12.11 | 25.55 | -39.58 | -50.07 | 5.06  | -0.16 | 74  |
| 96  | 12:24:16.11 | 25.51 | -39.03 | -49.29 | 5.00  | 0.24  | 91  |
| 97  | 12:24:21.10 | 25.54 | -38.46 | -49.16 | 5.06  | 0.71  | 94  |
| 98  | 12:24:26.11 | 25.56 | -39.59 | -50.59 | 5.06  | 1.17  | 69  |
| 99  | 12:24:31.11 | 25.57 | -39.05 | -51.00 | 5.20  | 1.64  | 63  |
| 100 | 12:24:46.11 | 25.69 | -38.58 | -47.67 | 4.39  | 1.78  | 131 |
| 101 | 12:24:58.11 | 25.82 | -37.96 | -44.11 | 3.46  | 1.71  | 300 |
| 102 | 12:25:09.14 | 25.93 | -37.73 | -41.46 | 2.45  | 1.64  | 549 |
| 103 | 12:25:24.14 | 25.85 | -37.58 | -41.53 | 1.51  | 2.58  | 538 |
| 104 | 12:25:36.15 | 25.75 | -37.64 | -42.67 | 0.51  | 3.32  | 422 |
| 105 | 12:25:38.14 | 25.74 | -37.44 | -43.21 | 0.37  | 3.59  | 372 |
| 106 | 12:25:45.14 | 25.73 | -38.04 | -45.28 | -0.23 | 4.05  | 225 |
| 107 | 12:25:46.14 | 25.68 | -38.12 | -45.85 | -0.36 | 4.19  | 200 |
| 108 | 12:25:51.14 | 25.65 | -37.45 | -46.25 | -0.70 | 4.46  | 184 |
| 109 | 12:26:03.15 | 25.61 | -38.29 | -48.73 | -0.90 | 4.86  | 104 |
| 110 | 12:26:50.18 | 25.75 | -38.31 | -50.29 | -1.57 | 5.13  | 72  |
| 111 | 12:26:53.19 | 25.75 | -38.38 | -49.87 | -1.63 | 4.99  | 80  |
| 112 | 12:26:57.18 | 25.73 | -37.98 | -48.41 | -1.63 | 4.72  | 112 |
| 113 | 12:26:59.19 | 25.72 | -37.76 | -47.37 | -1.57 | 4.52  | 142 |
| 114 | 12:27:00.18 | 25.71 | -38.25 | -47.44 | -1.63 | 4.39  | 140 |

|     |             |       |        |        |       |       |     |
|-----|-------------|-------|--------|--------|-------|-------|-----|
| 115 | 12:27:01.18 | 25.71 | -37.82 | -46.71 | -1.57 | 4.32  | 165 |
| 116 | 12:27:08.18 | 25.68 | -37.51 | -44.68 | -1.63 | 3.79  | 263 |
| 117 | 12:27:09.18 | 25.67 | -37.46 | -44.57 | -1.57 | 3.79  | 270 |
| 118 | 12:27:13.23 | 25.65 | -37.90 | -44.07 | -1.63 | 3.45  | 304 |
| 119 | 12:27:15.22 | 25.60 | -37.89 | -43.44 | -1.57 | 3.25  | 357 |
| 120 | 12:27:20.23 | 25.59 | -37.53 | -42.38 | -1.70 | 2.92  | 455 |
| 121 | 12:27:24.22 | 25.58 | -37.72 | -41.65 | -1.70 | 2.51  | 538 |
| 122 | 12:27:30.22 | 25.56 | -38.23 | -41.26 | -1.70 | 2.05  | 597 |
| 123 | 12:27:36.23 | 25.54 | -38.26 | -40.74 | -1.84 | 1.58  | 668 |
| 124 | 12:27:41.23 | 25.52 | -38.70 | -40.63 | -1.84 | 1.11  | 681 |
| 125 | 12:27:47.22 | 25.49 | -38.08 | -39.79 | -1.97 | 0.57  | 816 |
| 126 | 12:27:52.22 | 25.47 | -37.76 | -39.20 | -1.90 | 0.17  | 932 |
| 127 | 12:27:57.22 | 25.41 | -38.29 | -39.79 | -1.97 | -0.30 | 834 |
| 128 | 12:28:02.23 | 25.43 | -38.23 | -39.95 | -2.04 | -0.70 | 799 |
| 129 | 12:28:07.22 | 25.38 | -38.32 | -40.26 | -1.97 | -1.24 | 756 |
| 130 | 12:28:12.22 | 25.37 | -38.40 | -40.73 | -1.97 | -1.64 | 679 |
| 131 | 12:28:17.27 | 25.35 | -38.28 | -41.33 | -2.04 | -2.11 | 587 |
| 132 | 12:28:19.27 | 25.34 | -38.22 | -41.47 | -2.10 | -2.17 | 565 |
| 133 | 12:28:24.27 | 25.32 | -38.63 | -42.46 | -2.04 | -2.58 | 445 |
| 134 | 12:28:25.31 | 25.32 | -38.53 | -42.60 | -2.10 | -2.64 | 434 |
| 135 | 12:28:30.28 | 25.30 | -38.80 | -43.70 | -2.10 | -3.04 | 337 |
| 136 | 12:28:31.27 | 25.29 | -38.89 | -43.83 | -2.04 | -3.11 | 326 |
| 137 | 12:28:36.27 | 25.28 | -38.68 | -44.86 | -2.10 | -3.58 | 260 |
| 138 | 12:28:42.27 | 25.22 | -39.06 | -46.57 | -2.10 | -4.05 | 176 |
| 139 | 12:28:48.27 | 25.21 | -39.53 | -48.56 | -2.30 | -4.45 | 111 |
| 140 | 12:28:52.27 | 25.20 | -39.26 | -49.99 | -2.37 | -4.92 | 80  |
| 141 | 12:29:02.27 | 25.22 | -39.73 | -51.19 | -2.71 | -4.99 | 61  |
| 142 | 12:29:06.27 | 25.31 | -39.40 | -51.18 | -3.04 | -4.92 | 59  |
| 143 | 12:29:07.27 | 25.33 | -39.19 | -50.86 | -3.11 | -4.85 | 65  |
| 144 | 12:29:13.27 | 25.38 | -39.10 | -49.47 | -3.31 | -4.32 | 88  |
| 145 | 12:29:18.27 | 25.39 | -38.62 | -47.73 | -3.24 | -3.91 | 132 |
| 146 | 12:29:23.31 | 25.41 | -38.69 | -46.33 | -3.11 | -3.45 | 183 |
| 147 | 12:29:28.31 | 25.41 | -38.37 | -44.86 | -3.11 | -2.91 | 258 |
| 148 | 12:29:34.31 | 25.48 | -38.18 | -43.67 | -3.04 | -2.44 | 335 |
| 149 | 12:29:36.31 | 25.49 | -38.56 | -43.58 | -2.97 | -2.24 | 341 |
| 150 | 12:29:39.31 | 25.50 | -38.40 | -43.05 | -2.97 | -1.97 | 385 |
| 151 | 12:29:44.31 | 25.52 | -38.39 | -42.43 | -2.91 | -1.57 | 449 |
| 152 | 12:29:49.31 | 25.54 | -38.62 | -42.25 | -2.91 | -1.10 | 468 |
| 153 | 12:29:54.30 | 25.55 | -38.49 | -41.72 | -2.84 | -0.63 | 533 |
| 154 | 12:30:00.31 | 25.57 | -38.69 | -41.85 | -2.84 | -0.10 | 517 |
| 155 | 12:30:05.31 | 25.59 | -38.60 | -41.56 | -2.71 | 0.30  | 544 |
| 156 | 12:30:10.31 | 25.60 | -38.48 | -41.67 | -2.71 | 0.77  | 535 |
| 157 | 12:30:15.30 | 25.61 | -38.04 | -41.64 | -2.71 | 1.24  | 539 |
| 158 | 12:30:20.31 | 25.68 | -37.88 | -41.96 | -2.71 | 1.64  | 491 |
| 159 | 12:30:26.35 | 25.70 | -38.02 | -42.67 | -2.64 | 2.11  | 418 |
| 160 | 12:30:30.34 | 25.72 | -37.64 | -43.18 | -2.64 | 2.58  | 372 |
| 161 | 12:30:37.34 | 25.75 | -37.51 | -44.08 | -2.64 | 3.05  | 303 |
| 162 | 12:30:44.34 | 25.80 | -37.84 | -45.51 | -2.57 | 3.52  | 212 |
| 163 | 12:30:45.35 | 25.81 | -37.70 | -45.44 | -2.50 | 3.59  | 214 |
| 164 | 12:30:46.35 | 25.77 | -37.58 | -47.06 | -2.71 | 4.05  | 149 |
| 165 | 12:30:54.35 | 25.79 | -38.06 | -48.54 | -2.50 | 4.46  | 108 |
| 166 | 12:30:55.35 | 25.80 | -37.85 | -49.00 | -2.64 | 4.59  | 97  |
| 167 | 12:31:33.39 | 25.97 | -38.64 | -50.60 | -3.91 | 4.05  | 66  |
| 168 | 12:31:35.40 | 25.96 | -38.65 | -50.08 | -3.84 | 3.92  | 73  |
| 169 | 12:31:37.40 | 25.96 | -38.33 | -49.92 | -3.98 | 3.85  | 77  |
| 170 | 12:31:40.39 | 25.94 | -38.35 | -48.56 | -3.84 | 3.45  | 105 |
| 171 | 12:31:46.39 | 25.93 | -38.18 | -47.34 | -3.84 | 2.98  | 140 |
| 172 | 12:31:52.40 | 25.90 | -37.95 | -46.26 | -3.91 | 2.45  | 179 |
| 173 | 12:31:57.40 | 25.88 | -37.63 | -45.40 | -3.98 | 1.98  | 218 |
| 174 | 12:32:00.39 | 25.86 | -38.59 | -45.80 | -3.91 | 1.71  | 199 |
| 175 | 12:32:02.39 | 25.85 | -38.39 | -45.37 | -3.91 | 1.51  | 221 |

