Report for cruises ES031, ES038 and ES048

ACES-FOCAS cruise to the southern Weddell Sea

RRS Ernest Shackleton

16 January to 6 March 2007

Compiled by Keith Nicholls from contributions by:

Povl Abrahamsen, Martin Biuw, Lars Böhme and Phil Mele


ERNEST SHACKLETON

Contents

Introduction

Overview

Three different cruises are described in this report: ES031, ES038 and ES048. ES048 covers the LTMS-P work around the South Orkneys, in collaboration with Lamont-Doherty Earth Observatory (Columbia University, New York), ES038 was to be for LTMS-P work at the Filcher Sill, in collaboration with Bjerknes Centre for Climate Research (Bergen), southern Weddell Sea, and ES031 was to serve the ACES-FOCAS project, again in the southern Weddell Sea. In cooperation with the Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven (AWI) a mooring programme was carried out to extend the location facilities for the Weddell Sea under ice float programme.

In the event, sea ice conditions prevented ES038 from being accomplished: on two different attempts the ship encountered ten-tenths pack ice west of 031°W at the latitude of the mooring locations, with giant floes entirely stopping further progress westwards.

Despite very heavy sea ice, the majority of ES031 was achieved. The location of one of the moorings was again too far to the west to be accessed, and, in any case, the malfunction of one of the six Ixsea releaser units would have prevented its deployment. Some of the CTD sections that were to extend to the north and west also had to be shortened as a result of the sea ice conditions. The available time was spent undertaking a details hydrographic survey around, and to the north of Brunt Ice Shelf, a survey that will contribute directly to the ACES-FOCAS project. The final element of ES031 was the tagging of seals, in collaboration with the Sea Mammal Research Unit of St Andrews University. Four CTD tags were successfully deployed on Weddell seals in the vicinity of Helmert Bank, at the eastern Filchner Sill. A fifth tag was deployed on a male Elephant seal on Signy Island.

Personnel

Five of the science team embarked at the Falkland Islands at the beginning of the cruise. The sixth team member was uplifted from Halley on 2nd February.

Povl Abrahamsen (BAS)

Martin Biuw (SMRU)

Phil Mele (LDEO)

Keith Nicholls (BAS)

Lars Böhme (SMRU, but on short-term BAS contract for the cruise duration)

Andy Warner (BAS, uplifted from Halley)

Cruise narrative

The ship sailed first to South Georgia to remove waste from Bird Island (BI) and King Edward Point (KEP), and to remove a field hut from BI (please see Figure 1). Between the Falkland Islands and BI the continuous plankton recorder (CPR) was deployed following the instructions of Dr Pete Ward (BSD).

The majority of the mobilisation for the cruise was undertaken at KEP, though small jobs had been done en route from the Falklands. From KEP the ship sailed to the continental slope north of Coronation Island where two LTMS moorings (CI1 and CI2) had been deployed in late 2005. The acoustic releases on neither mooring could be heard, and poor surface visibility legislated against a blind release. A CTD profile was obtained from near each mooring site.

Ship proceeded to Orkney Passage where an LDEO mooring (M4) had been deployed in 2004. Again, the mooring could not be contacted, and, as it was getting dark, a blind release was not attempted. The ship sailed to the then-unoccupied LDEO mooring site M2, where a mooring was deployed and a CTD profile obtained. The ship sailed on to LDEO mooring M3, which was recovered after a blind release as, again, its acoustic release could not be heard. A CTD profile was obtained and the mooring re-deployed.

Passage was then made to the first of two areas where sound-source moorings were deployed in a joint programme with AWI to contribute to the Weddell Sea drifter programme. The first mooring was deployed and passage made towards the next mooring area. A CTD profile was taken about half way between the two areas. The second mooring was deployed, and another CTD profile attempted. However, the sheave on the winch seized, and the profile had to be aborted. As the repair was to take many hours, the ship set off for Halley.

Andy Warner was picked up from fast ice off Brunt Ice Shelf. Personnel were then divided into two 12-hour shifts, from midnight to noon (PA, PM, and AW), and from noon to midnight (KN, LB and MB). Shift working began after uplifting AW, and continued until the day prior to arrival for second call at Halley.

The main ACES-FOCAS work was begun. The ship proceeded as far south into the Filchner Depression as ice conditions allowed. The Coast Mooring was then deployed near to Luitpold Coast and a CTD profile obtained. The ship then sailed north to the continental slope to deploy the Slope North and Slope South moorings, and to construct a CTD section across the shelf break and slope. All of this work was hampered by difficult sea ice conditions, and the Slope South mooring had to be deployed anchor first.

The sea ice was relatively thin and rotten, and passage towards the S4 site was relatively quick east of, and over Helmert Bank. S4 was deployed anchor last in an open pool, but progress towards S4 West rapidly became impossible as the ice to the west became giant floes with little or no water between. With some difficulty, the ship turned and headed east to deploy S4 East, with CTD profiles obtained from both S4 mooring locations.

Sea ice conditions prevented further significant CTD work east of Helmert Bank, and so an extensive CTD survey was undertaken in the hitherto sparsely sampled continental shelf region north of Brunt Ice Shelf. This work included a comprehensive ice front survey around the ice shelf, although fast ice occasionally forced the line to deviate substantially seaward of the ice shelf.

The work was completed with the successful tagging of four Weddell Seals in the vicinity of Helmert Bank with CTD satellite tags, before completing a CTD section and returning to N-9 for the final Halley relief.

After leaving N-9 the ship returned to Orkney Passage, where M4 was released and recovered. While the instruments were being downloaded, and the instruments and acoustic releases were serviced and re-batteried, the ship sailed to Coronation Island to recover CI1 and CI2. This was when it was discovered that, in diesel-electric mode, and with the azimuthal thrusters set at zero rpm, the ship was quiet enough for the acoustic releases to be heard from several kilometres. With the moorings safely on board, the ship returned to Orkney Passage to redeploy instruments from CI1, CI2 and M4 as the new moorings: OP1, OP2 and OP3. In addition, a CTD section was completed across the passage. The ship then made passage to Signy Island. While logistics work was being undertaken at the base, a shore party scouted-out and tagged a male elephant seal, thereby completing the PSD element of the cruise.

En route from the South Orkneys to the Falklands, a second CPR tow was carried out.

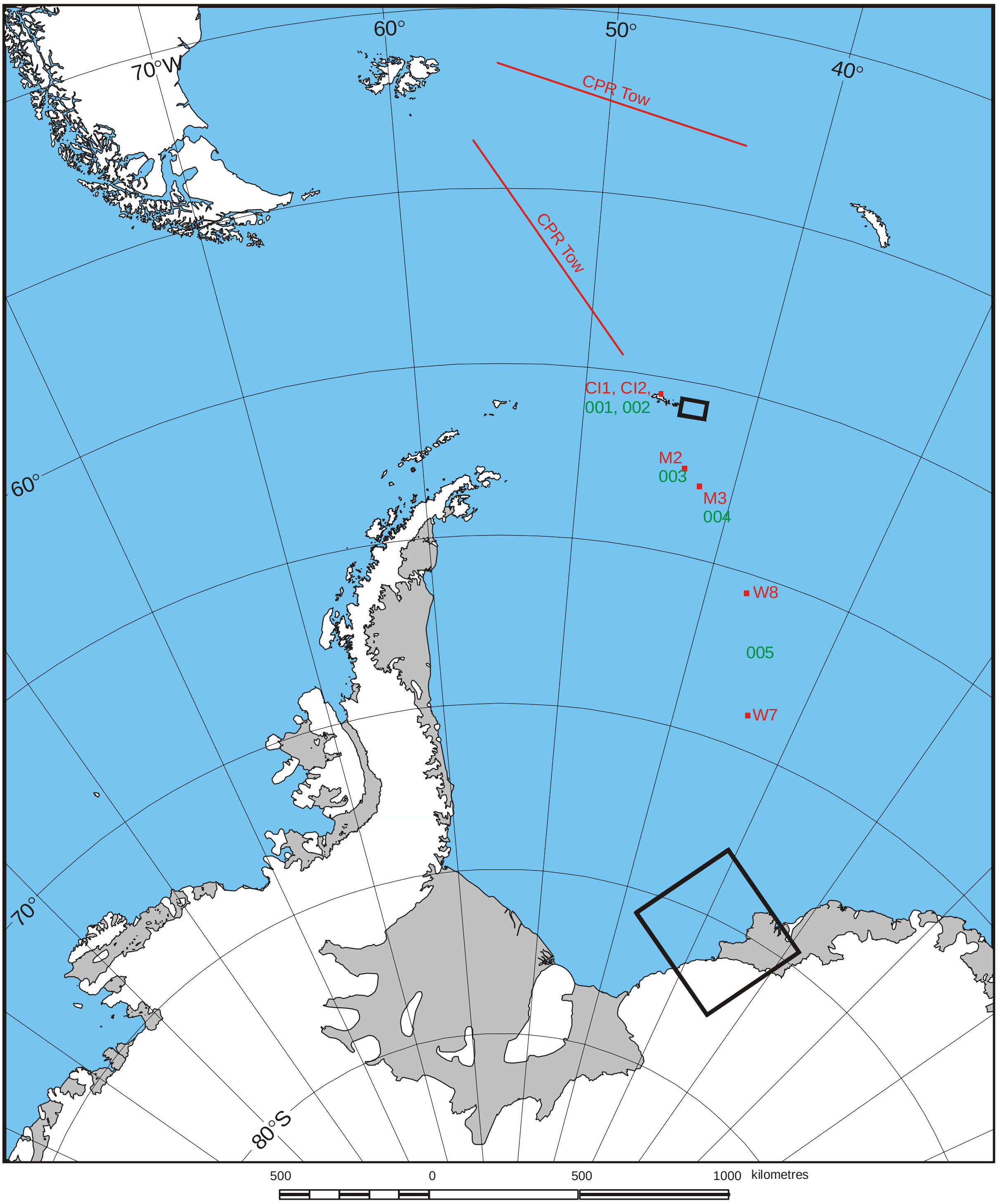


Figure 1 Map showing regions of main activity during the cruise. The two boxes indicate smaller scale maps showing the two principal work areas in detail.

