RRS *James Clark Ross* Cruise 58

Autosub cruise

Under Sea Ice and Pelagic Surveys (USIPS): fisheries- and plankton-acoustics, and oceanographic investigations of otherwise-impenetrable environments

A component of the NERC *Autosub Science Missions* Thematic Programme

January 20th to February 15th 2001

collated by Andrew Brierley

from contributions by the JR58 Scientific Party

Contents

Summary

The autonomous underwater vehicle (AUV) *Autosub-2* was deployed from RRS *James Clark Ross* during a 27-day cruise in January/February 2001. *Autosub* was equipped with a Simrad EK500 scientific echo sounder and sent on 20 missions beneath sea ice and icebergs in the northern Weddell Sea, and in open water off the Antarctic Peninsula, with the objectives of 1) collecting comparative data on the distribution and abundance of Antarctic krill (*Euphausia superba*) in open and ice-covered waters, 2) measuring sea ice thickness, 3) measuring attenuation of photosynthetically active radiation (PAR) by sea ice, 4) obtaining underwater profiles of icebergs, and 5) assessing possible avoidance by krill of RRS *James Clark Ross*. In total *Autosub* completed over 275 km of transect beneath sea ice. A series of ship-based echosounder, netting and CTD activities, and measurements of snow depth on ice floes, were carried out to obtain a regional physical and biological context within which to set the observations made by *Autosub*.

TUBA (Towed Undulating BioAcoustics) was deployed on 15 of the net hauls made during this cruise.

Background

This cruise was the Antarctic component of a collaborative *Autosub* project between the British Antarctic Survey (BAS), the Fisheries Research Services Marine Laboratory, Aberdeen (MLA), Southampton Oceanography Centre (SOC) and the Open University (OU). The project, entitled *Under Sea Ice and Pelagic Surveys (USIPS): fisheries- and plankton-acoustics, and oceanographic investigations of otherwise-impenetrable environments*, was funded by NERC under the *Autosub Science Missions* Thematic Programme (Grant No GST 022151 awarded in 1998 to AS Brierley (BAS, but now University of St. Andrews), MA Brandon (formerly BAS, now OU) and PG Fernandes (MLA)). The collaboration between BAS and MLA was founded upon a mutual desire to equip *Autosub* with a scientific echo sounder, and to use *Autosub* as a platform from which to make acoustic observations impossible from conventional research vessels. After a period of echo sounder (Simrad EK500) adaptation and sea trials, the system was deployed in the North Sea in 1999 to fulfill the fisheries objectives of the project. The specific USIPS objectives of this cruise were:

- to measure sea ice thickness acoustically from beneath
- to compare the distribution and abundance of Antarctic krill (*Euphausia superba*) beneath ice and in open water
- to obtain underwater profiles of ice bergs from beneath, and to assess the ability of *Autosub* to navigate beneath icebergs
- to investigate vessel avoidance by krill

In addition to the *Autosub* activites, work under the AFI TUBA project that had been planned for the previous cruise (JR57) was accommodated here. Once ready, TUBA was deployed on the BAS multinet during the majority of hauls to collect *in situ* multifrequency acoustic observations of the organisms caught by the net.

Scientific Party

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Ship's Personnel

Christopher Elliot	Master
Robert Paterson	Chief Officer
David Gooberman	Second Officer
Scott Baker	Third Officer
David Cutting	Chief Engineer
William Kerswell	Second Engineer
Glyn Collard	Third Engineer
Steven Eadie	Fourth Engineer
Norman Thomas	Electrical Engineer
Kenneth Olley	Catering Officer
Charles Waddicor	Radio Officer
John Summers	Deck Engineer
Simon Wright	Deck Engineer
George Stewart	Bosun
David Williams	Bosun's Mate
George Dale	Seaman
John McGowan	Seaman
James Baker	Seaman
Marc Blaby	Seaman
Derek Jenkins	Seaman
Sydney Smith	Motorman
Mark Robinshaw	Motorman
Roy Fox	Chef
Francis Hardacre	Second Cook
Clifford Pratley	Senior Steward
Tony Dixon	Steward
Kenneth Weston	Steward
James Newall	Steward
Pippa Bradbury	Doctor

Health and Safety

Personal Risk Assessments were carried out for each of the Science Party individually.

Scientific Equipment Guidance Notes (MSAQ) and a Risk Assessment (MSAY) were completed for *Autosub* deployment and recovery. A Risk Assessment (MSAY) was also completed for deployment and recovery of members of the Science Party on ice floes to measure snow depth.

Formaldehyde was used to preserve zooplankton samples. All personnel using formaldehyde were made aware of the relevant COSHH regulations.

Narrative

Pre cruise period: due to difficulties in obtaining flights for the Ship's Personnel and Scientific Party, the start date of the cruise was delayed by about a week. This meant that the ship was in the Falkland Islands for a week prior to the arrival of the main Scientific Party. During this time personnel remaining from JR57 were able to undertake some preparatory mobilization work for JR58:

Monday 15 January 2001

The ship was moved to a more central FIPASS berth at 08:00 L and moored port side on so that a shore crane could be used to manoeuvre the *Autosub* gantry. Although the aft crane has a ten tonne SWL and can lift the gantry aboard, its SWL when extended is only 3 tonnes, which is insufficient to move the 5.75 tonne gantry to the aft fixing location. The gantry has 4 mount points on each side, 0.5 m apart. Ship plans suggest that there are deck bolts as far aft as the stern rail, but are incorrect. With the gantry placed as far aft as required, the aft most gantry holes were beyond the span of the deck bolts and only 3 mounts per side were possible. Deck engineers are constructing additional brackets to ensure that there will be the required 1 mount per tonne (gantry plus AUV = 8 tonnes). The *Autosub* container was unloaded and contents distributed between the rough workshop, main lab and UIC room. Battery boxes were stowed in the scientific hold and the *Autosub* coms towfish was placed forward.

Tuesday 16 January 2001

Depart FIPASS 08:30 L to anchor off. Doug Trevett and John Summers construct an additional metal spar to go across the inside of the gantry, providing access to one extra bolt point, and run 2 wires/bottle screws forward to a further 2 bolts. Altogether there are now 9 attachment points.

The 2nd Mate (Justin) has been given the position 65°S 50°W as our first waypoint. This is at present just a best estimate and will probably need to be amended as more information on ice distribution is forthcoming and after consultation with the oncoming Master (Chris Elliot). Captain Jerry Burgan departed the ship.

Wednesday 17 January 2001

Ship remains at anchor in Port Howard. A new ice extent satellite image arrived late yesterday, on which the ice edge appears further north than previously. The position of the first cruise waypoint has been revised accordingly to 62°S, and to negate the need to replot the cruise track by hand on 4 charts the longitude passed at this latitude from the previous course of 52°W was adopted by default. This position is between the mouth of the Bransfield Strait and Signy, and might be very good for our purposes if theories relating to the transport of krill across the Scotia Sea from Bransfield Strait to South Georgia are correct.

Thursday 18 January 2001

Ship comes alongside FIPASS

Friday 19 January 2001

Tristar arrives on time and Ship's Crew and Science Party arrive as expected.

Saturday 20 January 2001

Mobilization begins. *Autosub* team set up their PCs in the UIC and main lab. Aerials mounted on external stairway and lead through glands. Towfish rigged to communicate to main lab along deck cable (slip rings not needed). EK500 bohemoth installed. USIPS microwave aerial positioned on rail outside UIC after door and lead through winch room gland.

We are informed that the ship has to leave FIPASS at 07:00 Monday.

Jon Watkins (TUBA) leaves the ship to return to Cambridge.

Sunday 21 January 2001

Alter waypoint to 62.25° S 54° W to proceed to a point that will enable *Autosub* test in shelter of Clarence Island, the nearest land.

Mobilization continues.

Monday 22 January 2001

Depart FIPASS 07:00 L as planned after Customs clearance. Flat calm seas: making 12.5 knots towards Clarence Island.

Science brief PM, followed by detailed discussion of *Autosub* missions.

Tuesday 23 January 2001

Proceeding across Drake Passage in calm conditions.

Test CTD deployment at 10:00 L.

Dartcom repaired and we are now able to receive images from the NOAA 16 satellite. A very clear image shows bands of ice to the north of a pronounced ice edge.

23:17 L alter course for our best estimate of the ice edge (based on Dartcom image = 63.5°S, 51°W, heading 157 [ship's estimate of ice edge = 62.75°S from telexed data]). The planned *Autosub* tasks for the sound between Clarence Island and Elephant Island are deferred in lieu of *Autosub* repair (router problem). We plan to run a CTD transect now before *the Autosub* missions to make best use of the time required for *Autosub* repair. Since it transpires that all our missions will be in deep water (beyond ADCP bottom track range), the necessity for the previously planned shallow water (ADCP bottom tracking) calibration run at Elephant Island is negated.

Our plan is to find the ice edge (what will constitute the edge in the highly banded zone that is expanding in the very calm conditions is as yet unclear), move 40 km south into the ice making visual observations, then returning north with CTD casts every 10 km. We hope that *Autosub* will be ready for deployment when we reach open water. There will also be some fishing opportunities.

Wednesday 24 January 2001

Proceed south towards the ice edge

Test haul with Multinet at 22:00 with TUBA attached (doesn't work).

Proceed 10 nautical miles further south and encounter a very clearly defined ice edge.

Fish krill swarms at the ice edge.

Wait until dawn to begin the CTD transect south into the ice.

Thursday 25 January 2001

Head into ice at approx 155 degrees at 04:00. Pass through one ice band, one open water patch (10 minutes to cross each) then enter pack of rotting multi-year ice through which ship makes good progress (3 knots).

Begin CTD transect 10:40, then proceed 333° doing CTD casts at 10 km intervals (except at ice edge which is 6 km), then 4 more CTDs to ice edge -40 km

Friday 26 January 2001

Ship comes on to station for *Autosub* deployment at 09:00 L, but positioning takes quite some time.

Autosub deployed on box mission (M244) for compass calibration, but descends to 405 m instead of planned 15. Despite the prior surface buoyancy test *Autosub* was overballasted and only surfaced after releasing its abort weight.

EK500 power has been lost on commencement dive, due to a fault in *Autosub's* main wiring.

Repair *Autosub* wiring, ballast problem and also fixed acoustic tracking.

JCR conducts small scale grid survey during *Autosub* repairs.

Autosub deployed at about 21:00 L to re-do compass calibration box plus 1 nm north/south run (M245).

Autosub recovered and EK500 has worked fine, detecting surface swarms and ice interface!

Saturday 27 January 2001

Autosub deployed on 1 nm test mission (M246) to check new speed / trim configuration, which are OK. Then first full 20, 8, 20 km *Autosub* under ice mission (M247): 1.4 GB acoustic data collected.

Sunday 28 January 2001

Autosub deployed on second under ice mission (M248) 21 nm east along ice edge from mission 1 by 10:30 L.

JCR follows *Autosub* towards ice edge, gathering avoidance data on the way. JCR has to stop following *Autosub* when AUV passes beneath a berg.

Autosub recovered at its final waypoint after an abortive attempt to locate it acoustically on its track away from the ice edge. Lesson: rendezvous with *Autosub* at its waypoint.

Monday 29 January 2001

JCR relocates overnight and is ready for the day's *Autosub* deployment at 08:30 (M249). We appear to be north of a tongue of ice and so set mission to turn to starboard instead of port at end of inbound leg in order to maximise time under ice.

Aerials are damaged on deployment and *Autosub* has to be recovered when an attempt to fix the aerial from a inflatable is unsuccessful.

JCR relocates closer to the ice edge after it is agreed that the launch criteria are 2 km north of edge in a 500 m patch of open water. *Autosub*'s return leg is consequently extended to make sure that it will run far enough north to clear the ice given the now more southerly start point, legs becoming 20, 8 and 27 (still M249 since the earlier aborted launch gets no number).

JCR followed *Autosub* to ice edge and then entered pack to try for a snow thickness measurement /CTD. Wor Geordie deployment aborted because of excessive swell. Ship moves deeper in to the pack for CTD. Conditions more favourable and we made snow thickness measurement, sacrificing the time for ship's reciprocal transects.

Autosub recovered. We find the EK500 is on but the Libretto (EK500 logging PC) has rebooted. Only 2 hours acoustic data collected.

Tuesday 30 January 2001

Repairing the EK500 (bohemoth removed from *Autosub*) and *Autosub* battery change in testing blizzard conditions. *Autosub* wiring investigated to see if power loss could have caused Libretto crash. Libretto replaced with a spare.

JCR carries out small scale grid survey 21 nm east of yesterday's *Autosub* deployment.

Ship's safety meeting.

Wednesday 31 January 2001

JCR relocates off a cluster of three bergs for our first under ice berg missions. *Autosub* launched (M250) 13:10 GMT and recovered in a freshening wind after its second pass.

Proximity to bergs exploited for *Autosub* photo call.

TUBA deployed on wire for calibration attempt.

Autosub deployed on second under berg missions (M251): a probable change in compass calibration brought on by the battery change led to the *Autosub*'s steered course not going beneath bergs.

Thursday 1 February 2001

Plan to resume long under ice missions. Relocate east over previous night but find that here the ice edge is not at all well defined, with brash extending 6 miles north of "edge". Following yesterday's berg miss we need a compass calibration. This requires 500 m open water, so we have to go north to the outer ice edge for deployment. Transect legs are extended to 23, 8, 28 km to compensate for the required more northerly start position. *Autosub* deployed 09:53 GMT. Compass calibration completed 10:25, mission proper (M252) commences 10:32.

CTD 5 km in to ice at 13:45.

JCR carries out reciprocal transects and fishing, arriving at *Autosub*'s final waypoint by 22:00 GMT. Sub detected acoustically but there is a berg on the waypoint. *Autosub* eventually recovered just after midnight after a difficult relocation, and it appears as though it has collided with the berg!

Friday 2 February 2001

Autosub deployed on long mission (M253, 25, 8, 31 km at 210 m (deeper now after yesterday's collision)) by 10:00 GMT. Beautiful calm, sunny weather with very well defined pack edge.

JCR proceeds in to pack for CTD and snow thickness measurements, then surveys reciprocal transects outside pack. Very few acoustic targets detected and so we don't fish until the last minute.

Autosub surfaces on time but recovery is very arduous: yellow ropes snag ship's rudder and Effer crane has to be used to lift lines high enough to be cut free. *Autosub* then has to be recovered by grappling for one cut line end and lifting by the tail only until the forward rope could be attached. Foul weather. *Autosub* team and those on deck did their best to recover the vehicle, and succeeded in very testing conditions.

Saturday 3 February 2001

Autosub repaired by 09:30. We have 14 hours batty life remaining in the present pack. The weather forecast for the next 36 hours is very bad so a long mission overnight is not possible. We consequently decide to do more iceberg work and the zig zag mission for Kate Stansfield.

JCR arrives off berg 11:00 L. JCR power blackout.

CTD conducted 1 mile east of berg 11:30.

Autosub deployed on short test mission and zig zag (M254) 12:18. Zig zag = 10 dives in total.

Autosub back at surface by 13:38 L and programmed for grid to pass under 2 neighbouring bergs (M255,6).

Autosub eventually surfaces very close to one of the bergs (which have been moving rapidly during the mission) and is recovered in worstening weather. Data suggest that *Autosub* has only passed under berg once.

Sunday 4 February 2001

Awake to very bad weather and brash blown well off the ice edge. JCR hove to. A tongue of ice to our east has been blown out in the south easterly wind. We decide to relocate west to get away from the brash in the hope of finding a more defined edge, aiming for an overnight long mission. We have only 9 hours battery left though and this, combined with the fact that even at our new location the brash extends 8 km from the edge and could move out a further 15 km in the southerly wind during the mission, and that we need the sub under ice at 21:00 and 05:00, makes the mission undoable. So, we decide to head 290° looking for bergs and fishing targets. We will do an under berg mission tomorrow am followed by a battery change, with a view to conducting a long under ice mission over Tuesday night/Wednesday morning

Monday 5 February 2001

Under iceberg mission (M257) starting 09:30 L with a repeat pass at 280 m. *Autosub* surfaces 12:10 L and is reprogrammed to run back towards berg at 10 m depth (M258) in preparation for a second under berg foray. Day’s second under iceberg mission (M259) starts at 14:52. JCR follows *Autosub* towards berg, stopping just 3 cables off for a CTD cast.

Conversation with Captain Lawrence on RRS *Shackleton* suggests that Signy / South Orkneys will not be a good place for the avoidance work because of horrible ice conditions there.

Autosub back alongside by 19:37 L after JCR sails a box around it to try and improve the compass calibration. Upon recovery we find that the EK500 has failed on the first dive. Is it just coincidence that the EK500 has failed again on the mission just before an *Autosub* battery change? Is there a power supply problem to the EK500 from *Autosub* when the *Autosub* battery levels are diminished?

Fish overnight and return south prospecting for the ice edge.

Autosub battery change commenced and bohemoth removed for bench testing after EK500 failure.

Tuesday 6 February 2001

The EK500 was bench tested overnight on external power and seems to be working OK.

Autosub battery change completed.

Autosub deployed on a compass calibration mission and then (at 15:00 L) a following mission (M260) through light brash.

Comms from Cambridge inform us that due to flight delays etc we have extra day's ship time.

Autosub recovered and we find that the EK500 has operated well (new battery pack gives no problems).

Fish overnight.

Wednesday 7 February 2001

Fish with TUBA through the day and plan for a long overnight under ice mission.

JCR relocates to 2.5 miles north of ice edge and *Autosub* deployed at about 17:00 L. There are some diving (M261) problems at the start that might be due to higher friction in the newly fitted prop motor bearings. *Autosub* dives on the third attempt and commences long overnight mission (M262) and is followed by JCR in to ice edge.

CTD at ice edge.

Fish with TUBA overnight

Thursday 8 February 2001

Fish with TUBA during the early part of the day.

Recover *Autosub* by midday after a protracted location process and then begin relocating towards Bransfield Strait at 13 knots.

Swap transducers from dorsal to ventral surface of *Autosub*.

Fish with TUBA after dinner.

Friday 9 February 2001

Pick our way through ice and dense fog from the tip of the Peninsula across Bransfield Strait to the north of King George Island, fishing with TUBA on the way.

Run an avoidance mission (M263) late PM (16:50 L) after first prospecting the line for bergs, but have problems with strong current and acoustic tracking. Recover *Autosub* and fish back over track (E66), catching large krill.

TUBA fishing continues through the night, although the team are tired by now.

Saturday 10 February 2001

Fish just after midnight with TUBA.

Weather breaks and we spend the day hove to in force 10 easterly.

Sunday 11 February 2001

Despite valiant attempts, at 04:00 we find it impossible to get in to Admiralty Bay, or any shelter, due to large swells and wind blown ice. We have run out of time and have to head north to the Falklands to calibrate there.

Monday 12 February 2001

On passage to the Falklands

Data meeting 13:30.

End of cruise dinner, now a little premature given that we need to calibrate tomorrow.

Tuesday 13 February 2001

Calibration in Berkeley Sound. A very long job but the technique of mounting the *Autosub* transducers on Doug's towfish worked well.

Calibration completed at around 3 am L Wednesday.

Wednesday 14 February 2001

Dock FIPASS and begin demobilization.

Thursday 15 February 2001

Demobilization complete. The cruise is over.

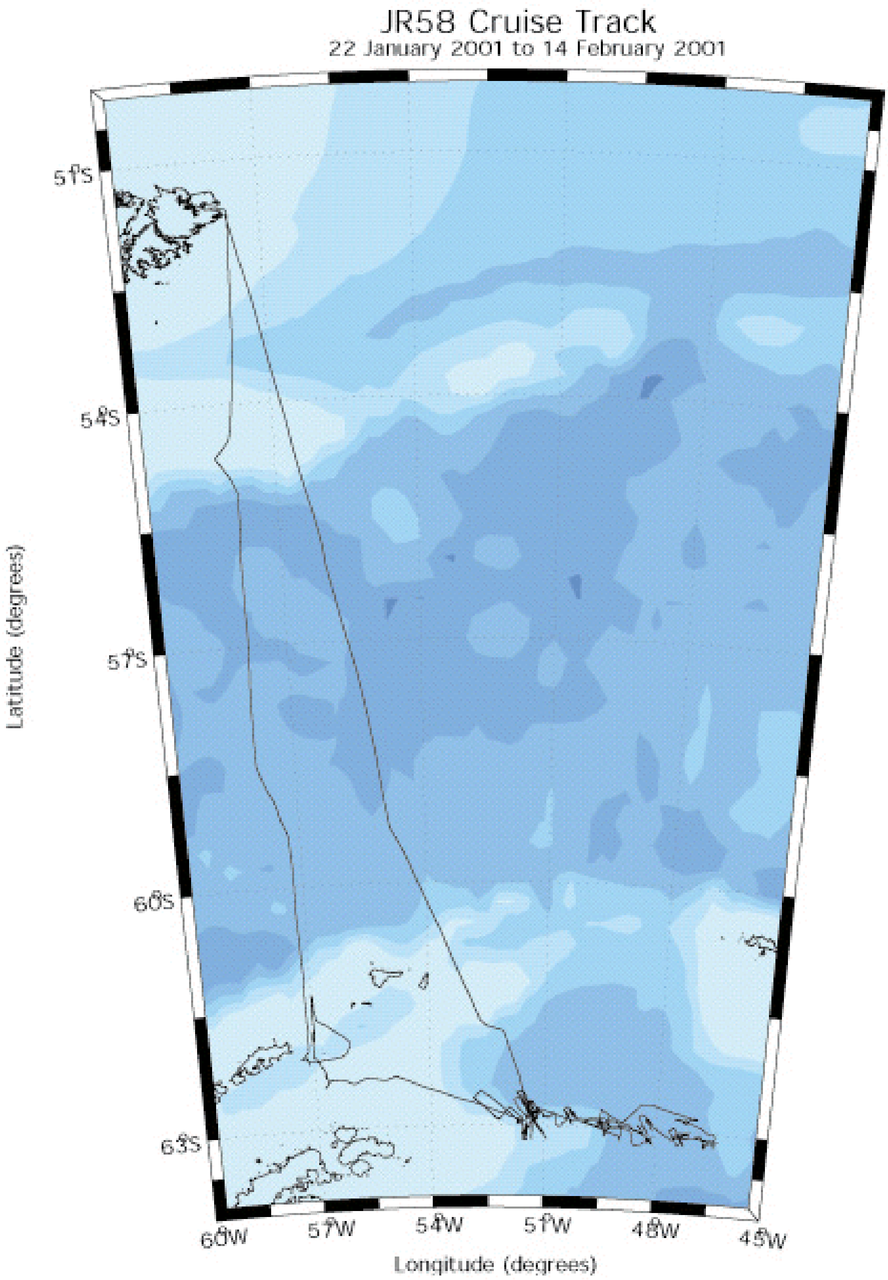
Summary Timetable

Day	Date	Activity
1	Sat Jan 20	Mobilization
2	Sun Jan 21	Mobilization
3	Mon Jan 22	Sail 07:00 for nominal position 62° 15' S 54° 00' W. Boat drill. Science brief.
4	Tue Jan 23	Cross DrakePassage. Test CTD. *Autosub* router repair. Head for ice edge.
5	Wed Jan 24	Test Multinet and TUBA. Arrive at ice edge. Fish.
6	Thu Jan 25	Head south into ice for CTD transect.
7	Fri Jan 26	*Autosub* test (M244), descends to 405 m and aborts. JCR conducts small scale survey.
8	Sat Jan 27	First full 20, 8, 20 km *Autosub* under ice mission (M247).
9	Sun Jan 28	2nd under ice mission (M248).
10	Mon Jan 29	3rd under ice mission (M249). Aerials damaged on deployment. Snow sample.
11	Tue Jan 30	*Autosub* battery change. EK500 repair. JCR small scale grid survey.
12	Wed Jan 31	*Autosub* on under iceberg missions (M250,1). TUBA calibration on wire.
13	Thu Feb 1	Compass calibration + 4th long mission (M252), which ends in collision with iceberg.
14	Fri Feb 2	5th long mission (M253). Snow thickness sample. Rudder tangle on *Autosub* recovery
15	Sat Feb 3	Test after repair. Zig zag mission (M254). Under iceberg observations (M255,6).
16	Sun Feb 4	Bad weather. Relocate west. Fishing.
17	Mon Feb 5	Under berg missions (M257,8,9). EK500 fails again prior to *Autosub* battery change.
18	Tue Feb 6	*Autosub* battery change. EK500 bench tests. Following mission thru light brash.
19	Wed Feb 7	TUBA fishing. *Autosub* deployed PM for long overnight under ice mission (M262).
20	Thu Feb 8	TUBA fishing. *Autosub* recovered. Begin relocating to Bransfield Strait.
21	Fri Feb 9	Avoidance mission (M263) in dense fog in Bransfield Strait. TUBA fishing.
22	Sat Feb 10	Hove to in easterly gale.
23	Sun Feb 11	Fail to enter Admiralty Bay due to ice. Begin heading back to Falklands.
24	Mon Feb 12	Crossing Drake Passage. “End” of cruise dinner.
25	Tue Feb 13	Calibration Berkeley Sound.
26	Wed Feb 14	Demobilization.
27	Thu Feb 15	Demobilization.

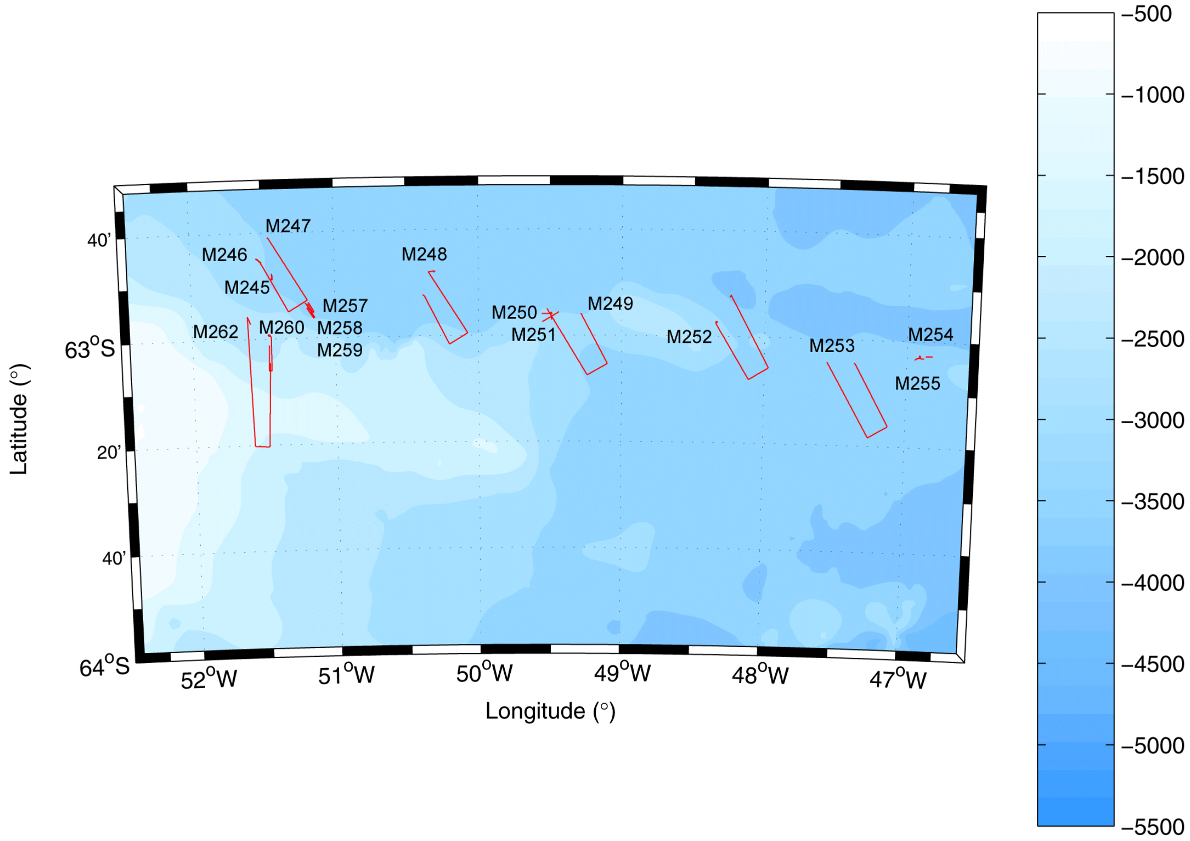
Area of operation

The cruise can be split in to two components, the first dealing with under sea ice missions and the second focussed on krill avoidance. The under ice work was conducted in the north eastern Weddell Sea because a) this provided the closes ice edge to the Falkland Islands, requiring least steaming time to reach, and b) because previous observations have suggested that this would be a region where krill were likely to be encountered. The open water work had originally been planned for the South Orkney islands but, after reports of unfavourable ice conditions, was switched to the Bransfield Strait region to the west of the Antarctic Peninsula.