|      |             |       |        |        |       |       |      |
|------|-------------|-------|--------|--------|-------|-------|------|
| 176  | 12:32:04.40 | 25.85 | -38.01 | -44.98 | -3.98 | 1.31  | 243  |
| 177  | 12:32:07.39 | 25.79 | -38.13 | -44.92 | -3.98 | 1.11  | 247  |
| 178  | 12:32:12.40 | 25.78 | -38.45 | -44.71 | -3.91 | 0.64  | 261  |
| 179  | 12:32:13.40 | 25.78 | -38.37 | -44.77 | -3.98 | 0.50  | 252  |
| 180  | 12:32:18.40 | 25.76 | -38.19 | -44.48 | -3.98 | 0.17  | 274  |
| 181  | 12:32:26.40 | 25.75 | -38.02 | -44.27 | -3.98 | -0.23 | 291  |
| 182  | 12:32:31.40 | 25.73 | -38.36 | -44.92 | -4.04 | -0.70 | 249  |
| 183  | 12:32:35.43 | 25.71 | -38.58 | -45.37 | -4.04 | -1.17 | 223  |
| 184  | 12:32:41.44 | 25.69 | -38.52 | -46.19 | -4.18 | -1.70 | 184  |
| 185  | 12:32:46.44 | 25.67 | -38.38 | -46.71 | -4.25 | -2.11 | 164  |
| 186  | 12:32:52.43 | 25.60 | -38.91 | -47.88 | -4.25 | -2.58 | 126  |
| 187  | 12:32:56.43 | 25.60 | -38.68 | -48.65 | -4.31 | -3.04 | 105  |
| 188  | 12:33:04.43 | 25.60 | -38.57 | -49.33 | -4.45 | -3.25 | 90   |
| 189  | 12:33:34.43 | 25.68 | -39.56 | -51.47 | -5.32 | -1.77 | 55   |
| 190  | 12:33:38.47 | 25.70 | -39.25 | -50.95 | -5.32 | -1.50 | 62   |
| 191  | 12:33:42.47 | 25.71 | -39.55 | -50.73 | -5.25 | -1.10 | 65   |
| 192  | 12:33:48.47 | 25.74 | -39.33 | -50.03 | -5.18 | -0.57 | 77   |
| 193  | 12:33:54.47 | 25.75 | -38.96 | -49.62 | -5.18 | -0.16 | 84   |
| 194  | 12:33:57.47 | 25.76 | -39.57 | -50.28 | -5.18 | 0.24  | 72   |
| 195  | 12:34:03.47 | 25.78 | -39.13 | -49.76 | -5.12 | 0.77  | 82   |
| 196  | 12:34:07.47 | 25.79 | -39.82 | -50.70 | -5.12 | 1.17  | 66   |
| 197  | 12:34:12.47 | 25.85 | -39.64 | -51.01 | -5.12 | 1.71  | 60   |
| 198  | 12:34:26.47 | 25.87 | -39.18 | -51.02 | -5.12 | 2.11  | 60   |
| 199  | 12:34:36.47 | 25.80 | -38.75 | -49.87 | -4.85 | 2.31  | 80   |
| 200  | 12:34:43.51 | 25.76 | -38.30 | -47.82 | -4.38 | 2.31  | 128  |
| 201  | 12:34:55.51 | 25.60 | -38.22 | -44.86 | -3.38 | 2.31  | 255  |
| 202  | 12:35:06.51 | 25.51 | -37.77 | -42.53 | -2.50 | 2.31  | 435  |
| 203  | 12:35:18.51 | 25.37 | -38.03 | -41.39 | -1.57 | 2.31  | 586  |
| 204  | 12:35:24.51 | 25.30 | -38.69 | -41.73 | -1.10 | 2.38  | 534  |
| 205  | 12:35:47.56 | 25.27 | -38.62 | -40.93 | -0.96 | 2.05  | 651  |
| 206  | 12:35:50.55 | 25.26 | -37.65 | -39.17 | -0.90 | 1.58  | 948  |
| 207  | 12:35:55.56 | 25.21 | -38.59 | -40.15 | -1.17 | 1.44  | 784  |
| 208  | 12:35:57.55 | 25.20 | -37.95 | -38.88 | -0.96 | 1.04  | 1028 |
| 209  | 12:36:03.55 | 25.21 | -38.26 | -39.04 | -1.17 | 0.64  | 995  |
| 210  | 12:36:04.55 | 25.18 | -38.42 | -38.96 | -1.03 | 0.44  | 1012 |
| 211  | 12:36:07.56 | 25.17 | -37.90 | -38.35 | -1.03 | 0.17  | 1161 |
| 212  | 12:36:12.55 | 25.15 | -38.37 | -38.77 | -1.03 | -0.30 | 1042 |
| *213 | 12:36:18.55 | 25.12 | -37.99 | -38.56 | -1.10 | -0.70 | 1098 |
| *214 | 12:36:19.56 | 25.12 | -37.89 | -38.57 | -1.17 | -0.83 | 1096 |
| 215  | 12:36:23.56 | 25.10 | -38.12 | -38.97 | -1.10 | -1.17 | 998  |
| 216  | 12:36:29.56 | 25.08 | -38.17 | -39.65 | -1.10 | -1.77 | 866  |
| 217  | 12:36:32.55 | 25.03 | -38.45 | -40.42 | -1.23 | -2.04 | 746  |
| 218  | 12:36:33.56 | 25.03 | -38.79 | -40.86 | -1.23 | -2.11 | 675  |
| 219  | 12:36:38.55 | 25.02 | -38.28 | -41.22 | -1.30 | -2.58 | 620  |
| 220  | 12:36:44.55 | 25.00 | -37.90 | -41.83 | -1.30 | -3.04 | 541  |
| 221  | 12:36:50.60 | 24.98 | -38.76 | -43.84 | -1.30 | -3.51 | 338  |
| 222  | 12:37:04.60 | 24.99 | -38.45 | -44.83 | -0.96 | -4.05 | 267  |
| 223  | 12:37:08.59 | 25.01 | -39.28 | -45.86 | -0.50 | -4.18 | 212  |
| 224  | 12:37:15.59 | 25.02 | -39.46 | -46.98 | -0.56 | -4.45 | 164  |
| 225  | 12:37:21.59 | 25.01 | -39.19 | -48.41 | -0.56 | -4.92 | 117  |
| 226  | 12:37:22.59 | 25.00 | -39.50 | -49.02 | -0.70 | -4.99 | 101  |
| 227  | 12:37:25.60 | 24.99 | -40.59 | -51.46 | -0.70 | -5.32 | 58   |
| 228  | 12:37:26.59 | 24.99 | -41.20 | -52.03 | -0.56 | -5.32 | 51   |
| 229  | 12:37:34.59 | 24.96 | -40.45 | -51.21 | -0.23 | -5.32 | 61   |
| 230  | 12:37:37.60 | 24.92 | -40.73 | -51.21 | 0.04  | -5.25 | 61   |
| 231  | 12:37:42.59 | 24.89 | -40.33 | -51.10 | 0.24  | -5.32 | 64   |
| 232  | 12:37:48.59 | 24.85 | -40.09 | -50.59 | 0.31  | -5.25 | 71   |
| 233  | 12:37:53.64 | 24.90 | -39.44 | -48.39 | 0.44  | -4.85 | 118  |
| 234  | 12:37:59.63 | 24.92 | -39.39 | -46.41 | 0.37  | -4.32 | 186  |
| 235  | 12:38:04.63 | 24.94 | -38.92 | -44.68 | 0.44  | -3.91 | 276  |
| 236  | 12:38:11.63 | 24.97 | -38.73 | -43.01 | 0.51  | -3.38 | 409  |



|      |             |       |        |        |       |       |      |
|------|-------------|-------|--------|--------|-------|-------|------|
| 237  | 12:38:19.63 | 24.98 | -39.45 | -42.58 | 0.44  | -2.91 | 453  |
| 238  | 12:38:25.63 | 25.00 | -38.68 | -41.00 | 0.51  | -2.51 | 651  |
| 239  | 12:38:30.63 | 25.02 | -38.29 | -39.82 | 0.51  | -2.04 | 847  |
| 240  | 12:38:35.64 | 25.06 | -38.52 | -39.46 | 0.58  | -1.57 | 903  |
| 241  | 12:38:41.64 | 25.08 | -38.59 | -39.13 | 0.64  | -1.10 | 984  |
| 242  | 12:38:44.63 | 25.09 | -38.56 | -38.96 | 0.71  | -0.83 | 1015 |
| 243  | 12:38:46.63 | 25.10 | -38.82 | -39.09 | 0.64  | -0.63 | 978  |
| 244  | 12:38:48.64 | 25.11 | -38.09 | -38.33 | 0.71  | -0.37 | 1155 |
| *245 | 12:39:01.68 | 25.17 | -38.44 | -38.48 | 0.17  | -0.37 | 1125 |
| *246 | 12:39:32.68 | 25.19 | -37.89 | -38.20 | 0.31  | 0.64  | 1208 |
| *247 | 12:39:42.68 | 25.17 | -38.32 | -38.44 | 0.37  | 0.17  | 1136 |
| 248  | 12:40:14.72 | 25.02 | -39.52 | -41.51 | 0.17  | -2.37 | 577  |
| 249  | 12:40:19.73 | 25.03 | -38.30 | -40.66 | 0.17  | -2.58 | 691  |
| 250  | 12:40:23.72 | 25.09 | -38.42 | -40.92 | -0.29 | -2.64 | 648  |
| 251  | 12:40:26.73 | 25.13 | -39.28 | -41.59 | -0.56 | -2.51 | 555  |
| 252  | 12:40:29.72 | 25.16 | -38.09 | -40.72 | -0.70 | -2.64 | 678  |
| 253  | 12:40:47.73 | 25.14 | -38.93 | -42.47 | -0.76 | -3.04 | 453  |
| 254  | 12:40:52.72 | 25.12 | -38.72 | -43.47 | -0.83 | -3.51 | 358  |
| 255  | 12:41:08.76 | 25.04 | -38.98 | -46.64 | -0.90 | -4.45 | 175  |
| 256  | 12:41:25.76 | 24.97 | -39.95 | -48.84 | -0.16 | -4.85 | 106  |
| 257  | 12:41:35.76 | 24.84 | -40.04 | -49.08 | 0.71  | -4.85 | 101  |
| 258  | 12:41:36.76 | 24.84 | -39.67 | -49.05 | 0.84  | -4.92 | 101  |
| 259  | 12:41:42.76 | 24.79 | -40.29 | -49.71 | 1.31  | -4.85 | 88   |
| 260  | 12:41:44.76 | 24.79 | -40.38 | -50.16 | 1.45  | -4.92 | 79   |
| 261  | 12:41:56.76 | 24.80 | -39.53 | -47.31 | 1.31  | -4.38 | 153  |
| 262  | 12:42:03.76 | 24.83 | -39.23 | -45.32 | 1.31  | -3.85 | 244  |
| 263  | 12:42:09.81 | 24.84 | -38.97 | -43.92 | 1.45  | -3.38 | 333  |
| 264  | 12:42:14.81 | 24.85 | -39.17 | -43.10 | 1.38  | -2.98 | 406  |
| 265  | 12:42:20.80 | 24.90 | -38.69 | -41.73 | 1.45  | -2.51 | 551  |
| 266  | 12:42:26.80 | 24.93 | -38.37 | -40.64 | 1.45  | -2.04 | 695  |
| 267  | 12:42:31.81 | 24.99 | -37.92 | -39.59 | 1.51  | -1.50 | 862  |
| 268  | 12:42:36.81 | 24.97 | -37.91 | -39.10 | 1.45  | -1.04 | 982  |
| 269  | 12:42:41.81 | 24.99 | -38.33 | -39.39 | 1.51  | -0.63 | 931  |
| *270 | 12:42:51.81 | 25.02 | -37.56 | -38.53 | 1.45  | 0.30  | 1129 |
| 271  | 12:43:37.84 | 24.74 | -38.15 | -42.87 | 3.25  | -1.17 | 424  |
| 272  | 12:43:43.84 | 24.71 | -38.62 | -43.92 | 3.32  | -1.64 | 336  |
| 273  | 12:43:53.85 | 24.66 | -38.65 | -44.18 | 3.19  | -2.11 | 317  |
| 274  | 12:43:57.84 | 24.65 | -38.65 | -44.90 | 3.19  | -2.58 | 271  |
| 275  | 12:44:03.84 | 24.63 | -38.88 | -46.00 | 3.19  | -3.04 | 209  |
| 276  | 12:44:08.85 | 24.62 | -38.89 | -47.05 | 3.19  | -3.51 | 163  |
| 277  | 12:44:14.85 | 24.60 | -39.28 | -48.80 | 3.19  | -4.05 | 110  |
| 278  | 12:44:24.88 | 24.58 | -39.56 | -50.39 | 3.25  | -4.45 | 75   |
| 279  | 12:44:36.89 | 24.61 | -39.80 | -50.73 | 2.99  | -4.65 | 70   |
| 280  | 12:44:40.88 | 24.64 | -39.78 | -49.69 | 2.52  | -4.58 | 90   |
| 281  | 12:44:52.88 | 24.73 | -39.72 | -48.65 | 1.98  | -4.52 | 112  |
| 282  | 12:44:58.89 | 24.74 | -39.37 | -47.86 | 1.98  | -4.38 | 135  |
| 283  | 12:45:04.89 | 24.76 | -38.86 | -45.91 | 1.98  | -3.91 | 209  |
| 284  | 12:45:09.88 | 24.78 | -38.89 | -44.48 | 1.85  | -3.45 | 293  |
| 285  | 12:45:19.89 | 24.77 | -38.52 | -43.86 | 2.12  | -3.18 | 337  |
| 286  | 12:45:51.92 | 24.71 | -38.63 | -44.77 | 2.58  | -3.18 | 277  |
| 287  | 12:45:57.92 | 24.72 | -38.91 | -44.74 | 2.65  | -2.98 | 278  |
| 288  | 12:46:03.92 | 24.74 | -38.78 | -43.61 | 2.65  | -2.44 | 357  |
| 289  | 12:46:07.92 | 24.76 | -38.83 | -43.18 | 2.72  | -2.04 | 395  |
| 290  | 12:46:13.92 | 24.78 | -38.62 | -42.40 | 2.72  | -1.57 | 476  |
| 291  | 12:46:20.92 | 24.77 | -38.26 | -41.50 | 2.52  | -1.44 | 586  |
| 292  | 12:46:24.92 | 24.73 | -38.84 | -41.07 | 2.18  | -0.97 | 647  |
| 293  | 12:46:27.97 | 24.67 | -38.60 | -40.36 | 1.98  | -0.70 | 778  |
| 294  | 12:46:28.97 | 24.67 | -38.72 | -40.35 | 1.91  | -0.63 | 784  |
| 295  | 12:47:06.97 | 24.61 | -38.37 | -38.42 | -0.36 | -0.30 | 1197 |
| *296 | 12:47:16.97 | 24.61 | -38.06 | -38.26 | -0.50 | -0.70 | 1243 |
| 297  | 12:47:21.97 | 24.59 | -38.33 | -38.82 | -0.50 | -1.17 | 1084 |

|     |             |       |        |        |       |       |      |
|-----|-------------|-------|--------|--------|-------|-------|------|
| 298 | 12:47:28.97 | 24.57 | -38.35 | -39.38 | -0.50 | -1.70 | 948  |
| 299 | 12:47:46.00 | 24.48 | -38.05 | -41.52 | -0.63 | -3.04 | 602  |
| 300 | 12:47:53.01 | 24.46 | -39.08 | -43.70 | -0.56 | -3.51 | 363  |
| 301 | 12:48:21.00 | 24.56 | -38.56 | -41.00 | -0.83 | -2.51 | 660  |
| 302 | 12:48:40.05 | 24.78 | -38.57 | -39.38 | -0.23 | -1.57 | 926  |
| 303 | 12:48:45.05 | 24.79 | -38.44 | -38.79 | -0.09 | -1.10 | 1075 |