Cruise diary

16-01-07 Science team (except AW) join ship

17-01-07 Depart Port Stanley

18-01-07 Deploy CPR

19-01-07 Commence mobilization: run power, phones and NMEA to CTD shack.

20-01-07 Recover CPR

21-01-07 – 25-01-07 Visit Bird Island and KEP.

26-01-07 Profiles to test CTD. Termination problems, altimeter failing, damage to termination and loss of bottles.

27-01-07 CTD profiles at moorings CI1 and CI2. No comms with either CI1 or CI2. Passage to M4 (Orkney Passage). No comms. With M4.

28-01-07 Passage to M2. CTD. Deploy mooring. Passage to M3. No comms with mooring. Blind release. Recover mooring.

29-01-07 CTD. Re-deploy M3. Passage to W8.

30-01-07 Deploy W8. Start passage to W7. CTD. Continue passage to W7.

31-01-07 Deploy W7. Attempt CTD, but sheave seized on winch. Abort CTD. Passage to Halley.

01-02-07 – 02-02-07 Continue passage to Halley

03-02-07 Arrive Halley. Pick up Andy Warner. Passage to coast mooring site.

04-02-07 Deploy coast mooring. CTD. Passage to Slope North mooring site. Deploy Slope North. Deploy Slope South, anchor first.

05-02-07 CTD line through Slope North and Slope South, from Helmert Bank.

06-02-07 Finish CTD line. Passage to S4. Deploy S4. Passage to S4W. No progress through ice. Return to S4. CTD at S4. Proceed S4E. Deploy at S4E. CTD at S4E. Proceed to Helmert Bank.

07-02-07 Attempt section NW along ridge. No progress in sea ice. Return to Helmert Bank, and commence CTD line west to east towards Stancomb-Wills.

08-02-07 Continue section towards Stancomb-Wills. Commence survey along ice front and fast ice looking for seals while blow goes through. Visit Weddell seal pubs in Precious Bay. Commence CTD section from Brunt Ice Front towards Helmert Bank.

09-02-07 Continue section. Start Brunt Ice Front (BIF) section.

10-02-07 Continue BIF section. Start repeat of RISOC (02-03) section.

11-02-07 Return to Precious Bay when sea ice prevents further progress along RISOC section. Inspect more Weddell seal pups. Head back towards pack for seal tagging, as wind died down.

12-02-07 Tag three Weddell seals near Helmert Bank.

13-02-07 Tag fourth Weddell seal, again near Helmert Bank. Head to attempt section along 075°S westwards. Two stations occupied before ice prevents further progress. Proceed to shelfbreak at 027°W to profile up slope. Complete section. Proceed to BIF-Helmert Bank section to occupy those stations previously inaccessible because of huge floe.

14-02-07 Complete section. Proceed N9 for Halley relief.

15-02-07 – 17-02-07 Halley relief.

18-02-07 Depart N9 for passage to M4, Orkney Passage.

19-02-07 – 22-02-07 Continue passage

23-02-07 Arrive M4. Blind release M4 and recover. Download instruments, renovate releases. Commence CTD section across Orkney Passage.

24-02-07 Passage to CI1 and CI2. Recover CI1 and CI2. Passage to OP sites.

25-02-07 Continue OP CTD section. Deploy OP1 and CTD. Deploy OP2 and CTD. Deploy OP3 and CTD

26-02-07 Depth profile through OP moorings and across Orkney passage. Passage to Signy. Demobilise and cargo work.

27-02-07 Visit Water Pipe Beach and Elephant Flats to locate suitable Elephant Seal for tagging. No success.

28-02-07 Visit Leonina Flats, locate and tag suitable Elephant Seal.

01-03-07 – 03-03-07 Visit Cape Geddes hut and Orcadas Station. Commence passage to Falklands.

04-03-07 Deploy CPR.

05-03-07 Continue passage to Falklands.

06-03-07 Recover CPR. Arrive Falklands.

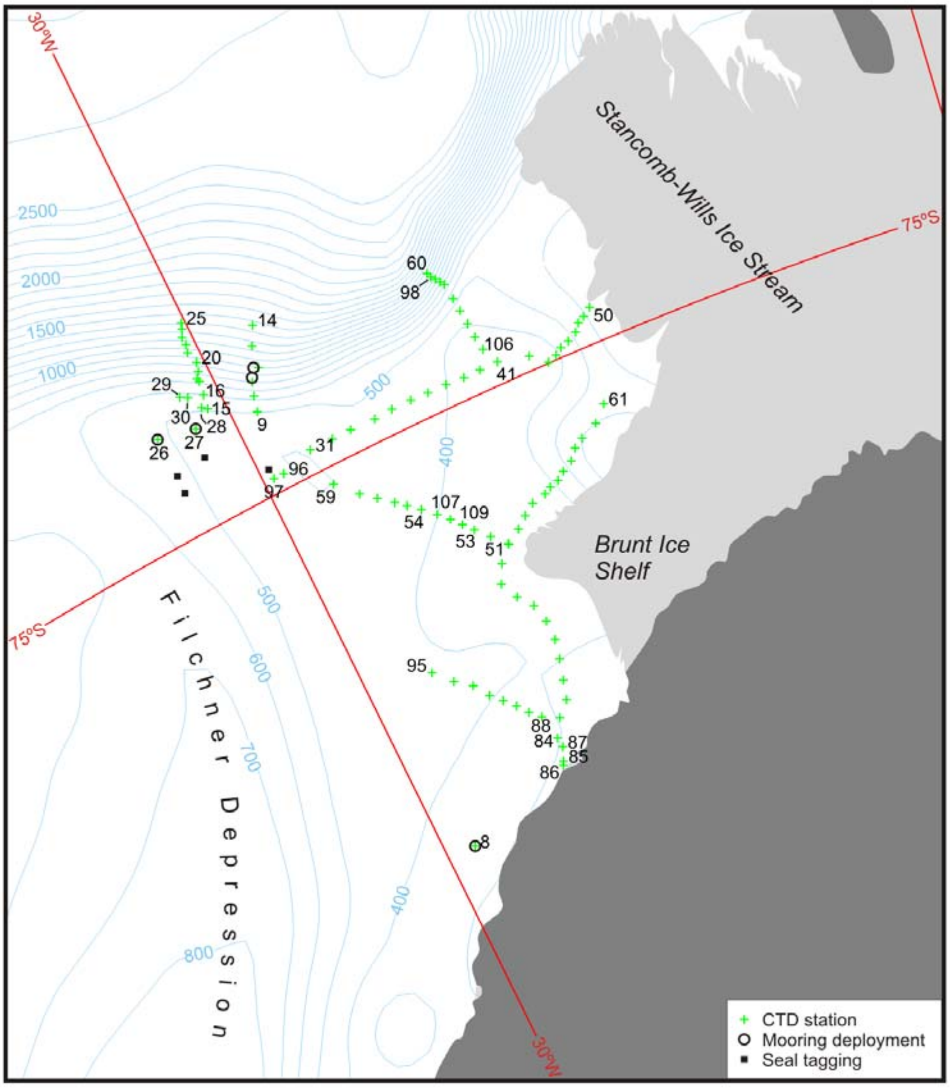


Figure 2. Map of Brunt region showing mooring and CTD locations. Also shown are the locations for the seal tagging

CTD operations

Winch

Description and installation

The CTD winch used during the cruise was the one originally developed for BAS by MPD in 1997. It was built for the ROPEX cruise to the southern Weddell Sea on board *HMS Endurance*, and was mounted on the quarterdeck, deploying over the ship's counter. After the ROPEX cruise the winch was returned to MPD for various modifications and improvements, and was maintained there until 2005, when it was transferred to UKORS at Southampton. Two obvious improvements were the addition of a heater for the hydraulic oil, and the screwing (rather than merely gluing) of the wire-out pickup magnets on the sheave wheel. Unlike during the ROPEX cruise, the magnets did not drop out, and we had no problems with the pump not starting in cold conditions.

The winch consists of a hydraulically powered 'A'-frame and winch drum mounted on a 10-foot container base. Six kilometres of coaxial CTD wire is accommodated on the drum. There is an integral electrically powered hydraulic power pack, a control panel and a remote control unit with 30-foot leads. The only other service required from the ship is a supply of cooling water.

The winch was borrowed from UKORS for the present cruise, and, after an architect's survey, was mounted on the ship during the refit in 2006. The site chosen for the winch was in the position of the aft Humber rack, between the forward Humber rack and the ROV crane, on the starboard side of the main deck.

Two UKORS technical staff sailed with the ship from the UK to test the winch in deep water on the way to Vigo, Spain. The tests were successful, except for the problem of spooling the wire back onto the drum (see emailed report in Appendix A). Inaccuracies in the setup, which the staff tried unsuccessfully to rectify, meant that a certain amount of manual intervention was necessary to obtain neat spooling. This is a problem that was noted during the ROPEX cruise, but had not been entirely remedied by MPD. Although adding to the labour of CTD casts, the inaccurate spooling was not detrimental to the cruise.

Problems encountered during the cruise, and suggested improvements

A series of problems were encountered, some were due to component failure, others to maintenance issues, and others to design flaws.