Cruise Track



Detailed map of *Autosub* under ice / iceberg missions



(colour bar shows water depth in m)

Autosub operations from RRS *James Clark Ross*

Autosub is 6.8 metres long, has a diameter of 0.9 metres and weighs 2,200kg in air. If the vehicle is snatched from the sea before entrained water is allowed to drain it can weigh up to 3,700kg. Launch and recovery is achieved through a purpose built gantry mounted on the port quarter of the aft deck. This location was not ideal as the view from the bridge is restricted and handling recovery ropes around the stern, after the normal practice of approaching and grappling recovery lines along the starboard side, was an added complication. However, there is insufficient space to starboard of the main 'A' frame which itself was required for fishing, thus precluding the possibility of locating the gantry in the space beneath it (even if were possible to locate it there because of the gate and roller) . Fixing of the gantry to the deck was a simple matter as it has 8 fixing points on a 1 metre matrix, similar to the ship, although to align it flush with the stern only 6 could be used. These were sufficient but wire strops tightened by bottle screws were added as a precaution. Hydraulic power of 140 lt/min at 200 bar was provided by the ship.

Launch

Launching *Autosub* is a simple procedure. The vehicle has two lifting points, 3 metres apart, which are attached to the 2 winches on the gantry via a simple, but safe, no load release system. *Autosub* is lifted in its fore/aft position clear of the deck, tight into its retaining cradle and then moved outboard. Rotation of the cradle brings the vehicle into the athwart position and with the ship making about half a knot headway, it is lowered into the water. As soon as the weight comes off the winch lines they are slipped and the vehicle is free to clear the ship. At this point the ship maintains position with *Autosub* 200 - 300 metres on its port quarter (this is because the radio modem antenna has the clearest view of *Autosub* in this position) while pre-mission checks are made. Finally a mission start command is sent after the ship assumes a safe position relative to the submarines expected trajectory during its dive sequence. The dive sequence involves the vehicle running at the surface for 90 seconds to build up speed to dive. During this period *Autosub* is very vulnerable to collision with ice bits and choosing clear areas places constraints on mission planning. For future ice work a strategy to dive in small clearings in the ice needs to be established.
During this cruise our deployment strategy was refined to allow *Autosub* to be deployed in an ice free patch 500 m diameter, with recovery planned for an area that would be well clear of ice. This involved planning the under ice parallel transects to have return legs longer than the outward legs.

Relocation

At the end of a mission the *Autosub* is relocated at the surface by radio direction finding and acoustic location systems. Often it is located by the acoustics before it has surfaced and escorted to its final waypoint. Displays from both radio and acoustic location systems were available on the bridge. The acoustic location system requires a fish to be towed from a winch on the starboard side, just forward of the bridge. This needs to be deployed before relocation can commence and recovered after visual sighting of the submarine in order to clear the starboard side of obstructions for the recovery phase. Aspects of this towed fish need to be addressed for the future as it limits the ship to 4 knots when deployed and the tow cable probably is not long enough to keep the acoustic transducers below the hull, possibly causing anomalous acoustic returns.

Recovery

Once visual sight and radio modem contact is established a message is sent to release a light recovery line from *Autosub* and the ship proceeds to make the well established manoeuvre to recover equipment along the starboard side. The light recovery line is 50 m long and it should stream well clear of *Autosub*, making an easy target to grapple. On occasions this does not happen, usually in calmer conditions, and the ship needs to make a closer than usual pass to allow the line to be recovered using a boat hook. This light line is attached to 2, 30 m long heavier lifting lines stowed within *Autosub*. These are pulled aboard and tied into a long, substantial rope which had previously been lead from the *Autosub* gantry, around the stern and forward to the midships CTD gantry. This allowed more freedom for the ship to regain position on the submarine as it was walked aft and then allowed to stream astern. When the situation stabilised, with the ship head to wind at half a knot, the rope was slowly recovered using the ship's capstan until *Autosub's* 2 recovery lines came into reach, coupled using snap hooks into the gantry winch lines, thus allowing final recovery to proceed. The rope leading forward was of a 3 core construction which induced multiple twists into the 2 recovery lines. In future it could be of a more suitable multi-platt construction to minimise its rotation.

Events

During the cruise there were 20 missions involving 15 launch and recovery operations. Most of these followed the procedures described above well, however on 3 occasions some difficulties were experienced.

At the fifth launch, prior to mision 249, *Autosub* was launched with insufficient way on the ship, resulting in damage to its aft antenna mast during a minor collision under the ships counter. A boat was launched in an attempt to fix the problem without recovering the vehicle. Even though conditions were calm it was found not to be possible so a recovery was made. *Autosub* was relaunched 2 hours later.

During the sixth recovery, after mission 249, before the practice of running a rope forward was established, the light recovery line parted company from the ship necessitating the ship to go around for a second approach.

The 10th recovery, after mission 253 was a protracted affair. During the tying of the 2 lifting lines to the rope leading forward, one of lines was lost overboard. Attempts to recover the lost line were successful but unfortunately *Autosub* passed under the stern of the ship, catching the 2 lifting lines around some obstruction. One line had to be cut before *Autosub* freed itself from the stern and was grappled during a second pass of the ship. The inboard end of cut line was recovered, the remaining length stayed with *Autosub*. With only the rear lifting line available, *Autosub* had to be lifted high out of the water while the short remaining length of the forward line was grappled and tied into the second recovery winch. Damage was sustained to the front of the vehicle and propeller but both were repairable for the next day's mission.

Battery changes

Two battery changes were made during the cruise. Both involved working under an improvised shelter over *Autosub* on the after deck, at night, in snowy and cold conditions. This problem needs to be addressed for future Polar work.

The first was between the recovery after mission 249 at 0400UTC - 30/01/01 and before launch for mission 250 at 1300UTC - 31/01/01.

The second was between the recovery after mission 259 at 2300UTC - 05/02/01 and before launch for mission 260 at 1700UTC - 06/02/01.

Summary

The JCR has proved to be an excellent platform for *Autosub* operations. The siting of the gantry is not ideal for reasons explained above but the launch and recovery strategy evolved during the cruise has resulted in safe and efficient operations. The use of a torque-balanced rope would minimise twists in the *Autosub* recovery lines.

The acoustic navigation fish requires a longer cable. Perhaps a hull-mounted system could be considered but I suspect that cost will preclude this option.

A means of providing shelter and warmth around *Autosub* on the after deck needs to be investigated.

The remote display on the bridge for the acoustic tracking is an essential item. At present the quality of the picture obtained using internal ships wiring is poor. It would greatly benefit from a dedicated CAT 5 cable run from the main lab to the bridge.

Radio direction information was compromised by the ship's superstructure and would benefit from a more elevated antenna site.

Finding areas sufficiently clear of ice to permit a mission start did on occasions reduce useful under ice mission time. Developing a system whereby *Autosub* is launched with an extra weight, later to be jettisoned, would allow missions to begin in areas of loose ice.

Acknowledgement

The *Autosub* team is very appreciative of the willing and professional help given by the ship's personnel, thank you.

Autosub Mission Log

Event number (Deployment)	Mission Number	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Start Lat. (deg N)	Start Long. (deg E)	End Lat. (deg N)	End Long (deg E)	Distance Travelled (km)
58AUV014	244	26 Jan 2001	14:22:00	26 Jan 2001	15:15:00	-62.8300	-51.4333	-62.8267	-51.4200	1.5
		Compass Calibration Mission.				Mission aborted due to extended dive to 405m. EK500 stopped logging shortly after dive. *Autosub* systems suffer power reset after recovery due to faulty cable on main ON/OFF switch.				
58AUV015	245	26 Jan 2001	23:45:56	27 Jan 2001	2:06:26	-62.8144	-51.4362	-62.8134	-51.4334	5
		Compass calibration mission. Box N, E, S, W 5 minutes each at 12 m depth. Surface, then correct for quadrant compass errors, then run north for 1 mile at 150 m depth. Surface, get fix then do reciprocal run south for 1 mile.				Two GPS navigated reciprocal runs are needed for compass alignment / declination adjustment, as no bottom track navigation will be available in deep water.				
58AUV017	246	27 Jan 2001	14:29:18	27 Jan 2001	15:05:40	-62.7475	-51.5387	-62.7597	-51.5112	2
		Straight run at 150 m , for about 1 mile in SE direction, as a test of new faring etc.				Successfully completed.				
58AUV017	247	27 Jan 2001	15:32:02	28 Jan 2001	3:44:30	-62.7590	-51.5128	-62.6859	-51.4604	50
		1st Under Pack Ice Mission. 20 km in, 8 km left, 28 km out. Starting about 5 km from the ice edge. Ship carrying out reciprocal track.				Mission successful. Mission stopped by acoustic command to save time.				
58AUV022	248	28 Jan 2001	13:41:06	29 Jan 2001	2:16:54	-62.8118	-50.1660	-62.8810	-50.2317	50
		2nd Under Pack Ice Mission. 20 km in, 8 km left, 25 km out. Starting about 5 km from the ice edge. Ship Carrying out reciprocal track.				Slow to dive into the waves. Otherwise no problems.				

Event number (Deployment)	Mission Number	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Start Lat. (deg N)	Start Long. (deg E)	End Lat. (deg N)	End Long (deg E)	Distance Travelled (km)
58AUV025	249	29 Jan 2001	14:50:13	30 Jan 2001	2:32:00	-62.9322	-49.2855	-62.9152	-49.5233	50
		3rd under Ice Pack Mission. 20 km in , 8 km right, 25 km out. Starting about 3 km from the ice edge. Ship Carrying out reciprocal track.				Little EK500 data. Libretto PC suspected. One mast ripped off by collision with ship on launch. Boat put into water to try and fix; second (ethernet) mast ripped off by boat. Vehicle brought back onboard for repair. On recovery both Antenna repaired				
58AUV031	250	31 Jan 2001	13:14:21	31 Jan 2001	15:25:41	-62.4505	-49.4886	-62.0995	-49.5555	5
		Attempt to go beneath Ice bergs. Run at 240 deep. Try to go beneath berg in S/N and E/W directions. Berg about 60 m diameter.				S/N transect successful. E/W missed main berg but glanced underneath second smaller berg. Berg draught measured by EK500 as 134 m. Sub recovered because of concerns about weather worsening. In fact wind decreased.				
58AUV33A	251	31 Jan 2001	20:46:36	31 Jan 2001	22:32:42	-62.9281	-49.4415	-62.9533	-49.5633	10
		Attempt to get under 3 icebergs in a row, at 240 m depth.				Missed all 3 bergs! Navigation seemed a long way out (about 6 degrees equivalent). Error seemed to be a little too much for known currents, hence will do compass calibration before the next mission.				
58AUV035	252	1 Feb 2001	10:00:49	1 Feb 2001	23:27:00	-62.9585	-48.3458	-62.8748	-48.2378	60
		Box compass calibration. Vehicle surfaced, calibration applied then vehicle sent on transect under sea-ice, 23km in, 8 km across, 28 km out.				Compass calibration suggested significant change from the previous calibration. Suggests that compass calibration should be carried out after each change of batteries or anything moved near the compass. Due to mistake the heading offset was set to 0.0 instead 0.085 radians. The ADCP and echo sounder data show that the *Autosub* hit an ice berg at 150 m depth, a few minutes before recovery. Damage to front stbd panel, Stbd CTD, and bent acoustic transducer guard. Stbd CTD pump damaged - therefore, data may be suspect . Otherwise little damage				

Event number (Deployment)	Mission Number	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Start Lat. (deg N)	Start Long. (deg E)	End Lat. (deg N)	End Long (deg E)	Distance Travelled (km)
58AUV041	253	2 Feb 2001	10:04:05	2 Feb 2001	23:42:00	-63.0728	-47.3689	-63.0758	-47.5586	63
		Under Ice Mission. In (south) by 25 km, turn right (west) 8km, then out by 30 km.				Mission Successful. One recovery line was dropped during recovery, resulting in a difficult recovery. Resultant damage to the sub was a lost front panel; broken aerials and broken prop. blades				
58AUV047	254	3 Feb 2001	15:25:21	3 Feb 2001	16:38:06	-63.0451	-46.8699	-63.0452	-46.8680	10
		For testing of the CTD sensors by Dr. Stansfield. Profile mission from 100m, up to 7 m, 5 profiles heading 90 deg, then 5 profiles returning at 270 deg				Mission Successful. Temperature gradients of about 1 Celsius per m depth seen.				
58AUV047	255	3 Feb 2001	17:48:33	3 Feb 2001	20:05:00	-63.0522	-46.8830	-63.0528	-46.9358	10
		Attempt to go under Ice berg with lawnmower pattern, at 180 m depth				Successful, but only small amount of data under Ice Berg. Drift rate of iceberg exceeded progression rate of lawnmower pattern. Consequently, very little time spent under the iceberg. Iceberg only intersected at near end of cover mission. *Autosub* surfaced close to the iceberg.				
58AUV047	256	3 Feb 2001	20:20:00	3 Feb 2001	20:30:00	-63.0528	-46.9358	-63.0567	-46.9317	0.7
		Short Mission to run *Autosub* on the surface to a safer place for recovery (*Autosub* have surfaced dangerously close to an iceberg.)				No data from EK500				
58AUV049	257	5 Feb 2001	12:34:52	5 Feb 2001	14:58:37	-62.8882	-51.1845	-65.8938	-51.1900	9
		Under large (1mile diameter) iceberg mission to collect EK500 (up) and ADCP up tracking data.								

Event number (Deployment)	Mission Number	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Start Lat. (deg N)	Start Long. (deg E)	End Lat. (deg N)	End Long (deg E)	Distance Travelled (km)
58AUV049	258	5 Feb 2001	16:36:00	5 Feb 2001	17:17:00	-62.9093	-51.1788	-62.8920	-51.2005	3
		Short transit mission at 10 m depth to get into better position for next iceberg mission.								
58AUV049	259	5 Feb 2001	17:48:28	5 Feb 2001	20:41:00	-62.9070	-51.1827	-62.9063	-51.1951	15
		Under Ice berg mission at a depth of 250 and 330 m , with intension of checking out the ADCP tracking performance. Initial heading 147 degrees. In 3.5 km, right 0.2 km, out 2.5 km, then repeated pattern at 330 m depth.				Successful completion of the mission. No EK500 data again. ADCP data was good. Tracking off lower surface of ice berg at a 170 m range.				
58AUV052	260	6 Feb 2001	17:04:58	6 Feb 2001	22:47:56	-62.9880	-51.4523	-63.0206	-51.4724	32
		Compass Calibration mission run at 50 m, to calibrate the compass following the battery change, followed by short 13km, -1km (to west), 16 km out, at initial heading of 180 degrees, also at 50m depth. Mission also to test EK500 following lack of data on previous mission.				Mission successful. EK500 worked OK. Seems that battery change and other remedies worked (insulating aerial, and cleaning up connector to reduce chance of earth leakage). The port side CTD sensors, were found to have connecting pipe between sensors missing. We do not know				
58AUV057	261	7 Feb 2001	20:04:11	7 Feb 2001	20:10:42	-63.0653	-51.4580	-63.0657	-51.4588	0.1
		Under Ice Pack at night				*Autosub* failed to dive, presumably due to unfavourable swell.				
58AUV057	262	7 Feb 2001	20:52:59	8 Feb 2001	13:20:00	-63.0653	-51.4580	-62.9753	-51.5573	80
		Under pack ice mission through the night. In 32.5 km, at 180 degrees, turn to 270 degrees for 5 km, then north and out of the ice for 42.5 km.				Mission Successful. Longest *Autosub* mission under ice so far. Mission was modified to dive on constant heading due to previous failed attempt. Dived without a problem. PAR sensor connector fault noticed, also bulkhead connector pin badly corroded. PAR sensor refitted with replacement connector. PAR data prior to this may be suspect.				
58AUV065	263	9 Feb 2001	19:46:16	9 Feb 2001	22:53:39	-61.8114	-57.0132	-61.9467	-56.9667	13
		Ship following mission. Run south for 13 km, at a depth of 10m.				Fog and occasional growlers made operation tricky. Otherwise successful.				

Autosub vehicle data: Sensor performance, calibration and problems

Autosub Data files

The data files on the CDROM are organised by day into separate directories.
In each directory you will find:

mnnn.hst
mnnn.bnv
mnnn.zip

where nnn is the *Autosub* mission number covered by the file (some days have more than one mission).

The mnnn.bnv file contains the best estimate of the vehicle position. See navprocess2_2.doc for more information about the fields contained in the .bnv file.

The zip file contains a file with the ls3 extension. This file contains selected variables from the *Autosub* logged data. For JCR58 there are 516 variables which are output at 3 second intervals. The first line contains the name of each variable while the second line contains the units for each variable.

The mnnn.hst file is a history file which contains information on the processing carried out to produce the sorted data contained in the .ls3 file. This includes the source file, the script file used to select which variables are to be output, the start time, end time and interval between records. The file will also indicate whether the data has been averaged, what value indicates missing data and whether any correction has been applied to the timing. The original logger elapsed time has been divided by this clock correction factor to give the output time.

Seabird Sensors

Many of the sensors used on *Autosub* are interfaced to the *Autosub* data recording system via the Seabird 911 CTD system. The 911 reads in the voltages and frequencies from the sensors, and outputs a frame of data 24 times per second, which are read by the *Autosub* data logger.

There are two sets of Conductivity and Temperature sensors: one on the port side front panel, the other on the starboard side. The C and T sensors are mounted protruding into the flow, to minimise any errors due to heat flow from the water trapped inside the *Autosub* body, to the sensors. Two independent pumps, pump water through the port and starboard side sensors. On the port side are also a Transmissometer, a Fluorometer., and a Beckman Oxygen sensor (see Dr. Stansfield's report on profiling tests to evaluate CT sensor performance).
C1,T1 are mounted on the port side; C2,T2 are mounted on the starboard side.

Internal to the Seabird electronics case is a Digiquartz 10,000 psi range pressure sensor. A Photosynthetically Available Radiation (PAR) sensor is mounted on the top front panel.

General Problems

On post-cruise inspection, seven sensor connectors showed slight corrosion problems , although all instruments except the transmissometer appeared to working correctly. We think that the most likely cause of the problem is the cold water and air temperatures which harden the rubber in the connector system, making successful sealing against water difficult. We found that it was much easier to make good connections by (carefully!) pre-heating the free plugs with a heat gun.

Seabird Sensor Calibration Data

Calibration Data for all the sensors attached to the Seabird system are held On CDROM in:
/CTD/JCR01.con

Serial numbers and dates of calibration are:

Conductivity sensors C1,C2:	S/N 042179 (port), 042219 (stbd)	13th October 2000.
Temperature sensors T1,T2:	S/N 03P2587 (port) , 03P2675 (stbd)	13th October 2000.
Oxygen Sensor (Beckman):	S/N 130508 (port)	11th October 2000.
Fluorometer (WetStar)	WS3S-431P (port)	8th August 1998.
Transmissometer (Wet labs C Star)	CST-2175DR (port)	26th August 1998
PAR Model QCD905L:	S/N 7252: (upper)	April 1999.
Pumps	02394 (port), 052203 (stbd)	

Problems and performance checks of the Seabird Sensors.

The sensor data were checked for *Autosub* Mission 262, the last long and deep running *Autosub* mission of the JR58 cruise.

CT sensors:

As a rough guide to the correct operation of the sensors, we calculated the mean and standard deviation of the difference between the port and starboard sensors. The low mean differences and standard deviations suggest sensors are working well, and are well calibrated.

Mean(T1-T2) = 0.00028 Celsius
Standard Deviation (T1-T2) = 0.0034 Celsius

Mean(C1-C2) = 0.000012 S/m
Standard Deviation(C1-C2) = 0.00026 S/m.

Post cruise inspection of the bulkhead connector revealed slight corrosion on the base of pin 2 (power presumably) of sensor T2.

Transmissometer:

The transmissometer appears to be faulty, or there is a problem with the data processing or calibration. Transmission shows only 5 values: 0.15, 0.16, 0.17, 0.18, 0.19. (much too low, and too few quantised levels)

Attenuation coefficient is 25.18 near surface to 25.09 at 200 m depth (value too high).

Post cruise inspection of the bulkhead connector revealed slight corrosion on the base of pin 2 (power presumably) of the transmissometer.

Fluorescence (Chlorophyll):

Seems to be working correctly, although the negative value at depth suggests calibration drift. Values of chlorophyll range from:

Near surface values : 0.02 to 0.1 mgram / Litre
At 200 m depth: -0.01 mgram / Litre

Photosynthetically Available Radiation (PAR):

After Mission 262 we noted that one PAR sensor bulkhead connector pins was badly corroded, indicating leakage of water into the connector. However, the PAR data for Mission 262 seems to be good, suggesting that the fault did not affect the data quality. We replaced the bulkhead connector before mission 263 (the final mission). The PAR sensor data was full scale for mission 263, suggesting that repair had been ineffective.

Near Surface values :	400 to 800 m Einsteins
At 200m depth, at night under sea ice:	0.046 m Einsteins

Presumably the 200 m at night reading is as accurate a dark current that we could hope to measure (at the operating temperature), so 0.046 should be subtracted from the PAR measurements (in m Einsteins).

BeckMan Oxygen Sensor (Checked on Mission 262)

Sensor appears to be working properly.

Values at near surface are 11 mg/Litre. At 200 m depth they are 8 mg/Litre.

Post cruise inspection of the bulkhead connector revealed slight corrosion on the base of pin 2.

Pumps

Pump serial number #052394 (port side) seems to have loose bearings on the impellor. There is corrosion at the base of the smaller bulkhead pin.

Pump serial number #052203 (starboard side) has corrosion at the base of pin 2.

Clock and Timing Problems

Seabird dropped data.

There has been a long standing problem that about 1% of Seabird data are missed or incorrectly ordered by the *Autosub* data logger. The most serious consequence of this is an apparent timing drift, as the Seabird software uses the count of Seabird data frames to calculate the sample time. Prior to the cruise we had been aware of this problem and had made efforts to correct it, hoping that this had been resolved. However on-cruise processing of data showed that the problem had not been fully corrected, with timing errors of several minutes accountable to this cause. This problem has now been corrected.

Data Logger Clocks

The *Autosub* Data Logger time runs fast by 0.64 +/-0.02 seconds per hour. This would have caused significant timing errors if not corrected for by the sensors which use independent clocks (such as Bohemoth and Seabird sensors).

The effective “clock” for the Seabird data is the 24 Hz frame output rate. The Seabird manual suggest that this should be accurate to +/-2 parts per million (+/-0.0072 seconds per hour), so this drift rate can be considered to be insignificant in the context of the length of missions, and the logger clock drift rate. Hence in practice the Seabird 24 Hz frame output has been used as the vehicle timing reference.

All the timing problems have now been corrected for and the data reprocessed, so that the time stamps in the ls3, bnv, and processed ctd files are as accurate as we can practically achieve at the present (about 1 second absolute, limited by the manual method used for time synchronisation between instruments). See the README file in the *Autosub* Data CDROM for more details.

ADCP data

Two 300 kHz RDI Workhorse ADCPs are installed on *Autosub*. One upward looking the other downward looking. The ADCPs are setup with the following configuration:

	ADCPdown	ADCPup
Bottom Track Pings per ensemble	1	1
Water Bin Pings per ensemble	2	2
Water Bin length (m)	4	4
Number of Water Bins	27	27
Ensemble Repetition time	2.7 seconds	Triggered at 1.5 seconds after ADCPdown
Beam Data Format	Geographical (Veast,Vnorth)	Geographical (Veast,Vnorth)

The ADCPs had several functions on the cruise:

1. To provide current profiles, up to a maximum of 100 m above and below the operating depth of Autosub.
2. For navigation - the measurement of *Autosub's* North and South velocity components. The maximum bottom range is generally about 200 m, and so the seabed was well out of range of the downward looking ADCP, consequenly all the vehicle navigation was based upon velocity through water, measure at profile bin 2, 9.84 m below *Autosub*. This reliance on water track data meant that the navigation accuracy is affected by currents.
3. As a back up to the EK500, to use the upward looking ADCP to detect the ranges to the under-ice surface of ice pack and ice bergs, and hence provide an estimate of ice thickness.
4. To investigate the effectiveness of the upward looking ADCP in providing relative velocity information between the *Autosub* and the under-ice surface. Such information is vital for the planning of the forth coming *Autosub* Under Ice (AUI) thematic program.

Both ADCPs appeared to work correctly throughout the missions, with useful engineering and scientific data recorded.

It is worth noting that the ADCP beam range data are not corrected for the pitch and roll of the vehicle; they simply have a constant correction factor to account for the 30 degree beam angle. So Reported Range = Range x cos(30 degrees).

ADCP relative rotations.

It was not possible to mechanically align the upward and downward looking ADCPs in yaw with sufficient accuracy, but by comparing the upward and downward looking ADCP current profile data it is possible to make an estimate of the misalignment error. Preliminary results show that the upward ADCP current data shows an apparent rotation of 2.9 degrees +/- 0.3 degrees, relative to the bottom looking ADCP.

In practice this means that the upward ADCP velocity data should be rotated by -2.9 degrees in Yaw. (rotation is in the normal maths sense - rotation cw is negative). Dr. Stansfield should be consulted for more details.

***Autosub* Depth Sensor Calibration problem**

Apart from the Seabird Pressure sensor there are two more Digiquartz depth sensors used for control of the vehicle, a 6000 psi unit (the primary sensor), and a 10000 psi sensor (used only as a backup for the Emergency abort system). Only the 6000 psi sensor data is recorded by the data logger.

Comparison of the *Autosub* primary depth sensor and the Seabird pressure sensor revealed that the Autosub depth sensor is incorrectly calibrated. To correct for the calibration error the Seabird pressure sensor was used as a standard. The final ascent of mission 259 was used to determine the conversion factor difference between the Seabird pressure and *Autosub* uncorrected depth (uncorDepth), by comparing mean pressure and depth values before and after the ascent from 300m.

	Seabird Pressure (dbar)	uncorDepth (m)
Before Ascent. Hrs 20:00 to 20:15	323.4957	330.008
After Ascent. Hrs 20:42 to 20:49	-0.0427	0.057
Difference	323.539	329.951

The conversion scale factor from uncorDepth to Pressure is calculated as

323.539/329.951 = 0.9805668

From the calculated Pressure, the corrected depth (Depth) can be calculated. According to (Unesco 1983), the conversion factor between Pressure and depth at a latitude of 63 degrees South and at 200 m depth is:

Depth(m) = Pressure(dbar)/1.0102.

This factor was used to calculate Depth from Pressure. It should be noted that this is a linear (straight line) approximation to a non-linear function. However evaluation of the error between this approximation and the CSIRO matlab function revealed that the error over the depth range 0 to 300m is a maximum of 1.02 cm, standard deviation 0.3 cm (much less than the sensor accuracy and resolution).

Hence the .bnv files were corrected with the following algorithm: (vector operations)

uncorDepth = Depth;	// Copy Autosub Depth to uncorDepth.
Pressure = 0.98056681 x uncorDepth;	// Autosub Pressure calculated in dbar
Depth = Pressure / 1.0102;	// Calculate corrected depth, replacing original Depth field.

In the .bnv files the Depth field is now corrected, and there are two extra fields, Pressure (dbar), and uncorDepth (m).

NB. Note that in the .ls3 files contain a field “DepCtldepth”. This contains **uncorrected** Depth.

References

1. UNESCO 1983. Algorithms for computation of fundamental properties of seawater, 1983. UNESCO Tech. Pap. In Mar. Sc. No. 44, 53 pp. Equation 25, p26.

***Autosub* Zig-Zag mission (M254) February 3rd 2001**

Summary: A 4.7 km long mission yo-yoing between 5 m and 80 m through a sharp temperature gradient (maximum gradient -0.4 deg C over 0.5 m) to investigate i) the responses of the *Autosub* conductivity and temperature sensors and ii) any thermal bias effect due to the location of the sensors within the body of *Autosub*.

Start position: 63.0451 S, 46.8699 W   End position: 63.0452 S, 46.8680 W
Nominal start time: 15:25:21   Nominal end time: 16:38:06

During this mission *Autosub* performed a total of 10 up and down profile pairs. The first 5 profiles were done over a distance of 2.35 km while the vehicle was heading east, at 090 degrees, the vehicle then turned though 180 degrees and carried out a further 5 profiles while heading west, at 270 degrees, back to the starting waypoint.

The 24 Hz CTD data were processed using the SEASOFT routine DATCNV and the file JCR01.con which contains the calibration constants for each sensor. The SEASOFT routine CELLTM was then used to correct the data for the thermal mass effect of the conductivity sensors. The values used for ", the amplitude of the thermal anomaly, and J, the thermal anomaly time constant, were the nominal values recommended by Sea-Bird for a 911 plus system, i.e., " = 0.03, J = 7.00. The data were then split into up and down profiles and averaged to 0.1 m vertical bins.

The location of the strong temperature gradient appeared to change by several metres between profiles, but no consistent bias between upward and downward temperature profiles was observed. A plot of temperature difference for each profile pair at each 0.1 m bin, (Tup(z)-Tdn(z), z=15:0.1:30 m) vs the difference in local rate of change of temperature for each pair at the same depth (dTup(z)/dt-dTdn(z)/dt), showed no obvious relationship, see Figure 1.

Observed variations in T-S space between the up and down profiles and any spiking in the conductivity/salinity data due to the sharp temperature gradient will be investigated in due course. The local Brunt Vaisala period about the “interface” was calculated to be about 1 minute.

Qualitative comparison between *Autosub* 300 kHz ADCP velocities and Shipboard 150 kHz ADCP velocities.

1.5 hours of data from the start of mission 248, where the ship followed *Autosub* to the ice pack edge, has been used to make a qualitative comparison between the ship ADCP and the *Autosub* ADCP velocity data. The data covers the period when *Autosub* was at a constant depth of 193 m and a heading of 148 degrees. The *Autosub* ADCP velocity data has been corrected for the misalignment of the upward and downward looking ADCP in the x-y plane, by applying a rotation of -3.03 degrees to the upward data.