### 200 kHz calibration

```

# Calibration Version 1.0.0.9
#
# Date: 2006-10-06
#
# Comments:
#
# Reference Target:
# TS -44.80 dB Min. Distance 23.00
m
# TS Deviation 4.5 dB Max. Distance 28.00
m
#
# Transducer: ES200-7 Serial No. 9072033191
# Frequency 200000 Hz Beamtype
Split
# Gain 24.01 dB Two Way Beam Angle -19.6
dB
# Athw. Angle Sens. 23.00 Along. Angle Sens.
23.00
# Athw. Beam Angle 6.32 deg Along. Beam Angle 6.22
deg
# Athw. Offset Angle -0.16 deg Along. Offset Angle 0.14
deg
# SaCorrection -0.28 dB Depth 0.00
m
#
# Transceiver: GPT 200 kHz 009072033f91 1 ES200-7
# Pulse Duration 1.024 ms Sample Interval 0.186
m
# Power 300 W Receiver Bandwidth 3.09
kHz
#
# Sounder Type:
# EK60 Version ComSounder
#
# TS Detection:
# Min. Value -50.0 dB
# Max. Beam Comp. 6.0 dB Min. Echolength 80
%
# Max. Phase Dev. 8.0 Max. Echolength 180
%
#
# Environment:
# Absorption Coeff. 39.8 dB/km Sound Velocity 1453.0
m/s
#
# Beam Model results:
# Transducer Gain = 22.03 dB SaCorrection = -0.31
dB
# Athw. Beam Angle = 6.43 deg Along. Beam Angle = 6.44
deg

```

```

# Athw. Offset Angle =-0.24 deg Along. Offset Angle= 0.17
deg
#
# Data deviation from beam model:
# RMS = 0.26 dB
# Max = 1.00 dB No. = 237 Athw. = 2.9 deg Along = -0.8
deg
# Min = -0.83 dB No. = 279 Athw. = 2.7 deg Along = -3.3
deg
#
# Data deviation from polynomial model:
# RMS = 0.23 dB
# Max = 0.87 dB No. = 237 Athw. = 2.9 deg Along = -0.8
deg
# Min = -0.68 dB No. = 241 Athw. = 3.0 deg Along = -1.8
deg
#
# Data:
# No. Time Distance TS-c TS-u Athw. Along Sa
# [m] [dB] [dB] [deg] [deg]
[m2/nm2]
#
1 23:37:27.65 25.79 -49.01 -49.09 -0.02 -0.20 70
2 23:37:28.66 25.91 -48.22 -48.36 -0.27 -0.32 82
3 23:37:30.66 25.83 -48.53 -48.64 0.16 -0.14 78
* 4 23:37:35.66 25.75 -49.22 -49.39 0.22 -0.20 69
5 23:37:45.66 25.77 -48.52 -48.66 0.22 -0.14 83
6 23:37:48.65 25.77 -48.41 -48.87 0.22 -0.63 79
7 23:37:53.66 25.74 -48.75 -49.25 0.16 -0.69 71
8 23:37:59.66 25.75 -48.29 -49.19 0.59 -0.81 70
9 23:38:01.65 25.75 -48.19 -49.22 0.47 -1.00 70
10 23:38:07.62 25.67 -46.99 -48.21 0.59 -1.06 85
11 23:38:08.62 25.71 -48.25 -50.41 0.53 -1.61 50
12 23:38:20.62 25.73 -48.61 -49.86 0.16 -1.24 56
13 23:38:32.62 25.73 -48.07 -49.49 0.04 -1.36 69
14 23:38:39.62 25.76 -48.56 -49.13 -0.21 -0.81 71
15 23:38:40.62 25.75 -47.84 -48.65 -0.27 -1.00 81
16 23:39:09.60 25.88 -48.66 -50.09 -0.39 -1.36 57
17 23:39:10.59 25.80 -48.84 -51.05 -0.39 -1.73 45
18 23:39:20.59 25.75 -48.45 -51.86 -0.63 -2.16 41
19 23:39:22.59 25.79 -49.15 -51.72 -0.57 -1.85 41
20 23:39:23.60 25.78 -47.73 -50.92 -0.51 -2.10 50
21 23:39:26.59 25.76 -48.14 -52.42 -0.51 -2.46 36
22 23:39:32.59 25.76 -47.55 -53.39 -0.63 -2.89 28
23 23:39:33.59 25.62 -47.95 -53.74 -0.51 -2.89 26
24 23:39:34.59 25.76 -47.95 -53.19 -0.76 -2.71 30
25 23:39:37.60 25.74 -47.33 -54.30 -0.45 -3.20 21
26 23:39:40.59 25.76 -47.14 -56.16 -0.82 -3.63 14
27 23:39:41.59 25.72 -47.21 -54.87 -0.82 -3.32 20
28 23:39:47.59 25.60 -46.99 -58.01 -0.57 -4.05 9
29 23:39:53.59 25.70 -46.89 -56.33 -0.39 -3.75 14
30 23:40:18.56 25.77 -47.40 -54.00 -1.06 -3.01 24
31 23:40:19.56 25.78 -47.87 -53.61 -1.12 -2.77 26
32 23:40:24.56 25.79 -47.78 -54.93 -1.37 -3.07 19
33 23:40:29.55 25.94 -47.00 -55.28 -1.98 -3.14 17
34 23:40:30.56 25.88 -48.53 -54.08 -1.49 -2.59 23
35 23:40:31.56 25.89 -47.20 -54.97 -2.29 -2.83 19
36 23:40:36.55 25.89 -48.09 -54.73 -1.92 -2.71 19
37 23:40:50.55 26.07 -47.82 -55.26 -2.22 -2.77 17
38 23:40:51.56 25.95 -49.00 -54.20 -1.86 -2.28 22
39 23:40:54.56 25.97 -48.26 -56.85 -2.47 -2.95 12

```

|      |             |       |        |        |       |       |    |
|------|-------------|-------|--------|--------|-------|-------|----|
| 40   | 23:40:56.55 | 26.07 | -46.73 | -57.24 | -2.90 | -3.20 | 11 |
| 41   | 23:40:57.55 | 25.99 | -47.02 | -57.10 | -2.90 | -3.07 | 11 |
| * 42 | 23:40:59.56 | 26.10 | -46.81 | -54.55 | -2.53 | -2.65 | 19 |
| 43   | 23:41:06.56 | 26.13 | -47.92 | -55.40 | -2.71 | -2.40 | 16 |
| 44   | 23:41:11.55 | 26.13 | -48.12 | -54.00 | -2.47 | -2.04 | 23 |
| 45   | 23:41:14.56 | 26.13 | -49.13 | -53.87 | -2.35 | -1.67 | 24 |
| 46   | 23:41:19.52 | 26.13 | -48.81 | -53.90 | -2.53 | -1.61 | 24 |
| 47   | 23:41:24.52 | 26.14 | -48.61 | -55.14 | -2.90 | -1.79 | 18 |
| 48   | 23:41:28.52 | 26.28 | -48.42 | -55.09 | -3.02 | -1.67 | 17 |
| 49   | 23:41:31.52 | 26.16 | -49.20 | -57.05 | -3.26 | -1.85 | 11 |
| 50   | 23:41:36.51 | 26.19 | -47.53 | -57.82 | -3.81 | -2.04 | 10 |
| 51   | 23:41:37.52 | 26.17 | -48.87 | -57.89 | -3.45 | -2.10 | 9  |
| 52   | 23:41:45.52 | 26.14 | -48.94 | -56.88 | -3.45 | -1.55 | 11 |
| 53   | 23:41:53.52 | 26.13 | -48.40 | -55.28 | -3.26 | -1.30 | 17 |
| 54   | 23:42:03.52 | 26.24 | -48.64 | -57.92 | -3.88 | -1.30 | 8  |
| 55   | 23:42:04.51 | 26.32 | -49.05 | -54.68 | -2.90 | -1.30 | 18 |
| 56   | 23:42:05.52 | 26.17 | -48.00 | -57.24 | -3.75 | -1.61 | 10 |
| 57   | 23:42:28.48 | 26.11 | -48.44 | -52.87 | -2.16 | -1.73 | 25 |
| 58   | 23:42:29.48 | 25.97 | -47.89 | -51.81 | -1.92 | -1.73 | 38 |
| 59   | 23:42:30.48 | 26.10 | -48.92 | -52.70 | -1.98 | -1.61 | 30 |
| * 60 | 23:42:36.48 | 25.93 | -47.37 | -50.70 | -1.67 | -1.67 | 51 |
| 61   | 23:42:37.48 | 25.93 | -48.49 | -51.90 | -1.55 | -1.79 | 38 |
| 62   | 23:42:42.48 | 25.94 | -48.66 | -51.23 | -1.25 | -1.61 | 46 |
| * 63 | 23:42:46.48 | 25.91 | -47.45 | -50.50 | -1.31 | -1.79 | 54 |
| 64   | 23:42:59.48 | 25.98 | -48.48 | -50.70 | -1.43 | -1.30 | 51 |
| 65   | 23:43:02.48 | 25.95 | -48.93 | -50.61 | -1.25 | -1.12 | 52 |
| 66   | 23:43:07.48 | 26.10 | -48.99 | -50.43 | -1.43 | -0.75 | 48 |
| 67   | 23:43:10.48 | 26.09 | -48.95 | -50.33 | -1.55 | -0.45 | 51 |
| 68   | 23:43:11.48 | 26.09 | -48.82 | -49.98 | -1.31 | -0.63 | 55 |
| 69   | 23:43:20.48 | 26.12 | -48.78 | -50.62 | -1.74 | -0.63 | 50 |
| 70   | 23:43:23.48 | 26.10 | -49.12 | -51.32 | -1.98 | -0.45 | 43 |
| 71   | 23:43:29.45 | 26.27 | -48.92 | -52.20 | -2.41 | -0.51 | 33 |
| 72   | 23:43:30.45 | 26.14 | -48.75 | -52.47 | -2.59 | -0.38 | 32 |
| 73   | 23:43:31.46 | 26.20 | -49.11 | -52.60 | -2.47 | -0.57 | 31 |
| 74   | 23:43:38.46 | 26.32 | -49.26 | -54.29 | -2.96 | -0.63 | 21 |
| 75   | 23:43:39.46 | 26.32 | -49.26 | -54.41 | -3.02 | -0.51 | 21 |
| 76   | 23:43:48.46 | 26.29 | -49.08 | -55.63 | -3.45 | -0.14 | 17 |
| 77   | 23:43:49.45 | 26.35 | -49.15 | -56.50 | -3.57 | -0.69 | 13 |
| 78   | 23:43:51.45 | 26.46 | -48.81 | -57.92 | -4.00 | -0.57 | 9  |
| 79   | 23:43:57.45 | 26.31 | -48.59 | -56.31 | -3.69 | -0.51 | 13 |
| 80   | 23:44:02.45 | 26.51 | -48.55 | -58.49 | -4.18 | -0.51 | 7  |
| 81   | 23:44:03.45 | 26.35 | -49.03 | -57.10 | -3.75 | -0.63 | 10 |
| 82   | 23:44:04.45 | 26.35 | -48.88 | -55.97 | -3.57 | -0.26 | 13 |
| 83   | 23:44:16.45 | 26.46 | -48.99 | -58.62 | -4.12 | 0.78  | 7  |
| 84   | 23:44:25.45 | 26.46 | -49.22 | -57.82 | -3.94 | 0.17  | 9  |
| 85   | 23:44:26.45 | 26.47 | -48.87 | -58.04 | -4.06 | 0.29  | 9  |
| 86   | 23:44:32.41 | 26.35 | -49.20 | -56.48 | -3.63 | 0.29  | 13 |
| 87   | 23:44:33.42 | 26.41 | -48.59 | -55.36 | -3.51 | 0.29  | 16 |
| 88   | 23:44:38.41 | 26.36 | -49.19 | -58.10 | -4.00 | -0.14 | 9  |
| 89   | 23:44:55.42 | 26.30 | -48.73 | -53.06 | -2.84 | 0.29  | 28 |
| 90   | 23:45:00.41 | 26.34 | -49.29 | -54.02 | -2.96 | 0.23  | 23 |
| 91   | 23:45:16.42 | 26.16 | -48.82 | -51.73 | -2.35 | 0.35  | 38 |
| 92   | 23:45:26.41 | 26.16 | -48.38 | -50.39 | -1.98 | 0.29  | 52 |
| 93   | 23:45:35.38 | 26.19 | -49.02 | -50.89 | -1.92 | 0.17  | 46 |
| 94   | 23:45:37.38 | 26.15 | -49.28 | -51.70 | -2.16 | 0.17  | 37 |
| 95   | 23:45:47.37 | 26.13 | -49.13 | -50.41 | -1.61 | 0.29  | 53 |
| 96   | 23:45:58.38 | 25.99 | -49.14 | -49.86 | -1.25 | 0.10  | 59 |
| 97   | 23:46:03.38 | 26.11 | -49.28 | -50.11 | -1.31 | 0.35  | 56 |
| 98   | 23:46:21.38 | 26.02 | -48.95 | -49.27 | -0.88 | 0.10  | 66 |
| 99   | 23:46:22.37 | 25.96 | -49.08 | -49.35 | -0.82 | 0.23  | 67 |
| 100  | 23:46:48.36 | 25.90 | -49.07 | -49.07 | -0.21 | 0.10  | 73 |