- Early in the cruise the winch hydraulic pump failed to start. This was suspected to be associated with a defective Remote Enable/Disable switch on the control panel. The problem appeared to rectify itself, and did not recur for the remainder of the work.

  The problem of the constant exposure of the control panel to the elements (even when under its tarp) could be resolved by having a dismountable panel with pluggable connectors rather than glands. The panel would not be mounted and dismounted routinely, only during mobilization and demobilization.

- Some communications problems with the CTD were found to be caused by water in the connection box mounted on the side of the winch drum. The box was dried out and the lid resealed, but later found to be wet again. The water was thought to have come from the wire side of the drum, wicking through the hole in the back of the connection box. Replacing the screw connections with soldered joints sealed with heat shrink solved the problem.

  The present fix appears to work fine.

- The tensiometer did not work from the very beginning of the cruise. This also meant that the Constant Tension (CT) feature could not be used. As the speed of motion of both 'A'-frame and winch drum is very controllable at low speed, the lack of the CT feature did not present any difficulties when deploying and recovering the CTD.

See below.

- The sheave wheel seized at a relatively early stage in the cruise. The ship's engineers removed the pin cleaned off the old, petrified grease, heli-coiled new grease nipples into the sheave (only two are accessible when the wheel is mounted, and these were popping out during greasing), and refitted the pin. During this work it became clear that the wires to the sensor in the pin had become disconnected at some point, explaining the non-working tensiometer.

  Return the pin to the manufacturers for overhaul or replacement.

- As mentioned above, the spooling cannot be adjusted precisely enough to provide a perfect lay for more than a few hundred metres. Manual intervention was required during each cast, both up and down.

  As discussed in the emails in Appendix A, this is unlikely to be fixable with the present spooling arrangement. It would be convenient, though, if the programming of the transistor network that counts the optical encoder pulses were made easier. The present programming arrangement is very cumbersome and clunky.

- The spooling ceased working entirely at one point, as a result of the failure of the mechanical connection between the end of the worm-axle that drives the spooling carriage and the encoder that feeds back the rotational position of the axle. The ship's engineers machined a brass collar to replace the broken linkage. This worked for most of the cruise. Unfortunately, the comparatively stiff brass linkage ended up damaging the optical encoder internally, and late in the cruise the spooling failed once more. For several casts the spooling was done entirely manually, until the optical encoder could be patched up and made to work for the last few profiles.

  Replace temporary fix with new coupling. Renew the optical encoder. It would be good to have a spare coupling.

- The wire on the drum had originally been wound with too little tension, meaning that on the deep casts (>4500 m) the wire was biting into the previous lay on the drum, making neat spooling difficult even with manual intervention.

  Rewind the wire at an appropriate tension

- At the low temperatures encountered during the cruise, ice build-up at the sheave caused jamming of the wheel. This was resolved by regularly chipping out the ice and applying warm water to melt it. The rather narrow gap between the cheeks of the sheave and the wheel itself readily fills with ice.

  Incorporate heaters in the cheeks of the sheave wheel. (Common on winches for polar use.)

- When the CTD was at depth (> 2000 m) the wire-out counter failed. The failure occurs with the wire spooling from (or to) the left hand end of the drum, when looking outboard. The reason seems to be that when the wire pulls from that direction a couple is applied to the sheave wheel which twists it on the pin, such that the magnetic discs are pulled away from the pickups for the wire-out counter. However, the problem disappeared once the pin had been overhauled after seizing up. The extra couple exerted with the increased friction at the pin was presumably the source of the problem.

- When paying out between 40 and 60 m min^{-1} there is significant juddering in the hydraulics, leading to a jerky descent of the CTD.

  Air in the oil? Dirt in the valves? Flush the hydraulic system and replace the oil?

Despite the length of the list of problems, they were mainly niggles that we were able to overcome with the assistance of the ship's engineers. On the whole the winch performed well, and could easily be converted into one very capable for work in polar regions. Possibly the greatest concern is the exposure of the control panel during passage: a significant failure in the electrics there might be difficult to deal with during a cruise.

Containerised Wet Lab

Description and configuration for the cruise

The CTD rosette always remained on the open deck. As the air temperatures were in general well below freezing, and it was often snowing, the water bottles had to be removed from the rosette and taken into a warmer location before the samples could be drawn. This was to avoid dilution by snow falling into the bottles, and to enable the spigots to be thawed-out and unblocked.

Located as it was on the afterdeck, the ship's Wetlab was a flight of stairs down, and some distance from the winch. This posed unacceptable risks to personnel carrying 10-litre water bottles; it also would have placed the CTD deck unit and computer inconveniently far from the winch. A containerised wetlab was therefore built during the summer of 2006, and mounted between the gash container, and the coaming of the main hatch. The 'CTD shack' has power for heating, lighting, deck unit and computer. It also has a bench, and racks mounted on one wall to take the 12 10-litre water bottles. The floor of the shack is coated with a non-slip, waterproof material, and the walls are clad in marine ply with Unistrut tracks. There is a gland to take cabling additional to the main power supply.

The shack was equipped with a desktop computer and flat-panel monitor, the Seabird deck unit and a small laser printer. Backups of the data were made on an external hard drive after each cast.

A NMEA feed providing GPS and depth data from the Bridge was routed into the CTD Shack, as was a telephone line. The NMEA feed was split to go both to the CTD deck unit and to the computer. 'Sea Clear II' was installed on the computer to provide a 'moving map' style display of the ship's position, track CTD locations. Overall the CTD Shack worked well, and the display of the ship's position and track overlying the AWI bathymetric map (BCWS Sheet 567) for the region proved to be an exceptionally good planning tool.

Suggestions for improvements

- The heater should be replaced with a more powerful (3 kW) fan heater mounted high on the left hand side of the end wall. The present heater is not quite powerful enough for the coldest conditions encountered, and takes up too much wall space.
- More shelf space should be made. This is easily done using Unistrut fittings.
- More power points should be installed, and a separate UPS supply is required for the deck unit and computer.
- Lack of visual contact with the winch is a drawback of the present arrangement. The easiest solution would be a CCTV camera that could be mounted on the container or elsewhere, with a monitor inside. The correct position for windows in the container walls would be too dependent on how the CTD shack is oriented with respect to the winch. A double-glazed window in the opening door, however, would be beneficial.

CTD equipment

Description

The equipment consisted of a Seabird 911*plus* CTD with a Seabird carousel mounted in a rosette that held 12 10-litre General Oceanics water bottles. In addition to the built-in pressure sensor, the configuration comprised two pairs of temperature and conductivity sensors, each pair independently pumped. The primary circuit included an SBE43 oxygen sensor. Also mounted on the rosette frame was a Tritech altimeter.

Performance

The sensors were blown through after each deployment to reduce the problem of icing-up on deck. Fresh water was never used to rinse the sensors. All the same, there were many occasions when ice was found to be blocking or partially blocking the pipe work at the start of a deployment. This was dealt with by gentle application of warm air. The SBE43 functioned only up until the first freeze-up, after which it gave spurious values.

The temperature sensors behaved very well up until cast 110, generally remaining within 10^{-3}°C of each other. The secondary then failed, giving a constant value of about 98°C. This was replaced with the spare, the configuration file was updated, and the temperature data thereafter were as good as before the failure. During the test profiles and cast 001 the conductivity sensors were within $2x10^{-3}$ of each other. At the deepest point of cast 002, however, the primary C-sensor started giving spuriously low values. On recovering the CTD, a fish was discovered sucked into the inlet of the primary circuit (see photograph). For may casts thereafter the primary cell was consistently offset from the secondary by $–7x10^{-3}$. Towards the end of the cruise the offset returned to its former level.

Particularly disappointing was the performance of the Tritech altimeter. Only sporadic returns were detected throughout the cruise. After an enquiry was sent to UKORS, we were advised that this type of altimeter was generally reliable within about 10 m of the seabed. Unfortunately, our experience was to the contrary and during one of the early test casts the CTD frame touched the bottom. The result was that the wire ended up looped around the water bottles, two of which were lost and a third broken beyond repair. In addition, the wire was kinked and had to be mechanically and electrically re-terminated.

The bottle release levers on the carousel routinely froze up on deck and failed to release during the cast. This was solved by briefly warming the levers with a hot-air source prior to each cast, thus ensuring free movement. Several arms on the bottle caps fractured during use. It is not clear whether this was a result of the low temperatures to which they were exposed while cocked, or if this type of bottle is particularly prone to that mode of failure.

Water sampling

For the vast majority of casts, water samples were drawn from the 10-litre sampling bottles in the CTD shack. On a few early casts, when there was no precipitation and the air temperatures were above freezing, samples were drawn on deck with the bottles remaining mounted on the rosette.

Samples were drawn for $\delta^{18}O$ and salinity determinations. The salinity bottles were 200 ml in volume, and sealed with a rubber cap held in place with crimped foil. The $\delta^{18}O$ bottles used the same sealing mechanism, but were 20 ml in volume.

The biggest problem encountered was the freezing-up of spigots, and the likely freezing within the water bottles themselves for some of the casts sampling potentially-supercooled water. On one occasion the upper air valve was removed and found to have ice packed inside. Often bottles were not sampled for salinity because of the suspicion that they contained some ice, and because of a shortage of salinity sample bottles.

Preliminary results

The tables in Appendix B detail all CTD casts and water samples. CTD profiles were taken at all mooring sites, except for the sound source sites, where winch problems prevented casts from being made. In addition, CTD sections were occupied in the region of Brunt Ice Shelf with aim of determining the flow of the coastal current around the continental shelf. The map in Figure 2 shows the location of the casts, and preliminary sections are given in Appendix C.