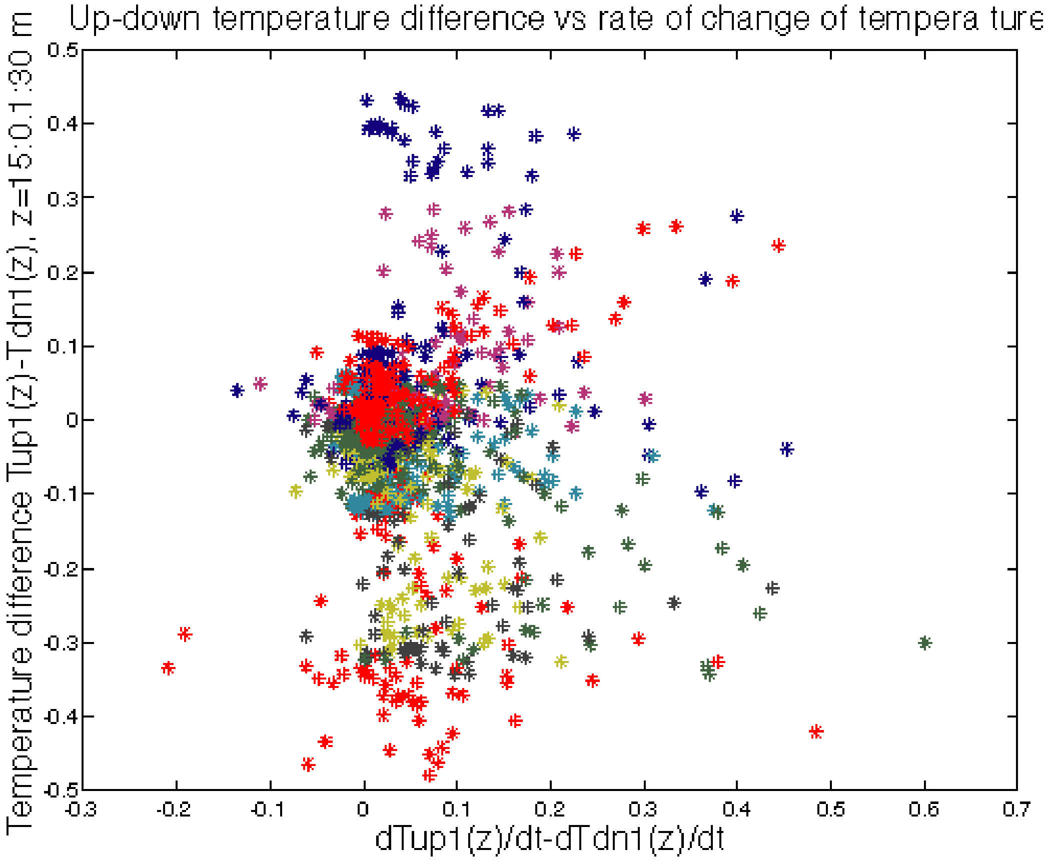

Up-down temperature difference vs rate of change of tempera ture
Temperature difference Tup1(z)-Tdn1(z), z=15:0.1:30 m
dTup1(z)/dt-dTdn1(z)/dt
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

Figure 1

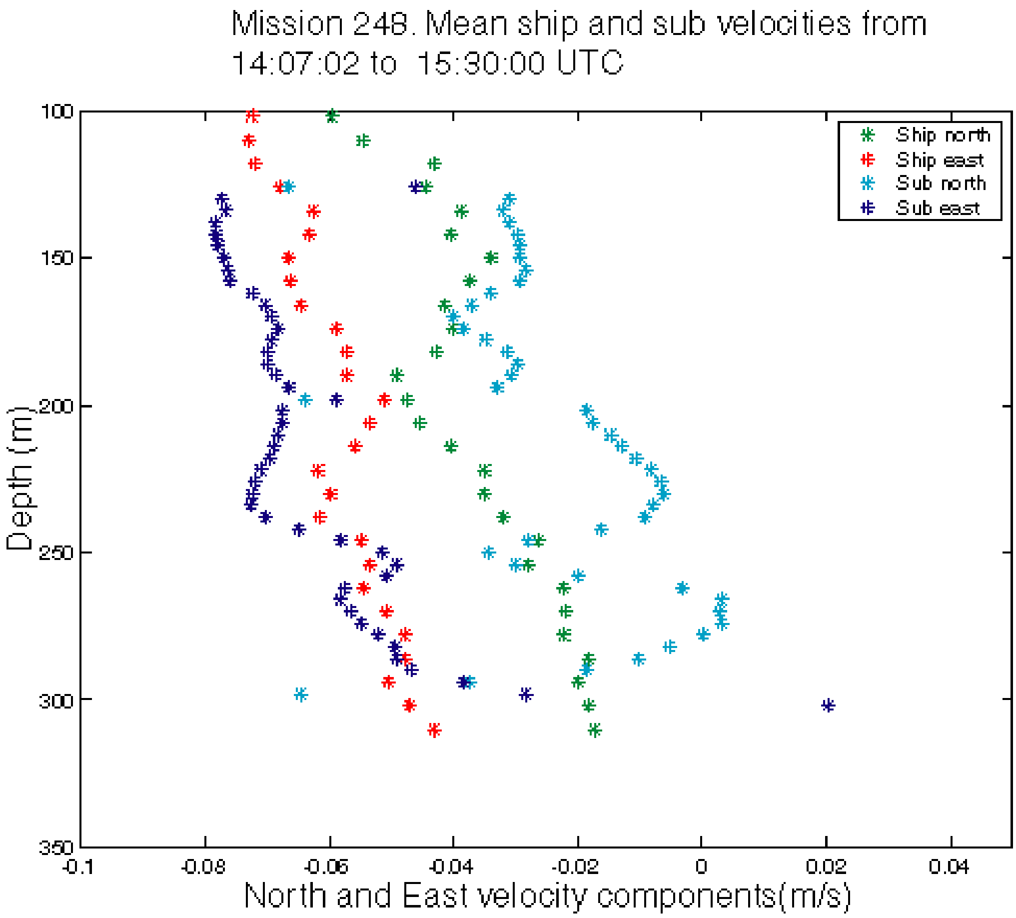


Figure 2

Figure 2 shows the mean east and north velocity components as measured by the ships ADCP and *Autosub*'s upward and downward looking ADCPs. *Autosub* ADCP data is referenced to bin 2 of the downward looking ADCP and the calculated mean drift rate for the entire mission (in this case -0.07 m/s east, -0.016 m/s north) and is therefore not "absolute" in the same sense as the ships ADCP data. The qualitative agreement of the two data sets is encouraging.

Fishing Gear

The only net sampling gear used during the cruise was the Antarctic Multiple Plankton Sampler. This was the first extensive use of this sampler, it proved to be very reliable and to take samples in very good condition. A total of 26 hauls were made and there were no failures. It has proved to be very stable in operation and when paid out to a given depth there is very little change of depth after paying out has ceased. Only variations in ship speed affect the depth.

No serious problems were experienced with the net, on one occasion some of the springs used to pull the cod-end net bars down spilled out of their housings as the net closed, this was almost certainly due to the fact that they were jammed up with frozen snow that did not melt in the water before the net was released. Various minor adjustments were required and some fasteners had to be replaced.

Operation with TUBA.

The TUBA acoustic device was attached to the AMPS frame and connected to the surface by an electromechanical cable (4 conductors plus screen) fed from a self tensioning slipring winch. a metering sheave was used to co-ordinate cable veer/haul rates between the self tensioning winch and the main towing cable winch.

Description of the AMPS.

The AMPS is a frame mounted net having a mouth area of 1.5m^2 , there is a main fixed catching net of 1.5 mm mesh and 5 cod-end nets of approx 1mm mesh. The cod-end nets each have an effective mouth area of 0.25 m^2. The AMPS is used in conjunction with the BAS Down Wire Net Monitor. The sampler is normally launched with all cod-end nets closed and the exit from the catching net open so that any animals entering the net are flushed straight through. On receipt of a command from the DWNM the first cod-end net bar is released and the net opens across the exit from the main net. Further commands in sequence close one cod-end and open another until all five have been used. A sixth command closes the fifth net leaving the exit of the catching net clear again. The mounting frame is 5 m long and carries a horizontal tailplane and vertical fins to stabilise the frame and ensure that it tows in an approximately horizontal attitude. Stability is further achieved by the fitting of a weight bar (approx. 110 kg) in the frame below the towing bar. A feature of the net is that the towing point is 1 m behind the mouth, ensuring that plankters receive the minimum of visual cues to the approach of the net. A drogue of 0.5 m diameter is used to steady the back end of the frame during launch and recovery.

Down Wire Net Monitor.

DWNM’s have been in use on the JCR for 9 years, the version in use this season is new and briefly described in the JR57 Cruise report. Problems were experienced on JR57 when used to operate the release mechanism on the AMPS, the problem related to the high current drawn by the release motor. A ‘work around’ was developed on JR57 whereby an external power supply was placed is series with the built in power supply. When switched on, the additional power supply caused a shift in the depth readout, as a result the unit was only switched on immediately before a net release was required and then off again immediately afterwards. One small problem was experienced at the start of the cruise when the DWNM was powered up. A delay built into the underwater unit, designed to prevent a pulse generated on startup from triggering premature release of nets, was found to be too short. This was corrected and no further problems were experienced throughout the cruise.

The following sensors were fitted to the DWNM:

Depth, (pressure)

Temperature,

Conductivity, (a readout being given in practical salinity units).

PAR.

Angle (of the DWNM housing)

Flow meter.

Altimeter.

An offset was apparent on the depth, in order to determine the extent and nature of this offset the altimeter was fitted to the top of the frame and pointed upwards, where it gave a reading off the surface. This revealed the depth offset to be a constant under-reading of 4 metres (down to 100 m, the limit of the altimeter range.)

EK500 Operation

Simrad EK500 scientific echosounders were run aboard RRS *James Clark Ross* and *Autosub*. On RRS *James Clark Ross* 3 frequencies were operated (38, 120 and 200 kHz) and on *Autosub* we ran 38 and 120 kHz transducers. All data were logged using SonarData's Echolog_EK software.

RRS *James Clark Ross* EK500

Operation

Details of the EK500 setup on RRS *James Clark Ross* are provided in the JR57 Acoustics report and repeated only briefly here: Clocks on the EK500 and both workstation 1 and 2 were synchronized manually with the ships clock daily, to the nearest second. EK500 settings were dumped to Workstation 1 D drive using echoconfig R* command (NB if Echoconfig has to be restarted the IP address of the EK500 may have to be re-entered in the file/settings option), and saved with date name. Changes in the settings were checked for using cygwin diff command (e.g. diff January5_2001.txt January6_2001.txt). All EK500 settings for each day of cruise JR58 can thus be found from the appropriate daily settings dump file.

.ek5 files from G:\logdata (D on workstation 1) were moved to a folder of the day's date in the JR58 folder and copied to the logdata directory on the D drive (workstation 2). A list of file names were made from the G drive folder of that date using msdos command dir/b >file.txt. This text file was copied into jr58_file_list.wpd and annotated with times of clock re-synchronisation and settings dump. Annotations from notebooks were also added adjacent to the relevant file.

Backups to CD were made after 650MB had been accumulated. Due to the large number of files produced whilst collecting EK500 samples data (high resolution), the second back up was of zipped files.

JCR EK500 interference and the Simrad Synchronization Unit

As in previous cruises, electrical interference was apparent on the ship's EK500. The interference manifested itself as a "herring bone" beat pattern. Why is there a beat pattern visible? It is not related to interference from another sounder. It is not related to propeller blade frequency - reducing from 100 rpm to 50 rpm showed no change. It is related to the main AC generators - not when purely spinning, but when they are 'on the board'.

This echotrace detail in Figure 3 shows the effect of different combinations of generators - the beat frequency is an indicator of how closely the EK500 trigger repeat period is a harmonic of the mains frequency.

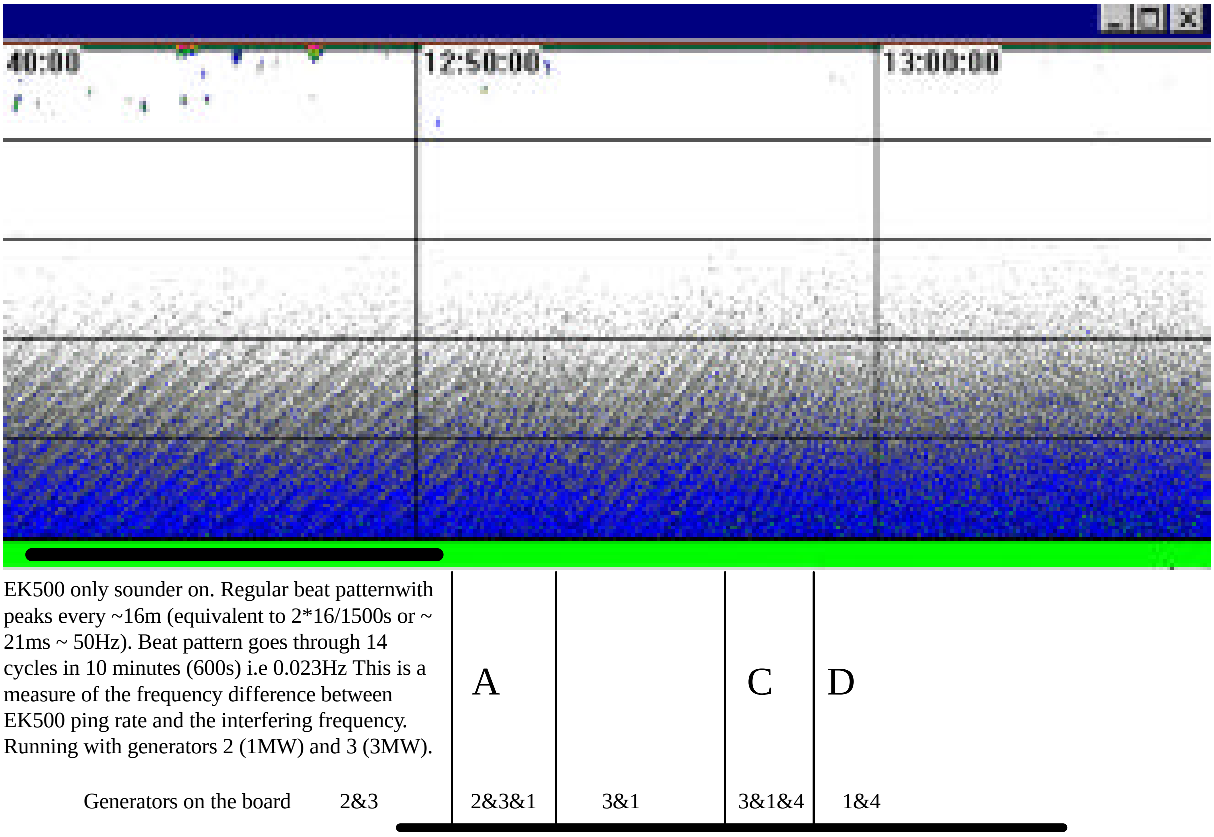


Figure 3

Notes for the periods above

A) No. 1 generator (1MW) added to the board. Slope of the beat pattern increases to ~ .059Hz.

B) No. 2 generator taken off line, Nos. 3 and 1 taking the load. Frequency drops for a short time, then increases to a beat of ~.025Hz. No. 2 stopped - no change. No. 4 started - no change.

C) No. 4 added to the board, increase in slope, to ~ .056 Hz.

D) No. 3 taken off the board, but still running, frequency increases, rather difficult to read, but ~ .0.1Hz.

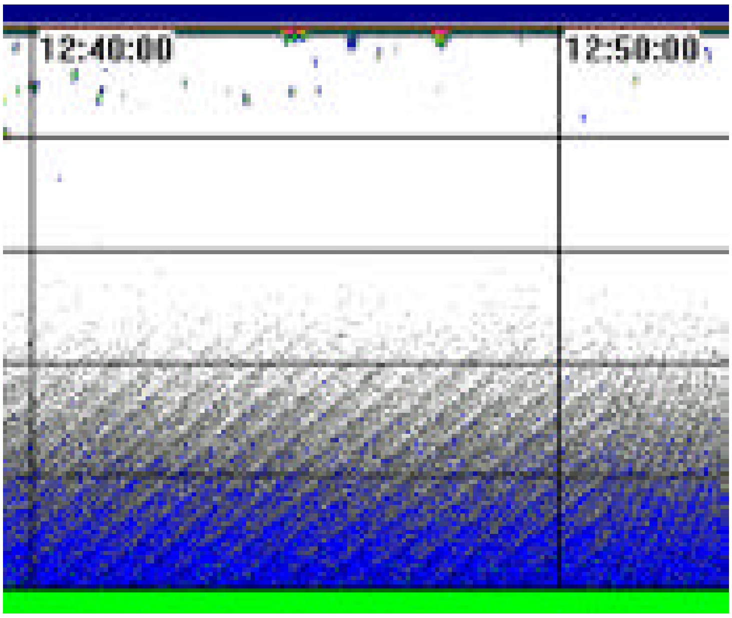
Why does the beat pattern breakdown when the EA500 echosounder is operated in conjunction with the EK500 through the Simrad Synchronisation Unit?

1. The EA500 and EK500 were treated as separate ‘groups’ in the Sync. unit. This means the sounders wait for each other to complete their listening periods before transmitting, in order to avoid the transmission pulse from either sounder occurring within the reception period of the other.

2. Furthermore, the listening time for the EA500 is a function of the bottom depth. That is, the deeper the bottom, the longer the sounder waits for a return, hence the longer the EK500 has to wait before it is allowed to transmit again.

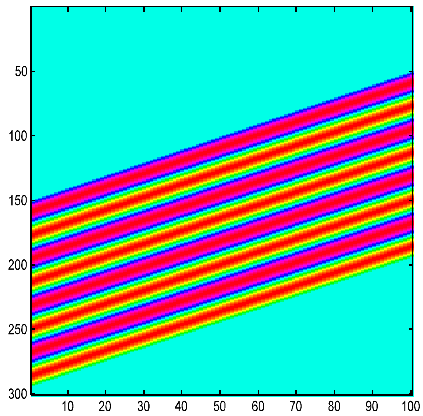
3. We remember that the EK500 echo trace is not time synchronous. That is, each vertical 'pixel line' (one transmission/reception) is drawn when it happens. There is no 'white' space as time progresses but no transmission is allowed by the sync. unit.

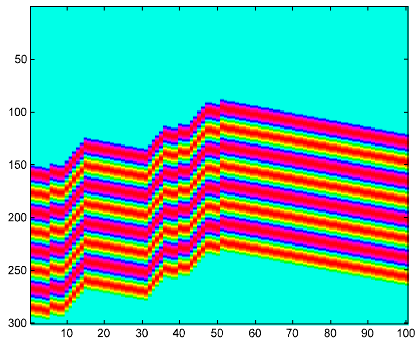
4. Now, take the very regular beat pattern observed at 120 kHz with the EK500 operating alone, below.

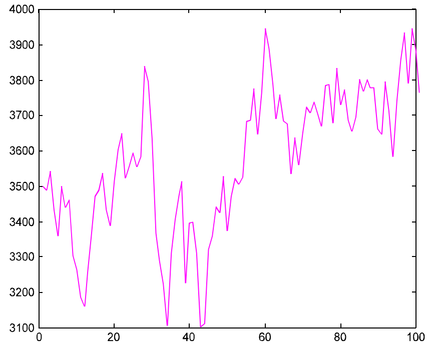


5. Consider what happens when the regularity of the EK500 trigger is disrupted by the sync. unit.

6. The situation can be simulated (in a simplified way) using Matlab. First the regular trigger situation is reproduced, below left, as a band of beats with a sinusoidal amplitude slowly changing position in time. Next, the simulation departs from a regular time or x axis. The time, or x value, for each 'ping' is made to be related to the 'bottom depth' see bottom panel, between 3100 and 4000 m.







7. Thus, to some extent, the position of the noise pattern on the EK500 reflects the depth of the sea!

8. As to what can be done .... on cruises where the EK500 is used for quantitative assessment of krill (or other) biomass it is imperative that the EK500 pings regularly and that it be given priority on the SSU. The change in beat pattern reported above would not occur if the EK500 was pinging regularly, say once every 1.5 seconds, and regular pinging (sampling) is required for statistically robust krill abundance estimation.

Autosub **EK500**

On all except the final USIPS *Autosub* mission the echosounder transducers were mounted on the vehicle's dorsal surface looking upwards. The ping interval was optimised to provide the fastest ping rate possible while sampling the entire water column above *Autosub*..

SonarData's Echoconfig program does not work with the *Autosub* EK500 system because the EK500 logging computer in *Autosub* is equipped with 2 ethernet cards and, by default, Echconfig does not select the card required for EK500 configuration. The EK500 in *Autosub* was configured via the serial line using Eric Armstrong's Delphi programme EK Control. EK Control did not enable us to gather a daily record of EK500 settings and so we record here that after and including *Autosub* mission 250 the bandwidth at 120 kHz was changed from Narrow to Wide.

RRS *James Clark Ross* and *Autosub* EK500 Calibrations

Bad weather and unfavourable ice conditions prevented us from calibrating either of the EK500 systems in Admiralty Bay, South Shetlands, as we had intended. Our only remaining option in the time we had available to us was to calibrate in the Falkland Islands. This was not ideal because the water temperatures there are considerably higher than those we had worked in in the northern Weddell Sea.

Calibration was carried out on January 13th and 14th in Berkeley Sound in water 32 m deep. Water temperature was 10.1°C, salinity was 33.7 psu and together these gave a sound velocity of 1488.9 ms^{-1}. All calibrations were conducted off a 38.1 mm diameter WC sphere.

We had some trouble locating the calibration sphere beneath the ship's transducers. This was possibly due to the fact that the water depth beneath the ship was shallower than that in our usual calibration sites: as a result of the need to suspend the sphere at a shallower depth the angles at which the suspension lines passed beneath the hull were greater than usual and this may have lead to increased instances of snagging.

The *Autosub* transducers were mounted in the BAS towfish for calibration. This enabled the BAS suspension booms and motors to be used to locate the spheres beneath the transducers, and worked very well.

Several calibrations were conducted using various bandwidths to cover all the combinations employed during the cruise, and using both the standard BAS calibration technique and the Marine Laboratory Aberdeen's technique of incorporating a receiver delay into the estimation of range for calculation of theoretical NASC. Results are given below:

EK500	Frequency*	Bandwidth	Pulse length	Receiver delay	Sv Gain	TS Gain
JCR	38 (JR58)	Wide (3.8 kHz)	Short (0.3 ms)	No	25.62	25.44
JCR	38 (JR58)	Wide (3.8 kHz)	Short (0.3 ms)	Yes	25.54	-------
JCR	38 (JR57)	Wide (3.8 kHz)	Medium (1.0 ms)	No	25.16	25.86
JCR	38 (JR57)	Wide (3.8 kHz)	Medium (1.0 ms)	Yes	25.10	-------
JCR	120	Narrow (1.2 kHz)	Long (1.0 ms)	No	21.42	21.12
JCR	120	Narrow (1.2 kHz)	Long (1.0 ms)	Yes	21.33	-------
JCR	200	Narrow (2.0 kHz)	Long (1.0 ms)	No	23.88	23.48
Autosub	38	Wide (3.8 kHz)	Short (0.3 ms)	Yes	24.04	23.96
Autosub	120	Wide (12.0 kHz)	Medium (0.3 ms)	Yes	22.46	22.61
Autosub	120	Narrow (1.2 kHz)	Medium (0.3 ms)	Yes	21.76	21.80

* bracketed cruise number indicates calibration carried out with settings as for JR57 or JR58

Temperature Effects

Our own and other previous work has shown that echosounder calibration is temperature dependant (eg Brierley, A.S., Goss, C., Watkins, J.L. and Woodroffe, P. (1998). Variations in echosounder calibration with temperature, and some possible implications for acoustic surveys of krill biomass. CCAMLR Science, 5: 273-281). To assess the possible impact of the elevated temperature at the Falklands calibration site on our actual echosounder calibration we next present equivalent JR58 calibration values (from the ship's echosounder, with pulse lengths equivalent to those used on JR57) alongside those obtained at Stromness, South Georgia, during JR57:

Gain	Pulse Length	Band Width	Receiver Delay	Stromness JR57	Berkeley Sound JR58	Difference JR57-JR58
38 Sv	Medium	Wide	No	25.59	25.16	0.43
38 TS	Medium	Wide	No	25.33	25.86	-0.53
120 Sv	Long	Narrow	No	20.32	21.42	-1.1
120 TS	Long	Narrow	No	20.32	21.12	-0.8
200 Sv	Long	Narrow	No	22.71	23.88	-1.17
200 TS	Long	Narrow	No	22.74	23.48	-0.74

From this it can be seen that, with the exception of the 38 kHz Sv gain (calibrated using a short pulse duration for which we have little previous data), the Berkeley Sound values are all higher than the Stromness values. This predominant direction in change of gains between warm and cold waters (higher in warm waters, lower in cold) is as we have previously observed on the RRS *James Clark Ross*. In light of this, the best course of action would seem to be to adjust the JR58 calibrations by the difference between the JR57 and JR58 calibrations, which we believe to be attributable to temperature.

We believe that the best and most appropriate JR58 calibration values available to us are those obtained with the receiver delay implemented. Thus for the ship's EK500 we will use the JR58 receiver delay calibrations adjusted by those amounts given in the difference column above.

Thus, the most appropriate calibration values for us to use for data processing are:

EK500	Freq	Bandwidth	Pulse Length	JR58 Logging Gains		JR58 Calibrated Gains		JR57/JR58 Temperature Adjustments		JR58 Gains Adjusted to JR57 = **FINAL**	
				Sv	TS	Sv	TS	Sv	Ts	Sv	TS
JCR	38	Wide (3.8 kHz)	Short (0.3 ms)	**25.49**	**25.60**	25.54	25.44	0.43	-0.53	**25.97**	**24.91**
JCR	38	Wide (3.8 kHz)	Medium (1.0 ms)	**25.49**	**25.60**	25.10	25.86	0.43	-0.53	**25.53**	**25.33**
JCR	120	Narrow (1.2 kHz)	Long (1.0 ms)	**20.26**	**20.26**	21.33	21.12	-1.1	-0.8	**20.23**	**20.32**
JCR	200	Narrow (2.0 kHz)	Long (1.0 ms)	**22.78**	**23.07**	23.88	23.48	-1.17	-0.74	**22.71**	**22.74**
Autosub	38	Wide (3.8 kHz)	Short (0.3 ms)	**26.50**	**26.50**	24.04	23.96	0.43	-0.53	**24.47**	**23.43**
Autosub	120	Wide (12.0 kHz)	Medium (0.3 ms)	**26.50**	**26.50**	22.46	22.61	-1.1	-0.8	**21.36**	**21.81**
Autosub	120	Narrow (1.2 kHz)	Medium (0.3 ms)	**26.50**	**26.50**	21.76	21.80	-1.1	-0.8	**20.66**	**21.00**

Physical Oceanography

ADCP measurements

Summary

This report describes the method of acquisition of ADCP data on JR58 and the problems encountered. The system was operated in two modes: in water track when water depths were greater than 300 m and bottom track in shallower waters. In general the ADCP worked very well with water track velocity information generally obtained down to 350 m depth and bottom track to 500m.

The configuration of the ADCP

The RRS *James Clark Ross* is fitted with an RD Instruments 153.6 kHz hull-mounted acoustic Doppler current profiler (ADCP). In contrast to other research ships in the NERC fleet, the orientation of the transducer head is offset by approximately 45° to the fore-aft direction in the hope that the instrument would give a better response in the main direction of motion (i.e fore-aft). Another difference with other British ships is that to protect the transducer from ice, it is mounted in a sea chest that is recessed in the hull. This sea chest is closed to the sea by a 33 mm thick window of Low Density PolyEthylene (LDPE).The cavity around the transducers is filled with a mixture of 90% de-ionised water / 10% ethylene glycol. This is a significant alteration to previous years when the cavity was filled with a silicone oil. The version of the firmware used by the ADCP was 17.07 and the version of RDI Data Acquisition Software (DAS) was 2.48. The software ran on a IBM 286 PC. For jr58 the ADCP was configured to record data in 64 x 8 m bins and in ensembles of 2 minute duration. The `blank beyond transmit' was set to 4 m, this coupled to the depth of the transducer being approximately 6 m gave the centre of the first bin depth at 14 m.

In water depths of less than 400 m the ADCP was operated in bottom track mode. Because of the nature of this cruise this data is limited to around the Falkland Islands, both transits across the Burdwood Bank and a small region around King George Island. Water track mode was used in deeper water. The Bottom track mode was configured through the Direct Command menu of the DAS software using the command FH0004. This sets the instrument to one bottom track ping for every four water tracked pings.

Unlike all other underway scientific instruments on the RRS *James Clark Ross*, the ADCP does not log to the SCS system and the 2 minutes ensembles of data are fed through a printer buffer directly into the Level C. This means that when there is a problem with the ships Level C system, data has to be recovered from the PC files. Such a problem occurred on day 039 and 2039 when I changed the ADCP from water track to bottom track and stalled the logging system. Data from this time period was recovered at a later date from the raw pingdata files that are output from the DAS software.