|      |             |       |        |        |       |      |    |
|------|-------------|-------|--------|--------|-------|------|----|
| *101 | 23:46:58.35 | 25.90 | -49.28 | -49.29 | -0.21 | 0.23 | 69 |
| 102  | 23:47:13.35 | 26.09 | -49.00 | -49.42 | -0.08 | 0.96 | 65 |
| 103  | 23:47:19.35 | 25.93 | -49.06 | -49.85 | -0.21 | 1.27 | 56 |
| 104  | 23:47:20.35 | 25.98 | -48.78 | -49.66 | -0.27 | 1.33 | 62 |
| 105  | 23:47:32.35 | 25.98 | -48.96 | -49.96 | -0.76 | 1.27 | 58 |
| 106  | 23:47:39.35 | 26.10 | -49.28 | -50.29 | -0.63 | 1.33 | 52 |
| 107  | 23:48:18.32 | 26.13 | -49.18 | -50.66 | -1.25 | 1.27 | 50 |
| 108  | 23:48:19.31 | 26.16 | -49.26 | -51.27 | -1.49 | 1.39 | 45 |
| 109  | 23:48:28.31 | 26.29 | -49.27 | -51.88 | -1.92 | 1.27 | 35 |
| 110  | 23:48:37.31 | 26.32 | -49.14 | -53.16 | -2.53 | 1.21 | 28 |
| 111  | 23:48:43.31 | 26.40 | -49.07 | -55.24 | -3.14 | 1.39 | 17 |
| 112  | 23:48:44.28 | 26.46 | -48.73 | -55.18 | -3.26 | 1.27 | 16 |
| 113  | 23:48:50.28 | 26.50 | -49.09 | -56.40 | -3.45 | 1.39 | 13 |
| 114  | 23:49:19.28 | 26.63 | -49.14 | -60.50 | -4.24 | 1.88 | 5  |
| 115  | 23:49:29.27 | 26.50 | -48.45 | -56.47 | -3.63 | 1.39 | 12 |
| 116  | 23:49:33.28 | 26.62 | -48.84 | -57.47 | -3.63 | 1.82 | 10 |
| 117  | 23:49:41.28 | 26.47 | -49.29 | -56.13 | -3.20 | 1.69 | 14 |
| 118  | 23:49:53.25 | 26.47 | -48.92 | -53.90 | -2.35 | 2.06 | 21 |
| 119  | 23:49:58.25 | 26.47 | -49.11 | -53.55 | -2.29 | 1.88 | 23 |
| 120  | 23:50:01.25 | 26.47 | -48.92 | -53.95 | -2.47 | 1.94 | 22 |
| 121  | 23:50:10.26 | 26.31 | -48.81 | -52.59 | -1.86 | 2.00 | 31 |
| 122  | 23:50:28.25 | 26.10 | -49.29 | -51.27 | -0.57 | 1.88 | 44 |
| 123  | 23:50:31.26 | 26.06 | -49.01 | -51.23 | -0.51 | 2.00 | 42 |
| 124  | 23:50:42.25 | 26.08 | -49.07 | -51.38 | -0.27 | 2.06 | 41 |
| 125  | 23:50:43.25 | 25.96 | -48.82 | -50.83 | -0.15 | 1.94 | 47 |
| 126  | 23:50:45.25 | 25.97 | -49.29 | -51.26 | 0.22  | 1.88 | 44 |
| 127  | 23:50:50.25 | 25.95 | -48.16 | -50.93 | -0.08 | 2.24 | 45 |
| 128  | 23:50:55.21 | 26.10 | -48.93 | -52.55 | -0.02 | 2.55 | 31 |
| 129  | 23:50:58.22 | 26.06 | -48.59 | -53.40 | -0.02 | 2.92 | 25 |
| 130  | 23:51:09.21 | 25.97 | -49.09 | -53.49 | -0.33 | 2.79 | 25 |
| 131  | 23:51:10.21 | 25.97 | -48.79 | -54.03 | -0.33 | 3.04 | 22 |
| 132  | 23:51:11.21 | 25.97 | -48.09 | -54.29 | -0.45 | 3.28 | 21 |
| 133  | 23:51:19.22 | 25.92 | -48.44 | -55.50 | -0.76 | 3.47 | 15 |
| 134  | 23:51:20.22 | 25.94 | -49.07 | -57.25 | -0.88 | 3.71 | 11 |
| 135  | 23:51:21.21 | 25.97 | -48.36 | -57.56 | -1.12 | 3.90 | 10 |
| 136  | 23:51:25.21 | 25.96 | -48.67 | -59.52 | -1.61 | 4.14 | 7  |
| 137  | 23:51:28.21 | 25.79 | -49.27 | -58.71 | -1.61 | 3.83 | 8  |
| 138  | 23:51:34.21 | 25.92 | -48.40 | -57.98 | -1.25 | 3.96 | 9  |
| 139  | 23:51:36.21 | 25.93 | -48.81 | -56.73 | -1.43 | 3.53 | 11 |
| 140  | 23:51:38.21 | 25.92 | -49.09 | -55.67 | -1.49 | 3.16 | 15 |
| 141  | 23:51:39.21 | 25.91 | -48.95 | -56.60 | -1.19 | 3.53 | 12 |
| 142  | 23:51:46.21 | 25.76 | -48.80 | -53.76 | -1.37 | 2.73 | 24 |
| 143  | 23:51:47.22 | 25.80 | -49.09 | -53.90 | -1.25 | 2.73 | 25 |
| 144  | 23:51:57.17 | 25.80 | -48.64 | -54.42 | -1.80 | 2.79 | 21 |
| 145  | 23:52:11.17 | 25.96 | -48.86 | -57.01 | -2.77 | 2.86 | 10 |
| 146  | 23:52:19.18 | 25.97 | -48.45 | -57.65 | -3.08 | 2.92 | 9  |
| 147  | 23:52:21.18 | 25.94 | -48.32 | -56.45 | -2.84 | 2.79 | 12 |
| 148  | 23:52:44.17 | 26.10 | -49.12 | -60.14 | -3.02 | 3.53 | 6  |
| 149  | 23:52:53.17 | 26.26 | -49.08 | -56.49 | -2.41 | 2.92 | 12 |
| 150  | 23:52:59.17 | 26.29 | -48.86 | -53.48 | -1.92 | 2.31 | 24 |
| 151  | 23:53:25.14 | 26.23 | -49.13 | -53.06 | -1.61 | 2.24 | 27 |
| 152  | 23:53:32.14 | 26.14 | -49.00 | -52.66 | -1.19 | 2.37 | 32 |
| 153  | 23:53:40.14 | 26.13 | -49.21 | -52.21 | -0.82 | 2.24 | 34 |
| 154  | 23:54:03.14 | 25.93 | -49.03 | -52.20 | 0.22  | 2.37 | 36 |
| 155  | 23:54:11.11 | 25.85 | -48.65 | -52.43 | 0.40  | 2.55 | 32 |
| 156  | 23:54:30.11 | 25.78 | -48.80 | -53.56 | 0.40  | 2.86 | 27 |
| 157  | 23:54:36.11 | 25.74 | -48.72 | -54.64 | -0.02 | 3.22 | 21 |
| 158  | 23:54:45.11 | 25.74 | -48.54 | -54.55 | 0.28  | 3.22 | 20 |
| 159  | 23:54:54.11 | 25.73 | -47.89 | -56.02 | 0.47  | 3.71 | 14 |
| 160  | 23:55:00.11 | 25.71 | -48.64 | -56.62 | 0.16  | 3.71 | 13 |
| 161  | 23:55:03.11 | 25.61 | -48.53 | -57.28 | 0.59  | 3.83 | 11 |