Mooring work

All moorings were deployed anchor last, except for the Slope South mooring, for which sea-ice conditions dictated an anchor-first deployment. The deployments used the 10-ton gantry beneath the helideck, in combination with the capstan mounted at the forward end of the poop deck. The Slope North, Slope South, S4 and S4 East moorings were all flaked out on the poop prior to deployment. The wire for the CORC-ARCHES (M2 and M3) moorings was taken off the drums via the capstan during the deployment.

The sound source moorings were handled differently, with the deepest 3500 m of Kevlar rope figure-of-eighted into palleted cages prior to deployment. The upper four hundred metres of each mooring were taken via the shoot connecting the main and poop decks from a wooden drum suspended from the ROV crane. The sound sources were then deployed, along with the short Kevlar lengths required to fine-tune the depth of the sources. The lower 3500 m of Kevlar were then lifted from the cages.

Mooring diagrams are given in Appendix D, together with details of each deployment. Details specific to the sound sources are given in Appendix E.

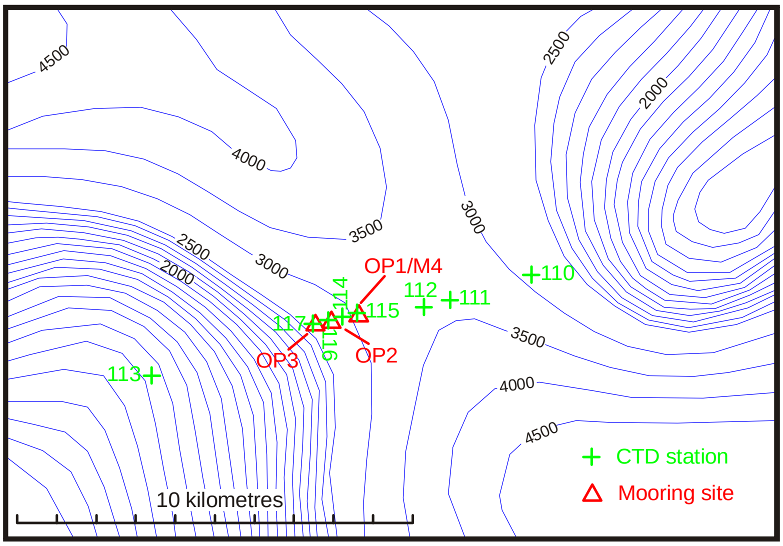


Figure 3. Orkney Passage, showing mooring and CTD locations. Note bathymetry is from BEDMAP, and in this area is indicative only

Equipment problems

One of the new BAS Aanderaa RCM11 current meters (S/N 590) failed to function correctly with a lithium battery. The fault has been isolated to the instrument itself. When the Coronation Island moorings were deployed during JR151, it was found that none of the three RCM11 current meters would function correctly with lithium battery packs. Those RCM11s were therefore deployed with alkaline packs and the lithium packs returned to the manufacturer for checking. The voltage of the packs was raised by changing the protection diode, but RCM11s do appear to have a sensitivity to the terminal voltage. This is an issue that will be raised with Aanderaa. For the purposes of the present cruise, the malfunction of one instrument was not a problem, as two were being rotated back to the U.K. for routine servicing.

One of the six new AR861 acoustic releases (S/N 562) failed to function correctly during tests, and will be returned to the U.K. for repair under warranty. Again, as one of the six mooring sites for which the releases were required could not be reached because of sea ice conditions, the malfunction of one release had no impact on the cruise outcome.

The ship was carrying four acoustic release command units: two Edetech units (for the CORC-ARCHES moorings), one Benthos unit (for the sound source moorings) and a MORS release unit (for the Ixsea, AR861 releases). At one time or another all but the simpler Edgetech unit failed in some way. Despite testing in the lab prior to shipment, the MORS release failed to transmit entirely for the first part of the cruise, and then started working and worked properly for the remainder of the work. The Benthos unit worked with one of the AWI releases, but not the other. Fortunately, the second release responded perfectly well to the Edgetech command unit. The Edgetech unit, when transmitting AR861 commands (in an attempt to replace the then not-working MORS unit) failed to transmit certain commands. Edgetech have since found a fault in the firmware. This more sophisticated unit has the advantage of being able to communicate with all three types of release.

Ship engine mode when listening for releases

The normal operating mode for the ship involves having the variable-pitch propeller running continuously. This seems to make the ship too noisy for responses from the releases to be heard, despite trying several different locations for the transducer. On one occasion a release was faintly heard when the command unit was operated away from the ship in the Fast Rescue Craft.

After various experiments, it transpired that the way of getting the ship quiet enough was to run it in Diesel-Electric Mode, which meant de-clutching the main propeller, and lowering the azimuthal thrusters. The azimuthal thruster (itself a variable pitch propeller) was then set to zero revolutions when communicating with the release. This worked well.

Performance of Coronation Island moorings

All of the instruments deployed on the Coronation Island moorings functioned for the 14-month deployment, although RCM11 s/n 521 displayed some data corruption. The new Aanderaa conductivity sensors were very disappointing, demonstrating large jumps in conductivity in two of the records, and an rapid initial drift as the sensor presumably distorts/creeps to accommodate the water pressure. A recommendation for the future is not to purchase any more of these sensors, but to make use of SBE37 Microcats instead.

Seal tagging

Introduction

One of the aims of the ACES-FOCAS observational programme was to find a method to observe the evolution of the oceanographic conditions over the southern Weddell Sea continental shelf during wintertime. Deploying traditional moorings is difficult because of the sea ice conditions that generally prevail over the continental shelf, even during summer. Even if moorings could be deployed in suitable locations, there is an unacceptably high risk of damage from passing icebergs.

The SEaOS project: Southern Elephant seals as Oceanographic Samplers has demonstrated the utility of Elephant seals as oceanographic platforms. There is good evidence that Elephant seals forage in the southern Weddell Sea, at least to the continental shelf break. To attempt to get wintertime data from over the shelf itself, the shallower diving Weddell seal was selected as a possible platform. Weddell seals maintain a seal hole in the ice, and therefore are likely to remain south throughout the wintertime, possibly not ranging far once the pack ice has set in. However, one tag was reserved for deployment on an Elephant seal at Signy Island, in the hope that that animal would forage as least as far as the southern Weddell Sea shelf break during the winter.

Four Weddell seals were found and tagged with CTD tags. They were all found on the western slope of Helmert Bank (about 75°S 030°W), on the eastern side of Filchner Sill. The fifth tag was used on a young, male Elephant seal at Leonina Flats, Signy Island.

Method

Once the seal had been spotted, the ship manoeuvred alongside the floe and the Geordie Personnel Basket used to land between four and six personnel on the ice. Bodgers and throw lines were taken, and all personnel wore life jackets. The SMRU personnel captured the animal using a head bag, and sedated it with an intravenous injection of Zoletil.

Ethanol was used to clean and dry the patch of the animal’s head where the tag was to be glued, and blood and blubber samples were taken. The tag was glued to the animal’s head using an epoxy resin, which took about 20 minutes to cure. Finally, the seal was rolled into a net and weighed using a tripod, a block and tackle, and a load cell.

By the time the weighing had been completed, the seal was alert and appeared to have recovered fully from the sedation.

The only difference with the technique for the capture and tagging of the elephant seal on Signy Island was that it was approached from land.

The locations of the Weddell seals when the tags were deployed are shown on the map in Figure F1. Details for the taggings are given in Appendix F.

Initial results

The four tags used on the Weddell seals were checked by attaching them to the CTD frame for some of the CTD casts. There are some significant offsets between the salinities recorded by the tags and the SeaBird instrument, and some less serious offsets in temperature and pressure. The salinity offsets are also clear from the profiles generated by the seal dives when plotted on a T-S diagram. The salinity of the Winter Water is well defined in the SeaBird data, and the data from the tags can easily be shifted to overlie them. In this way we see salinity offsets ranging from 0.16 to 0.22. Figure F2 shows the T-S plots from all the tags after the shift has been applied. The data from tags are shown individually, along with the profiles, in Figure F3.

Additional activities

Continuous Plankton Recorder deployments

A continuous plankton recorder was deployed shortly after leaving Port Stanley. This is part of a BSD study (contact, Peter Ward). The recorder was deployed and streamed behind the ship during the passage to Bird Island for a distance over the ground of 480 nm.

As the weather was poor, the afterdeck was inaccessible during the tow, and it was realized too late that the tow fish was shallower than ideal. The wire length had been fixed as the ship was gathering speed, but before the ship reached its full cruising speed, at which time the afterdeck was unsafe. In future it would be useful to have a mark on the wire to act as a guide for the amount of wire to be paid out for the normal cruising speed of the ship.

At the end of the tow (~480 nm: see tow log in Appendix G) the cassette was removed according to the instructions from BSD. The 100 marker line on the gauze was just at the mark point.

A second tow was obtained during the passage from Signy Island to the Falklands. The weather was more benign and the ship came up to speed before the wire was finally made fast, enabling the whipping on the tow wire to be positioned more or less at the sea surface.

At the end of the second tow (~480 nm: see tow log in Appendix G) the cassette was removed, the sample extracted and stored, and the empty cassette replaced in the tow fish. In the case of the second tow the gauze index had got to 96.5.

Water sampling for iron fertilization study

Water samples were obtained for one of Regine Rothlisberger's students. The aim was to obtain near surface samples in bottles free from iron contamination. Three 1-litre plastic bottles were obtained. They were washed by thorough rinsing, and then soaking in $1/10^{th}$ Normal hydrochloric acid (obtained from the doctor), further diluted by a factor of about 10:1. Halley Base then supplied some concentrated sulphuric acid (for use in batteries), which was diluted about 10:1 and used to soak the bottles again. The soaks lasted about 12 hours. The bottles were then rinsed thoroughly in fresh water (from the ship supply). A 10-litre water bottle was filled from 30 m depth using the CTD system, and used to rinse each bottle three times before filling them and securing the bottle caps with vinyl tape. They were consigned with the other water samples in cool stow.