Standard method of processing

The data path is detailed below and in Figure 4. From the Level C system data were read into pstar files of 12 hours length and processed using the pstar data processing software. The processing of the ADCP is complex and involves data from several navigation streams (described in the navigation data report).

Step 1: Read in the data.

The data were read using our conventions for underway data in 12 hour chunks containing either the period 0000 to 1159 or 1200 to 2359. This was achieved with a Unix script 58adpexec0 which outputs two files. One containing the water track data and one containing the bottom track data. When the ADCP was set to record only water track information the bottom track file contains only engineering data and zero's for the bottom velocity.

Step 2: Correction for temperature around transducers

With the replacement of the fluid surrounding the transducers from oil to the deionised water/ ethylene glycol mix, the correction to water velocities that has previously applied to the RRS James Clark Ross data has required modification. This modification was derived by Dr Mike Meredith (BAS), and Dr Brian King (SOC). I reproduce Dr Meredith's description of the verbatim below.

"The ADCP DAS software assumes that the fluid surrounding the transducers is ambient seawater, and derives a speed of sound through measured temperature at the transducer head and an assumed salinity of 35. However, a correction is clearly needed to account for the fluid being the 90% de-ionised water / 10% ethylene glycol mixture instead of seawater.

From point measurements obtained from RDI, we previously derived the following equation for the speed of sound through the mixture as a function of temperature:-

$$c = 1484 + 3.6095t - 0.0352 t^2$$

The individual velocity measurements from which this equation was derived were quoted to an accuracy of 0.01%, with the environmental conditions being known to within ± 35 kPa pressure and ± 0.5°C temperature.

This equation was used to derive a correction term to adjust the speed of sound assumed by the DAS to one appropriate for the mixture in the sea chest. The correction term was:-

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

This correction is applied to both the raw water and bottom tracked velocities using the unix script 58adpexec0.1. A further correction for temperature is applied in this script, due to the temperature-dependency of the velocity scaling correction A (see later). This correction was the value derived on JR55, i.e. (1-0.00152*temp)."

Step 3: Correction for the PC clock drift.

Another problem that has to be accounted for in ADCP processing is that the DAS software time stamps the data. Unfortunately this time stamp comes from the 286 PC clock which drifts at a rate of approximately one second per hour. To correct this to the ships master clock, the time drift was measured several times a day and a correction derived and applied to the ADCP data time using the Unix script 58adpexec1.

Step 4: Correction for the gyrocompass error.

The ADCP actually measures water velocity relative to the ship. To calculate east and north water velocities from the ADCP data, information is required on the ship's heading and velocity over the ground. This is partially fulfilled with input is from the ship's gyrocompass (described in the navigation report). However it is well known that in addition to having an inherent error, gyrocompasses can oscillate for several minutes after a turn before steadying on a new course. As well as that there is an additional deviation that varies as cosec (latitude). To overcome these difficulties the ADCP data is "corrected" with data from the Ashtec ADU-2 (see navigation data report). We cannot use the Ashtec as a gyrocompass substitute because we do not have continuous coverage, we can however correct the data on an ensemble by ensemble basis. From the navigation report, after the "standard processing" the Ashtec data edited according to standard criteria is a file of 2 minute averages. The data still however contains both gaps, and large spikes. These spikes are removed using an interactive editor, and the gyrocompass correction linearly interpolated. The correction is applied to the ADCP data through the Unix script 58adpexec2.

Step 5: Calibration of the ADCP data

A final correction is now required to correct for the misalignment between direction as defined by the Ashtech ADU-2 antenna array and the actual direction of the ADCP transducers. This correction is called the heading misalignment N. There is also an inherent scaling factor , A, associated with the ADCP by which the water velocities must be multiplied by to scale them correctly. The method of calculating A and N is described below. These corrections are applied through the Unix script 58adpexec3.

Step 6: Derivation of Absolute velocities

By this stage the data contains calibrated water velocity relative to the ship. To derive absolute velocity we merge the files with position from the "bestnav" navigation file (see navigation report for description) and derive ship velocity between ensembles. This velocity is then removed from the water velocity data to give absolute water velocity. This is performed using the Unix script 58adpexec4.

Method of derivation of the calibration coefficients A and N.

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

1. Periods where identified when the ADCP gave bottom tracked velocities - that is when the ship was working in water depths of generally less than 300 m. With the survey plan of the Core Programme we have many such periods.

2. The files with bottom tracking velocities were then calibrated with a nominal scaling in 38adpexec3 by setting the scaling factor A to one and the misalignment angle N to zero.

3. The two minute ensembles of ADCP data were then merged with bestnav position fixes.

From these bestnav fixes the ship's east and north velocity over ground were calculated. Time periods within each data file were then identified where the ship's heading and velocity did not deviate greatly over a period of at least 6 minutes.

4. The ADCP bottom track velocities are then multiplied by -1 as the velocity of the ship given by the bestnav fixes is in the opposite sense to the velocity of the bottom as derived by the ADCP.

5. Values for *A* and *N* for each time period are then derived from vector mathematics using

$$A = U_{gps}/U_{ADCP}$$

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

$$N = N_{gps} - N_{adcp}$$

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

There are significant amounts of bottom tracked data on this cruise, however for the moment I have applied calibration values of *N* = -1.4781 and A of 1.0253 derived by Dr Meredith on cruise jr57. On return to the UK I will reassess the data and will most likely revise these figures.

Summary

The ADCP has worked very well.

Suggestions

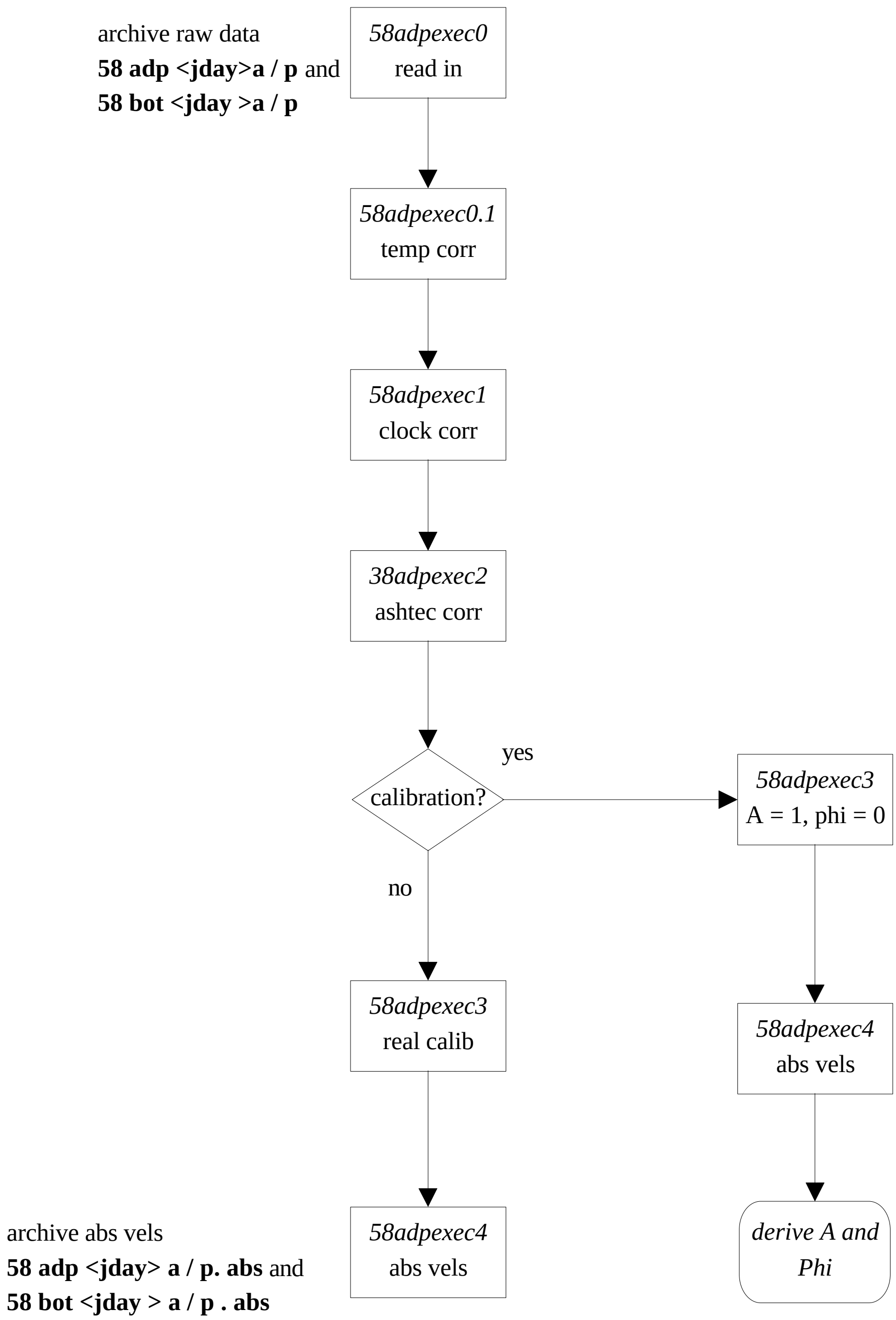
I have two suggestions:

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

ii. A different data path should be investigated to make the instrument fit in with the SCS system.

Figure 4 The ADCP data processing route

Figure 1: The ADCP data processing route



CTD Operations

Summary

In this report we give details of the method of acquisition, and calibration of CTD data on JR58. The system performed excellently throughout the cruise, and no problems were encountered. A full station list is given in Table 1. In all profile CTD stations the 2 dbar averages of the downcast data are reported as the final product.

The CTD configuration

The CTD system used on JR58 was the BAS Sea-Bird 911 plus (serial number 09P15759-0480). The CTD was fitted with seven scientific sensors:-

1) primary temperature (SBE 3 plus, serial number 032191, calibrated 22-6-2000)

2) primary conductivity (SBE 4C, serial number 041913, calibrated 26-6-2000)

3) pressure (series 410K-105 Digiquartz pressure transducer, serial no. 067241, calibrated 30-6-2000)

4) secondary temperature (SBE 3 plus, serial number 032307, calibrated 22-6-2000)

5) secondary conductivity (SBE 4C, serial number 041912, calibrated 26-6-2000)

6) transmissometer (serial number CST-396DR, calibrated 17-10-2000)

7) fluorometer (Chelsea Instruments Aquatracka Mk.III, serial number 088216, calibrated 7-1-2000)

The temperature and conductivity sensors were connected to two SBE 5 T submersible pumps (serial numbers 051813 (to 032191 and 041913), and 051807 (to 032307 and 041912)). The CTD was connected to an SBE 32, 12 position carousel water sampler carrying twelve 10 litre Niskins. In addition to these, an altimeter was fitted to permit accurate near-seabed approach, but the altimeter data were not processed alongside the data from the other sensors. Also fitted to the water sampler frame was an SBE 35 high precision thermometer (serial number 3515759-005).

Deployment and data capture

Deployment of the CTD package was from the midships gantry and A-frame on a single conductor, torque balanced cable made by Rochester Cables and hauled on a 10T traction winch. There were no problems deploying the CTD package as close control was maintained with the gib arm and two hand lines by the ship's crew whilst the package was suspended above the surface. Once in the water the package was lowered to 10 m depth and left to soak for 2 minutes. After this period of time the package was returned to the surface and lowered without stopping to 1000m. On the upcast the package was stopped at 200 m interval to close bottles for calibration samples. At each bottle level the package was left for 30 seconds before closing a bottle.

The CTD data were logged via an SBE 11 plus deck unit to a 486 Viglen PC running version 4.225 of Seasoft Data Acquisition Software (Sea-Bird Electronics Inc.). For data acquisition this interface was used to first reset the PC clock to the ship clock, then to enter the SEASAVE module of the Seasoft software. This module is used for real time data acquisition. As well as allowing graphs of various parameters to be drawn in real time the software allows the user to set a data rate. On jr58 this rate was set to 1 giving a data rate of 24Hz. When the CTD cast was over and the SEASAVE module exited, there were four files created:

58ctdNNN.dat (binary raw data file)

58ctdNNN.con (configuration data, actually a copy of the input configuration file jr58.con)

58ctdNNN.hdr (header file containing sensor information)

58ctdNNN.bl (file with data cycle numbers for bottle closures)

Following *Seasave,* the SBE program *Datcnv* was run to calibrate the data, and convert to ASCII output. This file was named as 58ctdNNN.cnv.

Within the Datcnv module the calibration for each sensor was as follows:

For the Pressure Sensor:

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

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

$$D = D_1 + D_2 U$$

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

$$T_o = T_1 + T_2 U + T_3 U^2 + T_4 U^3 + T_5 U^4$$

and C is

$$C = C_1 + C_2 U + C_3 U^2$$

all other coefficients are listed in Appendix A

For the Conductivity Sensor:

$$cond = \frac{\left(g + h\,f^2 + i\,f^3 + j\,f^4\right)}{10\left(1 + d\,t + e\,p\right)}$$

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

and for the temperature sensor:

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

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

The seasoft module *Celltm* was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This correction followed the algorithm dt = temperature - previous temperature

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

and

corrected conductivity = c + ctm.

and

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

b = 1 - (2 * a / alpha)

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

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

The resultant file was named as 58cnvNNN.cnv. These ascii files were then transfered to unix for a further processing.

SBE35 High precision thermometer

Every time a water sample is taken using the rosette, the SBE 35 recorded a temperature in EPROM. This temperature was the mean of 8.8 seconds data. The thermometer has the facility to record 157 measurements but we downloaded the data approximately every 5 casts (60 measurements). At a suitable time the data from this thermometer was downloaded to the same 486 PC used for the CTD data acquisition by plugging the thermometer through an interface box to the PC. This downloading procedure is clearly the cause of problems as one pin on the SBE35 is badly corroded. This is covered in more detail in the BAS ETS report (Preston).

To process the SBE35 data

Communication must be established between the CTD PC and the SBE35 by connecting the leads at both the CTD unit and the deck unit. The programs used to process the data are:

term35

This is a simple terminal emulator set up to talk to the SBE35.

The program gives the last calibration of the SBE35 and asks for an output file name.
On jr58 data was downloaded once a day - so the filename used was **jday.out**.

The contents of this entire session is kept in this file. There are three commands necessary for the session:

ds

This stands for ***d****isplay* ***s****tatus*. The SBE35 responds by telling you the date and time of the internal clock, and how many data cycles it is currently holding in memory.

dd

This stands for ***d****ump* ***d****ata*. The data currently held in the memory is listed to the screen. This can be slow due to the low data transfer rate.

il

This stands for ***i****nitialize* ***l****ogging*. The command clears the memory and so must only be entered after the data has been downloaded with the ***dd*** command.

The program is exited using the “end” key.

cnv35

This program uses the SBE35 calibration data to convert the engineering units to real temperatures. The program asks for an input file **jday.out**, and an output file **jday.txt**. This output file contains the real temperature data.

The Sea Bird programme CNV35 converts the output of the SBE35 to temperature using the formula:

$$t_{90} = \frac{1.0}{a_o + a_1\ln(n) + a_2\ln^2(n) + a_3\ln^3(n) + a_4\ln^4(n)} - 273.15$$

and

$$t_{90} = slope \times t_{90} + offset$$

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

Salinity Samples

Twelve salinity samples were taken for Station 1. For all other casts (excluding 58ctd046 and 58ctd069) 6 samples were taken. This gave a total of 150 salinity samples. The salinity samples were taken in 200 ml medicine bottles, each bottle being rinsed twice before being filled to just below the neck. The rim of the bottle was then wiped with tissue, a plastic seal inserted and the screw cap replaced. The salinity samples were then placed in the chemistry lab with the salinometer, and left for at least 24 hours before measuring them. This allowed the sample temperatures to equalise with the salinometer. The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360.

This salinometer was purchased from Ocean Scientific International in 1998. The salinity samples were analysed two stations at a time, and using standard seawater (batch P137, K15 = 0.99995, S = 34.998, date of preparation = 9-12-1999). One vial of OSIL standard seawater was run through the salinometer at the beginning and end of each stations samples to enable a calibration offset to be derived and check the stability of the salinometer. Once analysed the conductivity ratios were entered by hand into an PC based Quattro Pro spreadsheet before being transferred to the UNIX system and read into a pstar data file following a scheme detailed below.

The quality of the conductivity calibration procedure

After analyzing the salinity samples the initial offsets are shown in Table 2. Since all CTD stations were in the same water mass and similar range of conductivities, the mean conductivity offset of all measurements ( ) *C* = -0.0015 mS/cm) is applied to each cast in seactd5 as below. After applying the calibration coefficients and adjusting for the residual offset) *C*. After rejecting samples detailed in Table 2 the mean salinity offset of the remaining samples was 0.000 with a standard deviation of 0.0014 (psu on the 1978 scale).

Additional Instruments

The transmissometer and fluorometer have had only factory default values applied.

The CTD processing route for jr58

Step 1: seactd0

Purpose: To read in the CTD data from the ascii data file.

The output is 58 ctd $num .raw and
58 ctd $num

Step 2: seactd2

Purpose: To create sample files from the CTD data, the salt samples and the SBE 35 data

The output files are:

58 ctd $num . bottle - This is a file with 12 levels containing the CTD data averaged for the 10 seconds around the bottle confirmation data cycle number in the Sea Bird .bl file

58 ctd $num . samp - This contains the data in the above file with the addition of the salinity sample data and the temperature data from the SBE 35 thermometer.

58 sam $num . dif - This is the .samp file with the pre conductivity salinity residual.

Step 3: seactd4

Purpose: This exec takes the .samp file from seactd2, derives a conductivity for the salinity sample, derives the conductivity residual and plots two diagnostic plots.

The file output is 58 ctd $num . cond

Step 4: ctdoff

Purpose: To calculate the conductivity offset for the station.

Step 5: seactd5

Purpose: To apply the conductivity residual to the file 58 ctd $num and re-derive salinity.

The output file is 58 ctd $num .cal

Step 6: seactd6

Purpose: This is a repeat of seactd2 except with the corrected salinity.

The output files are:

58 ctd $num . cbottle - This a file with 12 levels containing the CTD data averaged for the 10 seconds around the bottle confirmation data cycle number in the Sea Bird .bl file

58 ctd $num . csamp - This contains the data in the above file with the addition of the salinity sample data and the temperature data from the SBE 35 thermometer.

58 sam $num . cdif - This is the .samp file with the pre conductivity salinity residual.

Step 7: seactd7

Purpose: To derive the down cast of the ctd data.

Two files are output: 58 ctd $num.24hz

and the final product 58 ctd $num .2db

Table 1 Full CTD station list

Station	DOY	HH:MM	Date	LAT	LAT	L ON	LON	ctd depth	Water depth
58ctd001	23	13:32	23 01 2001	-57 1.87	-57.0312	-55 37.99	-55.6331	1017	4092
58ctd004	25	12:37	25 01 2001	-63 8.97	-63.1495	-50 56.04	-50.934	1016	1831
58ctd005	25	14:56	25 01 2001	-63 4.56	-63.076	-51 1.67	-51.0279	1015	1983
58ctd006	25	17:18	25 01 2001	-63 0.57	-63.0095	-51 7.53	-51.1254	1017	2301
58ctd007	25	19:43	25 01 2001	-62 56.50	-62.9417	-51 14.91	-51.2484	1017	2744
58ctd008	25	21:44	25 01 2001	-62 53.67	-62.8945	-51 20.04	-51.3339	1017	3390
58ctd009	25	23:29	25 01 2001	-62 49.51	-62.8252	-51 26.37	-51.4395	1008	3337
58ctd010	26	01:23	26 01 2001	-62 44.94	-62.749	-51 31.26	-51.5209	1017	3337
58ctd011	26	03:15	26 01 2001	-62 40.08	-62.6679	-51 37.33	-51.6221	1016	3284
58ctd012	26	05:03	26 01 2001	-62 35.16	-62.5859	-51 43.25	-51.7209	1011	3224
58ctd018	27	17:52	27 01 2001	-62 49.40	-62.8233	-51 24.65	-51.4109	1016	3347
58ctd020	27	22:22	27 01 2001	-62 33.99	-62.5664	-51 34.29	-51.5715	1017	3271
58ctd023	28	15:51	28 01 2001	-62 56.42	-62.9404	-50 17.95	-50.2991	1016	3424
58ctd024	28	19:50	28 01 2001	-62 45.34	-62.7557	-50 20.63	-50.3438	1014	3423
58ctd026	29	18:05	29 01 2001	-63 2.15	-63.0358	-49 20.86	-49.3476	993	-999
58ctd032	31	16:28	31 01 2001	-62 55.80	-62.9299	-49 29.70	-49.4949	1018	3045
58ctd036	32	11:51	01 02 2001	-63 1.24	-63.0206	-48 15.77	-48.2629	1014	-99
58ctd037	32	13:49	01 02 2001	-63 3.51	-63.0585	-48 12.98	-48.2163	1018	-999
58ctd038	32	17:34	01 02 2001	-62 49.32	-62.822	-48 20.13	-48.3355	1018	-999
58ctd042	33	11:18	02 02 2001	-63 6.59	-63.1098	-47 18.99	-47.3164	1017	3079
58ctd044	33	16:20	02 02 2001	-62 59.50	-62.9916	-47 39.13	-47.6522	1016	3168
58ctd046	34	14:28	03 02 2001	-63 2.70	-63.045	-46 52.10	-46.8683	203	2800
58ctd050	36	18:29	05 02 2001	-62 55.28	-62.9214	-51 9.76	-51.1627	1017	3224
58ctd058	38	23:25	07 02 2001	-63 10.19	-63.1698	-51 27.33	-51.4555	1016	-999
58ctd059	39	01:24	08 02 2001	-63 8.67	-63.1445	-51 33.40	-51.5567	1015	-999
58ctd069	44	12:20	13 02 2001	-51 34.45	-51.5742	-57 56.04	-57.9339	33	38

Table 2 Calibration summary for CTD stations

Cast	cond offset (mS/cm)	bottles rejected
58ctd001	-0.00113	5,6
58ctd004	-0.00165	
58ctd005	-0.00167	11
58ctd006	-0.00114	7,11
58ctd007	-0.00123	7,9
58ctd008	-0.00173	9, 11
58ctd009	-0.00101	
58ctd010	-0.00148	
58ctd011	-0.00125	
58ctd012	-0.00155	1,7
58ctd018	-0.00185	7,11
58ctd020	-0.00125	7
58ctd024	-0.00165	bad sample set - offset from 58ctd024
58ctd026	-0.00165	7,9
58ctd032	-0.00202	5,11
58ctd036	-0.00178	11
58ctd037	-0.00178	11
58ctd038	-0.00169	9
58ctd042	-0.00129	9
58ctd044	-0.0012	9
58ctd050	-0.00157	
58ctd058	-0.0013	
58ctd059	-0.00113	7

Appendix A: Calibration data

Pressure Sensor SN 67241 Calibration date 30 June 2000

Coefficients:

C1 = -4.461418E+04 D1 = 3.645500E-02

C2 = 3.038286E-02 D2 = 0

C3 = 1.224130E-02

T1 = 2.999608E+01 ∶S

T2 = 3.512191E-04 ∶S / degc

T3 = 3.729240E-06 ∶S / deg c^2

T4 = 4.918760E-09 ∶S / deg c^3 T5 = 0

AD509M = 0.0128328

AD590B = -9.4744912

Calibration Correction Slope 0.99992 Offset -0.8815

SBE 3 plus temperature sensor S/N 2307

Calibration date 22-June-00

g = 4.33423304e-03

h = 6.44279635e-04

i = 2.35320295 e-05

j = 2.25247882e-06

fo = 1000.000

SBE 4C conductivity sensor S/N 1912

Calibration date on 26 June 2000

g = -4.16390422e+00

h = 5.36973955e-01

i = -8.02788477e-04

j = 6.71130207e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

SBE 35 Reference Temperature Sensor S/N 0315759-0005

Calibrated on 13 August 1998

a0 = 5.731929187e-03

Slope = 0.999992, Offset = 0.000085

a1 = -1.634408781e-03

a2 = 2.346628834e-04

a3 = -1.294062389e-5

a4 = 2.724825969e-7

SBE 3 plus temperature sensor S/N 2191

Calibration date 22-June-00

g = 4.31953065e-03

h = 6.38536354e-04

i = 2.25769542 e-05

j = 2.12570795e-06

fo = 1000.000

SBE 4C conductivity sensor S/N 1913

Calibration date on 26 June 2000

g = -4.02777511e+00

h = 5.32311709e-01

i = -6.61532593e-04

j = 6.04202239e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

Oceanlogger

Summary

This report summarises the state of the Oceanlogger data collected on JR58. Generally the system worked well with the following problems: the usual problem of the time lag on the thermosalinograph sensor, a persistent problem with the anemometer freezing up and providing no sensible data, and an eratic time stamp on the data.

Introduction

The Oceanlogger system is a PC based logging system that is BAS designed and built (P. Woodroffe, E.T.S.). It has an input from the ship's master clock, a real time display of data and logs sea surface data gathered from the ship's non-toxic pumped sea water supply, and some meteorological parameters. Instruments with an analogue output are connected to self-contained digitising Rhopoint modules located close to the relevant instrument. The modules are then interrogated by the controlling PC using the RS485 protocol. In addition this author chose to integrate wind data from a Guildline Sonic Anemometer at the earliest level of processing. A full list of the sensors used is given in Table 3.

Table 3 The instruments connected to the Oceanlogger

instrument	type	location	Field Name
sea temperature	4 wire PRT	Transducer space	sstemp
flow meter	Liter Meter	prep lab	flow
Thermosalinograph	Sea Bird SBE 21 serial No. 214800-0820	prep lab	tstemp and cond
fluorometer	Turner Systems	prep lab	fluor
Air temperature	vector T351	foremast	atemp
PAR sensor	Kipp & Zonen CM5	foremast	par
TIR sensor	Didcot DRP1	foremast	tir
Barometer	Vaisala PA11 S/N 88149	UIC	Press
Anemometer	Guildline Sonic	formast	wnd_speed, wind_dir

All instruments with the exception of the anemometer functioned well. The Anemometer was affected by icing and frequently gave no data.

Routine logging

The last calibration of the Seabird SBE 21 S/N 820 was on 23 June 1999 by Seabird Inc, Seattle, U.S.A. The calibration of the Vaisala PA11 was on 24 June 1999 by the Meteorological Office. For the duration of cruise JR58 the data were logged to SCS system. One feature of this system appears to be the eratic time stamping of the data. In the Level ABC system that was on the RRS *James Clark Ross* before Summer 2000, the oceanlogger system could log data at a maximum of 0.2Hz. In this new system such a restriction appears to be removed and the data has rather eratic time stamps. This should be investigated in future.

Routine Processing

The data were read into the UNIX system twice daily in 12 hour sections using a Unix script (jr58_ocean), the two time periods being 0000 to 1159 and 1200 2359. This script also produces a series of five diagnostic plots for the 12 hours of data against time. At this point the data are also split up into five files.

File 1: The raw data. This file contains all 5 second data cycles for the 12 hour period in a completely unedited form. Following standard MLS procedure the filenames are of the form

58ocl<jday><a or p>.raw

File 2: Ocean Data. This file contains the data for the sea surface streams and has some initial editing described below in the detailed description of the data processing route. The variables in this file are time, sea surface temperature (stream: sstemp), Thermosalinograph temperature (stream: tstemp), conductivity from the Thermosalinograph (stream: cond), flow from the Liter meter (stream: flow), raw fluorescence from the Turner Fluorometer (stream: fluor), and a derived raw salinity value. At this stage the salinity is usually very noisy as will be described below. Filenames were constructed in the form 58ocl<jday><a or p> .

File 3: Averaged data. This file contains 2 minute averages of file 2 with positional information merged in from the differential GPS data stream. Thus, the file contains the same variables as above with the addition of latitude and longitude. This file was mainly used for rapid plotting of data using geographical coordinates. Filenames were constructed in the form 58ocl<jday><a or p>.2min

File 4: Meterological data. This file contains the data for the meterological parameters recorded by the Oceanlogger for a 12 hour period in a completely unedited form. The variables in the file are time, air temperature (stream: atemp), air pressure (stream: press), the total incident radiation (stream: tir), the photosynthetically active radiation (stream: par), and the wind speed and direction (streams: wind_spd and wind_dir). File names were constructed in the form 58met<jday><a or p>.raw .

Further processing

The meterological data from file 4 above were combined with gyrocompass data and positional information from the gps trimble data stream to derive true wind velocity using a Unix script called *twvelec*. Thus true winds were derived for the whole cruise.

Underway salinity samples

Salinity samples were drawn from the non-toxic supply as it left the thermosalinograph. These samples were treated in the exactly the same manner as those taken for the CTD calibration. The 200 ml sample bottle was rinsed twice and the neck of the bottle dried carefully before an air tight plastic seal was inserted and the cap screwed back on. The samples were then stored in the chemistry lab beside the Guildline Salinometer for at least 24 hours before the conductivity was measured against Ocean Scientific Standard Seawater batch P137. The sample conductivity values were entered into a Quattro Pro Spreadsheet and transferred to Unix. The data were then converted into a standard time format using the script *oclexec3*. In total there were 41 underway salinity samples.

Problems

There were two serious problems in addition to the sensor failures already noted.