|     |             |       |        |        |      |       |    |
|-----|-------------|-------|--------|--------|------|-------|----|
| 162 | 23:55:10.07 | 25.56 | -48.99 | -55.51 | 0.71 | 3.28  | 14 |
| 163 | 23:55:13.07 | 25.58 | -47.91 | -57.02 | 1.02 | 3.83  | 12 |
| 164 | 23:55:15.08 | 25.61 | -48.91 | -56.68 | 1.20 | 3.47  | 13 |
| 165 | 23:55:20.07 | 25.58 | -48.65 | -58.61 | 1.02 | 4.02  | 9  |
| 166 | 23:55:21.08 | 25.54 | -48.75 | -58.05 | 1.38 | 3.77  | 10 |
| 167 | 23:55:25.07 | 25.62 | -47.89 | -57.58 | 0.71 | 4.02  | 10 |
| 168 | 23:55:38.07 | 25.54 | -48.20 | -53.59 | 1.08 | 2.86  | 27 |
| 169 | 23:55:40.07 | 25.59 | -49.03 | -55.04 | 0.65 | 3.16  | 19 |
| 170 | 23:55:45.07 | 25.57 | -48.88 | -53.79 | 0.83 | 2.79  | 26 |
| 171 | 23:55:52.07 | 25.56 | -48.75 | -53.37 | 1.08 | 2.61  | 27 |
| 172 | 23:56:01.07 | 25.56 | -48.80 | -53.56 | 1.51 | 2.43  | 28 |
| 173 | 23:56:04.08 | 25.56 | -48.95 | -53.52 | 1.57 | 2.31  | 27 |
| 174 | 23:56:05.08 | 25.61 | -48.44 | -53.06 | 1.75 | 2.18  | 30 |
| 175 | 23:56:09.07 | 25.58 | -49.11 | -53.19 | 1.69 | 2.00  | 28 |
| 176 | 23:56:28.03 | 25.60 | -48.12 | -51.25 | 1.63 | 1.57  | 45 |
| 177 | 23:56:37.04 | 25.58 | -49.06 | -51.28 | 1.44 | 1.21  | 46 |
| 178 | 23:56:39.04 | 25.55 | -48.49 | -50.34 | 1.44 | 0.84  | 57 |
| 179 | 23:56:50.04 | 25.57 | -48.33 | -51.01 | 1.87 | 0.72  | 50 |
| 180 | 23:56:52.04 | 25.58 | -48.86 | -51.56 | 1.93 | 0.47  | 43 |
| 181 | 23:56:54.03 | 25.59 | -49.22 | -52.56 | 2.18 | 0.41  | 33 |
| 182 | 23:56:58.04 | 25.64 | -48.22 | -52.06 | 2.36 | 0.04  | 37 |
| 183 | 23:56:59.04 | 25.71 | -48.01 | -52.43 | 2.54 | -0.02 | 33 |
| 184 | 23:57:10.04 | 25.57 | -48.75 | -54.90 | 3.03 | 0.04  | 20 |
| 185 | 23:57:17.01 | 25.55 | -47.67 | -54.81 | 3.28 | 0.04  | 21 |
| 186 | 23:57:24.01 | 25.43 | -47.07 | -55.81 | 3.65 | 0.04  | 16 |
| 187 | 23:57:28.01 | 25.41 | -48.22 | -56.96 | 3.65 | 0.23  | 12 |
| 188 | 23:57:29.00 | 25.41 | -48.64 | -56.82 | 3.52 | 0.23  | 12 |
| 189 | 23:57:34.01 | 25.40 | -48.24 | -55.18 | 3.22 | 0.53  | 18 |
| 190 | 23:57:35.01 | 25.40 | -48.74 | -55.00 | 3.03 | 0.59  | 20 |
| 191 | 23:57:39.01 | 25.40 | -48.78 | -54.02 | 2.73 | 0.78  | 25 |
| 192 | 23:57:42.01 | 25.35 | -48.68 | -54.13 | 2.73 | 1.02  | 24 |
| 193 | 23:57:44.01 | 25.36 | -48.94 | -53.44 | 2.42 | 1.08  | 29 |
| 194 | 23:57:45.01 | 25.36 | -47.61 | -52.41 | 2.42 | 1.33  | 35 |
| 195 | 23:57:50.00 | 25.24 | -48.26 | -52.28 | 2.06 | 1.51  | 36 |
| 196 | 23:57:52.01 | 25.21 | -47.62 | -51.62 | 1.87 | 1.76  | 38 |
| 197 | 23:58:07.01 | 25.36 | -48.87 | -54.24 | 1.81 | 2.43  | 22 |
| 198 | 23:58:13.01 | 25.38 | -48.94 | -55.75 | 1.81 | 2.92  | 17 |
| 199 | 23:58:15.01 | 25.36 | -48.71 | -55.27 | 1.69 | 2.92  | 19 |
| 200 | 23:58:16.01 | 25.37 | -47.98 | -56.16 | 1.87 | 3.28  | 15 |
| 201 | 23:58:24.05 | 25.38 | -48.89 | -56.74 | 1.57 | 3.35  | 13 |
| 202 | 23:58:34.06 | 25.40 | -48.02 | -56.14 | 2.30 | 2.98  | 14 |
| 203 | 23:58:35.06 | 25.53 | -48.26 | -55.47 | 2.30 | 2.67  | 16 |
| 204 | 23:58:39.06 | 25.43 | -49.18 | -56.23 | 2.48 | 2.43  | 14 |
| 205 | 23:58:40.06 | 25.44 | -48.59 | -55.68 | 2.54 | 2.37  | 16 |
| 206 | 23:58:43.05 | 25.57 | -48.91 | -57.02 | 2.91 | 2.31  | 12 |
| 207 | 23:58:46.06 | 25.55 | -48.18 | -56.42 | 3.16 | 1.94  | 14 |
| 208 | 23:58:47.06 | 25.55 | -48.34 | -56.95 | 3.28 | 1.88  | 12 |
| 209 | 23:58:52.06 | 25.61 | -48.69 | -57.57 | 3.46 | 1.57  | 11 |
| 210 | 23:58:54.06 | 25.61 | -47.53 | -57.48 | 3.71 | 1.57  | 10 |
| 211 | 23:58:55.06 | 25.64 | -48.01 | -57.05 | 3.58 | 1.27  | 11 |
| 212 | 23:58:57.05 | 25.72 | -49.07 | -59.51 | 3.89 | 1.27  | 6  |
| 213 | 23:58:59.06 | 25.73 | -47.73 | -58.76 | 4.01 | 1.27  | 8  |
| 214 | 23:59:00.06 | 25.61 | -48.18 | -58.62 | 3.95 | 0.90  | 8  |
| 215 | 23:59:02.06 | 25.74 | -48.88 | -60.24 | 4.13 | 0.90  | 5  |
| 216 | 23:59:14.06 | 25.76 | -48.26 | -56.60 | 3.52 | 0.72  | 14 |
| 217 | 23:59:19.05 | 25.78 | -48.74 | -55.95 | 3.22 | 0.96  | 15 |
| 218 | 23:59:29.02 | 25.92 | -48.82 | -53.07 | 2.42 | 0.78  | 30 |
| 219 | 23:59:49.02 | 26.08 | -49.13 | -50.86 | 1.32 | 0.96  | 47 |
| 220 | 00:00:00.01 | 26.07 | -49.12 | -50.48 | 1.20 | 0.78  | 52 |
| 221 | 00:00:06.01 | 25.96 | -48.88 | -50.25 | 1.32 | 0.41  | 56 |
| 222 | 00:00:07.01 | 25.94 | -48.51 | -49.95 | 1.38 | 0.29  | 61 |

|     |             |       |        |        |      |       |    |
|-----|-------------|-------|--------|--------|------|-------|----|
| 223 | 00:00:13.01 | 25.94 | -48.65 | -49.40 | 0.83 | 0.65  | 66 |
| 224 | 00:00:20.01 | 25.91 | -48.86 | -49.72 | 0.47 | 1.14  | 60 |
| 225 | 00:00:24.02 | 25.78 | -49.19 | -50.18 | 0.04 | 1.39  | 55 |
| 226 | 00:00:33.98 | 25.73 | -49.28 | -50.75 | 0.22 | 1.63  | 50 |
| 227 | 00:00:36.98 | 25.74 | -48.86 | -50.46 | 0.59 | 1.57  | 53 |
| 228 | 00:00:44.98 | 25.71 | -48.28 | -50.45 | 1.08 | 1.57  | 53 |
| 229 | 00:00:57.98 | 25.58 | -49.15 | -51.83 | 1.20 | 1.76  | 41 |
| 230 | 00:01:24.98 | 25.74 | -47.99 | -53.20 | 2.30 | 1.82  | 29 |
| 231 | 00:01:34.98 | 25.72 | -48.58 | -54.50 | 2.54 | 1.82  | 20 |
| 232 | 00:01:35.96 | 25.72 | -48.54 | -54.66 | 2.73 | 1.57  | 19 |
| 233 | 00:01:38.95 | 25.71 | -49.11 | -56.16 | 2.97 | 1.63  | 13 |
| 234 | 00:02:06.95 | 25.57 | -49.08 | -57.92 | 2.18 | 3.28  | 10 |
| 235 | 00:03:11.92 | 25.58 | -49.21 | -54.46 | 2.79 | 0.23  | 21 |
| 236 | 00:03:15.91 | 25.57 | -49.11 | -54.66 | 2.85 | -0.26 | 21 |
| 237 | 00:03:21.91 | 25.55 | -46.15 | -52.32 | 2.91 | -0.81 | 35 |
| 238 | 00:03:25.92 | 25.55 | -48.16 | -55.20 | 3.09 | -1.00 | 18 |
| 239 | 00:03:27.91 | 25.58 | -48.68 | -54.33 | 2.73 | -0.93 | 23 |
| 240 | 00:03:34.91 | 25.58 | -47.93 | -54.88 | 2.91 | -1.42 | 18 |
| 241 | 00:03:37.92 | 25.52 | -49.12 | -56.95 | 2.97 | -1.79 | 12 |
| 242 | 00:03:42.91 | 25.55 | -47.96 | -55.29 | 2.79 | -1.85 | 17 |
| 243 | 00:03:44.88 | 25.55 | -48.56 | -56.98 | 2.91 | -2.16 | 12 |
| 244 | 00:03:47.88 | 25.42 | -47.41 | -57.01 | 3.03 | -2.46 | 11 |
| 245 | 00:03:55.88 | 25.54 | -46.98 | -55.61 | 2.79 | -2.40 | 16 |
| 246 | 00:03:57.88 | 25.55 | -47.01 | -55.09 | 2.48 | -2.52 | 18 |
| 247 | 00:03:59.88 | 25.52 | -48.93 | -56.49 | 2.42 | -2.40 | 13 |
| 248 | 00:04:02.88 | 25.57 | -47.94 | -55.20 | 2.24 | -2.46 | 18 |
| 249 | 00:04:05.88 | 25.56 | -47.49 | -53.57 | 1.81 | -2.40 | 27 |
| 250 | 00:04:06.88 | 25.59 | -47.37 | -54.08 | 1.93 | -2.52 | 24 |
| 251 | 00:04:11.88 | 25.60 | -47.29 | -53.39 | 1.63 | -2.52 | 27 |
| 252 | 00:04:13.88 | 25.60 | -48.80 | -54.56 | 1.32 | -2.59 | 20 |
| 253 | 00:04:17.88 | 25.74 | -47.15 | -52.25 | 1.26 | -2.40 | 34 |
| 254 | 00:04:25.88 | 25.71 | -48.07 | -51.79 | 0.89 | -2.10 | 38 |
| 255 | 00:04:26.88 | 25.59 | -47.51 | -50.70 | 0.71 | -1.97 | 50 |
| 256 | 00:04:34.88 | 25.70 | -48.07 | -50.66 | 0.53 | -1.79 | 52 |
| 257 | 00:04:35.88 | 25.59 | -49.00 | -51.35 | 0.59 | -1.67 | 45 |
| 258 | 00:04:55.85 | 25.60 | -49.11 | -50.29 | 1.02 | -0.63 | 56 |
| 259 | 00:05:08.85 | 25.57 | -47.01 | -48.98 | 1.44 | -0.69 | 79 |
| 260 | 00:05:16.85 | 25.72 | -47.25 | -50.83 | 1.87 | -1.24 | 45 |
| 261 | 00:05:18.85 | 25.70 | -46.99 | -49.80 | 1.69 | -1.00 | 59 |
| 262 | 00:05:19.85 | 25.72 | -48.48 | -52.73 | 2.06 | -1.36 | 28 |
| 263 | 00:05:20.85 | 25.61 | -48.39 | -53.73 | 2.30 | -1.61 | 25 |
| 264 | 00:05:23.85 | 25.71 | -48.20 | -54.37 | 2.54 | -1.67 | 22 |
| 265 | 00:05:26.85 | 25.70 | -47.46 | -53.40 | 2.42 | -1.73 | 27 |
| 266 | 00:05:36.85 | 25.72 | -47.26 | -57.57 | 3.40 | -2.22 | 10 |
| 267 | 00:05:43.85 | 25.59 | -46.54 | -58.40 | 3.65 | -2.46 | 9  |
| 268 | 00:05:44.85 | 25.72 | -48.45 | -57.51 | 3.28 | -1.85 | 10 |
| 269 | 00:05:47.85 | 25.73 | -48.14 | -56.76 | 3.28 | -1.61 | 12 |
| 270 | 00:05:56.81 | 25.70 | -48.00 | -56.30 | 3.34 | -1.24 | 14 |
| 271 | 00:05:58.82 | 25.63 | -47.64 | -55.27 | 3.28 | -0.87 | 18 |
| 272 | 00:06:01.81 | 25.69 | -46.85 | -56.73 | 3.71 | -1.24 | 12 |
| 273 | 00:06:08.81 | 25.57 | -46.46 | -58.44 | 4.13 | -1.30 | 9  |
| 274 | 00:06:15.81 | 25.62 | -47.72 | -59.55 | 4.07 | -1.42 | 7  |
| 275 | 00:06:18.82 | 25.60 | -47.66 | -58.83 | 3.95 | -1.36 | 8  |
| 276 | 00:06:28.81 | 25.62 | -46.72 | -58.29 | 3.83 | -1.97 | 9  |
| 277 | 00:07:18.78 | 25.62 | -48.84 | -60.44 | 3.03 | -3.14 | 5  |
| 278 | 00:07:20.78 | 25.64 | -48.76 | -60.24 | 2.85 | -3.26 | 5  |
| 279 | 00:07:21.78 | 25.66 | -49.29 | -60.43 | 2.73 | -3.26 | 5  |
| 280 | 00:07:25.78 | 25.59 | -48.71 | -58.23 | 2.36 | -3.07 | 8  |
| 281 | 00:07:26.78 | 25.60 | -47.94 | -58.57 | 2.24 | -3.44 | 8  |
| 282 | 00:07:32.78 | 25.60 | -49.26 | -58.29 | 1.81 | -3.26 | 8  |
| 283 | 00:07:33.78 | 25.61 | -47.99 | -57.03 | 2.06 | -3.14 | 12 |