The sample was taken from a depth of 30 m to avoid iron contamination from the ship's hull, and to avoid any discharges from the ship's systems.

Acknowledgements

The science team is deeply grateful to the officers and crew of RRS Ernest Shackleton for their help and support during the cruise. The bridge, engineering and deck teams all provided invaluable and enthusiastic assistance to the project. The science team is also indebted to UKORS and BAS AME for their assistance in preparing for the cruise.

Appendix A. Winch correspondence

From:	"Colin Day" <cdy@noc.soton.ac.uk>
To:	kwni@bas.ac.uk, CJHH@bas.ac.uk
CC:	gerw@noc.soton.ac.uk, sandm@noc.soton.ac.uk, s.bremner@bas.ac.uk, ukorsops@noc.soton.ac.uk, alsh@noc.soton.ac.uk
Date:	Monday - November 6, 2006 2:06 PM
Subject:	Shackleton ROPEX CTD winch trials

Keith/Steve,
Please see the comments below regarding the ROPEX winch trial on the Shackleton. Jason's suggests that the scrolling must have had attention during deployments on previous cruises as there does not appear to be 'any new fault' with the scrolling, it is simply inaccurate by design and needs to be adjusted throughout deployments. I think the issue here is if technical staff were on previous cruises then this would have been a minor concern (nevertheless should have been reported with a view to rectification), but, as we do not have technical staff on your cruise, who will carry out this role? If the scrolling is not 'managed' there is potential for failure, this is not good for your science or for the equipment (obviously). I have copied this to Steve Bremner and Chris Hindley for comment as I am not sure of the remit of BAS or the Shackleton engineers with regard to third party equipment support on the Shackleton and whether they can assist or not.

Cheers,
Colin

Colin Day
UKORS Operations Manager
National Oceanography Centre

-----Original Message-----
From: jesc@noc.soton.ac.uk [mailto:jesc@noc.soton.ac.uk]
Sent: 06 November 2006 13:10
To: cdy@noc.soton.ac.uk
Subject: LOOK AND SEND- no email address

Keith
This is just a heads up on the commissioning report of the portable ctd winch fitted to the Ernest Shackleton for your 2007 cruise. During the first deployment it was noticed that the scrolling carriage was leading the cable. This is easily adjusted by the controls fitted to the electrical box on the winch. 4500m depth was reached but required scrolling to be altered every 2 lays. A fix was attempted and the 50kg weight deployed. This did not cure the fault.

I believe that the scroll design is not built to a high enough tolerence to correct the scrolling. There is not enough control over setting scroll movement which causes this mis-alignment. So - you have used this winch in the past - have you had this scrolling problem? my concern is that i am uncertain to who will be operating and maintaining this winch on your cruise. There will be a big crew changeover in the next 3 weeks so no crew/ engineers will not have any experience of this winch.

We need to know how this winch has been used in the past before we can commit to using it for your cruise. - although the fault can be monitored an engineer would be required for the ctd operation - do you know if this is possible?

Sorry about the news
Regards
Jason Scott

Appendix B CTD stations

Stn No.	Date	Time (Z)	Latitude (degrees)	Longitude (degrees)	Depth (m)
001	27/01/07	05:32:23	60.2959°S	045.2666°W	???
002	27/01/07	08:59:33	60.2667°S	045.2667°W	3874
003	28/01/07	14:10:02	62.6242°S	043.2478°W	???
004	29/01/07	02:11:11	63.5265°S	041.7905°W	???
005	30/01/07	16:05:56	67.5217°S	035.3232°W	???
008	04/02/07	06:37:17	76.3517°S	029.5812°W	284
009	05/02/07	03:18:08	74.7260°S	029.6738°W	394
010	05/02/07	04:25:10	74.6747°S	029.6228°W	478
011	05/02/07	05:46:36	74.6303°S	029.5653°W	717
012	05/02/07	07:22:07	74.5963°S	029.4128°W	946
013	05/02/07	09:03:51	74.5225°S	029.3680°W	1160
014	05/02/07	11:03:48	74.4618°S	029.2493°W	1373
015	05/02/07	15:49:38	74.6400°S	030.2295°W	440
016	05/02/07	18:53:18	74.5920°S	030.1990°W	437
017	05/02/07	20:24:26	74.5457°S	030.1707°W	516
018	05/02/07	21:31:17	74.5345°S	030.1795°W	607
019	05/02/07	22:52:31	74.5155°S	030.1272°W	729
020	06/02/07	00:16:36	74.4860°S	030.0952°W	869
021	06/02/07	02:25:39	74.4430°S	030.1427°W	988
022	06/02/07	03:55:04	74.4160°S	030.1158°W	1090
023	06/02/07	05:27:10	74.3895°S	030.1195°W	1186
024	06/02/07	07:08:11	74.3638°S	030.0732°W	1296
025	06/02/07	08:39:23	74.3463°S	030.0467°W	1365
026	06/02/07	19:01:31	74.6512°S	030.9845°W	512
027	06/02/07	23:31:39	74.6808°S	030.4837°W	454
028	07/02/07	01:22:57	74.6277°S	030.2947°W	442
029	07/02/07	03:01:07	74.5622°S	030.4852°W	467
030	07/02/07	04:56:31	74.5768°S	030.3958°W	445
031	07/02/07	10:50:23	74.9200°S	029.2655°W	391
032	07/02/07	12:18:39	74.9205°S	028.9437°W	388
033	07/02/07	13:42:41	74.9210°S	028.6752°W	447
034	07/02/07	14:56:46	74.9240°S	028.3293°W	461
035	07/02/07	16:05:44	74.9200°S	028.0730°W	449
036	07/02/07	17:22:44	74.9198°S	027.7957°W	453
037	07/02/07	18:32:12	74.9223°S	027.5520°W	457
038	07/02/07	19:36:27	74.9235°S	027.2928°W	430
039	07/02/07	20:43:44	74.9267°S	027.0395°W	373
040	07/02/07	21:41:56	74.9262°S	026.8073°W	304
041	07/02/07	22:34:15	74.9267°S	026.5562°W	282
042	07/02/07	23:51:39	74.9515°S	026.1408°W	282
043	08/02/07	00:51:10	74.9962°S	025.9343°W	272
044	08/02/07	01:41:46	74.9848°S	025.8080°W	214
045	08/02/07	02:27:23	74.9677°S	025.7100°W	383
046	08/02/07	03:29:11	74.9578°S	025.5878°W	478
047	08/02/07	05:14:08	74.9403°S	025.4565°W	516
048	08/02/07	06:35:39	74.9155°S	025.3768°W	519
049	08/02/07	07:45:28	74.9022°S	025.2808°W	543
050	08/02/07	08:43:10	74.8820°S	025.1660°W	671
051	08/02/07	22:46:10	75.4918°S	027.3793°W	265
052	08/02/07	23:56:01	75.4462°S	027.5613°W	289
053	09/02/07	00:53:47	75.4028°S	027.7258°W	333
054	09/02/07	04:46:25	75.2640°S	028.2668°W	435
055	09/02/07	05:48:13	75.2313°S	028.4195°W	440
056	09/02/07	06:46:10	75.2037°S	028.5490°W	440
057	09/02/07	07:49:07	75.1650°S	028.7380°W	423
058	09/02/07	08:57:39	75.1257°S	028.9267°W	393
059	09/02/07	10:29:59	75.0578°S	029.1828°W	393
060	09/02/07	16:38:42	74.5602°S	026.9472°W	1369
061	09/02/07	22:45:39	75.1972°S	025.4625°W	530
062	10/02/07	00:01:36	75.2460°S	025.6578°W	567
063	10/02/07	01:04:58	75.2737°S	025.9028°W	582
064	10/02/07	02:01:22	75.2945°S	026.0423°W	595
065	10/02/07	02:59:52	75.3285°S	026.1538°W	538
066	10/02/07	04:01:51	75.3493°S	026.3067°W	467
067	10/02/07	04:52:34	75.3695°S	026.4203°W	446
068	10/02/07	05:42:23	75.3802°S	026.5530°W	343
069	10/02/07	06:29:32	75.3930°S	026.6540°W	313
070	10/02/07	07:17:51	75.4030°S	026.8570°W	232
071	10/02/07	08:11:46	75.4318°S	027.0145°W	248
072	10/02/07	09:05:34	75.4630°S	027.1753°W	255
073	10/02/07	10:09:13	75.4955°S	027.3762°W	262
074	10/02/07	11:04:18	75.5445°S	027.5695°W	274
075	10/02/07	12:03:36	75.6053°S	027.6908°W	279
076	10/02/07	13:00:32	75.6665°S	027.5632°W	284
077	10/02/07	13:58:44	75.7162°S	027.3985°W	261
078	10/02/07	15:06:43	75.7812°S	027.3278°W	366
079	10/02/07	16:08:03	75.8488°S	027.3188°W	352
080	10/02/07	17:00:12	75.9142°S	027.3697°W	388
081	10/02/07	17:57:21	75.9833°S	027.4410°W	366
082	10/02/07	18:54:00	76.0472°S	027.5107°W	478
083	10/02/07	20:02:54	76.0920°S	027.7018°W	368
084	10/02/07	21:01:49	76.1507°S	027.8488°W	469
085	10/02/07	22:03:29	76.2300°S	027.9087°W	347
086	10/02/07	22:55:57	76.2412°S	027.9320°W	343
087	11/02/07	00:02:23	76.1848°S	027.8313°W	564
088	11/02/07	01:26:38	76.0632°S	027.9295°W	316
089	11/02/07	02:22:23	76.0317°S	028.0733°W	366
090	11/02/07	03:16:41	75.9945°S	028.1905°W	353
091	11/02/07	04:08:13	75.9577°S	028.3337°W	375
092	11/02/07	04:57:03	75.9233°S	028.4750°W	366
093	11/02/07	06:00:52	75.8695°S	028.6275°W	390
094	11/02/07	07:02:23	75.8278°S	028.8468°W	443
095	11/02/07	08:09:25	75.7685°S	029.0735°W	407
096	13/02/07	06:58:53	74.9497°S	029.7165°W	394
097	13/02/07	08:07:12	74.9492°S	029.8588°W	398
098	13/02/07	14:17:39	74.5763°S	026.9188°W	988
099	13/02/07	15:35:15	74.5892°S	026.8758°W	705
100	13/02/07	16:28:31	74.6047°S	026.8320°W	442
101	13/02/07	17:57:42	74.6178°S	026.7973°W	429
102	13/02/07	19:00:06	74.6728°S	026.7667°W	429
103	13/02/07	19:51:12	74.7190°S	026.7423°W	403
104	13/02/07	20:52:06	74.7687°S	026.7202°W	380
105	13/02/07	21:40:31	74.8192°S	026.6963°W	345
106	13/02/07	22:31:00	74.8682°S	026.6655°W	298
107	14/02/07	02:00:27	75.3027°S	028.0995°W	431
108	14/02/07	02:55:38	75.3365°S	027.9643°W	389
109	14/02/07	03:56:42	75.3692°S	027.8445°W	339
110	23/02/07	15:26:54	60.6033°S	041.6275°W	2714
111	23/02/07	19:59:53	60.6340°S	041.8392°W	2959
112	23/02/07	22:48:09	60.6425°S	041.9078°W	3430
113	25/02/07	05:49:52	60.7224°S	041.6225°W	1299
114	25/02/07	08:48:06	60.6544°S	042.1219°W	3299
115	25/02/07	12:32:54	60.6496°S	042.0844°W	3626
116	25/02/07	18:21:44	60.6586°S	042.1592°W	2651
117	25/02/07	21:53:55	60.6628°S	042.2003°W	1856