The first problem is the still unexplained lag in response between the temperature sensor and the conductivity cell in the thermosalinograph. The problem was first reported during WOCE leg A23 (JR10) when it was noticed that conductivity from the SBE - 21 lagged the temperature of the housing (tstemp). This of course causes a spike in the derived salinity signal. The A23 scientists overcame this by applying a lag through a filter to the stream tstemp. On previous MLS cruises (CF reports for JR16 and JR17, JR28, JR38, JR47) I have tried filters of varying length in time to lag the temperature, before settling on a length 48 one-way filter with n = 48 successive coefficients given by $W(1 - W)^{n-1}$. W was found by experiment to reduce the salinity spiking best at a value of 0.03 for this data set. Although a solution this degrades the ability of the instrument to be used to investigate rapid changes in sea surface parameters. For example, at 10 knots - a typical survey speed, the filter smooths data over distances of 1.2 km.

The second problem concerns the anemometer and the fact that is provided little data for much of the cruise.

Suggestions

The priority must be shared between getting to the cause of the temperature and conductivity lag problem and investigating the sourcing of an anemometer that can function in the conditions encountered during jr58. In addition a reason should be sought for the erratic time intervals of the data.

Navigation data

There were five navigational instruments for scientific use on the RRS *James Clark Ross* (listed in Table 4). Although the five instruments seem in some cases similar, they are all unique. As well as the three GPS systems listed in Table 4, there are three additional GPS systems on board the JCR for the ship's use. These are a Leica MX400 and two Ashtech G12 receivers as part of the dynamic positioning system. In addition there is a Racal Satcom which receives GPS SV range correction data via INMARSAT B. This data is passed to the Trimble, Leica, and G12 receivers allowing them to operate in Differential mode (DGPS). During JR58 the DGPS reference station at Stanley was used. Although the ship is fitted with a Sperry SRD 421 Doppler this was not operational.

Table 4 Scientific navigation instruments on the RRS *James Clark Ross*

Instrument	Type	Code	Use
Trimble 4000	GPS receiver	gps	Primary positional information
Ashtec GG24	GLONASS / GPS receiver	glo	positional information
Ashtec ADU-2	GPS receiver	ash	Attitude information
Gyrocompass	Sperry Mk 37 model D	gyr	Heading information
Electromagnetic Log	Chernikeeff log Aquaprobe Mk V	eml	Velocity information

The collection and use of all of the navigation data are linked. All of the instruments are currently logged to the SCS system, and then transferred to the old RVS level C system where they are currently read. This intermediate step should be removed and the data read into pstar directly from the SCS system. On this cruise the data for all five instruments and the standard editing procedures were done in one Unix script called "jr58_nav_go". This script requires the Julian day as an input and then executes a further 8 C shell scripts to read in 12 hours of data, and edit where necessary all five streams. In this short report I briefly describe each instrument and explain the processing, as was done on the USIPS Cruise - JR58.

The instruments

Trimble 4000

The Trimble 4000 receiver in differential mode was the primary source of positional information for the scientific work on jr58. This instrument worked well on jr58 with the exception of a complete 7 minute power cut on day 034 at 1136Z, a 95 minute period on day 034, 1943Z when the power supply blew and had to be replaced, and a 21 minute period on day 039 1837Z. The data were logged at 1 second intervals and read into 12 hour pstar files from the SCS derived Level C stream using the Unix script gpsexec0. Individual steps in this exec are

gpsexec0:

purpose: To read Trimble data into the pstar format.

The programmes are

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

Two files are output from this script.
One is just before the editing stage (datpik) and is called 58 gps<jday>.raw
the other is after the datpik, this is 58 gps <jday>.

Ashtec GLONASS (GG24)

The Ashtec GG24 works by accepting data from both American GPS and the Russian GLONASS satellite clusters. This extends the constellation of available satellites to 48 and should theoretically be significantly more accurate. However, my experiments on previous cruises have suggested that the accuracy is significantly lower than the differential GPS. Data were logged routinely using *ggexec0*, called from *jr58_nav_go*, but were not used in the processing of other data streams. Filenames were of the form 58glo[jday][a/p].raw**.** Some basic quality control is performed on this file, with the resulting data stored in 58glo[jday][a/p].

Ashtec ADU-2

The Ashtec ADU-2 GPS is used to correct errors in the gyrocompass heading that are input to the ADCP. The configuration of the receiver is complex, made more so by the fact that the receiver can only be configured with the use of laptop running a terminal emulation program. The Ashtec functioned well on jr58 until the previously noted 7 minute power cut on day 034 at 1136Z. Unfortunately from this time onwards there was clearly a problem with the data that only became apparent when I started looking in detail at the data some 48 hours after the event. The amount of “good” data in the Level C Stream had dropped significantly. However throughout this period the SCS display screen in the UIC room showed that the data from the Ashtec ADU-2 was good.. I originally thought the problem was that in the power cut the Ashtec had lost its configuration and reverted to default values. The ITS people checked using a laptop the configuration values in the instrument and having changed some parameters waited for me to check the data. I looked again at the data on the Level C after a period of time and was surprised to find that the number of good data cycles had not increased. After further investigation I traced the problem back to the SCS data file from which the Level C data is created. This file had become corrupted during the power cut. The solution is written in the ITS computer report. From a user point of view it seemed a little poor that whilst the data coming in was good, and flagged as good, the data being written to the SCS files that users access was poor. However this data gap is recoverable from the lowest level raw SCS system data that I have, and will have to be recovered from the raw NMEA messages. This should not be too difficult but is a waste of effort. With the benefit of some hindsight I should have spotted the problem within 12 hours. That I did not is partially due to the UIC SCS display showing that the data was good. I am sure that such a problem will be caught by the ITS staff very rapidly in the future. The important configuration data for the Ashtec aerial cluster is shown in Table 5.

Table 5 The configuration data for the Ashtec aerial cluster

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

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

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

ashexec0:

purpose: This exec reads in data from the GPS3DF into pstar format

The programmes are

datapup - transfers the data from RVS binary files to pstar binary files.

pcopya - resets the raw data flag on the binary file.

pheadr - sets up the header and dataname of the file.

The output file is in the form 58 ash < jday> .raw

ashexec1:

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

The programmes are

pmerg2 - merge the ashtec file with the master gyro file.

parith - calculate the differences in the ashtec and gyro headings (delta heading).

prange - force delta heading to lie around zero.

The output file is in the form 58 ash < jday > .mrg

ashexec2:

purpose: This exec is complicated as it edits the merged data file.

The programmes are.

datpik - reject all data outside the following limits

heading outside 0° and 360°

pitch outside -5° to 5°

roll outside -7° to 7°

attf outside -0.5 to 0.5

mrms outside 0.00001 to 0.01

brms outside 0.00001 to 0.1

delta heading outside -5° to 5°

pmdian - we remove flyers in delta heading of greater than 1° from a 5 point mean.

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

phisto - calculate the pitch limits.

datpik - further selection of bad data outside the following limits

pitch outside the limits created

mrms outside the range 0 - 0.004

pavrge - again set the data file to be on a 2 minute time base.

pmerge - merge back in the heading data from the gyro from the master gyro file.

pcopya - change the order of the variables.

The output files are 58 ash < jday > .edit

and 58 ash < jday > .ave.

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

Gyrocompass

The gyrocompass is a fundamental data stream. It is used by the RVS program *bestnav* to derive dead reckoning in the absence of gps data - as well as being used for ADCP processing (ADCP report) and derivation of true wind velocity (ocean logger report). For JR58 the gyrocompass data was read in 12 hour chunks using the Unix exec gyroexec0

gyroexec0:

purpose: This exec reads in the gyrocompass data and removes the inevitable bad data.

The programmes are.

datapup - transfers the data from RVS binary files to pstar binary files.

pcopya - resets the raw data flag on the binary file.

pheadr - sets up the header and dataname of the file.

datpik - forces all data from the gyro to be between 0 and 360°.

The output file is in the form 58 gyr < jday > .raw

The script also appends the day file to a master file called 58 gyr 01.

Electromagnetic Log

The Electromagnetic Log gives water velocity relative to the ship in both the fore-aft direction. This data was read in as 12 hour chunks using a simple exec emlexec0.

emlexec0: This exec reads in data from the Doppler log into pstar format.

datapup - transfers the data from RVS binary files to pstar binary files.

pcopya - resets the raw data flag on the binary file.

pheadr - sets up the header and data name of the file.

The output file is in the form 58 eml < jday> .raw

Doppler Log

The Doppler log gives water velocity relative to the ship in both the fore-aft and port starboard direction but was completely unserviceable for JR58.

Daily Navigation Processing

As stated above the data was read in as twice daily (12 hour) files; the time periods being either from 0000 Z to 1159Z or 1200Z to 2359Z. Our primary navigation data was taken from the RVS file bestnav. This program uses the navigation data from various streams to construct a file with 30 second fixes. For JR58 the primary input to bestnav was the Trimble 4000 DGPS. This navigation file was read into a pstar file using the scrip navexec0.

navexec0:

purpose: This exec reads in data from the bestnav stream into pstar format.

The programmes are.

datapup - transfers the data from RVS binary files to pstar binary files.

pcopya - resets the raw data flag on the binary file.

pheadr - sets up the header and data name of the file.

posspd - here we calculate the east and north velocities from position and time.

papend - the output file is added to the master file.

pdist - we now recalculate the distance run variable.

pcopya - and take out the RVS calculated distance run.

The output master file was called abnv581 and was used for all pstar required navigation information (i.e ADCP processing etc).

Photographic data

Photographs were taken from the Monkey Island, the bridge wing or the forecastle during transects into the sea ice with a digital camera. All photographs are therefore time stamped with a clock set to ship time. The purpose of the measurement was to provide an independent measure of ice floe size. To this end a piece of superstructure of known height or thickness was placed in each photograph. In post processing I will be able to determine average floe size with distance from the ice edge. These photographic transects are listed in Table 6.

Table 6 Photographic data from the *Autosub* under sea ice missions

Date	AUV Mission	Number of photographs
January 25 2001	N/A - long transect through the ice	78
January 29 2001	M249	47
February 01 2001	M252	56 (+ 10 shots of iceberg that AUV hit)
February 02 2001	M253	114
February 06 2001	M260	32

As well a sea ice data photographs were taken of icebergs that the AUV was known to have flown beneath. These are listed in Table 7.

Table 7 Photographic data from the *Autosub* under iceberg missions

Date	AUV Mission	Number of photographs
January 31 2001	M250	80
February 01 2001	M252	10 of iceberg AUV collided with
February 03 2001	M255	33
February 05 2001	M258 and M259	63

Snow thickness measurements

Measurements of snow depth were made at two sites in the Marginal Ice Zone in the region of ice that is known the AUV flew under. At each site four people got off the ship and made measurements of snow depth along four perpendicular transects using a 2m long 1.5 cm diameter steel bar marked up as a measuring rule in 1 cm divisions. Snow depth measurements were made nominally at 1m intervals. In addition at site 1 three snow pits were dug to ascertain if individual layers could be observed. At site 2, samples of snow (obtained with a shovel), and surface ice (obtained with a pick axe) were taken and analyzed for salinity. The sites are listed in Table 8.

Table 8 Locations of the ice stations

Station	Date	Associated AUV mission	Time	Position	Number of snow depth measurements
1	January 29 2001	M249	2122	63 5.84 S, 49 22.5 W	32
2	February 02 2001	M253	1330	63 9.88 S, 47 14.86 W	57

TUBA

The Towed Undulating BioAcoustic Sensor, TUBA, is a high-frequency, multi-frequency sonar operating at seven frequencies from 175kHz to 2.2MHz, designed for the study of oceanic zooplankton abundance. As such, TUBA is a very compact instrument designed primarily for towed use on undulators such as SeaSoar and is also suitable for small net systems.

The experiments with TUBA on this cruise have resulted from a joint Antarctic Funding Initiative (AFI) bid with BAS, and involved mounting the TUBA transducer head directly in the centre of the mouth of the AMPS net system. The main electronics were mounted just above the frame of the net, connected to the transducer head via 1m length cables. With this configuration of acoustics on a net system capable of target fishing, we have been able to collect unique data on aggregations of krill and salps.

Delays in the building of TUBA, which is based on an earlier prototype, have meant that it was not a fully working system prior to the cruise. Consequently, 10 days in port prior to departure of JR58, and the first few days of the cruise were spent completing, setting-up and testing the system.

TUBA Electronics

TUBA consists of seven high frequency Echo Sounders. These are housed in a bi-sect chassis on circular printed circuit boards in a pressure tube. One chassis section is devoted exclusively to the analogue circuitry. These are the low noise linear components that make up the transmitters and receivers. The other section houses the I²C remote control, frequency synthesiser and power supply circuits.

The design, construction, some integration and testing of this instrument had been completed prior to shipping to the Falklands. The 10 days in port before sailing were spent setting up and testing the Digital control, Transmitter and Receiver circuits. Having chosen the I²C protocol to control TUBA'S operational parameters and had it working down 1000m of tow cable we encountered one unexpected problem. During the evaluation phase the tow cable we used did not have the DC current flowing that supplies the instrument. The voltage drop caused by this raises the ground return and prevents I²C communication. Circuitry was designed and constructed on board, which overcame this problem.

The proximity of the transmitter/receiver circuits, that is transmitter-to-transmitter and receiver-to-receiver caused breakthrough and sympathetic oscillation. With three working channels (250kHz, 370kHz, and 920kHz), the system was deployed on the AMPS net on the 1st Feb until the evening of the 2nd, during which four successful deployments took place. At this point it was decided to remove TUBA, and to attempt to fix problems with the other channels before collecting more data. After re-routing of chassis wiring and introduction of screening, 2 further channels (175 kHz and 2200 kHz) were set-up and made stable.

The system was re-installed onto the AMPS net on the 7th Feb, and remained on for the remainder of the cruise. For all of the following deployments, the system was set-up with a 4 metre sampling bin, starting 1.25m from the transducer head. The pulse duration was 200 micro-seconds, and ping rate, 10 Hz.

All of the raw sampled data were logged to disk at a rate of approximately 280Mbytes/h. Storage of the raw data means that we can fully post-process the data using a variety of techniques (e.g. analysing single-target returns versus MVBS for a chosen sampling volume). The development of these processing techniques will be finalised back at SOC. The current real-time display of TUBA data shows a composite time-domain waveform for all frequencies vs distance from the Transducer head. In addition to this display, the frequency Power Spectrum for the sampling volume is displayed, along with calculated relative MVBS values in dB in each frequency band.

The real-time visuals provided by the TUBA software complemented the EK500 information on the location of targets and enabled us to identify when we had fully passed through krill swarms once they had been encountered – much of the uncertainty of the net position (and delay behind the ship) with respect to targets seen on the EK500 was eliminated.

Enhancement of the TUBA software, written in C using LabWindows CVI ®, included the implementation of a TVG correction (either 20logR, or 40logR), the ability to replay data files at up to 10 times the original logging rate, and a utility to display histograms of MVBS at each frequency, over a user-defined number of pings. A small suite of m-files was also developed so that data could be imported and replayed in MATLAB. This is the package that will be used for the majority of the subsequent data analysis.

Calibration

A calibration of TUBA was carried out in Berkeley sound during the EK500 calibration exercises. TUBA was suspended vertically from the aft, starboard crane with 3 SIMRAD copper calibration spheres suspended first at distances of 2.4m, 3.2m and 4.6m, and then during a second exercise at distances of 3.8m, 4.6m and 6m. The spheres used were two 200 kHz 13 mm spheres and, at the further distance, a 23 mm 120 kHz sphere. Despite the spheres being suspended on a single mono-filament line, connected at the transducer head, the stillness of the water in the sound, and the fact that the ship was at anchor enabled the spheres to be acoustically visible for over ~70% of the time. As with the net tows, all of the raw data were logged with all of the spheres visible in a 4m bin, so that full analysis can take place back at the laboratory by re-binning the sampling volume and analysing the returns from each sphere individually. A further calibration exercise will also be made in the acoustic tank at SOC, so that the positioning of a calibration sphere can be more precisely determined.

TUBA and Target fishing

Target selection

Suitable targets were identified from the EK500 echosounder, usually swarms or layers, and the time of their occurrence taken from Echoview to get the target position for the bridge. The ship was positioned 1-1.5 nm down wind of the target point. Greater distance was required for deep targets to enable the net to reach sufficient depth or if particularly cold to enable ice of the net deployment mechanism a chance to melt to prevent jamming. AMPS was deployed with ship head to wind at a speed of approximately 3.5 knots. Winch cable out was zeroed at the surface. Maximum veering and hauling rates of 25m min^{-1} were used. Depth from the net monitor reading had an offset of approx. 4m (actual depth= reading + 4m, although this can be corrected for future cruises). The depth reading on a couple of cold days did not register for several minutes into the tow. This is thought to be due to ice crystals in the capillary to the pressure transducer. Correct readings occurred once the ice had melted. Time, Depth, cable out details were recorded with net firing. Due to the distance of the net behind the ship, a delay between the EK500 and net was estimated

Delay estimation

Gantry height =12.5m

Distance from transducers to stern =65m

Distance delay (D in metres)

$$D = 65 + \sqrt{(12.5 + cableout)^2 - (12.5 + Depth)^2}$$

Speed (S ms-1)

$$S = \frac{S(knots) \times 1852}{3600}$$

Time delay (T in seconds)

$$T = \frac{D}{S}$$

After all 6 bars had been fired (5 nets all closed), the net was recovered. The cod end bags removed, shaking down any animals caught in the upper part of the cod end, and placed in labelled buckets.

Net processing

The samples were emptied from the cod end bags into trays, and the major components identified. If a small volume was collected (less than approx. 250ml) the whole sample was preserved in 4% buffered formalin, with at least 4x the volume of formalin. If a larger volume was collected, the total volume was measured and a known sub-sample of 150-250ml was preserved. All samples were labelled inside with cruise, event number, net number, date, time, depth of sample, formalin and owners initials, and any other relevant details (e.g. volume sub-sampled), and on the outside with formalin labels. Samples were stored in the explosives store (scientific hold) in plastic crates. Length frequency measurements of samples containing krill were made, and lengths are summarised in Table 9 (Also see Figure 5). A summary of all net hauls made is given in Table 10.

Krill length frequency measurements

Krill from net samples were stored in the cold room until processing. *Euphausia superba* were measured by placing against a ruler to straighten, from the tip of the rostrum to the tip of the tail. Measurements were rounded down to the nearest mm. Up to 100 krill were measured from each net.

Table 9 Summary of Length-Frequency of krill

Event	Total number	Mean size (mm)	Standard deviation
E03	100	32.9	8.9
E13	100	26.3	3.1
E19	119	28.3	6.9
E21	51	34.9	9.0
E28	8	31.6	1.5
E33	106	42.5	5.2
E34	200	27.5	8.0
E40	200	23.6	3.0
E45	200	23.3	2.3
E48	57	43.2	4.7
E51	200	25.3	3.1
E53	98	42.4	7.7
E54	150	29.2	4.8
E55	100	25.3	4.5
E56	100	25.7	3.9
E61	150	36.8	7.1
E64	100	40.9	7.8
E66	100	44.0	7.6
overall	2139	33.6	

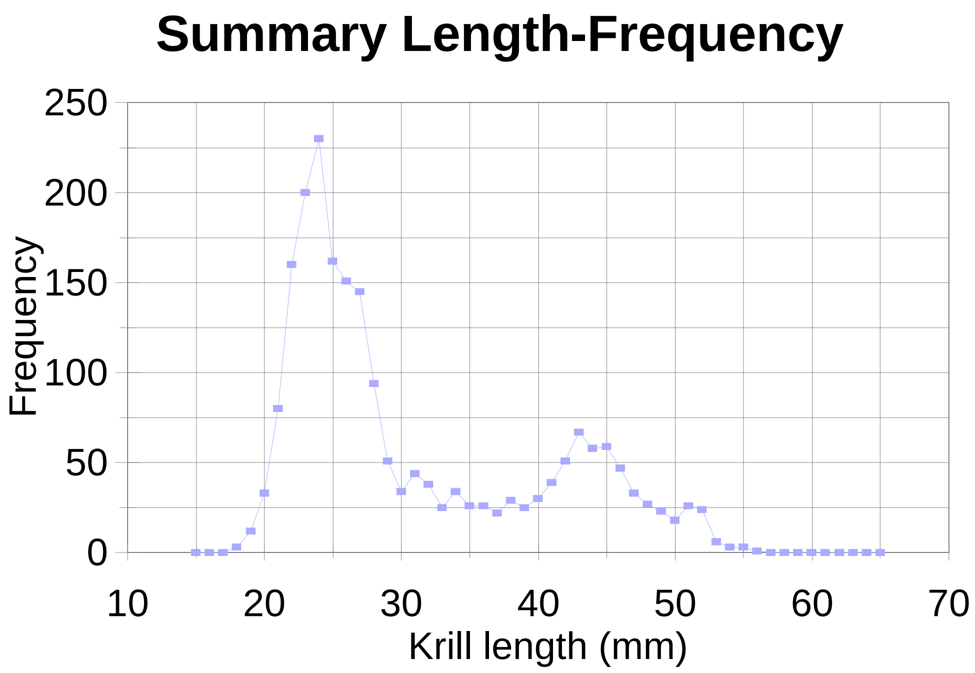


Figure 5 Summary of krill length frequency

Table 10 Net sampling summary

Event	Start JDay	Start date	Start time (GMT)	End Jday	End date	End time (GMT)	Start Latitude (º N)	Start Longitude (º W)	End Latitude (º N)	End Longitude (º W)	Net 1	Net 2	Net 3	Net 4	Net 5	Length Freq	TUBA	Comments
02	24	24-Jan-01	22:10	24	24-Jan-01	23:35	-62.66	-51.52	-62.74	-51.42	1	1	1	1	1		y	mainly krill
03	25	25-Jan-01	01:16	25	25-Jan-01	02:05	-62.82	-51.36	-62.89	-51.34	1	1	1	1	1	y		mainly krill
13	26	26-Jan-01	07:29	26	26-Jan-01	08:00	-62.68	-51.62	-62.69	-51.57	1	1	1	1	1	y		mainly krill
16	27	27-Jan-01	07:32	27	27-Jan-01	08:12	-62.75	-51.33	-62.78	-51.32	1	1	1	1	1			copepods & small euphausids. Cover left on flowmeter
19	27	27-Jan-01	20:00	27	27-Jan-01	20:35	-62.73	-51.58	-62.74	-51.49	1	1	1	1	1	y		mainly krill
21	28	28-Jan-01	07:03	28	28-Jan-01	07:40	-62.88	-51.03	-62.88	-50.93	1	1	1	1	1	y		krill, copepods & small euphausids
28	30	30-Jan-01	17:54	30	30-Jan-01	19:09	-63.15	-48.23	-63.09	-48.10	1	1	1	1	1	y		copepods & small euphausids
30	31	31-Jan-01	03:55	31	31-Jan-01	05:12	-63.01	-48.60	-62.95	-48.75	1	1	1	1	1			mainly krill
33	31	31-Jan-01	18:50	31	31-Jan-01	19:36	-62.93	-49.34	-62.96	-49.43	1	1	1	1	1	y		krill, copepods & small euphausids
34	32	01-Feb-01	00:15	32	01-Feb-01	00:55	-62.95	-49.50	-62.95	-49.61	1	1	1	1	1	y	y	mainly krill
39	32	01-Feb-01	19:37	32	01-Feb-01	20:22	-62.90	-48.25	-62.93	-48.15	1	1	1	1	1		y	small euphausids
40	33	02-Feb-01	07:31	33	02-Feb-01	08:38	-63.01	-47.12	-63.01	-47.15	1	1	1	1	1	y	y	mainly krill
45	33	02-Feb-01	20:16	33	02-Feb-01	20:53	-63.07	-47.42	-63.04	-47.35	1	1	1	1	1	y	y	mainly krill
48	36	05-Feb-01	08:01	36	05-Feb-01	08:40	-62.79	-51.14	-62.80	-51.05	1	1	1	1	1			mainly krill
51	36	05-Feb-01	23:43	37	06-Feb-01	00:25	-62.87	-51.29	-62.89	-51.26	1	1	1	1	1	y		mainly krill
53	38	07-Feb-01	00:05	38	07-Feb-01	00:38	-63.01	-51.50	-63.03	-51.44	1	1	1	1	1	y		mainly krill
54	38	07-Feb-01	08:00	38	07-Feb-01	08:55	-62.66	-52.87	-62.70	-52.76	1	1	1	1	1	y	y	mainly krill
55	38	07-Feb-01	11:54	38	07-Feb-01	12:55	-62.88	-52.32	-62.92	-52.20	1	1	1	1	1	y	y	mainly krill, few copepods
56	38	07-Feb-01	16:33	38	07-Feb-01	17:42	-62.92	-51.67	-62.93	-51.52	1	1	1	1	1	y	y	mainly krill
60	39	08-Feb-01	08:40	39	08-Feb-01	09:20	-63.09	-51.58	-63.06	-51.51	1	1	1	1	1		y	mainly krill
61	39	08-Feb-01	22:50	39	08-Feb-01	23:26	-62.40	-54.92	-62.38	-54.85	1	1	1	1	1	y	y	mainly krill
62	40	09-Feb-01	11:30	40	09-Feb-01	12:20	-62.49	-56.75	-62.44	-56.67	1	1	1		1		y	mainly salps. Net 4 lost
63	40	09-Feb-01	14:05	40	09-Feb-01	14:48	-62.37	-56.72	-62.33	-56.72	1	1	1	1	1		y	krill & salps
64	40	09-Feb-01	17:30	40	09-Feb-01	18:05	-62.11	-57.00	-62.07	-57.00	1	1	1	1	1	y	y	krill & salps
66	41	10-Feb-01	00:01	41	10-Feb-01	01:09	-61.86	-56.99	-61.90	-56.97	1	1	1	1	1	y	y	krill & salps
67	41	10-Feb-01	02:56	41	10-Feb-01	04:04	-61.80	-57.00	-61.79	-56.97	1	1	1	1	1		y	salps & few krill