|     |             |       |        |        |       |       |    |
|-----|-------------|-------|--------|--------|-------|-------|----|
| 284 | 00:07:40.78 | 25.75 | -49.08 | -56.62 | 1.63  | -2.95 | 13 |
| 285 | 00:07:47.78 | 25.77 | -48.87 | -56.36 | 1.14  | -3.14 | 14 |
| 286 | 00:07:50.78 | 25.76 | -48.42 | -53.62 | 0.89  | -2.59 | 26 |
| 287 | 00:08:02.75 | 25.75 | -47.91 | -53.89 | 0.83  | -2.83 | 23 |
| 288 | 00:08:06.75 | 25.73 | -48.51 | -55.17 | 0.53  | -3.07 | 16 |
| 289 | 00:08:07.75 | 25.61 | -48.52 | -56.04 | 0.95  | -3.20 | 14 |
| 290 | 00:08:08.75 | 25.59 | -48.68 | -56.85 | 0.83  | -3.38 | 12 |
| 291 | 00:08:11.74 | 25.67 | -48.01 | -57.61 | 0.89  | -3.69 | 9  |
| 292 | 00:08:15.75 | 25.60 | -48.12 | -58.70 | 0.65  | -3.93 | 8  |
| 293 | 00:08:16.75 | 25.57 | -48.19 | -58.14 | 0.95  | -3.75 | 7  |
| 294 | 00:08:38.75 | 25.61 | -48.88 | -53.91 | 0.47  | -2.65 | 23 |
| 295 | 00:10:29.68 | 25.22 | -48.92 | -49.42 | 0.71  | -0.14 | 68 |
| 296 | 00:12:17.61 | 25.21 | -48.87 | -50.79 | -1.00 | 1.69  | 52 |
| 297 | 00:12:22.62 | 25.21 | -49.19 | -50.58 | -1.00 | 1.39  | 55 |
| 298 | 00:12:28.62 | 25.16 | -48.82 | -49.45 | -0.82 | 0.90  | 72 |
| 299 | 00:12:34.61 | 25.07 | -49.26 | -49.85 | -1.00 | 0.65  | 66 |
| 300 | 00:12:56.62 | 24.94 | -49.11 | -49.20 | 0.22  | 0.23  | 74 |

## Event Log

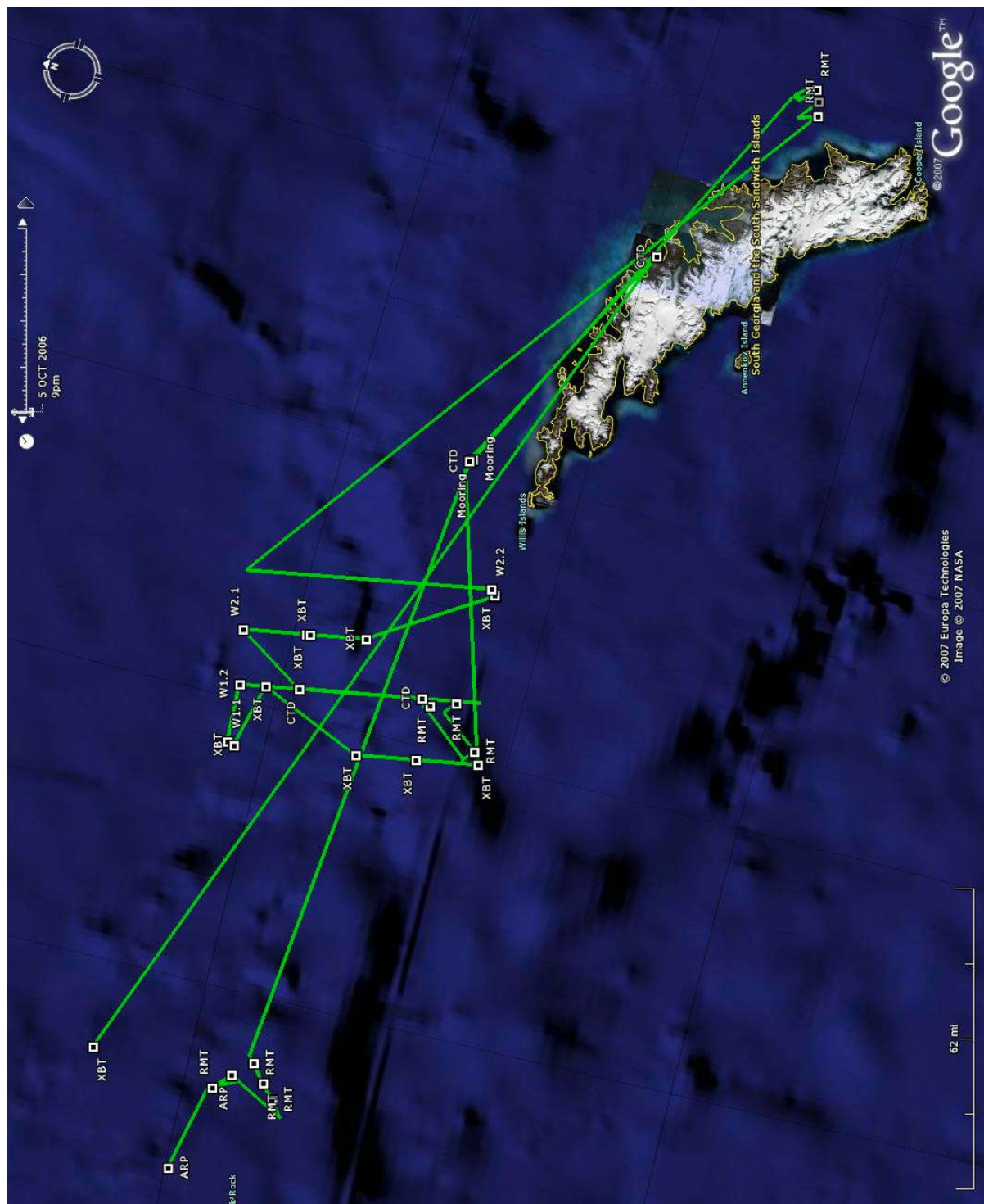
| Time             | Event | Lat       | Lon       | Comment  |
|------------------|-------|-----------|-----------|--|
| 05/10/2006 20:48 | 1     | -53.15117 | -41.21994 | Test XBT deployed  |
| 06/10/2006 17:57 | 1     | -54.15887 | -36.69725 | Test CTD deployed for calibration  |
| 06/10/2006 18:07 | 2     | -54.15886 | -36.69726 | CTD recovered  |
| 12/10/2006 20:08 | 3     | -53.79976 | -37.93687 | Vessel On DP 300m north of shallow mooring                               |
| 12/10/2006 20:11 | 3     | -53.79977 | -37.93686 | Buoy Released  |
| 12/10/2006 20:13 | 3     | -53.79976 | -37.93688 | Buoy on the surface and sighted, transponder recovered                   |
| 12/10/2006 20:25 | 3     | -53.80318 | -37.93741 | mooring grapnelled   |
| 12/10/2006 20:45 | 3     | -53.80118 | -37.94591 | Mooring release hook recovered   |
| 12/10/2006 20:51 | 3     | -53.80042 | -37.94759 | Mooring recovered to deck  |
| 12/10/2006 21:38 | 3     | -53.78827 | -37.94339 | deck secure moving off station   |
| 13/10/2006 08:57 | 4     | -54.05599 | -39.39183 | XBT Deployed. Commence Western Core Box @ W1.1S                          |
| 13/10/2006 10:04 | 5     | -53.87647 | -39.44557 | XBT Deployed   |
| 13/10/2006 11:11 | 6     | -53.70197 | -39.49702 | XBT Deployed   |
| 13/10/2006 12:17 | 7     | -53.39572 | -39.28019 | XBT Deployed   |
| 13/10/2006 13:20 | 8     | -53.3486  | -39.60116 | XBT Deployed   |
| 13/10/2006 13:30 |       | -53.32765 | -39.59055 | Transect 1.1 Complete  |
| 13/10/2006 14:38 |       | -53.32043 | -39.30306 | Commence Transect 1.2  |
| 13/10/2006 18:55 |       | -54.02219 | -39.0894  | End of transect 1.2 - A/C to run back up transect for RMT target fishing |
| 13/10/2006 19:30 | 9     | -53.95644 | -39.10923 | Slowing for RMT deployment   |
| 13/10/2006 19:33 | 9     | -53.95288 | -39.11344 | Bridge ready to deploy   |
| 13/10/2006 19:41 | 9     | -53.94956 | -39.12328 | Deploying RMT  |
| 13/10/2006 19:43 | 9     | -53.94847 | -39.12596 | RMT Deployed   |
| 13/10/2006 19:59 | 9     | -53.92261 | -39.18206 | RMT @ 346m   |
| 13/10/2006 20:23 | 9     | -53.9225  | -39.18216 | RMT @ Surface  |
| 13/10/2006 20:27 | 9     | -53.92413 | -39.17934 | RMT Recovered  |
| 13/10/2006 20:37 | 9     | -53.92174 | -39.18251 | Moving off station   |
| 13/10/2006 22:00 | 10    | -54.04002 | -39.33141 | Slowing for RMT deployment   |
| 13/10/2006 22:02 | 10    | -54.03667 | -39.3317  | Bridge ready to deploy   |
| 13/10/2006 22:03 | 10    | -54.03629 | -39.33313 | Deploying RMT  |
| 13/10/2006 22:05 | 10    | -54.03554 | -39.33548 | RMT Deployed   |
| 13/10/2006 22:28 | 10    | -54.00776 | -39.39238 | RMT @ 505m   |