Bottle samples

Cast	Pressure/bottle code										
	1	2	3	4	5	6	7	8	9	10	
001	2972	2430	1918	1410	802	196					Confusion with numbering
002	3835±	3511±	3046±	2714–	2066–	999–	46–				
003	3094–	2501–	1901–	1301–	701–	51–					
004	4631±	4488+	4377+	4086+	3786±	3331+	2909±	1991–	1003–	429–	
005	4629±	4560+	4452+	3812–	2997–	1880–	624±				
008	272*	221±	170+	120+	69+	39±					B2&6 re-sampled for S (freezing)
009	387*	267±	100*								
010	455±	394±	192±								
011	701±	502±	302+	151±							
012	932±	720±	397+	179±							
013	1162±	902+	651±	402+	176±						
014	1377±	1050+	751±	450+	174±						
015	429±	369±	293±	133±							
016	421±	354+	249+	97±							
017	*	*	507±	406±	154±						
018	603±	502+	203±	42+							
019	729±	607+	304+	153±							
020	870±	709+	406+	204±							
021	1006±	821+	608±	405±	178*						
022	1108±	910+	709±	406±*	174*						B4 frozen
023	1203±	960+	708±	447+	179±	179					B6 used as backup for B5
024	1302±	998+	798±	455+	173±						
025	1372±	1098+	797±*	456+	184±						B3 tap not secure?
026	501±	405+	314+	123±							
027	444±	419+	152±								
028	429*	204±									
029	456±	176±									
030	441*	179*									
031	376±	176±*									Possible ice in B2
032	377±	179±									
033	442±	179±									
034	449±	203+	21±								
035	447±	384+	252±	26±							
036	447±	304+	153±								
037	451±	319+	233±	72+							
038	423±	254+	22±								
039	365±	254–	122+								
040	122±										
041	275?	176?									No indication on log as to what samples drawn.

Cast	Pressure/bottle code							
	1	2	3	4	5	6	7	
042	271±	126+						
043	261?	113?						No indication
044	205+	177±	101+					
045	371*	335+	214+	146+				
046	467+	305+	148+					Ice in/on all bottles
047	511*	249*	53*					
048	507*	356*	54±					
049	533+	195+*	50+					Ice in/on all bottles
050	667*	667*	667*	667+	407+	144+	49+	
051	254*	154+	21±					
052	276*	276*	153*	12*				
053	321*	321*	153*	153*	17*	17±		
054	426+	255±	104+					
055	426*	255+	104±					
056	428*	254+	104±					
057	410±	254+	103+					
058	392+	252±	102+					
059	382+	254+	103±					
060	1405?							No Indication
061	522*	204±						
062	554+	204+						
063	574+	458+	226+	155+				
064	587+	358+	160+					
065	527+	330+	163+					
066	457+	304+	163+					
067	437+	285+	153+					
068	331+	154+						
069	302+	153+						
070	213?	173?	122?	26?				No indication
071	239+	153+						
072	242+	153+						
073	246?	202?						No indication
074	253+*	123+						B1 top valve open
075	267+	113+						
076	264+	128*						
077	253+	153+						
078	353+	243+	153+					
079	341+	142+						
080	224?	132?						No indication

Cast	Pressure/bottle code						
	1	2	3	4	5	6	
081	353+	153+					
082	465+	154+	93±				
083	353?	224?	53?				No indication
084	465+	244+					
085	331+	103+	22+				
086	333+						
087	554*						
088	304+	154+	39+				
089	348?						No indication
090	343+	155+					
091	365±	98+					
092	358+*	83+					Leak from bottom cap of B1
093	381+	78+					
094	432+	371+	220+				
095	399+	280+	154+				
096	381+	254+	133+				
097	386+	264+	153+	6**	6**		
098	987+	709+	456+	184+			
099	700+	627+	480+	304±			
100	433?	303?	164?				No indication
101	427+	427*	399+	203±			
102	421+	204+					
103	397+	348+	202+	81+			
104	371?	304?	138?				No indication
105	337+	239+	133+	47+			
106	286?						No indication
107	426+	268+	122±				
108	377+	253+	122+				
109	327+	203+	77+				
110	2528±	2430+	2064+	1409+	806±	32**	
111	2997+	2535+	2026+	1517+	1012+	505+	
112	3457+	3061+	2550+	2045+	1536+	1031+	
113	1293+	960+	505+				
114	3350+	3038+	2527+	2021+	1525+	662+	
115	3673+	3036+	2427+	1821+	1214+	607+	
116	2653+	2023+	1516+	1007+			
117	1862±	1213+	708±				

Notes:

± Salinity and $\delta^{18}O$ sampled

– Salinity sampled

** Surface sample for Regine Rothlisberger

+ $\delta^{18}O$ sampled

* Samples failed for some reason, or is suspect

? Log sheet did not indicate which samples were taken (to be determined on return of bottles).

CTD configuration

The following sensors were used during the cruise:

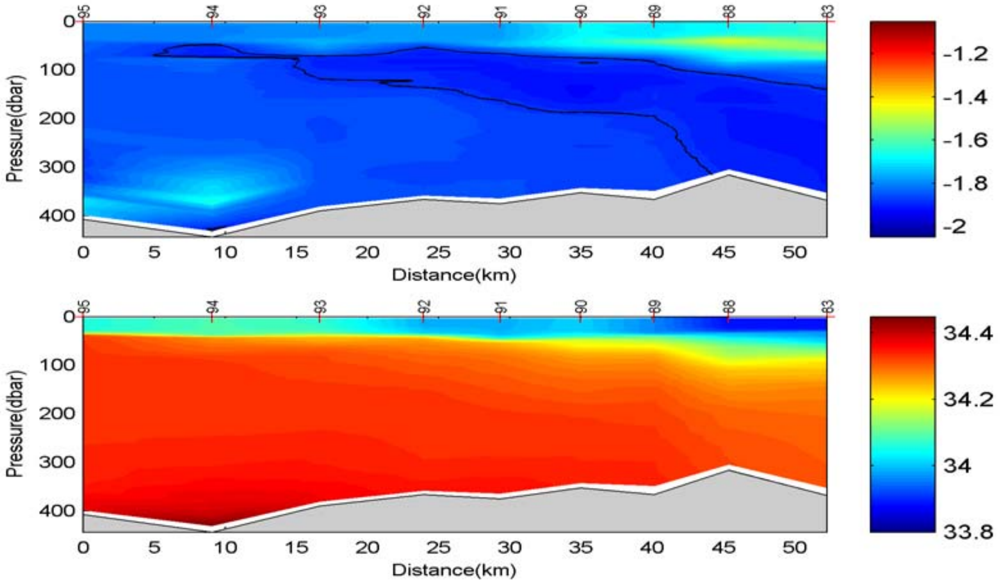
Temperature (SBE3plus):	Cast 1 to 110*: 2705 & 2679. From cast 111, 2705 & 4235
Conductivity (SBE4plus):	2222 & 2248
Pressure:	0480
Oxygen (SBE43):	43-0363
Altimeter (Tritech):	6196.112522