Event Log

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58CTD001	CTD	Tue 23 January 2001	13:35	Tue 23 January 2001	14:26:00	1000, 800, 600, 400, 200 and 100m	CTD deployment delayed at 13:20 due to Hydraulic Leak. Salinity Samples taken at each depth.	-57.03235	-55.63297	-57.0277	-55.6285	Mark Brandon
58NET002	MUL-NET	Wed 24 January 2001	22:10:00	Wed 24 January 2001	23:35:00		5 nets fired.	-62.66484	-51.51707	-62.7418	-51.4187	Rachel Wood-Walker
58NET003	MUL-NET	Thu 25 January 2001	01:16:00	Thu 25 January 2001	02:05:00		5 nets fired at Ice edge.	-62.81918	-51.35702	-62.8852	-51.3402	Rachel Wood-Walker
58CTD004	CTD	Thu 25 January 2001	12:33:00	Thu 25 January 2001	13:28:00	As CTD001	Salinity Samples at each depth	-63.14896	-50.93405	-63.1516	-50.9331	Mark Brandon
58CTD005	CTD	Thu 25 January 2001	14:57:00	Thu 25 January 2001	15:43:00	As CTD001	Salinity Samples at each depth	-63.07584	-51.02807	-63.0763	-51.0206	Mark Brandon
58CTD006	CTD	Thu 25 January 2001	17:21:00	Thu 25 January 2001	18:08:00	As CTD001	Salinity Samples at each depth	-63.00948	-51.12541	-63.0089	-51.1254	Mark Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58CTD007	CTD	Thu 25 January 2001	19:45:00	Thu 25 January 2001	20:33:00	As CTD001	Salinity Samples at each depth	-62.94165	-51.2482	-62.9464	-51.2549	Mark Brandon
58CTD008	CTD	Thu 25 January 2001	21:47:00	Thu 25 January 2001	22:31:00	As CTD001	Salinity Samples at each depth	-62.89473	-51.33437	-62.8979	-51.3344	Mark Brandon
58CTD009	CTD	Thu 25 January 2001	23:25:00	Fri 26 January 2001	00:21:00	As CTD001	Salinity Samples at each depth	-62.82522	-51.43945	-62.8276	-51.4274	Mark Brandon
58CTD010	CTD	Fri 26 January 2001	01:25:00	Fri 26 January 2001	02:14:00	As CTD001	Salinity Samples at each depth	-62.74873	-51.5205	-62.7462	-51.5187	Mark Brandon
58CTD011	CTD	Fri 26 January 2001	03:04:00	Fri 26 January 2001	04:05:00	As CTD001	Salinity Samples at each depth	-62.66739	-51.62195	-62.6655	-51.6212	Mark Brandon
58CTD012	CTD	Fri 26 January 2001	05:05:00	Fri 26 January 2001	05:51:00	As CTD001	Deployment delayed due to investigation of bow thruster alarm. Salinity Samples at each depth	-62.58583	-51.7208	-62.5805	-51.7269	Mark Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58NET013	MUL-NET	Fri 26 January 2001	07:29:00	Fri 26 January 2001	08:00:00			-62.68108	-51.61955	-62.6894	-51.5727	Rachel Wood-Walker
58AUV014	AUTOSUB	Fri 26 January 2001	13:55:00	Fri 26 January 2001	15:51:00		Compass Calibration + buoyancy test	-62.82574	-51.43	-62.8241	-51.4154	Brierley / Fernandes / Brandon
58AUV015	AUTOSUB	Fri 26 January 2001	23:45:00	Sat 27 January 2001	02:53:00		Compass Calibration + buoyancy test	-62.81455	-51.43567	-62.8168	-51.4344	Brierley / Fernandes / Brandon
58NET016	MUL-NET	Sat 27 January 2001	07:32:00	Sat 27 January 2001	08:12:00		5 nets fired	-62.74713	-51.32851	-62.7844	-51.3209	Rachel Wood-Walker
58AUV017	AUTOSUB	Sat 27 January 2001	14:24:00	Sun 28 January 2001	04:22:00		20x8x20km under ice mission	-62.74742	-51.53813			Brierley / Fernandes / Brandon
58CTD018	CTD	Sat 27 January 2001	17:55:00	Sat 27 January 2001	18:39:00	As CTD001	Salinity Samples at each depth	-62.82336	-51.40973			Mark Brandon
58NET019	MUL-NET	Sat 27 January 2001	20:00:00	Sat 27 January 2001	20:35:00		5 nets fired.	-62.73054	-51.57626	-62.7447	-51.49	Rachel Wood-Walker
58CTD020	CTD	Sat 27 January 2001	22:24:00	Sat 27 January 2001	23:10:00	As CTD001	Salinity Samples at each depth	-62.56599	-51.57177	-62.5655	-51.5805	Mark Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58NET021	MUL-NET	Sun 28 January 2001	07:03:00	Sun 28 January 2001	07:40:00		5 nets fired.	-62.88465	-51.02658	-62.87507	-50.92705	Rachel Wood-Walker
58AUV022	AUTOSUB	Sun 28 January 2001	13:36:00	Mon 29 January 2001	02:52:00			-62.87068	-50.38423	-62.79576	-50.29681	Brierley / Fernandes / Brandon
58CTD023	CTD	Sun 28 January 2001	15:53:00	Sun 28 January 2001	16:35:00	As CTD001	Salinity Samples at each depth	-62.94055	-50.29977	-62.94222	-50.30166	Mark Brandon
58CTD024	CTD	Sun 28 January 2001	19:52:00	Sun 28 January 2001	20:38:00	As CTD001	Salinity Samples at each depth	-62.75578	-50.34373	-62.76042	-50.34795	Mark Brandon
58AUV025	AUTOSUB	Mon 29 January 2001	11:52:00	Tue 30 January 2001	04:00:00		Mission aborted due to damage during launch. On deck 13:05 - relaunched 14:40	-62.86493	-49.27896	-62.9104	-49.5373	Brierley / Fernandes / Brandon
58CTD026	CTD	Mon 29 January 2001	18:06:00	Mon 29 January 2001	18:49:00	As CTD001	Salinity Samples at each depth	-63.03605	-49.34777	-63.04805	-49.34745	Mark Brandon
58ICE027	ICE OBS.	Mon 29 January 2001	21:02:00	Mon 29 January 2001	21:26:00		4 men and a 20m lump of ice+snow	-63.09405	-49.38596	-63.09807	-49.37364	Mark Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58NET028	MUL-NET	Tue 30 January 2001	17:54:00	Tue 30 January 2001	19:09:00		5 nets fired.	-63.15045	-48.23216	-63.08552	-48.10374	Rachel Wood-Walker
58TUB029	TUBA	Tue 30 January 2001	21:40:00	Tue 30 January 2001	23:00:00		Deployed from Strbd. Crane.	-63.15704	-48.09386	-63.16801	-48.09993	Crisp / Harris
58NET030	MUL-NET	Wed 31 January 2001	03:55:00	Wed 31 January 2001	05:12:00		5 nets fired. Very successful.	-63.01381	-48.60392	-62.94691	-48.74764	Rachel Wood-Walker
58AUV031	AUTOSUB	Wed 31 January 2001	13:10:00	Wed 31 January 2001	16:01:00			-62.95034	-49.48965	-62.93509	-49.55100	Brierley / Fernandes / Brandon
58CTD032	CTD	Wed 31 January 2001	16:27:00	Wed 31 January 2001	17:22:00	As CTD001	Salinity Samples at each depth	-62.92987	-49.49519	-62.92964	-49.48992	Mark Brandon
58NET033	MUL-NET	Wed 31 January 2001	18:50:00	Wed 31 January 2001	19:36:00		5 nets fired.	-62.93125	-49.34348	-62.96413	-49.42599	Rachel Wood-Walker
58AUV33A	AUTOSUB	Wed 31 January 2001	20:45:00	Wed 31 January 2001	22:40:00		End Time is the time Autosub stopped logging - event entry not made in book.	-62.92800	-49.44436	-62.95199	-49.55804	Brierley / Fernandes / Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58NET034	MUL-NET	Thu 1 February 2001	00:15:00	Thu 1 February 2001	00:55:00			-62.95443	-49.50483	-62.94781	-49.60677	Rachel Wood-Walker
58AUV035	AUTOSUB	Thu 1 February 2001	09:54:00	Fri 2 February 2001	00:15:00			-62.95713	-48.34283	-62.87009	-48.24116	Brierley / Fernandes / Brandon
58CTD036	CTD	Thu 1 February 2001	11:52:00	Thu 1 February 2001	12:35:00	As CTD001	Salinity Samples at each depth	-63.02041	-48.26314	-63.01604	-48.27185	Mark Brandon
58CTD037	CTD	Thu 1 February 2001	13:51:00	Thu 1 February 2001	14:34:00	As CTD001	Salinity Samples at each depth	-63.05817	-48.21611	-63.05716	-48.21861	Mark Brandon
58CTD038	CTD	Thu 1 February 2001	17:37:00	Thu 1 February 2001	18:19:00	As CTD001	Salinity Samples at each depth	-62.82236	-48.33509	-62.82274	-48.33714	Mark Brandon
58NET039	MUL-NET	Thu 1 February 2001	19:37:00	Thu 1 February 2001	20:22:00		5 Nets Fired. Tuba attached to net	-62.90056	-48.25083	-62.92624	-48.14825	Rachel Wood-Walker
58NET040	MUL-NET	Fri 2 February 2001	07:31:00	Fri 2 February 2001	08:38:00		5 Nets Fired. Tuba attached to net	-63.01257	-47.12206	-63.01430	-47.14836	Rachel Wood-Walker
58AUV041	AUTOSUB	Fri 2 February 2001	10:00:00	Sat 3 February 2001	02:06:00		Problems encountered recovery sub.	-63.07264	-47.37217	-63.0905	-47.4979	Brierley / Fernandes / Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58CTD042	CTD	Fri 2 February 2001	11:20:00	Fri 2 February 2001	12:06:00	As CTD001	Salinity Samples at each depth	-63.11037	-47.31630	-63.11407	-47.31756	Mark Brandon
58ICE043	ICE OBS.	Fri 2 February 2001	13:14:00	Fri 2 February 2001	13:40:00			-63.16481	-47.25013	-63.16450	-47.24551	Mark Brandon
58CTD044	CTD	Fri 2 February 2001	16:18:00	Fri 2 February 2001	17:05:00	As CTD001	Salinity Samples at each depth	-62.99158	-47.65209	-62.99130	-47.65422	Mark Brandon
58NET045	MUL-NET	Fri 2 February 2001	20:16:00	Fri 2 February 2001	20:53:00		5 Nets Fired. Tuba attached to net	-63.07485	-47.41605	-63.044	-47.3543	Rachel Wood-Walker
58CTD046	CTD	Sat 3 February 2001	14:35:00	Sat 3 February 2001	14:48:00	None	200 metre cast for Temperature Profile	-63.04492	-46.86829	-63.0449	-46.8682	Mark Brandon
58AUV047	AUTOSUB	Sat 3 February 2001	15:19:00	Sat 3 February 2001	21:29:00		Textbook recovery	-63.04445	-46.8673	-63.0576	-46.9463	Brierley / Fernandes / Brandon
58NET048	MUL-NET	Mon 5 February 2001	08:01:00	Mon 5 February 2001	08:40:00		5 nets fired. No TUBA	-62.78541	-51.13523	-62.7998	-51.0469	Rachel Wood-Walker
58AUV049	AUTOSUB	Mon 5 February 2001	00:27:00	Mon 5 February 2001	19:46:00			-62.88833	-51.18468	-62.9074	-51.1897	Brierley / Fernandes / Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58CTD050	CTD	Mon 5 February 2001	18:33:00	Mon 5 February 2001	19:16:00	As CTD001	Salinity Samples at each depth	-62.92121	-51.16261	-62.9226	-51.1658	Mark Brandon
58NET051	MUL-NET	Mon 5 February 2001	23:43:00	Tue 6 February 2001	00:25:00		5 Nets Fired. No Tuba attached.	-62.86858	-51.28569	-62.8925	-51.2617	Rachel Wood-Walker
58AUV052	AUTOSUB	Tue 6 February 2001	16:57:00	Tue 6 February 2001	23:20:00			-62.98803	-51.4503	-63.0218	-51.4691	Brierley / Fernandes / Brandon
58NET053	MUL-NET	Wed 7 February 2001	00:05:00	Wed 7 February 2001	00:38:00		5 Nets Fired. Tuba attached to net	-63.00838	-51.4997	-63.0323	-51.437	Rachel Wood-Walker
58NET054	MUL-NET	Wed 7 February 2001	08:00:00	Wed 7 February 2001	08:55:00		5 Nets Fired. Tuba attached to net	-62.65739	-52.87322	-62.7008	-52.7592	Rachel Wood-Walker
58NET055	MUL-NET	Wed 7 February 2001	11:54:00	Wed 7 February 2001	12:55:00		5 Nets Fired. Tuba attached to net	-62.88341	-52.32256	-62.923	-52.2014	Rachel Wood-Walker
58NET056	MUL-NET	Wed 7 February 2001	16:33:00	Wed 7 February 2001	17:42:00		5 Nets Fired. Tuba attached to net	-62.9199	-51.66781	-62.9348	-51.5154	Rachel Wood-Walker
58AUV057	AUTOSUB	Wed 7 February 2001	19:58:00	Thu 8 February 2001	14:38:00			-63.06541	-51.45777	-62.9409	-51.5791	Brierley / Fernandes / Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58CTD058	CTD	Wed 7 February 2001	23:23:00	Thu 8 February 2001	00:07:00	As CTD001	Salinity Samples at each depth	-63.16988	-51.45528	-63.17	-51.4586	Mark Brandon
58CTD059	CTD	Thu 8 February 2001	01:31:00	Thu 8 February 2001	02:15:00	As CTD001	Salinity Samples at each depth	-63.14482	-51.55675	-63.1458	-51.5579	Mark Brandon
58NET060	MUL-NET	Thu 8 February 2001	08:40:00	Thu 8 February 2001	09:20:00		5 Nets Fired. Tuba attached to net	-63.0945	-51.57922	-63.0581	-51.5094	Rachel Wood-Walker
58NET061	MUL-NET	Thu 8 February 2001	22:50:00	Thu 8 February 2001	23:26:00		5 Nets Fired. Tuba attached to net.	-62.39589	-54.92493	-62.3803	-54.8546	Rachel Wood-Walker
58NET062	MUL-NET	Fri 9 February 2001	11:30:00	Fri 9 February 2001	12:20:00		4 Nets Fired (Net 4 Lost). Tuba attached to net	-62.48805	-56.7478	-62.4416	-56.6747	Rachel Wood-Walker
58NET063	MUL-NET	Fri 9 February 2001	14:05:00	Fri 9 February 2001	14:48:00		5 Nets Fired. Tuba attached to net	-62.36936	-56.71653	-62.3255	-56.7178	Rachel Wood-Walker
58NET064	MUL-NET	Fri 9 February 2001	17:30:00	Fri 9 February 2001	18:05:00		5 Nets Fired. Tuba attached to net	-62.1084	-56.99878	-62.0716	-56.9989	Rachel Wood-Walker
58AUV065	AUTOSUB	Fri 9 February 2001	19:43:00	Fri 9 February 2001	23:18:00		5 Nets Fired. Tuba attached to net	-61.81101	-57.01578	-61.8995	-56.9813	Brierley / Fernandes / Brandon

Event number	Event type	Start date (GMT)	Start time (GMT)	End date (GMT)	End time (GMT)	Bottle Depths	Comments	Start Latitude (degrees N)	Start Longitude (degree W)	End Latitude	End Longitude	Scientist
58NET066	MUL-NET	Sat 10 February 2001	00:01:00	Sat 10 February 2001	01:09:00		5 Nets Fired. Tuba attached to net	-61.85997	-56.98512	-61.9011	-56.9735	Rachel Wood-Walker
58NET067	MUL-NET	Sat 10 February 2001	02:56:00	10 Feb01	04:04:00		5 Nets Fired. Tuba attached to net	-61.79538	-56.99519	-61.7851	-56.9682	Rachel Wood-Walker
58CTD068	CTD	13 -Feb-01	00:22:00	13 Feb 01	00:30:00	None	To Sea bed (35 metres)	-51.573	-57.933	-51.5733	-57.933	Mark Brandon

Transect Log

NB The Distance Travelled is only a nominal estimation of the distance between the start and end positions of a transect.

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T1	Cape Pembroke (Fipass)	58CTD001 station	On Passage	22 Jan 2001	10:00:00	-51.6900	-57.824	23 Jan 2001	13:10:00	-57.031	-55.631	641.63
T2	58CTD001 Station	Towards Elephant Island	On Passage	23 Jan 2001	14:32:00	-57.0310	-55.620	24 Jan 2001	02:04:00	-59.301	-54.853	266.34
T3	Change of course toward Clarence Island		On Passage	24 Jan 2001	02:04:00	-59.2805	-54.859	24 Jan 2001	16:04:00	-61.673	-52.720	356.69
T4	Change of Course around Ice Berg		On Passage	24 Jan 2001	16:04:00	-61.6729	-52.720	24 Jan 2001	21:56:00	-62.670	-51.510	174.34
T5	Regain course towards ice edge		Multi-net	24 Jan 2001	23:35:00	-62.7419	-51.418	25 Jan 2001	01:10:00	-62.881	-51.288	21.23
T6	Hold Position at ice edge		Multi-net	25 Jan 2001	02:05:00	-62.8852	-51.340	25 Jan 2001	04:00:00	-62.818	-51.189	18.33
T7	Ice Edge	58CTD004 (40Km into ice)	Ice Survey	25 Jan 2001	04:00:00	-62.8186	-51.189	25 Jan 2001	12:25:00	-63.120	-54.978	422.37
T8	58CTD004	58CTD005 (30km into ice)	CTD	25 Jan 2001	13:32:00	-63.1516	-50.933	25 Jan 2001	14:54:00	-63.075	-51.028	13.58
T9	58CTD005	58CTD006 (20km into ice)	CTD	25 Jan 2001	15:44:00	-63.0766	-51.023	25 Jan 2001	17:12:00	-63.009	-51.123	13.46
T10	58CTD006	58CTD007 (10km into ice)	CTD	25 Jan 2001	18:12:00	-63.0097	-51.125	25 Jan 2001	19:43:00	-62.941	-51.248	15.61
T11	58CTD007	58CTD008 (ice edge)	CTD	25 Jan 2001	20:39:00	-62.9465	-51.255	25 Jan 2001	21:46:00	-62.894	-51.334	10.49
T12	58CTD008	58CTD009 (10km north of	CTD	25 Jan 2001	22:35:00	-62.8984	-51.334	25 Jan 2001	23:10:00	-62.825	-51.439	14.20
T13	58CTD009	58CTD010 (20km north of	CTD	26 Jan 2001	00:21:00	-62.8272	-51.428	26 Jan 2001	01:10:00	-62.749	-51.524	13.72
T14	58CTD010	58CTD011 (30km north of	CTD	26 Jan 2001	02:20:00	-62.7460	-51.519	26 Jan 2001	03:00:00	-62.668	-51.621	14.28
T15	58CTD011	58CTD012 (40km north of	CTD	26 Jan 2001	04:13:00	-62.6649	-51.623	26 Jan 2001	04:52:00	-62.587	-51.719	13.77
T16	58CTD012	Towards Ice	On Passage	26 Jan 2001	05:56:00	-62.5798	-51.727	26 Jan 2001	07:29:00	-62.681	-51.619	16.43
T17	58NET013 deployment	58NET013 recovery	Multi-net	26 Jan 2001	07:29:00	-62.6811	-51.619	26 Jan 2001	08:09:00	-62.689	-51.572	5.28
T18	58NET013 recovery	Head south towards ice	On Passage	26 Jan 2001	08:09:00	-62.6894	-51.572	26 Jan 2001	09:34:00	-62.866	-51.388	28.46
T19	Heading East along ice		On Passage	26 Jan 2001	09:34:00	-62.8669	-51.388	26 Jan 2001	10:15:00	-62.851	-51.275	12.64
T20	Heading West then SW		On Passage	26 Jan 2001	10:15:00	-62.8515	-51.275	26 Jan 2001	11:18:00	-62.916	-51.490	24.93
T21	Heading NW	3km north of ice edge	On Passage	26 Jan 2001	11:18:00	-62.9166	-51.490	26 Jan 2001	12:10:00	-62.829	-51.425	12.02

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T22	Calibration and buoyancy test centred around 62.1167 S,		Autosub	26 Jan 2001	12:10:00	-62.8296	-51.425	26 Jan 2001	13:42:00	-62.829	-51.436	1.18
T23	Deploying and recovering Autosub (aborted mission)		Autosub	26 Jan 2001	13:42:00	-62.8293	-51.436	26 Jan 2001	16:37:00	-62.833	-51.428	1.01
T24	58AUV014	Ice Edge	7knt Transect	26 Jan 2001	16:37:00	-62.8330	-51.428	26 Jan 2001	16:56:00	-62.869	-51.380	6.70
T25	Ice Edge	Course 330 deg T	7knt Transect	26 Jan 2001	16:56:00	-62.8692	-51.380	26 Jan 2001	17:47:00	-62.754	-51.519	20.13
T26	Alter course to 8km transect parallel to ice		7knt Transect	26 Jan 2001	17:47:00	-62.7540	-51.519	26 Jan 2001	18:04:00	-62.734	-51.453	7.67
T27	Alter course to 15km course @ 150deg T		7knt Transect	26 Jan 2001	18:04:00	-62.7348	-51.453	26 Jan 2001	18:53:00	-62.851	-51.302	21.18
T28	8km transect next to ice edge		7knt Transect	26 Jan 2001	18:53:00	-62.8516	-51.302	26 Jan 2001	19:10:00	-62.851	-51.202	11.21
T29	Ice Edge	Course 315E T for 15km	7knt Transect	26 Jan 2001	19:10:00	-62.8517	-51.203	26 Jan 2001	19:19:00	-62.846	-51.205	0.66
T30	WP 10	WP11 (course 330E T)	7knt Transect	26 Jan 2001	19:19:00	-62.8461	-51.205	26 Jan 2001	20:07:00	-62.716	-51.380	24.24
T31	WP11	WP12 (Course 60E T)	7knt Transect	26 Jan 2001	20:07:00	-62.7167	-51.380	26 Jan 2001	20:25:00	-62.697	-51.314	7.72
T32	WP12	WP13 (course 150 deg T)	7knt Transect	26 Jan 2001	20:25:00	-62.6974	-51.314	26 Jan 2001	21:31:00	-62.855	-51.141	25.97
T33	Ice Edge	58AUV015 deployment	On Passage	26 Jan 2001	21:31:00	-62.8551	-51.141	26 Jan 2001	22:32:00	-62.831	-51.434	32.66
T34	Deploying and following Autosub for 58AUV015		Autosub	26 Jan 2001	22:32:00	-62.8310	-51.434	27 Jan 2001	03:01:00	-62.817	-51.434	1.55
T35	58AUV015 recovery	Ice Edge	7knt Transect	27 Jan 2001	03:01:00	-62.8170	-51.434	27 Jan 2001	03:25:00	-62.846	-51.404	4.71
T36	Ice Edge	Transect 7 - 15km 330deg	7knt Transect	27 Jan 2001	03:25:00	-62.8466	-51.404	27 Jan 2001	04:20:00	-62.754	-51.518	16.28
T37	Alter course to 8km transect parallel to ice		7knt Transect	27 Jan 2001	04:20:00	-62.7549	-51.518	27 Jan 2001	04:43:00	-62.738	-51.447	8.08
T38	Alter course to 15km course @ 150deg T		7knt Transect	27 Jan 2001	04:43:00	-62.7380	-51.447	27 Jan 2001	05:43:00	-62.837	-51.321	17.84
T39	Ice Edge	15km at 330 deg T	7knt Transect	27 Jan 2001	05:43:00	-62.8377	-51.321	27 Jan 2001	06:12:00	-62.843	-51.218	11.49
T40	Alter course to find suitable multinet deployment site		On Passage	27 Jan 2001	06:12:00	-62.8438	-51.218	27 Jan 2001	07:32:00	-62.752	-51.325	15.54
T41	58NET016	180 deg T @ 3.5 knots.	Multi-net	27 Jan 2001	07:32:00	-62.7529	-51.325	27 Jan 2001	08:12:00	-62.784	-51.320	3.53
T42	58NET016 recovery	resume transect @ 7knots	7knt Transect	27 Jan 2001	08:12:00	-62.7844	-51.320	27 Jan 2001	09:00:00	-62.717	-51.380	9.93
T43	Alter course to 8km transect parallel to ice		7knt Transect	27 Jan 2001	09:00:00	-62.7176	-51.380	27 Jan 2001	09:26:00	-62.701	-51.308	8.21
T44	Alter course to 15km course @ 150deg T		7knt Transect	27 Jan 2001	09:26:00	-62.7011	-51.308	27 Jan 2001	10:37:00	-62.821	-51.158	21.30
T45	Alter course to approximately 220 deg		7knt Transect	27 Jan 2001	10:37:00	-62.8212	-51.158	27 Jan 2001	10:50:00	-62.839	-51.188	3.88

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T46	Alter course to approximately 280 deg		7knt Transect	27 Jan 2001	10:50:00	-62.8399	-51.188	27 Jan 2001	11:19:00	-62.832	-51.319	14.63
T47	Alter course to 15km @ 330 deg		7knt Transect	27 Jan 2001	11:19:00	-62.8321	-51.319	27 Jan 2001	11:37:00	-62.807	-51.381	7.43
T48	Alter course to approximately 300 deg - Ice berg?		7knt Transect	27 Jan 2001	11:37:00	-62.8070	-51.381	27 Jan 2001	12:02:00	-62.787	-51.471	10.17
T49	Resume 330 deg course		7knt Transect	27 Jan 2001	12:02:00	-62.7870	-51.471	27 Jan 2001	12:30:00	-62.748	-51.536	8.40
T50	Deploying and following Autosub for 58AUV015		Autosub	27 Jan 2001	12:30:00	-62.7488	-51.536	27 Jan 2001	18:44:00	-62.821	-51.412	15.99
T51	Ice Edge	Resume Transects.	7knt Transect	27 Jan 2001	18:44:00	-62.8218	-51.412	27 Jan 2001	19:30:00	-62.734	-51.543	17.50
T52	Alter course to find suitable multinet deployement		On Passage	27 Jan 2001	19:30:00	-62.7342	-51.543	27 Jan 2001	19:45:00	-62.700	-51.587	6.14
T53	58NET019 deployment	106deg T @ 3.5 knots	Multi-net	27 Jan 2001	20:00:00	-62.7009	-51.587	27 Jan 2001	20:35:00	-62.744	-51.488	11.99
T54	58NET019 recovery	060 deg T course to	7knt Transect	27 Jan 2001	21:44:00	-62.7449	-51.488	27 Jan 2001	22:20:00	-62.566	-51.571	21.81
T55	58CTD020	Towards Autosub	On Passage	27 Jan 2001	23:10:00	-62.5655	-51.580	28 Jan 2001	01:16:00	-62.753	-51.340	33.95
T56	Alter course to 330 deg after hearing Autosub		Autosub	28 Jan 2001	01:16:00	-62.7538	-51.340	28 Jan 2001	03:07:00	-62.683	-51.456	15.11
T57	Acoustic search for Autosub		Autosub	28 Jan 2001	03:07:00	-62.6831	-51.456	28 Jan 2001	04:40:00	-62.697	-51.435	2.83
T58	58AUV017 recovery	Ice Edge	Transect	28 Jan 2001	04:40:00	-62.6979	-51.435	28 Jan 2001	06:35:00	-62.881	-50.990	53.43
T59	90deg T	Mapping Edge of ice pack	Ice Survey	28 Jan 2001	06:35:00	-62.8810	-50.990	28 Jan 2001	06:40:00	-62.880	-50.971	2.12
T60	Ice Edge	Alter course to 58NET021	Multi-net	28 Jan 2001	06:40:00	-62.8809	-50.971	28 Jan 2001	07:03:00	-62.884	-51.026	6.10
T61	Multi-net fishing @3.5 knots		Multi-net	28 Jan 2001	07:03:00	-62.8847	-51.026	28 Jan 2001	07:40:00	-62.875	-50.927	11.11
T62	58NET021 recovery	Mapping Edge of ice pack	Ice Survey	28 Jan 2001	07:40:00	-62.8751	-50.927	28 Jan 2001	13:18:00	-62.873	-50.393	59.33
T63	58AUV022 deployment	deployment complete	Autosub	28 Jan 2001	13:18:00	-62.8730	-50.393	28 Jan 2001	13:42:00	-62.868	-50.381	1.39
T64	Following Autosub @ 150 deg T.		Autosub	28 Jan 2001	13:42:00	-62.8686	-50.381	28 Jan 2001	15:00:00	-62.916	-50.325	8.16
T65	Ice Edge	58CTD023	CTD	28 Jan 2001	15:00:00	-62.9163	-50.325	28 Jan 2001	15:48:00	-62.940	-50.297	4.06
T66	58CTD023	Follow Autosub Route into	Autosub	28 Jan 2001	16:39:00	-62.9426	-50.302	28 Jan 2001	17:11:00	-62.967	-50.250	6.45
T67	Ice Pack	Course 330 deg T out of ice	On Passage	28 Jan 2001	17:11:00	-62.9675	-50.250	28 Jan 2001	19:05:00	-62.791	-50.475	31.80
T68	Alter course to 60deg T	58CTD024	CTD	28 Jan 2001	19:05:00	-62.7915	-50.475	28 Jan 2001	19:49:00	-62.755	-50.343	15.18
T69	150deg T @ 7 knots	Vessel stopped	7knt transect	28 Jan 2001	20:52:00	-62.7576	-50.342	28 Jan 2001	21:50:00	-62.850	-50.218	17.13

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T70	Resume 150deg course	Vessel stopped	7knt transect	28 Jan 2001	23:10:00	-62.8406	-50.250	28 Jan 2001	23:51:00	-62.882	-50.184	8.68
T71	Alter course to 330 deg, listening for Autosub		Autosub	29 Jan 2001	00:23:00	-62.8941	-50.178	29 Jan 2001	00:58:00	-62.868	-50.230	6.44
T72	Towfish Retracted and speed increased		Autosub	29 Jan 2001	00:58:00	-62.8685	-50.230	29 Jan 2001	02:05:00	-62.787	-50.302	12.02
T73	Autosub located and recovered.		Autosub	29 Jan 2001	02:05:00	-62.7877	-50.302	29 Jan 2001	03:20:00	-62.787	-50.303	0.15
T74	58AUV022 recovery	Ice Edge	On Passage	29 Jan 2001	03:20:00	-62.7871	-50.303	29 Jan 2001	04:45:00	-62.902	-50.102	25.69
T75	Alter course to 90 deg T	Mapping Edge of Ice Pack	Ice Survey	29 Jan 2001	04:45:00	-62.9025	-50.102	29 Jan 2001	11:26:00	-62.864	-49.278	91.68
T76	Deploying, Recover, Re-deploy Autosub for 58AUV025		Autosub	29 Jan 2001	11:26:00	-62.8644	-49.278	29 Jan 2001	15:18:00	-62.946	-49.268	9.19
T77	Entering Ice Pack	Searching for suitable floe	Ice Survey	29 Jan 2001	15:18:00	-62.9465	-49.268	29 Jan 2001	17:55:00	-63.033	-49.346	12.97
T78	58CTD026	Continue search for	CTD	29 Jan 2001	17:55:00	-63.0333	-49.346	29 Jan 2001	18:51:00	-63.048	-49.347	1.70
T79	Searching for suitable floe	58ICE027	Ice Survey	29 Jan 2001	18:51:00	-63.0486	-49.347	29 Jan 2001	21:26:00	-63.098	-49.373	6.23
T80	58ICE027 heading NW	Ice Edge	On Passage	29 Jan 2001	21:26:00	-63.0981	-49.373	30 Jan 2001	00:10:00	-62.936	-49.474	21.11
T81	Ice Edge	58AUV025 Recovery	Autosub	30 Jan 2001	00:10:00	-62.9369	-49.474	30 Jan 2001	04:00:00	-62.910	-49.537	7.63
T82	58AUV025 recovery	Head WSW towards ice	Transect	30 Jan 2001	04:00:00	-62.9105	-49.537	30 Jan 2001	08:10:00	-62.928	-49.938	44.60
T83	Ice Edge	Investigate Ice Edge,	Transect	30 Jan 2001	08:10:00	-62.9280	-49.938	30 Jan 2001	10:13:00	-63.001	-49.417	58.44
T84	Ice Edge	Alter course to follow	Transect	30 Jan 2001	10:13:00	-63.0018	-49.417	30 Jan 2001	12:35:00	-63.008	-48.788	69.90
T85	Ice Edge	Alter course to follow	Transect	30 Jan 2001	12:35:00	-63.0081	-48.788	30 Jan 2001	14:33:00	-63.192	-48.568	31.94
T86	Ice Edge	Alter course to start of	Transect	30 Jan 2001	14:33:00	-63.1922	-48.568	30 Jan 2001	16:03:00	-63.139	-48.228	38.20
T87	15km @330 deg True	Alter course to 8km section	Transect	30 Jan 2001	16:03:00	-63.1398	-48.228	30 Jan 2001	16:29:00	-63.098	-48.279	7.31
T88	8km @60 deg True	Alter Course to 15km	Transect	30 Jan 2001	16:29:00	-63.0981	-48.279	30 Jan 2001	16:36:00	-63.096	-48.258	2.28
T89	15km @150 deg True	Alter course to along ice	Transect	30 Jan 2001	16:36:00	-63.0964	-48.258	30 Jan 2001	17:03:00	-63.145	-48.195	8.90
T90	8km@60 deg True	Alter Course away from Ice	Transect	30 Jan 2001	17:12:00	-63.1424	-48.176	30 Jan 2001	17:24:00	-63.119	-48.206	4.19
T91	Ice Edge	Alter course to SW to	On Passage	30 Jan 2001	17:24:00	-63.1192	-48.206	30 Jan 2001	17:54:00	-63.150	-48.231	4.42
T92	58NET028 Deployment	58NET028 recovery	Multi-net	30 Jan 2001	17:54:00	-63.1501	-48.231	30 Jan 2001	19:09:00	-63.085	-48.103	15.89
T93	58NET028 Recovery	Return to point were T90	Transect	30 Jan 2001	19:09:00	-63.0855	-48.103	30 Jan 2001	20:00:00	-63.116	-48.212	12.59
T94	Resume T90	Alter course to 8km section	Transect	30 Jan 2001	20:00:00	-63.1162	-48.212	30 Jan 2001	20:12:00	-63.102	-48.226	2.14