|                  |    |   |
|------------------|----|---|
| 13/10/2006 22:53 | 10 | -54.00703 -39.39399 RMT @ Surface   |
| 13/10/2006 22:58 | 10 | -54.01252 -39.38231 RMT Recovered   |
| 14/10/2006 00:42 | 11 | -53.86781 -39.18566 Slowing for RMT deployment                                |
| 14/10/2006 01:03 | 11 | -53.86717 -39.18652 Clear to deploy RMT                                       |
| 14/10/2006 01:06 | 11 | -53.87632 -39.16812 RMT Deployed  |
| 14/10/2006 01:17 | 11 | -53.8655 -39.18818 Commence Recovery of RMT                                   |
| 14/10/2006 01:18 | 11 | -53.86426 -39.18871 RMT @ Surface   |
| 14/10/2006 01:23 | 11 | -53.86382 -39.18838 RMT Recovered   |
| 14/10/2006 01:29 | 11 | -53.86354 -39.18785 Moving off station  |
| 14/10/2006 01:50 | 12 | -53.84789 -39.1417 Slowing for CTD Deployment                                 |
| 14/10/2006 02:05 | 12 | -53.84789 -39.14169 On Station  |
| 14/10/2006 02:21 | 12 | -53.84788 -39.14169 Clear to deploy CTD                                       |
| 14/10/2006 02:23 | 12 | -53.84791 -39.14168 CTD deployed  |
| 14/10/2006 02:41 | 12 | -53.8479 -39.14169 CTD recovered  |
| 14/10/2006 02:51 |    | -53.84479 -39.14473 Vessel moving off station                                 |
| 14/10/2006 05:00 | 13 | -53.50529 -39.24487 commence slowing for CTD station                          |
| 14/10/2006 05:02 | 13 | -53.50101 -39.24712 Bow thruster problem                                      |
| 14/10/2006 05:20 | 13 | -53.49321 -39.25096 bow thruster problem resolved                             |
| 14/10/2006 05:24 | 13 | -53.49283 -39.25065 V/L on station for CTD deployment                         |
| 14/10/2006 05:28 | 13 | -53.49282 -39.25068 CTD 1.2N deployed   |
| 14/10/2006 05:49 | 13 | -53.4928 -39.25073 CTD @ depth 1000m  |
| 14/10/2006 06:07 | 13 | -53.49278 -39.25105 CTD recovered   |
| 14/10/2006 06:19 |    | -53.49237 -39.25119 vessel off station, proceeding to start of 2.1            |
| 14/10/2006 09:00 | 14 | -53.28905 -39.03752 Commence Transect W2.1N @ 10.0kts                         |
| 14/10/2006 10:02 | 15 | -53.48366 -38.97845 XBT Deployed  |
| 14/10/2006 10:03 | 15 | -53.48442 -38.97817 XBT Aborted   |
| 14/10/2006 10:05 | 16 | -53.47248 -38.982 XBT Deployed  |
| 14/10/2006 11:07 | 17 | -53.64552 -38.92816 XBT Deployed  |
| 14/10/2006 12:10 | 18 | -53.97699 -38.55799 XBT Deployed  |
| 14/10/2006 13:14 | 19 | -53.97613 -38.5523 XBT Deployed   |
| 14/10/2006 14:25 |    | -53.96219 -38.52707 Commence Transect W2.2N@ 10kt<br>Complete Transect W2.2N, |
| 14/10/2006 19:36 |    | -53.25461 -38.75209 Proceeding to Royal Bay due to Adverse weather conditions |
| 15/10/2006 09:30 | 20 | -54.49797 -35.75695 Slowing for RMT deployment                                |
| 15/10/2006 09:36 | 20 | -54.49792 -35.76329 Bridge ready to deploy                                    |
| 15/10/2006 09:42 | 20 | -54.4932 -35.76705 Deploying RMT  |
| 15/10/2006 09:53 | 20 | -54.48405 -35.77417 RMT @ 65m   |
| 15/10/2006 10:38 | 20 | -54.44842 -35.7999 RMT @ Surface  |
| 15/10/2006 10:42 | 20 | -54.44562 -35.80215 RMT Recovered   |
| 15/10/2006 10:50 | 20 | -54.43965 -35.80737 deck secure moving off station                            |
| 15/10/2006 11:33 | 21 | -54.48486 -35.69377 Clear to deploy RMT                                       |
| 15/10/2006 11:36 | 21 | -54.48264 -35.69473 RMT Deployed  |
| 15/10/2006 12:23 | 21 | -54.40784 -35.70721 RMT at Depth  |
| 15/10/2006 12:53 | 21 | -54.42908 -35.71777 Commence Recovery of RMT                                  |
| 15/10/2006 12:56 | 21 | -54.42684 -35.71877 RMT Recovered   |
| 15/10/2006 13:46 | 21 | -54.47255 -35.63159 V/L head to wind and 2Kts through the water               |
| 15/10/2006 13:56 | 21 | -54.46627 -35.63808 RMT Deployed  |
| 15/10/2006 14:41 | 21 | -54.43736 -35.65938 Commence Recovery of RMT                                  |
| 15/10/2006 14:45 | 21 | -54.43488 -35.6608 RMT Recovered  |
| 15/10/2006 15:10 | 21 | -54.40784 -35.70721   |

|                  |                        |  |   |
|------------------|------------------------|--|---|
|                  |                        |  | V/L on station 0.5nm downwind of mooring site.                            |
| 16/10/2006 17:09 | -53.81139 -37.92998    |  | Evaluating suitability of conditions for deployment                       |
|                  |                        |  | Commence deployment of shallow water mooring –                            |
| 16/10/2006 18:47 | -53.80924 -37.92898    |  | Commence moving ahead at 1 knot   |
| 16/10/2006 18:50 | 22 -53.80848 -37.92997 |  | Buoy deployed   |
| 16/10/2006 18:52 | -53.80809 -37.9306     |  | Releases deployed   |
| 16/10/2006 19:19 | 22 -53.80242 -37.93854 |  | Mooring Released, water depth 319m  |
| 16/10/2006 19:33 | 23 -53.79953 -37.94261 |  | Vessel on DP 500m upwind of mooring reday to deploy ctd                   |
| 16/10/2006 19:43 | 23 -53.79951 -37.94274 |  | CTD deployed  |
| 16/10/2006 19:50 | 23 -53.7995 -37.94272  |  | CTD stopped @ 303m  |
| 16/10/2006 19:59 | 23 -53.79953 -37.94271 |  | CTD recovered   |
| 16/10/2006 20:13 | 24 -53.79946 -37.94272 |  | commence deployment of Whale Listening buoy                               |
| 16/10/2006 20:15 | 24 -53.79949 -37.94273 |  | Whale Listening buoy deployed in 318m                                     |
| 16/10/2006 20:40 | 25 -53.80283 -37.9376  |  | Vessel on DP over Shallow mooring site                                    |
| 16/10/2006 21:21 | 25 -53.8028 -37.93765  |  | Vessel moving off station   |
| 17/10/2006 09:00 | 26 -53.60921 -41.07897 |  | Vessel head to wind @ 2.5 Kts, assessing weather for RMT deployment       |
| 17/10/2006 09:28 | 26 -53.62231 -41.10645 |  | Deploying RMT   |
| 17/10/2006 09:35 | 26 -53.62529 -41.11308 |  | RMT Deployed  |
| 17/10/2006 09:43 | 26 -53.62965 -41.12149 |  | RMT @ 32m   |
| 17/10/2006 10:11 | 26 -53.64213 -41.14929 |  | RMT @ 43m   |
| 17/10/2006 10:40 | 26 -53.65464 -41.17896 |  | recovering RMT  |
| 17/10/2006 10:43 | 26 -53.65621 -41.18192 |  | RMT @ Surface   |
| 17/10/2006 10:49 | 26 -53.65962 -41.18791 |  | RMT Recovered   |
| 17/10/2006 10:58 | 27 -53.66381 -41.1962  |  | Deploying RMT   |
| 17/10/2006 11:02 | 27 -53.6658 -41.19996  |  | RMT Deployed  |
| 17/10/2006 12:06 | 27 -53.69624 -41.25914 |  | Commence Recovery of RMT  |
| 17/10/2006 12:14 | 27 -53.69927 -41.26579 |  | RMT on deck   |
| 17/10/2006 12:22 | 28 -53.70205 -41.27225 |  | RMT Deployed  |
| 17/10/2006 13:39 | 28 -53.73552 -41.34646 |  | Commence Recovery of RMT  |
| 17/10/2006 13:45 | 28 -53.73875 -41.35231 |  | RMT on deck   |
| 17/10/2006 15:04 | -53.56922 -41.19658    |  | V/L on DP awaiting deployment of whale listening buoy                     |
| 17/10/2006 15:18 | 29 -53.56921 -41.19653 |  | Whale Listening buoy deployed in 199m                                     |
| 17/10/2006 15:25 | 30 -53.59849 -41.21632 |  | V/L off DP preparing for RMT  |
| 17/10/2006 15:28 | 30 -53.57068 -41.19738 |  | Commence deployment of RMT  |
| 17/10/2006 15:32 | 30 -53.52185 -41.28156 |  | RMT deployed  |
| 17/10/2006 15:36 | 30 -53.57726 -41.20164 |  | Stop veering 80m cable out  |
| 17/10/2006 15:48 | 30 -53.58761 -41.2088  |  | Commence recovery of RMT  |
| 17/10/2006 15:53 | 30 -53.5921 -41.21197  |  | RMT @ Surface   |
| 17/10/2006 15:57 | 30 -53.5954 -41.2144   |  | RMT Recovered   |
| 17/10/2006 16:00 | -53.59822 -41.21615    |  | Fishing postponed till further notice due to deteriorating sea conditions |
| 17/10/2006 16:10 | -53.51094 -41.28652    |  | Decision make to proceed 20Nm NW to next whale buoy location              |
| 17/10/2006 19:53 | 31 -53.44581 -41.72734 |  | Vessel stopped on D.P. in 193m water                                      |
| 17/10/2006 20:09 | 31 -53.44578 -41.72723 |  | Whale Listening buoy deployed, ready to deploy whale listening buoy       |

# Cruise track



## Appendix 6: Western Core Box Protocol

### ***General description***

The Western Core Box (WCB) acoustic survey has been undertaken since 1994 and provides a time series of krill biomass estimation as part of the Long Term Monitoring Series. The WCB is composed of 8 semi-randomly spaced transects orientated in a north-south direction, just north of Bird Island and South Georgia (Figure 1).

### ***General protocols***

1) **The preferred direction of survey is from west to east**, against the prevailing currents. In some cases the Captain may ask you if it can be run in the other direction. It can, but this compromises the data as you potentially sample the same water more than once. It does not matter whether you start from the north or the south end of transect 1.1

2) **The WCB lasts for 4 days, once it has started you have to insist not to break off unless there is a really good reason to split it.** The survey is supposed to be synoptic (i.e. a camera snapshot), it seriously compromises the data quality and usefulness if it is broken up.

3) **The acoustic data must be collected within certain instrument settings. The ping interval must be 2 seconds, data must be stored to at least 300 m and the correct setup of the SSU should be undertaken to minimise interference.** This will enable the data collected to be directly comparable with previous years – the whole point of a time series!

**For reference, the ping interval is the most important consideration in the WCB acoustics – then minimising interference.**

### ***EK60 Operation and settings***

The core of EK60 operations is undertaken using the two computers in the UIC, labelled EK60 Main Processor (APC10) and EK60 Workstation (JCR-EK60WS-D1). The EK60 Main Processor runs the EK60 itself and it is important that this computer is not used for anything else. The EK60 Workstation is creating the backup log files and likewise should not be used unnecessarily.

#### **Step 1**

Set up the file structure on the drive that the EK60 will be logging to in both the U:\data\EK60 raw data\JR\$\$\$WCB Transect W1.1 etc. folder and also U:\data\Echolog\JR\$\$\$WCB Transect W1.1 etc. An example of the file structure to be used (which can be copied across) is given in c:\WCB acoustic survey\example file structure to copy and paste\ on the EK60 workstation

## EK60 operation

Switch the EK60 GPTs on using the switch (labelled EK60 remote on/off switch) on the wall to the left of the EK60 Main Processor PC.

Switch on the EK60 by turning on the EK60 Main Processor (unscrew the plate on the front of the blue machine to the bottom left of the EK60 Main Processor monitor).

Run the **ER60** software (icon on desktop), choose last recent settings, and the main ER60 screen (empty) should come up.

### Step 2

Check settings of the EK60 and record on excel spreadsheet found on EK60 Workstation

#### a) Operation – Normal – check the following and when the same as below - ok

You should see the following settings – if not please change to the following settings

| Channel                                 | Mode   | Pulse interval/Bandwidth | duration/Sample | Power  | Depth (m) |
|---|--------|--------------------------|-----------------|--------|-----------|
| GPT 38 kHz<br>009072033fa5*<br>ES38     | Active | 1024us / 256us / 2425Hz  |                 | 2000 W | 0.00      |
| GPT 120 kHz<br>00907203422d*<br>ES120-7 | Active | 1024us / 256us / 3026Hz  |                 | 500 W  | 0.00      |
| GPT 200 kHz<br>009072033f91*<br>ES200-7 | Active | 1024us / 256us / 3088Hz  |                 | 300 W  | 0.00      |

\* these are the serial numbers of the installed GPTs – please note these in the excel spreadsheet. If you have to change a GPT please note the time and date of the change in the event log and the new serial number.

On clicking ok 3 windows should appear – although they may not show anything depending on whether the EK60 is actively pinging.

#### b) Install – environment – check and record the settings - ok

The conditions should be Seawater. Please record the temperature, salinity and sound speed that are being used (you do not need to click any buttons for this – just record) in the excel spreadsheet.

#### c) Operation – ping control – view/change settings - close

Operation should show only the start or stop option, Set ping mode to interval (2.00) and, for the moment, make sure the incoming and outgoing trigger boxes are empty. The EK60 should now commence displaying data.