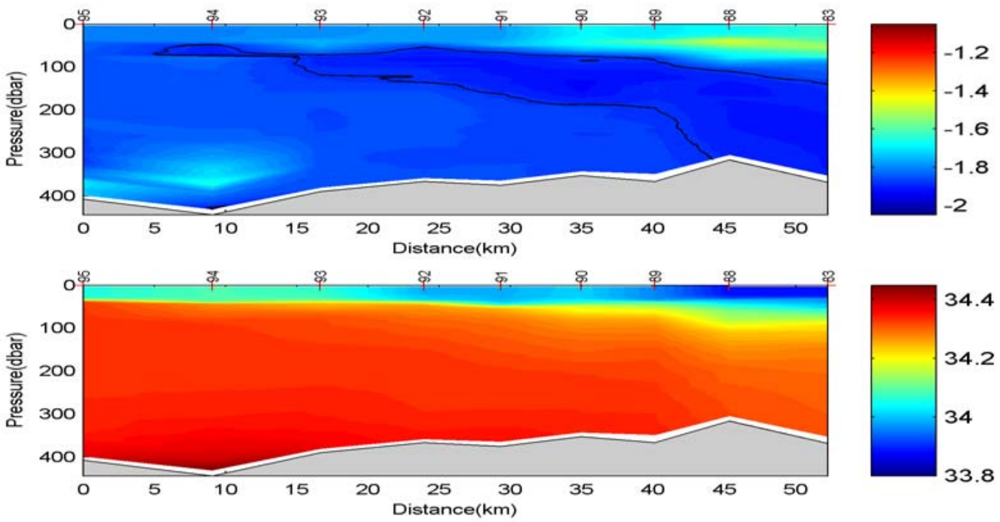
* Temperature sensor 2679 failed early in cast 110.

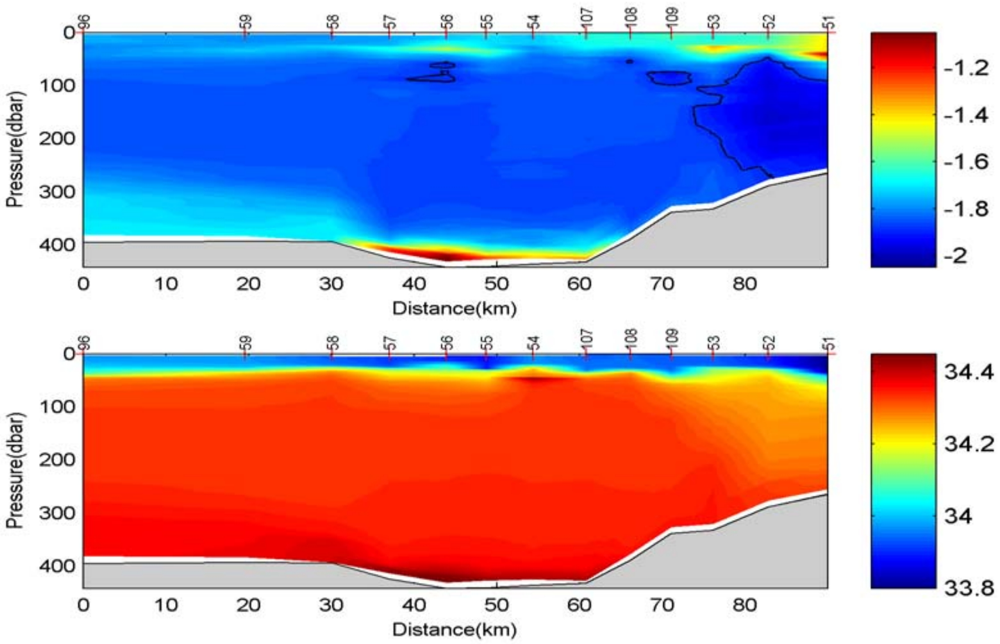
Seal tag checks were performed by attaching the tags to the CTD rosette during some early casts that were shallower than 2000 db. The pressure offsets noted during the trials are also listed.

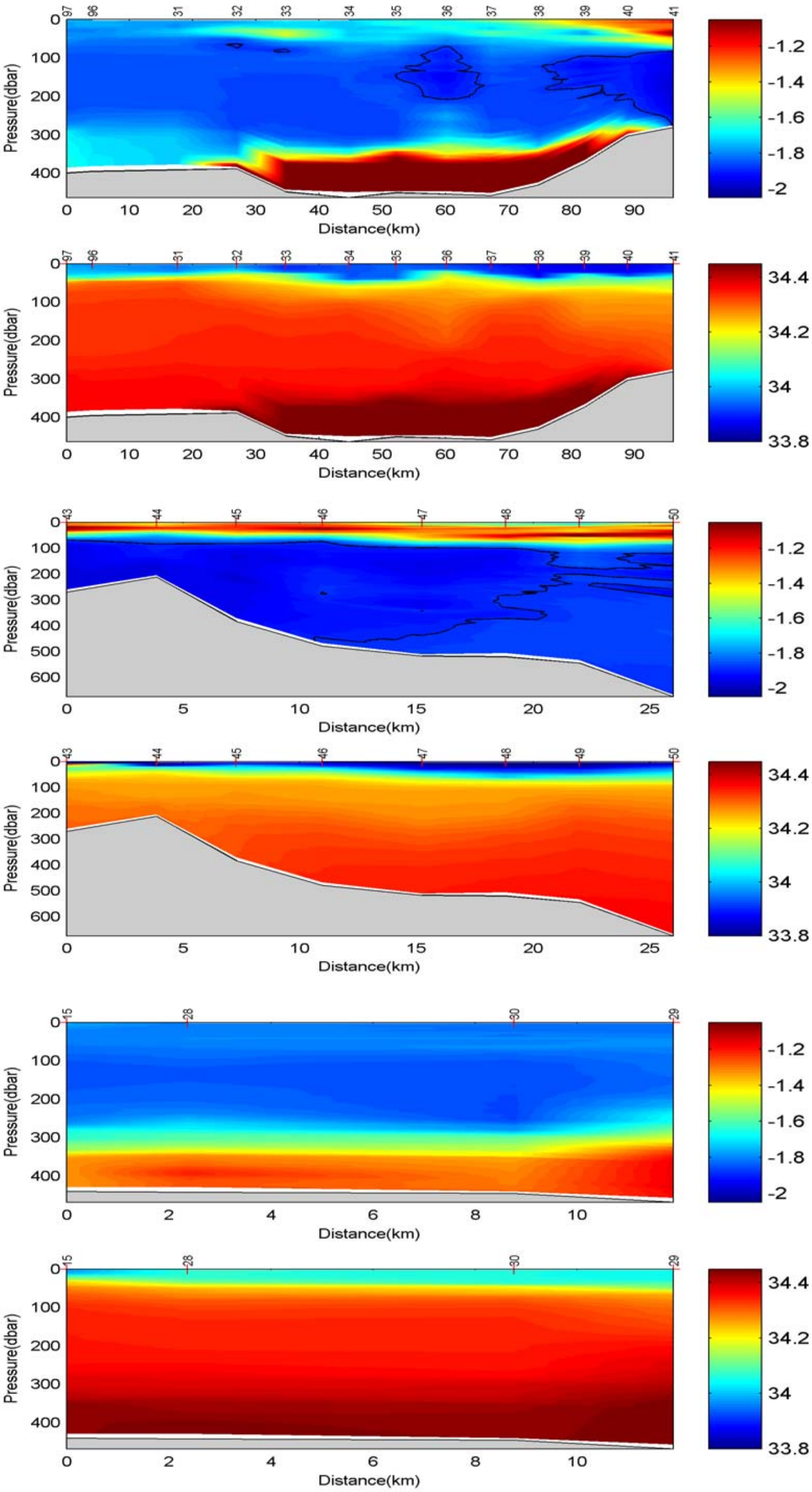
Tag #	Pressure offset (db)	Casts
10488	10	010, 011, 012, 013, 014
10578	6	008, 015
10584	7	008, 015
10586	1.2	009, 010, 011, 012