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T95	8km @60 deg True	Alter course to 15km	Transect	30 Jan 2001	20:12:00	-63.1027	-48.226	30 Jan 2001	20:23:00	-63.101	-48.205	2.37
T96	15km @150 deg True	58TUB029 deployment	Transect	30 Jan 2001	20:23:00	-63.1011	-48.205	30 Jan 2001	21:40:00	-63.157	-48.093	13.87
T97	Vessel Stationary For TUBA deployment		Stationary	30 Jan 2001	21:40:00	-63.1570	-48.093	30 Jan 2001	23:00:00	-63.168	-48.099	1.42
T98	59TUB029 Recovery	Relocate NW for Autosub	On Passage	30 Jan 2001	23:00:00	-63.1682	-48.099	31 Jan 2001	03:28:00	-62.993	-48.642	63.37
T99	Multi-net fishing @3.5 knots	58NET030 recovery	Multi-net	31 Jan 2001	03:28:00	-62.9930	-48.642	31 Jan 2001	03:55:00	-63.014	-48.603	4.99
T100	58NET030 recovery	Alter course to westerly.	Transect	31 Jan 2001	03:55:00	-63.0142	-48.603	31 Jan 2001	05:14:00	-62.946	-48.751	18.18
T101	Proceed on Westerly course		Transect	31 Jan 2001	05:14:00	-62.9460	-48.751	31 Jan 2001	05:35:00	-62.946	-48.829	8.59
T102	Alter course to NW, still searching for suitable ice berg.		Transect	31 Jan 2001	05:35:00	-62.9460	-48.829	31 Jan 2001	08:25:00	-62.777	-49.458	72.44
T103	Alter course to 200deg, still searching for suitable ice		Transect	31 Jan 2001	08:25:00	-62.7773	-49.458	31 Jan 2001	08:50:00	-62.844	-49.499	8.70
T104	Alter course to 180 deg		Transect	31 Jan 2001	08:50:00	-62.8444	-49.499	31 Jan 2001	09:12:00	-62.905	-49.484	6.97
T105	Circling around suitable bergs for Autosub Mission		Ice Survey	31 Jan 2001	09:12:00	-62.9054	-49.484	31 Jan 2001	11:53:00	-62.947	-49.485	4.68
T106	Deploying and following, then recovery of Autosub for		Autosub	31 Jan 2001	11:53:00	-62.9475	-49.485	31 Jan 2001	16:01:00	-62.935	-49.551	7.43
T107	Relocate to 58CTD032	58CTD032 completed	CTD	31 Jan 2001	16:01:00	-62.9351	-49.551	31 Jan 2001	17:36:00	-62.925	-49.487	7.16
T108	Leave 58CTD032 station heading SE		Transect	31 Jan 2001	17:36:00	-62.9254	-49.487	31 Jan 2001	18:08:00	-62.961	-49.280	23.37
T109	Alter course to return along track for fishing.		Transect	31 Jan 2001	18:08:00	-62.9616	-49.280	31 Jan 2001	18:36:00	-62.935	-49.372	10.65
T110	Alter course to NE for Multinet Deployment		Transect	31 Jan 2001	18:36:00	-62.9359	-49.372	31 Jan 2001	18:50:00	-62.931	-49.343	3.26
T111	Multi-net fishing @3.5 knots		Multi-net	31 Jan 2001	18:50:00	-62.9313	-49.343	31 Jan 2001	19:36:00	-62.964	-49.426	9.87
T112	Return to Ice Bergs used in event 031, for 58AUV33A		On Passage	31 Jan 2001	19:36:00	-62.9641	-49.426	31 Jan 2001	20:45:00	-62.928	-49.444	4.50
T113	Deploying and following, then recovery of Autosub for		Autosub	31 Jan 2001	20:45:00	-62.9280	-49.444	31 Jan 2001	22:40:00	-62.952	-49.558	12.91
T114	Searching for suitable Fishing Location		On Passage	31 Jan 2001	22:40:00	-62.9520	-49.558	1 Feb 2001	00:15:00	-62.954	-49.504	5.92
T115	Multi-net fishing @3.5 knots		Multi-net	1 Feb 2001	00:15:00	-62.9544	-49.504	1 Feb 2001	00:55:00	-62.947	-49.606	11.35
T116	58NET034 recovery	Ice Edge	On Passage	1 Feb 2001	00:55:00	-62.9478	-49.606	1 Feb 2001	02:04:00	-62.986	-49.268	37.85
T117	Ice Edge	Heading approximately	Ice Survey	1 Feb 2001	02:04:00	-62.9865	-49.268	1 Feb 2001	03:20:00	-62.973	-48.816	50.25
T118	Ice Edge	Heading southerly	Ice Survey	1 Feb 2001	03:20:00	-62.9735	-48.816	1 Feb 2001	04:45:00	-63.036	-48.414	45.22

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T119	Continuous altering of course due to ice presence - head		Ice Survey	1 Feb 2001	04:45:00	-63.0365	-48.414	1 Feb 2001	05:55:00	-63.033	-48.375	4.32
T120	Heading North		Transect	1 Feb 2001	05:55:00	-63.0337	-48.375	1 Feb 2001	07:35:00	-62.949	-48.504	17.07
T121	Heading South or SSE		Transect	1 Feb 2001	07:35:00	-62.9496	-48.504	1 Feb 2001	07:57:00	-62.979	-48.433	8.48
T122	Heading NorthEast		Transect	1 Feb 2001	07:57:00	-62.9791	-48.433	1 Feb 2001	08:10:00	-62.962	-48.372	7.09
T123	Head to Ice Edge to check conditions		Ice Survey	1 Feb 2001	08:10:00	-62.9625	-48.372	1 Feb 2001	08:48:00	-63.012	-48.262	13.36
T124	Head to 58AUV035 deployment		On Passage	1 Feb 2001	08:48:00	-63.0126	-48.262	1 Feb 2001	09:54:00	-62.956	-48.342	10.83
T125	Deploying and following Autosub to ice edge for		Autosub	1 Feb 2001	09:54:00	-62.9567	-48.342	1 Feb 2001	11:47:00	-63.021	-48.262	11.45
T126	58CTD036 at ice edge		CTD	1 Feb 2001	11:47:00	-63.0213	-48.262	1 Feb 2001	12:41:00	-63.015	-48.272	1.33
T127	Head 5km into ice pack		Ice Survey	1 Feb 2001	12:41:00	-63.0154	-48.272	1 Feb 2001	13:45:00	-63.059	-48.216	7.91
T128	58CTD037		CTD	1 Feb 2001	13:45:00	-63.0590	-48.216	1 Feb 2001	14:38:00	-63.056	-48.218	0.37
T129	Head out of ice on bearing of 330 deg True		Ice Survey	1 Feb 2001	14:38:00	-63.0567	-48.218	1 Feb 2001	16:46:00	-62.859	-48.467	35.23
T130	At outer WP of reciprocal Transect. Alter course to 60		Transect	1 Feb 2001	16:46:00	-62.8594	-48.467	1 Feb 2001	17:14:00	-62.816	-48.373	11.41
T131	At NE WP for 58CTD038		CTD	1 Feb 2001	17:14:00	-62.8165	-48.373	1 Feb 2001	18:24:00	-62.823	-48.337	4.13
T132	58CTD038	Ice Edge (Autosub WP for	Transect	1 Feb 2001	18:24:00	-62.8230	-48.337	1 Feb 2001	19:07:00	-62.913	-48.224	16.04
T133	Alter course to NW for Multinet Deployment		Transect	1 Feb 2001	19:07:00	-62.9132	-48.224	1 Feb 2001	19:24:00	-62.893	-48.279	6.46
T134	Multi-net fishing @3.5 knots		Multi-net	1 Feb 2001	19:24:00	-62.8938	-48.279	1 Feb 2001	20:27:00	-62.927	-48.134	16.48
T135	58NET039 recovery		Transect	1 Feb 2001	20:27:00	-62.9276	-48.134	1 Feb 2001	20:45:00	-62.916	-48.213	8.79
T136	Resume Transect towards Ice Edge		Transect	1 Feb 2001	20:45:00	-62.9160	-48.213	1 Feb 2001	21:17:00	-62.993	-48.115	13.84
T137	At Ice Edge	Turn 180deg to 58AUV035	Transect	1 Feb 2001	21:17:00	-62.9931	-48.115	1 Feb 2001	21:55:00	-62.898	-48.237	17.21
T138	Recovering Autosub		Autosub	1 Feb 2001	21:55:00	-62.8982	-48.237	2 Feb 2001	00:15:00	-62.870	-48.241	3.15
T139	Heading SouthEast - back to ice Edge.		Transect	2 Feb 2001	00:15:00	-62.8701	-48.241	2 Feb 2001	03:09:00	-63.106	-47.603	75.59
T140	Alter course to NE		Transect	2 Feb 2001	03:09:00	-63.1061	-47.603	2 Feb 2001	03:54:00	-63.026	-47.480	16.24
T141	Alter course to Easterly		Transect	2 Feb 2001	03:54:00	-63.0263	-47.480	2 Feb 2001	05:05:00	-63.013	-47.144	37.45
T142	Alter course to do rectangle		Transect	2 Feb 2001	05:05:00	-63.0134	-47.144	2 Feb 2001	05:13:00	-63.025	-47.138	1.46
T143	Start rectangle going West		Transect	2 Feb 2001	05:13:00	-63.0255	-47.138	2 Feb 2001	05:55:00	-63.031	-47.319	20.08

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T144	2nd leg going south		Transect	2 Feb 2001	05:55:00	-63.0310	-47.319	2 Feb 2001	06:08:00	-63.057	-47.319	2.88
T145	3rd Leg going East		Transect	2 Feb 2001	06:08:00	-63.0570	-47.319	2 Feb 2001	06:48:00	-63.068	-47.143	19.61
T146	4th Leg going North		Transect	2 Feb 2001	06:48:00	-63.0680	-47.143	2 Feb 2001	07:15:00	-63.016	-47.145	5.77
T147	Finish Rectangle, head NE.		Transect	2 Feb 2001	07:15:00	-63.0162	-47.145	2 Feb 2001	07:22:00	-63.009	-47.110	3.89
T148	Alter course for Multi-net deployment 58NET040		Multi-net	2 Feb 2001	07:22:00	-63.0098	-47.110	2 Feb 2001	08:45:00	-63.014	-47.163	5.83
T149	South-west transect to 58AUV041 deployment		On Passage	2 Feb 2001	08:45:00	-63.0140	-47.163	2 Feb 2001	09:15:00	-63.071	-47.357	22.48
T150	Deploying Autosub 58AUV040		Autosub	2 Feb 2001	09:15:00	-63.0713	-47.357	2 Feb 2001	10:02:00	-63.073	-47.374	1.96
T151	Following Autosub to ice edge		Autosub	2 Feb 2001	10:02:00	-63.0735	-47.374	2 Feb 2001	11:17:00	-63.109	-47.316	7.62
T152	58CTD042 deployment at ice edge		CTD	2 Feb 2001	11:17:00	-63.1098	-47.316	2 Feb 2001	12:10:00	-63.114	-47.318	0.58
T153	Entering Ice Pack		Ice Survey	2 Feb 2001	12:10:00	-63.1146	-47.318	2 Feb 2001	13:05:00	-63.164	-47.250	9.33
T154	58ICE043 and searching for suitable CTD position -		Ice Survey	2 Feb 2001	13:05:00	-63.1648	-47.250	2 Feb 2001	14:10:00	-63.146	-47.264	2.48
T155	Heading NW out of Ice Pack		Ice Survey	2 Feb 2001	14:10:00	-63.1468	-47.264	2 Feb 2001	14:34:00	-63.113	-47.304	5.81
T156	Ice Edge		Transect	2 Feb 2001	14:34:00	-63.1138	-47.304	2 Feb 2001	15:41:00	-62.955	-47.516	29.37
T157	At NE WP of reciprocal Transect		Transect	2 Feb 2001	15:41:00	-62.9551	-47.516	2 Feb 2001	16:18:00	-62.991	-47.652	15.66
T158	At NW WP of reciprocal Transect - deploy 58CTD044		Transect	2 Feb 2001	16:18:00	-62.9916	-47.652	2 Feb 2001	17:10:00	-62.991	-47.655	0.36
T159	58CTD044	Ice Edge (Autosub WP for	CTD	2 Feb 2001	17:10:00	-62.9918	-47.655	2 Feb 2001	18:40:00	-63.175	-47.411	33.99
T160	Ice Edge	Following Ice Edge back to	Transect	2 Feb 2001	18:40:00	-63.1759	-47.411	2 Feb 2001	19:56:00	-63.059	-47.388	13.16
T161	Multi-net fishing @3.5 knots across T156 line		Multi-net	2 Feb 2001	19:56:00	-63.0595	-47.388	2 Feb 2001	20:53:00	-63.043	-47.353	4.29
T162	58NET045	Return to Transect T159	Transect	2 Feb 2001	20:53:00	-63.0437	-47.353	2 Feb 2001	21:28:00	-63.078	-47.541	21.19
T163	Heading 330 deg True along T159		Transect	2 Feb 2001	21:28:00	-63.0788	-47.541	2 Feb 2001	23:03:00	-63.072	-47.553	1.51
T164	Recovering Autosub		Autosub	2 Feb 2001	23:03:00	-63.0725	-47.553	3 Feb 2001	02:12:00	-63.080	-47.537	1.99
T165	58AUV041 recovery	Course 090 deg True	Transect	3 Feb 2001	02:12:00	-63.0802	-47.537	3 Feb 2001	06:56:00	-63.068	-46.798	82.06
T166	Ship heading Generally SE'ly investigating Ice Edge		Transect	3 Feb 2001	06:56:00	-63.0688	-46.798	3 Feb 2001	09:10:00	-63.164	-46.451	39.99
T167	Ice Edge	Alter course to 010 deg T,	Transect	3 Feb 2001	09:10:00	-63.1640	-46.451	3 Feb 2001	10:00:00	-63.101	-46.324	15.73

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T168	3 miles north of Ice	Heading 270 deg Parellel to	Transect	3 Feb 2001	10:00:00	-63.1014	-46.324	3 Feb 2001	10:32:00	-63.108	-46.496	19.14
T169	Parellel to Ice Edge	Alter Heading to 250 deg	Transect	3 Feb 2001	10:32:00	-63.1081	-46.496	3 Feb 2001	11:15:00	-63.146	-46.730	26.31
T170	3 miles north of ice	Ice Edge on heading 155	Transect	3 Feb 2001	11:15:00	-63.1467	-46.730	3 Feb 2001	11:32:00	-63.175	-46.715	3.59
T171	In Ice, Exploring East of	Alter course to south, back	Ice Survey	3 Feb 2001	11:32:00	-63.1755	-46.715	3 Feb 2001	12:25:00	-63.144	-46.657	7.39
T172	Ice Edge	Autosub Ice edge mission	On Passage	3 Feb 2001	12:25:00	-63.1448	-46.657	3 Feb 2001	13:17:00	-63.175	-46.666	3.54
T173	Heading 335 Deg True	At Latitude of Tabular Ice	Transect	3 Feb 2001	13:17:00	-63.1752	-46.666	3 Feb 2001	14:08:00	-63.042	-46.805	21.29
T174	Heading West to 58CTD046		Transect	3 Feb 2001	14:08:00	-63.0426	-46.805	3 Feb 2001	14:23:00	-63.044	-46.870	7.31
T175	On Station for 58CTD046 + 58AUV047 deployment,		CTD	3 Feb 2001	14:23:00	-63.0447	-46.870	3 Feb 2001	18:55:00	-63.044	-46.914	4.86
T176	Hove to in Freshening	110 deg True @2.5 knots	Hove To	3 Feb 2001	21:29:00	-63.0576	-46.946	3 Feb 2001	22:30:00	-63.070	-46.862	9.39
T177	Heading altered to 098 deg	Hove To.	Hove To	3 Feb 2001	22:30:00	-63.0703	-46.862	4 Feb 2001	01:50:00	-63.084	-46.458	44.99
T178	Build up of pack ice - alter	Hove To.	Hove To	4 Feb 2001	01:50:00	-63.0848	-46.458	4 Feb 2001	02:45:00	-63.005	-46.439	9.01
T179	Alter course to westerly	Hove To.	Hove To	4 Feb 2001	02:45:00	-63.0058	-46.439	4 Feb 2001	03:33:00	-62.991	-46.640	22.35
T180	298 deg course	Hove To.	Hove To	4 Feb 2001	03:33:00	-62.9916	-46.640	4 Feb 2001	06:06:00	-62.873	-47.158	59.03
T181	Alter course to 270 deg	Hove To.	Hove To	4 Feb 2001	06:06:00	-62.8732	-47.158	4 Feb 2001	06:37:00	-62.880	-47.278	13.33
T182	113 deg course	Hove To.	Hove To	4 Feb 2001	06:37:00	-62.8804	-47.278	4 Feb 2001	07:30:00	-62.895	-47.225	6.09
T183	074 deg course	Hove To.	Hove To	4 Feb 2001	07:30:00	-62.8952	-47.225	4 Feb 2001	08:15:00	-62.888	-47.158	7.48
T184	Heading Downwind to clear floating ice		Hove To	4 Feb 2001	08:15:00	-62.8883	-47.158	4 Feb 2001	09:26:00	-62.847	-47.509	39.22
T185	Heading altered to 110 deg	Hove To.	Hove To	4 Feb 2001	09:26:00	-62.8478	-47.509	4 Feb 2001	10:00:00	-62.849	-47.465	4.89
T186	088 deg	Hove To.	Hove To	4 Feb 2001	10:00:00	-62.8494	-47.465	4 Feb 2001	10:32:00	-62.848	-47.429	3.92
T187	Alter Heading to SE'ly	Hove To.	Hove To	4 Feb 2001	10:32:00	-62.8489	-47.429	4 Feb 2001	12:36:00	-62.863	-47.262	18.63
T188	065 deg	Hove To.	Hove To	4 Feb 2001	12:36:00	-62.8636	-47.262	4 Feb 2001	16:10:00	-62.843	-46.943	35.59
T189	Alter course to 290	Seeking Ice Edge	On Passage	4 Feb 2001	16:10:00	-62.8432	-46.943	4 Feb 2001	19:00:00	-62.693	-48.164	136.80
T190	Alter course to 270	Seeking Ice Edge	Transect	4 Feb 2001	19:00:00	-62.6931	-48.164	4 Feb 2001	19:35:00	-62.699	-48.428	29.34
T191	Alter course to 225	Seeking Ice Edge	Transect	4 Feb 2001	19:35:00	-62.6994	-48.428	4 Feb 2001	21:13:00	-62.941	-48.928	61.68

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T192	Alter course to 180 deg	Seeking Ice Edge	Transect	4 Feb 2001	21:13:00	-62.9418	-48.928	4 Feb 2001	21:52:00	-63.071	-48.934	14.43
T193	Alter course to 200	Entered brash ice at 22:00	Ice Survey	4 Feb 2001	21:52:00	-63.0715	-48.934	4 Feb 2001	22:28:00	-63.144	-48.992	10.39
T194	Alter course to 020	Open Water	Transect	4 Feb 2001	22:28:00	-63.1448	-48.992	4 Feb 2001	23:00:00	-63.096	-48.971	5.86
T195	Alter course to 290 for Ice Edge Mapping		Ice Survey	4 Feb 2001	23:00:00	-63.0961	-48.971	5 Feb 2001	07:54:00	-62.782	-51.148	244.32
T196	Alter course to 110 deg	Multinet Fishing 58NET048	Multi-net	5 Feb 2001	07:54:00	-62.7828	-51.148	5 Feb 2001	08:40:00	-62.799	-51.046	11.41
T197	58NET048	Southerly to Ice berg for	On Passage	5 Feb 2001	08:40:00	-62.7998	-51.046	5 Feb 2001	11:36:00	-62.888	-51.184	18.19
T198	On station for 58AUV049 +	On station at Ice berg	Stationary	5 Feb 2001	11:36:00	-62.8883	-51.184	5 Feb 2001	23:09:00	-62.897	-51.246	6.95
T199	Alter course for Multi-net	Fishing towards ice edge	Multi-net	5 Feb 2001	23:09:00	-62.8970	-51.246	6 Feb 2001	01:54:00	-62.940	-51.220	5.61
T200	At Ice Edge - fishing	Heading NE	Transect	6 Feb 2001	01:54:00	-62.9401	-51.220	6 Feb 2001	05:01:00	-62.633	-51.606	54.79
T201	Reach NE corner of	Heading 240 deg	Transect	6 Feb 2001	05:01:00	-62.6335	-51.606	6 Feb 2001	06:01:00	-62.681	-51.801	22.33
T202	Reach NW corner of	Heading 150 deg towards	Transect	6 Feb 2001	06:01:00	-62.6814	-51.801	6 Feb 2001	08:41:00	-62.940	-51.319	60.77
T203	Alter course to Southerly - into Ice		Ice Survey	6 Feb 2001	08:41:00	-62.9401	-51.319	6 Feb 2001	11:10:00	-63.162	-51.327	24.71
T204	Reach Southerly point of transects	Reciprocal course out of ice	Ice Survey	6 Feb 2001	11:10:00	-63.1623	-51.327 8	6 Feb 2001	13:25:00	-62.941 8	-51.317 3	24.53
T205	Exit Ice pack	Alter course to Westerly	Ice Survey	6 Feb 2001	13:25:00	-62.9418	-51.317	6 Feb 2001	14:16:00	-62.953	-51.381	7.29
T206	Alter course to Southerly	Mapping Ice	Ice Survey	6 Feb 2001	14:16:00	-62.9538	-51.381	6 Feb 2001	14:51:00	-63.021	-51.380	7.51
T207	Alter course to Westerly		Ice Survey	6 Feb 2001	14:51:00	-63.0213	-51.380	6 Feb 2001	15:18:00	-63.020	-51.400	2.17
T208	Alter course to Northerly	To find clear water for	On Passage	6 Feb 2001	15:18:00	-63.0208	-51.400	6 Feb 2001	15:31:00	-62.991	-51.442	5.71
T209	Deploying Autosub 58AUV052		Autosub	6 Feb 2001	15:31:00	-62.9918	-51.442	6 Feb 2001	18:18:00	-62.990	-51.462	2.18
T210	Following Autosub to ice edge		Autosub	6 Feb 2001	18:18:00	-62.9906	-51.462	6 Feb 2001	20:40:00	-63.107	-51.454	13.02
T211	Following Autosub west through Ice		Autosub	6 Feb 2001	20:40:00	-63.1075	-51.454	6 Feb 2001	20:52:00	-63.107	-51.476	2.47
T212	Following Autosub out of ice		Autosub	6 Feb 2001	20:52:00	-63.1072	-51.476	6 Feb 2001	22:53:00	-63.017	-51.474	10.00
T213	Recovering Autosub		Autosub	6 Feb 2001	22:53:00	-63.0173	-51.474	6 Feb 2001	23:20:00	-63.021	-51.469	0.74
T214	Alter course to NE		Transect	6 Feb 2001	23:20:00	-63.0218	-51.469	7 Feb 2001	06:01:00	-62.571	-52.675	143.09

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T215	Reach NE corner of	Alter heading to 240 deg	Transect	7 Feb 2001	06:01:00	-62.5715	-52.675	7 Feb 2001	06:54:00	-62.659	-52.849	21.67
T216	Reach NW corner of	Alter heading to 150 deg	Transect	7 Feb 2001	06:54:00	-62.6592	-52.849	7 Feb 2001	07:28:00	-62.709	-52.745	12.83
T217	Alter course for Multi-net deployment 58NET053		On Passage	7 Feb 2001	07:28:00	-62.7093	-52.745	7 Feb 2001	07:52:00	-62.661	-52.875	15.32
T218	Deploying Multinet along	steering 125 deg	Multi-net	7 Feb 2001	07:52:00	-62.6617	-52.875	7 Feb 2001	08:55:00	-62.701	-52.758	13.68
T219	Finish Fishing	Continue on course T215	Transect	7 Feb 2001	08:55:00	-62.7012	-52.758	7 Feb 2001	11:26:00	-62.911	-52.243	61.84
T220	Alter course for Multi-net	steering 130 deg True	Multi-net	7 Feb 2001	11:26:00	-62.9113	-52.243	7 Feb 2001	12:58:00	-62.925	-52.194	5.67
T221	Finish Fishing	Alter heading to 60 deg T	Transect	7 Feb 2001	12:58:00	-62.9256	-52.194	7 Feb 2001	14:14:00	-62.772	-51.915	35.35
T222	Alter heading to 150 deg T		Transect	7 Feb 2001	14:14:00	-62.7727	-51.915	7 Feb 2001	15:27:00	-62.906	-51.580	40.03
T223	Alter heading to 240 deg T		Transect	7 Feb 2001	15:27:00	-62.9060	-51.580	7 Feb 2001	16:02:00	-62.976	-51.712	16.62
T224	Alter course for Multi-net deployment 58NET056		On Passage	7 Feb 2001	16:02:00	-62.9762	-51.712	7 Feb 2001	16:27:00	-62.919	-51.680	7.24
T225	Deploying Multinet		Multi-net	7 Feb 2001	16:27:00	-62.9192	-51.680	7 Feb 2001	17:51:00	-62.938	-51.484	21.94
T226	Multinet recovered		On Passage	7 Feb 2001	17:51:00	-62.9380	-51.484	7 Feb 2001	18:36:00	-63.076	-51.471	15.44
T227	On Station for 58AUV057 deployment		Stationary	7 Feb 2001	18:36:00	-63.0764	-51.471	7 Feb 2001	21:10:00	-63.068	-51.452	2.33
T228	Following Autosub to ice edge		Autosub	7 Feb 2001	21:10:00	-63.0685	-51.452	8 Feb 2001	23:15:00	-63.169	-51.454	11.25
T229	On station for 58CTD058		CTD	7 Feb 2001	23:15:00	-63.1697	-51.454	8 Feb 2001	00:18:00	-63.170	-51.461	0.81
T230	Heading through ice to Autosub exit transect		Ice Survey	8 Feb 2001	00:18:00	-63.1708	-51.461	8 Feb 2001	01:20:00	-63.144	-51.558	11.15
T231	On station for 58CTD059		CTD	8 Feb 2001	01:20:00	-63.1442	-51.558	8 Feb 2001	02:22:00	-63.145	-51.556	0.21
T232	Leave station for Transects	Heading 60 deg	Transect	8 Feb 2001	02:22:00	-63.1454	-51.556	8 Feb 2001	03:36:00	-63.035	-51.448	17.19
T233	Alter course to 180 deg		Transect	8 Feb 2001	03:36:00	-63.0353	-51.448	8 Feb 2001	04:49:00	-63.171	-51.461	15.17
T234	Alter course to 270 deg		Transect	8 Feb 2001	04:49:00	-63.1712	-51.461	8 Feb 2001	05:06:00	-63.172	-51.513	5.82
T235	Alter course to 000 deg		Transect	8 Feb 2001	05:06:00	-63.1721	-51.513	8 Feb 2001	06:12:00	-63.039	-51.515	14.70
T236	Alter course to 270 deg		Transect	8 Feb 2001	06:12:00	-63.0398	-51.515	8 Feb 2001	06:19:00	-63.038	-51.547	3.58
T237	Alter course to 180 deg		Transect	8 Feb 2001	06:19:00	-63.0388	-51.547	8 Feb 2001	07:22:00	-63.171	-51.558	14.80
T238	Heading North out of ice		Transect	8 Feb 2001	07:22:00	-63.1715	-51.558	8 Feb 2001	08:20:00	-63.063	-51.558	12.05
T239	Alter course for Multi-net deployment 58NET060		On Passage	8 Feb 2001	08:20:00	-63.0631	-51.558	8 Feb 2001	08:35:00	-63.096	-51.585	4.85