\*\*\*\*\*

### CHECK THE FORMAT THE RAW DATA AND WHERE IT IS SAVED

\*\*\*\*\*

d) Output – file -

**Directory** - Use browse to choose the correct folder to log the data to

**Raw data** - File name prefix should be JR\$\$\$ (\$\$\$ = cruise no.)

Range (m) = 500

File size

Max vessel distance (nmi) = 0

Max file size (Mb) = 25

**TICK** Save raw data

**Processed data** – leave un-ticked

The following will show if all is working correctly. See below for picture accompaniment.

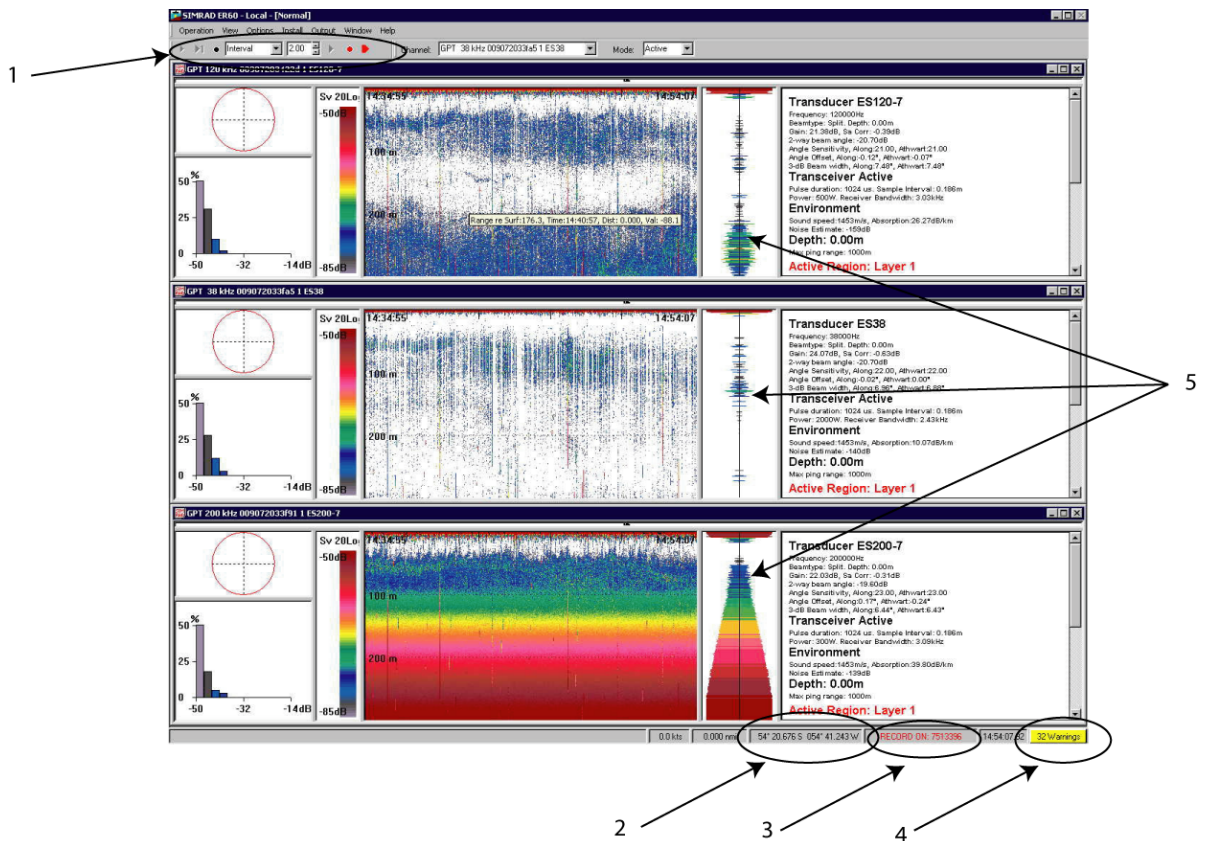
1) Ping control area (on/off) - the dot (stop) should be black, the play and pause should be grey (equals echosounder pinging and on). Interval = 2.00. The red buttons are the record control. The little play button (on the left of the three) is greyed out, the dot (stop) should be red, and the big play button should be red.

2) These are lat/long positions and should be changing as you move! If not there may be a problem with the GPS system and you need to call the IT support person.

3) This is the file name being recorded and should be in red when recording. If not recording it will be in black – this is bad if happening when doing the survey!

4) These are EK60 warnings, such as losing contact with the transducers. Do not be concerned if there are a number of warnings during the whole survey (e.g. 0 – 150), but if tens of warnings occur in a few minutes then rebooting the system might be necessary or there may be a network problem.

5) Single ping display. This panel shows the results from each single ping. It should change every two seconds (since that is the desired ping rate), and is a good indication that the echosounder is working.



Finally record the Gain, Sa correction, 2-way beam angle, Angle sensitivity along and athwart, Angle offset along and athwart, 3-dB beamwidth along and athwart and the absorption coefficient for each frequency in the excel spreadsheet provided.

## Echolog setup

Echolog runs on the EK60 Workstation

Start – programs – Sonardata 4 – Echolog 60

Right click on top left corner (Echoview icon) for options (there are no obvious menu options) – go to:

### Settings

EK60 survey folder = U:\data\EK60 raw data\JR\$\$\$ i.e. the folder that the ER60 software is saving to.

Folder check interval (ms) = 250

Echodepth broadcast interval (ms) = 500

Live viewing broadcast interval (seconds) = 10

Warn when hard disk has less than (MB) = 50

Warn when hard disk has less than (minutes) = 60

Equipment name = JCR-EK60WS-D1

Warn if no activity (minutes) is un-ticked

### Data compression:

Tick enable

Delete original files after compression is **UN-TICKED**

Suspend when hard disk has less than (MB) = 10

Write compressed files to folder = U:\data\Echolog\JR\$\$\$ i.e. the folder that mirrors where the data is saved in the EK60 raw data folder

Click **Compression settings**

**Compression settings need to be set for each of the three transducers** – that is Transducer 1, Transducer 2 and Transducer 3. The following are therefore the compression settings for all frequencies.

1) **Tick store power data**

Start range (m) = 0

End range (m) = 300

Reduced data resolution:

Average samples where both Sv below (dB) = -80 and TS below (dB) = 20.

Average samples below sounder detected bottom + offset is UN-TICKED.

Maximum number of samples to average = 50.

2) **Split beam data is UN-TICKED**

All the boxes should then be greyed out

3) **Sounder detected bottom**

Ignore bottom detection if range less than (m) = 10

4) **Click OK - Click OK again**

If the echosounder is working Echolog should now indicate that a file is being written. The data throughput is displayed in the top-left of the menu bar. It is typically between 16 and 25 KB/s. To check that the ER60 software and the Echolog software are working correctly, file names (that are time stamped) can be viewed in the file manager window.

### **SSU setup**

1) Make sure the EM120 (Swath bathymetry system) is turned **OFF**

2) Phone bridge and ask them to switch the EA600 to **active mode** and on **external trigger**

3) Make sure SSU mode is **EM EA&EK TO ADCP**

| <b>Group</b> | <b>Sub-group</b> | <b>Trigger</b> | <b>Time usage</b> |
|--------------|------------------|----------------|-------------------|
| EM           | EM120            | OFF            |                   |
| EA/EK        | EA600            | ON             | TX pulse          |
| EA/EK        | EK60             | ON             | Calculated        |
| TO           | Topas            | OFF            |                   |
| AD           | ADCP             | OFF            |                   |

4) Now go to the EK60:

Click operation – ping control

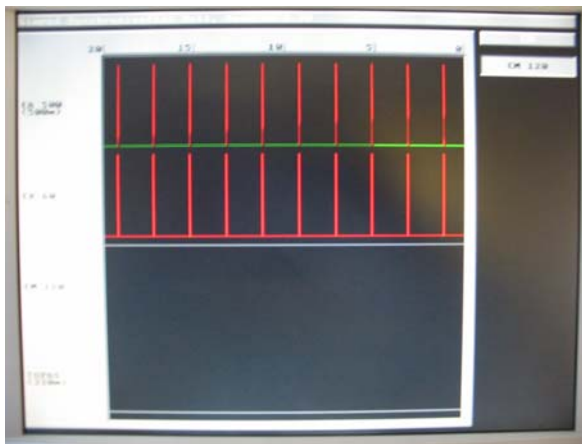
Make sure ping rate is 2 seconds

TICK box for triggering ingoing

It should now read GPT auxiliary port.

The SSU should now look like this:





### SSU monitor:

EA (top) + EK (below) must ping at the **same time**

EA + EK must show a **red (active)** signal

EA must show a **green line (waiting)** between pings

Topas must show a **grey line (system off)**

## General Guidance

If you have to slow down due to icebergs, fog or weather, no problem, just make a note in the eventlog and carry on (same for a detour, due to an iceberg).

The CTDs during the nights will not take all night. If there is bad weather sit and wait to do the CTD until you have to break off to make sure you arrive in the morning at the start of the next transect.

If the EK60 falls over, close the ER 60 software, switch off the GPTs, reboot the computer (APC10), wait 30 seconds, switch on the GPTs and start the ER60 software again – MAKE SURE IT IS LOGGING AGAIN. Please make a note of this in the event log.

If you are not sure then ring either Peter Enderlein or Sophie Fielding. Their phone numbers are in this document.

## Appendix 7: Cruise Report Guidelines

The science part of the cruise will soon be finished and now is the time to start thinking about cruise report and intranet web page. This needs to be finished while on the ship; trying to think about what we did on this cruise once we are back does not bear thinking about.

The aims are a) to show each other where samples/data/experiments were done so that we can cross-reference analysis and b) to show what went wrong and how it could be fixed. It also shows others what we did, but we are the main users so it needs to be useful. It would be great if we can show some results as well, but don't spend lots of time trying to work up data. A few sentences about values being low/high/regional trends is fine. It's a reference document, not flag waving. The scientific value of a cruise is only known 10 years later when its papers/reports start being quoted.

The reports for JR70, JR82, etc outlines the format, (see JCR intranet site under bioscience under other pages).

Please place all the information for JR116 on q:\JR116\_Shared\Cruise\_Report. Please create a directory with a meaningful name to place your material for the cruise report in. My life will be much easier if the follow formats are used when creating your contribution: WORD, RTF, EXCEL, ACCESS, PDF, HTML plus JPEG images.

To avoid loads of "table 1" etc, please cite tables and figures prefixed by first 4 letters of section name, e.g. "table ceta1"

A suggested format for the report is in the table below. Please modify to suite.

A general format within each section (or in some cases subsections) is:

*Introduction*

*Aim*

*Method/system specification (main bit)*

*Data coverage (main bit)*

### ***Preliminary results (if any)***

*Problems encountered (if any)*

*References (if unavoidable)*

Most people did same basic measurements at South Georgia, so no need to split these continually (I will give an overview of the Western Core Box "protocol").

Lift relevant chunks from previous cruise reports to save time.

Nathan Cunningham  
9<sup>th</sup> January 2005

| <b>Section</b>                   | <b>Subsection</b>            |
|----------------------------------|------------------------------|
| Introduction                     |                              |
| Aims                             |                              |
| Cruise overview                  |                              |
| Timetable                        |                              |
| Oceanography                     | Navigation                   |
|                                  | CTD and XBT transects        |
|                                  | ADCP                         |
|                                  | Oceanlogger                  |
|                                  |                              |
| Moorings                         |                              |
| Optics Rig                       | AC9                          |
|                                  | Hydroscat                    |
|                                  | Seabird CTD                  |
| Nutrients and Primary Production | Nutrients                    |
|                                  | Chlorophyll distribution     |
|                                  | Microplankton sampling       |
|                                  | Primary production           |
|                                  | FRRF                         |
| Mesozooplankton                  | Horiz/vertical distribution  |
|                                  | Copepod condition factor     |
|                                  | Copepod rate processes       |
|                                  | Larval krill                 |
| Macroplankton                    | Larval icefish age structure |
|                                  | Krill target fishing         |
|                                  | Growth rates of krill        |
|                                  | Krill moult stage analysis   |
|                                  | RMT8 sampling in WCB         |
| Acoustics                        | Setup/calibration            |
|                                  | Acoustic transects           |
| Cetaceans and seals              | Visual observations          |
|                                  | Acoustic observations        |
| Technical                        | Gear                         |
|                                  | ETS support                  |
|                                  | ITS support                  |
|                                  | Data management              |
| Acknowledgements                 |                              |
| Appendices                       |                              |

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