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T240	Multinet fishing on course 40 deg T		Multi-net	8 Feb 2001	08:35:00	-63.0969	-51.585	8 Feb 2001	09:28:00	-63.052	-51.491	11.63
T241	Multinet recovered	Proceed to Autosub	On Passage	8 Feb 2001	09:28:00	-63.0525	-51.491	8 Feb 2001	09:50:00	-63.106	-51.562	9.94
T242	Heading North along Autosub Course		Transect	8 Feb 2001	09:50:00	-63.1060	-51.562	8 Feb 2001	10:37:00	-63.057	-51.556	5.46
T243	On Station awaiting Autosub Surfacing, then recovery.		Stationary	8 Feb 2001	10:37:00	-63.0572	-51.556	8 Feb 2001	14:45:00	-62.935	-51.572	13.65
T244	58AUV057 recovery	heading NE	Autosub	8 Feb 2001	14:45:00	-62.9354	-51.572	8 Feb 2001	22:50:00	-62.395	-54.923	377.26
T245	Multinet deployed	Course 065 deg T	Multi-net	8 Feb 2001	22:50:00	-62.3957	-54.923	8 Feb 2001	23:26:00	-62.380	-54.853	7.99
T246	Multinet 58NET061	Heading on SE'ly course	Transect	8 Feb 2001	23:26:00	-62.3801	-54.853	9 Feb 2001	00:56:00	-62.426	-55.162	34.72
T247	Alter course to NE'ly		Transect	9 Feb 2001	00:56:00	-62.4267	-55.162	9 Feb 2001	03:44:00	-62.390	-55.665	56.01
T248	Alter course to SE'ly		Transect	9 Feb 2001	03:44:00	-62.3908	-55.665	9 Feb 2001	05:23:00	-62.456	-55.988	36.65
T249	Alter course to NE'ly		Transect	9 Feb 2001	05:23:00	-62.4565	-55.988	9 Feb 2001	09:44:00	-62.393	-56.591	67.31
T250	Alter course to SE'ly		Transect	9 Feb 2001	09:44:00	-62.3936	-56.591	9 Feb 2001	11:16:00	-62.481	-56.758	20.98
T251	Alter course for Multi-net Fishing @ 11:03 location		On Passage	9 Feb 2001	11:16:00	-62.4818	-56.758	9 Feb 2001	11:30:00	-62.487	-56.746	1.40
T252	Multinet fishing on course 037 deg T		Multi-net	9 Feb 2001	11:30:00	-62.4875	-56.746	9 Feb 2001	12:29:00	-62.434	-56.665	10.79
T253	Fishing completed	Heading NE'ly	Transect	9 Feb 2001	12:29:00	-62.4342	-56.665	9 Feb 2001	13:34:00	-62.321	-56.750	15.66
T254	Alter course for Multi-net Fishing		On Passage	9 Feb 2001	13:34:00	-62.3217	-56.750	9 Feb 2001	14:05:00	-62.368	-56.716	6.45
T255	Multinet fishing		Multi-net	9 Feb 2001	14:05:00	-62.3688	-56.716	9 Feb 2001	14:48:00	-62.325	-56.717	4.87
T256	Fishing completed	Retrurn to T252 course	Transect	9 Feb 2001	14:48:00	-62.3250	-56.717	9 Feb 2001	17:30:00	-62.108	-56.998	39.43
T257	Deploy Multinet for 58NET064		Multi-net	9 Feb 2001	17:30:00	-62.1084	-56.998	9 Feb 2001	18:13:00	-62.062	-57.011	5.28
T258	Fishing completed	Resume Northerly course	Transect	9 Feb 2001	18:13:00	-62.0625	-57.011	9 Feb 2001	19:42:00	-61.811	-57.015	27.95
T259	Deploy Autosub for 58AUV065, stay on station, followed		Autosub	9 Feb 2001	19:42:00	-61.8110	-57.015	10 Feb 2001	01:09:00	-61.901	-56.973	11.05
T260	Fishing completed	Heading North	Transect	10 Feb 2001	01:09:00	-61.9011	-56.973	10 Feb 2001	02:45:00	-61.777	-56.989	13.80
T261	Alter course for Multi-net Fishing		On Passage	10 Feb 2001	02:45:00	-61.7779	-56.989	10 Feb 2001	04:04:00	-61.785	-56.967	2.50
T262	Multinet fishing 58NET067	Fishing completed	Multi-net	10 Feb 2001	04:04:00	-61.7853	-56.967	11 Feb 2001	07:30:00	-61.341	-56.990	49.37

Name	From	To	Activity	Start Date	Start (GMT)	Start Lat (deg N)	Start Long	End Date	End (GMT)	End Latitude	End Long	Distance Travelled
T263	Heading North towards South Shetlands	Weather worsening - Hove to, heading SE	On Passage	10 Feb 2001	07:30:00	-61.3416	-56.990	10 Feb 2001	21:30:00	-61.949	-56.069	122.69
T264	Hove to, heading south		Hove To	10 Feb 2001	21:30:00	-61.9498	-56.069	10 Feb 2001	22:40:00	-62.016	-56.100	8.07
T265	Attempting to head West towards King George Island		Hove To	10 Feb 2001	22:40:00	-62.0157	-56.100	11 Feb 2001	07:15:00	-62.124	-57.350	139.45
T266	Abandoned South Shetlands heading - too	Heading North - to Falkland Islands	On Passage	11 Feb 2001	07:15:00	-62.1244	-57.350	12 Feb 2001	21:25:00	-59.370	-57.277	306.15
T267	Alter course during Captain's Dinner.		On Passage	12 Feb 2001	21:25:00	-59.3703	-59.370	12-Feb-2001	21:44:00	-	-	535.60
T268	Alter course to downwind during Captain's Dinner		On Passage	12 Feb 2001	21:44:00	-54.6476	-	12-Feb-2001	22:57:00	-	-	40.25
T269	Resume North Transect		On Passage	12 Feb 2001	22:57:00	-54.4400	-	13-Feb-2001	10:53:00	-	-	317.15
T270	Reach Entrance to Berkeley Sound		On Passage	13 Feb 2001	10:53:00	-51.6009	-	13-Feb-2001	11:00:00	-51.608	-	1.42
T271	Heading NE into Strait		On Passage	13 Feb 2001	11:00:00	-51.6079	-51.608	13-Feb-2001	11:25:00	-51.579	-57.810	16.66
T272	Alter course to Westerly		On Passage	13 Feb 2001	11:25:00	-51.5787	-51.579	13-Feb-2001	11:50:00	-51.574	-	13.82
T273	Reach Station for EK500 calibration and 58CTD068. Data logging switched off at 16:44		On Passage	13 Feb 2001	11:50:00	-51.5741	-51.574					

Long-term data storage

A ROSCOP Cruise Summary report was completed, and all ship-based and *Autosub* data were given to Mary Robjant of BODC for long term archival.

Computing

Data Acquisition Systems

SCS

Data acquisition on the SCS was started on January 21st and the system ran, with very few problems, throughout the cruise. No changes were made to the system configuration file, with the effect that data was logged on the SCS server for the following instruments continually:

Glonass	Emlog
Ashtec-ADU2	Simrad-EA500
Trimble	Net-Monitor
Anemometer	Winch
TSSHRP	New_stcm
Oceanlogger	Gyro
BASSTCM	
Dopplerlog	

Data for the winch, gyro and new_stcm was logged to the server using the Java applications ("AtoSCS" and "gyro").

The "Send Socket SCS Message" facility was used to redistribute GPS data from the Trimble to a PC in the Wet Lab.

The SCS appeared unaffected by a 10 minute power cut on February 3rd, running on UPS battery power. All sensors were without power, but when power returned acquisition continued and all seemed normal. However, it was later noted that there was a problem with the Ashtec-ADU2 Level C data. This problem was initially thought to be due to settings having been lost on the Ashtec unit when it was power cycled. However, after inspecting the Ashtec data on the SCS, the processed data files (.ACO and .LAB) were found to be corrupted, although the RAW file was unaffected. It appeared that no CR/LF was being placed after the data in the files, with the effect that all incoming data had been logged on a single line since the power cut. The solution was to stop and start acquisition. Data was then appended to the existing .ACO and .LAB files in the correct format. Having restarted data acquisition, COM port 14 (the Oceanlogger) seemed to lock up. Data acquisition was stopped again and the SCS server power cycled. This resolved the problem.

Timescale of SCS events

Date	**Time (GMT)**	**Event**
06/02/01 (jday 037)	335	Acquisition stopped
06/02/01 (jday 037)	340	Acquisition restarted
06/02/01 (jday 037)	421	Acquisition stopped
06/02/01 (jday 037)	433	Acquisition restarted

Level C

The program “scs2levc” was run on the Level C machine (jrub) throughout the cruise to convert the SCS data to Level C format. This ran without problems. However, jrub rebooted automatically following the power cut on February 3rd, which meant the Level C data streams had to be recreated and the “scs2levc” process restarted.

The “bestnav” and “relmov” utilities were run constantly on jrub to create their respective data streams.

ADCP

As the ADCP logs directly to the Level C machine, the existing data stream was copied away and a new stream created, before the “fromadcp” process was restarted following the power cut. Following configuration changes on the ADCP PC, the “fromadcp” process stopped and was restarted again on February 8th/9th. The pingdata files for the period when the ADCP data wasn’t being logged by the Level C were recovered from the PC and manually converted to a Level C data stream.

Timescale of ADCP events

Date	**Time (GMT)**	**Event**
08/02/01 (jday 039)	2042	Logging stopped
09/02/01 (jday 040)	208	Logging restarted

Processed file corruption following a power cut

On 3/2/2001 the RRS *James Clark Ross* suffered a power cut. This affected all ships systems for approximately 10 minutes. The SCS server UPS maintained operation throughout this period, but all sensors were without power. When the power returned acquisition continued and all seemed normal.

A day later it was noted that the Ashtec-ADU2 GPS .ACO and .LAB files were corrupt. Investigation showed the Ashtec unit was performing normally and the .RAW data file format is identical before and after the power cut. The .RAW .LAB and .ACO files are shown below. Please note : the word processor has taken the minus signs to be hyphenation and broken the lines, the point of showing these files is to indicate that there are no cr/lf in the .ACO and .LAB files after the power cut)

`Ashtec-ADU2_20010121-115954.RAW`

(after power cut)

```
20010206-
02:23:17.518,$GPPAT,022317.00,6253.7430,S,05116.5944,W,+00055.5,350.574,+00
.00,+00.00,0.0075,9.9999,1*54
20010206-
02:23:18.096,$GPPAT,022318.00,6253.7414,S,05116.5965,W,+00055.6,350.574,+00
.00,+00.00,0.0000,9.9999,1*5F
20010206-
02:23:19.096,$GPPAT,022319.00,6253.7396,S,05116.5985,W,+00055.4,350.574,+00
.00,+00.00,0.0000,9.9999,1*5F
20010206-
02:23:20.096,$GPPAT,022320.00,6253.7378,S,05116.6004,W,+00055.0,350.574,+00.00,+00.00,0.0000,9.
9999,1*52
```

`Ashtec-ADU2.ACO`

The file below shows the data pre and post power cut.

The post power cut data is a truncated piece of a single line approximately 18Mb long.

```
2001,34.483933,34,0.48393253,-63.17114,-46.70390,061.813,+00.53,-
01.30,0.0030,0.0178,
2001,34.483944,34,0.48394411,-63.17112,-46.70383,061.819,+00.44,-
01.49,0.0029,0.0206,
2001,34.483956,34,0.48395586,-63.17110,-46.70376,061.839,+00.45,-
01.69,0.0040,0.0259,
2001,34.483967,34,0.48396743,-63.17108,-46.70370,061.833,+00.36,-
01.77,0.0030,0.0235,
2001,34.483979,34,0.48397900,-63.17107,-46.70363,061.783,+00.40,-
01.71,0.0033,0.0185,
2001,34.490861,34,0.49086106,-
63.17105,5.06667,S,04641.1252,W,+00069.7,000.000,.002001,34.490873,34,0.490
87318,-63.16715,
46.68542,000.000,+00.00,+00.00,0.0000,0.0000,.002001,34.490885,34,0.4908845
7,-63.16714,-
46.68541,154.130,+00.00,+00.00,9.9999,9.9999,.002001,34.490896,34,0.4908961
```

```
5,-63.16714,-
46.68539,170.058,+00.00,+00.00,9.9999,9.9999,.002001,34.490908,34,0.4909079
1,-63.16714,-
46.68538,151.373,+00.00,+00.00,9.9999,9.9999,.002001,34.490919,34,0.4909192
9,-63.16714,-
46.68537,159.897,+00.00,+00.00,9.9999,9.9999,.002001,34.490931,34,0.4909310
5,-63.16714,-
46.68537,154.841,+00.00,+00.00,9.9999,9.9999,.002001,34.490942,34,0.4909424
4,-63.16715,-
46.68536,182.793,+00.00,+00.00,9.9999,9.9999,.002001,34.490954,34,0.4909540
2,-63.16715,-
46.68536,142.680,+00.00,+00.00,9.9999,9.9999,.002001,34.490966,34,0.4909655
9,-63.16716,-
46.68535,150.668,+00.00,+00.00,9.9999,9.9999,.002001,34.490977,34,0.4909771
6,-63.16716,-
```

Ashtec-ADU2.LAB

The file below shows data pre and post power cut.

The post power cut data is a truncated piece of a single line approximately 600Kb long.

```
2001 34.482358 34 0.48235828 -63.17313 -46.71234 063.319 +00.70 -01.37 0.0028 0.0396
2001 34.482717 34 0.48271689 -63.17273 -46.71061 061.836 +00.43 -01.23 0.0022 0.0248
2001 34.483076 34 0.48307605 -63.17225 -46.70873 061.852 +00.56 -01.48 0.0031 0.0306
2001 34.483435 34 0.48343521 -63.17178 -46.70676 061.546 +00.72 -00.91 0.0022 0.0223
2001 34.483794 34 0.48379382 -63.17128 -46.70469 061.697 +00.50 -01.14 0.0025 0.0288
2001 34.491023 34 0.49102328 -63.16718 -46.68533 172.371 +00.00 +00.00 9.9999 9.9999 .002001
34.491406 34 0.49140576 -63.16736 -46.68525 071.712 +00.00 +00.00 0.0000 9.9999 .002001
34.491940 34 0.49193980 -63.16760 -46.68522 132.620 +00.77 -00.47 0.0029 0.0296 .002001
34.492299 34 0.49229860 -63.16778 -46.68528 139.867 +01.02 -00.26 0.0024 0.0351 .002001
34.492657 34 0.49265740 -63.16799 -46.68534 140.769 +00.35 +00.15 0.0025 0.0178 .002001
34.493017 34 0.49301674 -63.16824 -46.68535 135.721 +00.00 +00.00 0.0030 0.0579 .002001
34.493393 34 0.49339344 -63.16851 -46.68527 126.700 +00.00 +00.00 0.0000 9.9999 .002001
34.493792 34 0.49379183 -63.16881 -46.68505 116.552 +00.65 +00.24 0.0037 0.0298 .002001
34.494151 34 0.49415135 -63.16904 -46.68473 106.224 +00.59 -00.10 0.0027 0.0284 .002001
34.494510 34
```

The solution was to stop and start acquisition. Data was then appended to the existing .ACO and .LAB files in the correct format.

Unix Systems

JRUF

JRUF (the general purpose Unix server) rebooted cleanly after the power cut on February 3rd.

As noted on the previous cruise, the single user licence for "Matlab" on the JCR is insufficient. Again, for JR58, an extra temporary licence had to be obtained from MathWorks to enable Matlab to be run on bsumlsb also - this was granted until the end of February 2001. One of the scientists requested a personal copy of Matlab (Release 12) be installed on jruf. This was installed, temporarily, under /nerc/packages/mbmatlab. There appeared to be no problem running the two versions simultaneously, by combining the two licences in a single "licence.dat" file (as below). The licence manager was restarted manually, specifying this temporary licence file.

```
# MATLAB license passcode file for use with FLEXlm 6.1g
# LicenseNo: 188251       HostID: 80A1326C
SERVER jruf 80a1326c 27000
DAEMON MLM /nerc/packages/mbmatlab/12/etc/lm_matlab
INCREMENT TMW_Archive MLM 5 01-jan-0000 0 DC49B017469875483777 \
  VENDOR_STRING="1" HOSTID=DEMO
INCREMENT MATLAB MLM 5 01-jan-0000 1 8C75705129D5E10F3735 DUP_GROUP=UH
INCREMENT TMW_Archive MLM 12 01-jan-0000 0 DC3AF1E01D5798366148 \
  VENDOR_STRING="40081" HOSTID=DEMO SN=188251
INCREMENT MATLAB MLM 12 01-jan-0000 1 BC08C0217EC9F54E6EF4 \
  HOSTID=80A1326C DUP_GROUP=UH SN=188251
INCREMENT Signal_Toolbox MLM 12 01-jan-0000 1 8C1850F1AC1987C38653 \
  HOSTID=80A1326C DUP_GROUP=UH SN=188251
INCREMENT Statistics_Toolbox MLM 12 01-jan-0000 1 \
  4C2830F1C123C8288BB2 HOSTID=80A1326C DUP_GROUP=UH SN=188251
```

Due to the sheer volume of user data being accumulated on jruf (and the DLT drive only able to backup up to 40Gb data), the daily backup script was altered towards the end of cruise to exclude the /jra1000/lun0 filesystem (application files), but continue backing up all user data and system files.

Simrad Synchronization Unit (SSU)

This unit has a fairly simple task to perform. It should control the triggering, that is the transmit/receive phases, of the following four devices; ea500, ek500, em120 and topas so that they do not interfere with one another. It does this with varying degrees of success.

For cruises where swath bathymetry is required the role of the SSU is to synchronise the ea500, EM120 and Topas. For Bioscience cruises the ea500 and ek500 are required.

During this cruise the SSU was tested with a new configuration file from Kongsberg Simrad.

The original file configuration (used since installation, backup name SSU.001)

- two modes (shallow and deep)
- two groups (echo sounders in one, the topas in the other)

The new file configuration (backup name SSU.002)

- three modes (fast, safe, shallow)

- three groups (em120/ek500, ea500 and topas)

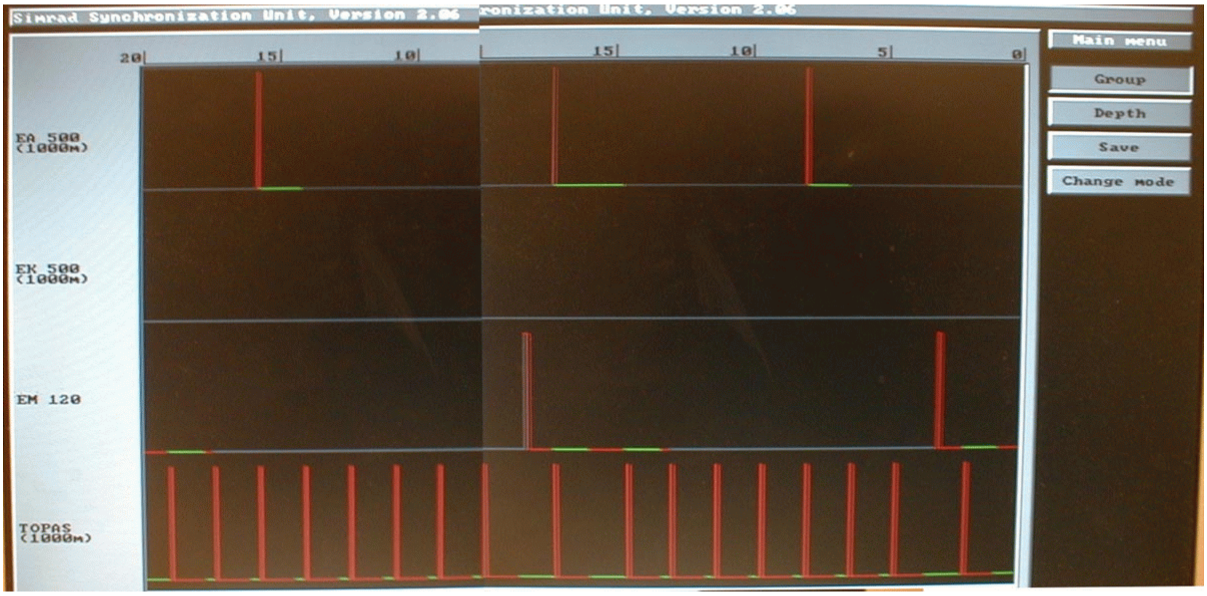
The modes in the new file configuration are allocated in this way:

Fast: EM 120 and EK 500
EA 500 and TOPAS

Safe: EM 120 and EK 500
EA 500
TOPAS

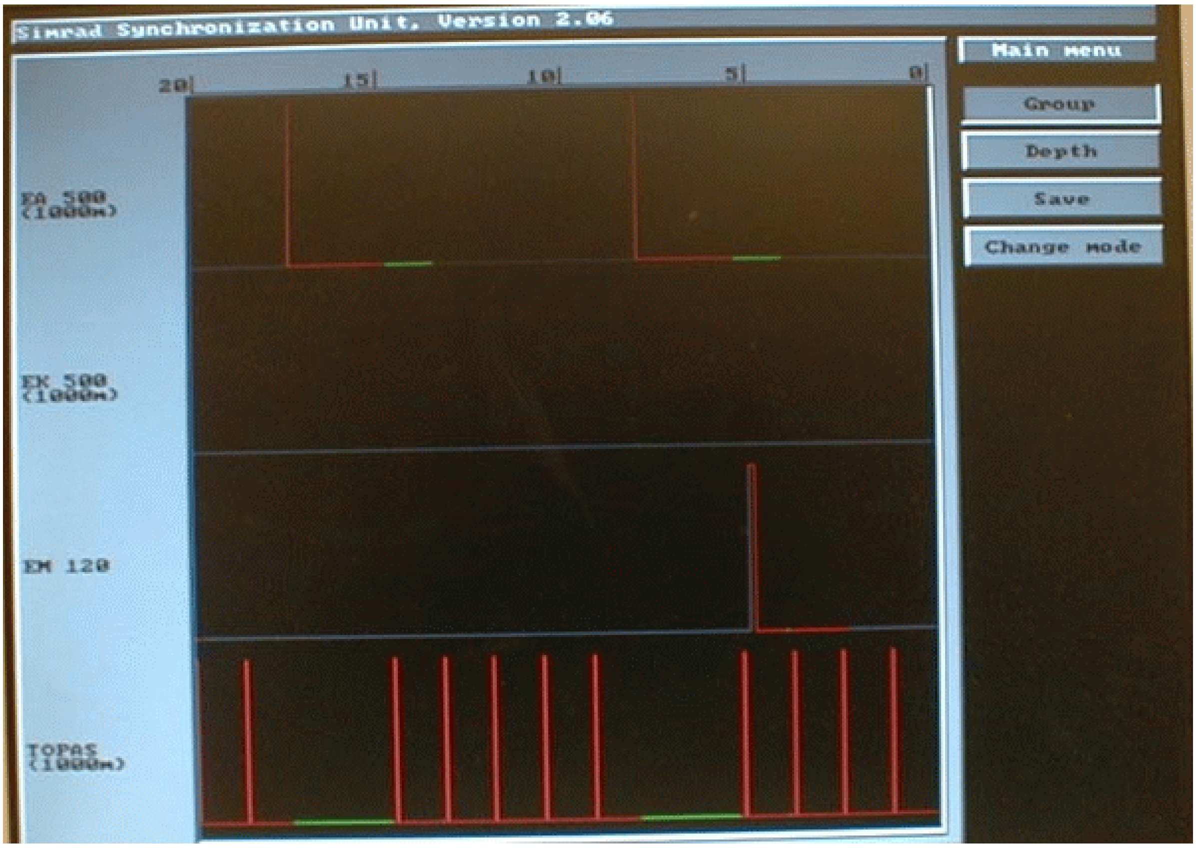
Shallow: EM 120 and TOPAS
EA 500 and EK 500

The following image was taken using these settings
em120 - on, calculated
ek500 - off
ea500 - on, fixed time=10ms
topas - on, calculated, multipulse enabled=on, interval=1000



this pattern is the same for both Fast and Safe Modes.

Shallow mode is as follows:



problems still exist:

1. The SSU has not been consistent, in that, the order in which devices are started can occasionally give different triggering patterns. Kongsberg Simrad suggest that this is because the ea500 and ek500 are not talking to the SSU on the network.

2. Em120 doesn't respond fast enough to a trigger. This gives a slight delay which usually results in the em120 transmitting while other devices are receiving. This results in interference between the em120 and the echo sounders.

3. Ek500 triggering interval is inconsistent. During JR58, two devices were required; the ea500 and the ek500. The ek500 was set to trigger every 1500ms (fixed time). The ea500 was set to trigger whenever it was ready. The two devices are in the same group meaning that they fire at precisely the same moment and do not interfere. However, at random times the ek500 trigger would include a slight delay before triggering.

Konsberg Simrad accept that the SSU seems to be more difficult to understand and configure than expected. They will be adding chapters to the manual to cover:

- Troubleshooting and configuring the network
- Solution examples
- Description of how to configure other equipment run with the SSU with external
- trigger

Kongsberg Simrad will also develop a software update to compensate for the slow trigger response in the em120.

Electronics activities

SBE35 temperature sensor

The SBE 35 temperature sensor on the CTD frame worked perfectly throughout the duration of the cruise however it was noted early on that one of the pins in the connector was badly eroded by electrical action on the salt water that had leaked in to the connector. Considerable caution was therefore needed in connecting/disconnecting to download data as the pin looked very fragile. The connector on the SBE35 needs replacing when the unit is sent for calibration and the cable mounted mating half should also be changed as water ingress will have corroded the contacts in there too.

Ocean logger air temperature and humidity sensors

On arrival at the ship there was a note from the last ETS member to the effect that the temperature and humidity sensors on the for-mast had failed during the last cruise. There had been no time on their return to Stanley to investigate. Upon opening the junction boxes it was obvious what the problem was. There was about 5mm of sea water in the bottom of the JB that contains the temperature and humidity Rho-point modules. Fortunately the module that was nearest the bottom of the box (and therefore the one that was flooded) was the humidity module. Removing this wrecked unit, drying the box and re-sealing it proved effective in restoring comms to the fore-mast and temperature data was recorded for the rest of the cruise. The ocean logger is due for replacement this season and a more robust approach to construction needs to be considered with possibly a ‘box within a box’ design being adopted.

Ashtec ADU2

Coinciding with the power outage (mentioned under Trimble 4000 below) it was reported that Ashtec ADU2 data wasn’t being logged properly by the SCS. Before the outage thousands of messages per day were being recorded, after only tens of records. At this point an incorrect assumption was made. That was that the ADU2 had reset some filter or quality flag somewhere in it’s setup. Investigating this necessitated the use of a laptop running Ashtec ‘Evaluate’ software as the ADU2 has no front panel display. After some considerable investigation it was found that the problem lay not with the ADU2 itself but with the comm port on the SCS. It is presumed that the Ashtec must somehow have corrupted the comm port on the SCS as it’s power failed. Re-booting the SCS cured the problem and data was recorded for the duration of the cruise.

Multinet PAR sensor

Doug Bone reported that the PAR sensor on the multinet was giving no data. The unit was opened but nothing obvious could be seen, The manual helpfully didn’t contain a circuit diagram so fault finding was near impossible. A spare unit was used instead. The faulty unit needs returning to Chelsea instruments for repair. A circuit diagram needs to be obtained and included in the manual if this equipment is to be supported at sea.

Autosal heater

Mark Brandon reported that the Autosal was having difficulty keeping the water bath up to temperature. The cause was traced to one of the heater bulbs, which had failed. This was replaced from the stock of spares held on board and the Autosal then functioned as required.

Multinet lockup

The multinet system suffered what looked like an electrical failure early on in the cruise with the net motor remaining ‘on’ continuously. Telephone and email contact with the designer (P Woodroffe, ETS) gave some likely suggestions. These were all investigated and found unfortunately not to be the cause. The unit was re-assembled and tried on the bench and all seemed OK. The unit was then tried ‘down wire’ and again all seemed well. The supposition is that there was probably a software lockup, a situation had occurred that the software wasn’t expecting and therefore didn’t know what to do. Further improvements need to be made to the software and hardware to increase reliability and to make the system more robust.

Trimble PSU failure

The ship suffered a brief power outage about halfway through the cruise. This outage coincided with the failure of the GPS power supply and was therefore presumably the cause. The Power supply produced 24V from the mains which was later regulated down further. Since the Bridge already has a 24V DC supply available it was decided by the R/O that it would indeed be preferable if the Trimble run from this in future as the supply is battery backed. The R/O wired this in.

Libretto modification

Autosub’s echo sounder is controlled by an ultra miniature laptop pentium pc called a Libretto. After experiencing reliability problems with recording echo data it was decided that the Libretto might be the cause of the problem and was to be changed. A replacement unit was available, however it had not been modified, like the fitted unit, with a remote on/off switch. Modifying the unit required a certain amount of disassembly, some very fine soldering and the drilling of holes. It was with much relief that this ‘mission critical’ piece of modified equipment was found to function correctly.