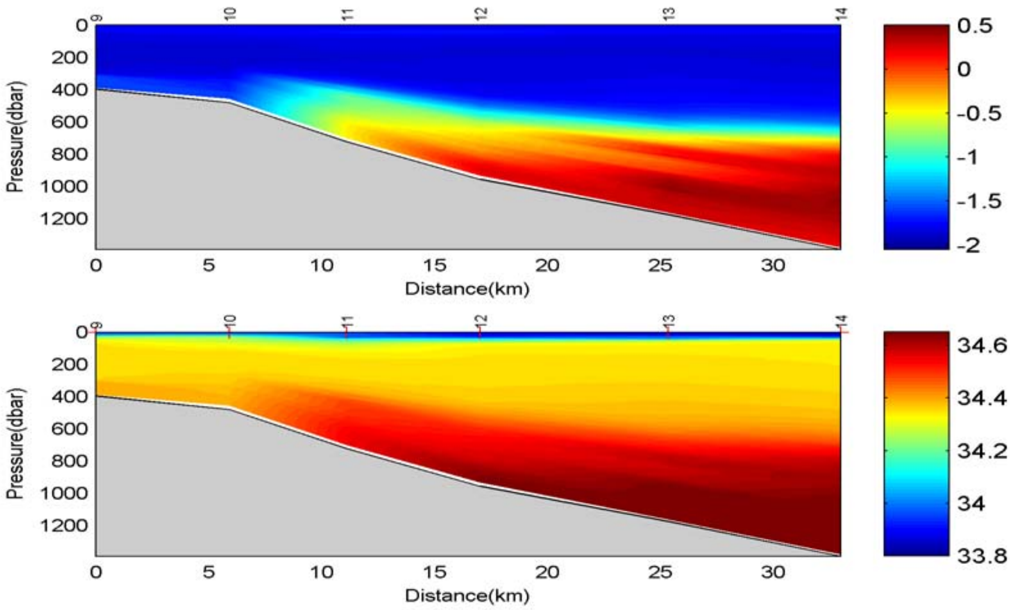
Appendix C Initial CTD sections

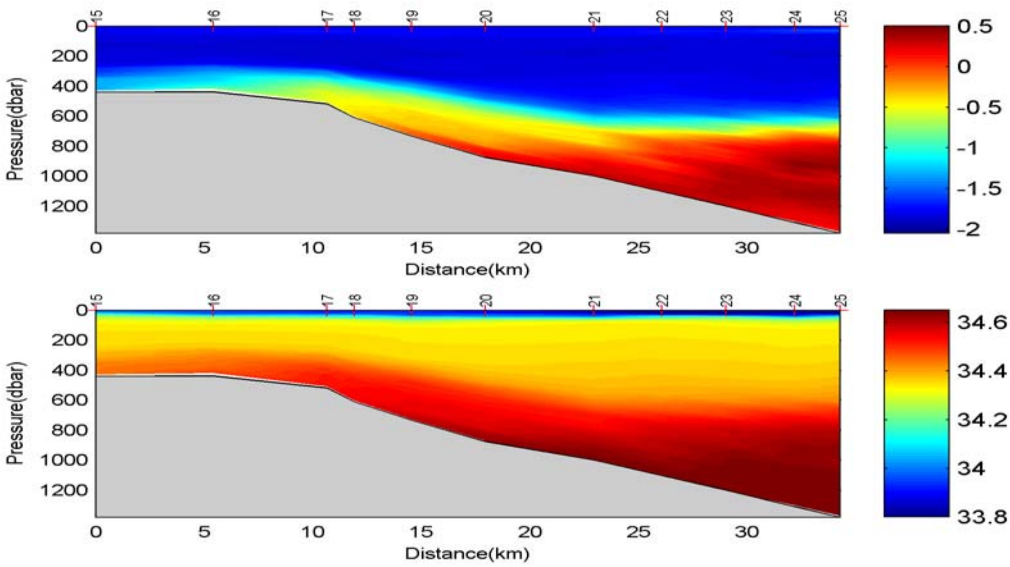


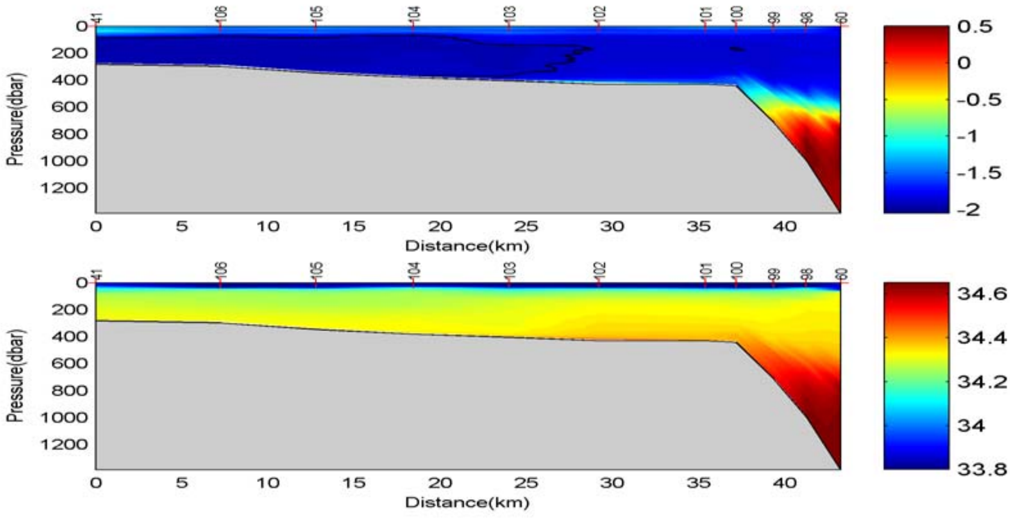





Pressure(dbar)
Distance(km)
-1.2
-1.4
-1.6
-1.8
-2
34.4
34.2
34
33.8


9
10
11
12
13
14
Pressure(dbar)
0
200
400
600
800
1000
1200
Distance(km)
0
5
10
15
20
25
30
0.5
0
-0.5
-1
-1.5
-2
34.6
34.4
34.2
34
33.8


15
16
17
18
19
20
21
22
23
24
25
Pressure(dbar)
0
200
400
600
800
1000
1200
Distance(km)
0
5
10
15
20
25
30
0.5
0
-0.5
-1
-1.5
-2
34.6
34.4
34.2
34
33.8


41
106
105
104
103
102
101
100
99
98
60
Pressure(dbar)
0
200
400
600
800
1000
1200
Distance(km)
0
5
10
15
20
25
30
35
40
0.5
0
-0.5
-1
-1.5
-2
34.6
34.4
34.2
34
33.8

Appendix D Instrumentation notes and mooring diagrams

All times UTC.

Acoustic releases AR861 SN562-567:

#562 does not work; battery voltage in the instrument appears to be OK (V_{CC}=3.266 V, V_R=ARG=1.637 V, high voltage=48.06 V), transducer does work (tested on #566), and instrument does chirp when power is applied. But no reply or response to interrogation from deck units, either MORS or Edgetech.

Other releases appear to be OK.

Serial number	562	563	564	565	566	567
Diag. delay	--	5183	5183	5161	5195	5183
Voltage (main/PP3)	9.05V/ 9.55V				9.09V/ 9.55V	
Int./arm code	15D7	15D8	15D9	15DA	15DB	15DC
Release code	1555					
Pinger on	1547					
Pinger off	1548					
Diagnostic	1549					
Location	Return to Ixsea	Slope N	Coast	S4 E	S4	Slope S

The LDEO Edgetech 8011M deck unit cannot send some codes. Below is a list of codes attempted:

Work: 9171, 9179, 1547, 1548, 1549, 1555, 15D8, 15D9

Do not work: 15DA, 15DB, 15DC

RCM8 deployed on M2

RCM8S (Savonius rotor) #9924 (belongs to GFI, UiB, contact: Svein Østerhus),

DSU 2990E #15238 (belongs to BAS, contact: Keith Nicholls)

Conductivity cell #2321, compass #6626, main board #1518 (ref. reading 439), fitted with lithium battery (7.39 V)

Sampling interval: 60 minutes, started at 01:00 on 28/1/2007. Word count increased from 66 to 72 at 11:00:07.

RCM8's recovered from M3

RCM8 #12558, DSU #12083:

Word count increased from 203838 to 203844 at 02:16:38 on 29/1/2007.

DSU clock was 02:56:24 when the real time was 03:38:00.

RCM8 #12670, DSU #?????:

Word count increased from 203838 to 203844 at 02:21:38 on 29/1/2007.

DSU clock was 01:59:50 when the real time was 02:40:00.

RCM8 #12670 was restarted at 05:00 on 29/1/2007 with DSU #11534, and with a sampling interval of 30 minutes. Word count increased from 34 to 42 at 07:31:07. It was redeployed on M3.

Current meters

Recovery from Coronation Island moorings:

	RCM8	RCM8	RCM11	RCM11	RCM11
SN	12677	12669	517	521	532
DSU SN	11533	11121	14742	14743	14744
Location	CI1 600 m	CI2 50 m	CI1 50 m	CI2 300 m	CI1 200 m
# words	64164	64170	74430	69336*	74289
First sampling	03:00 24/12/2005	03:00 24/12/2005	03:00 24/12/2005	13:00 24/12/2005	13:00 24/12/2005
Last sampling	20:05:55 24/02/2007	21:15:35 24/02/2007	20:07:09 24/02/2007	21:17:55 24/02/2007	22:09:30 24/02/2007
Time off	20:51	21:30	20:20	21:57	22:10
DSU clock offset	00:19:09	00:12:59	00:17:46	00:16:30	00:11:34
Battery type	Lithium	Lithium	Lithium	Alkaline	Alkaline
V in situ	7.21 V	7.19 V	7.10 V	7.02 V	7.63 V
V open	7.29 V	7.27 V	7.30 V	7.07 V	7.65 V
Channels	R,P,E,AT,D,S	R,T,E,AT,D,S	R, S, D, AT, C, tilt, signal strength		

R=ref., S=speed, D=direction, AT=Arctic temperature, E=empty

* When RCM11 #521 was recovered, the word count was 69307; when the multimeter probes were placed on the battery terminals the instrument started sampling again, and the word count jumped up to 69332.

Redeployment on OP moorings:

	RCM8	RCM8	RCM11	RCM11	RCM11
SN	12677	12669	517	532	592
DSU SN	12084	12608	15235	15239	15236
Location	OP3 200 m	OP3 50 m	OP1 50 m	OP2 50 m	OP2 600 m
Battery type	A1 lithium	A1 lithium	A1 lithium July 2005	A1 lithium July 2005	A1 lithium June 2006
Voltage	7.28 V	7.28 V	7.31 V	7.34 V	7.31 V
First	23:59:55 24/02/2007	23:59:55 24/02/2007	23:59:55 24/02/2007	23:59:55 24/02/2007	23:59:55 24/02/2007
# words at 11:00 25/2	84 (2*6+12*6)	84 (2*6+12*6)	96 (2*6+12*7)	96 (2*6+12*7)	96 (2*6+12*7)

All RCM11's are set to measure conductivities in the range 28.5-31.5 mS/cm (with rollover), giving a resolution of approx. 0.003 mS/cm. The effective temperature resolution is approx. 0.009 °C.

Acoustic releases:

SN	433	434
Location	CI2/OP1	CI1/OP2
Voltage on recovery (D/PP3) – Varta industrial	8.64 V/9.60 V	8.62 V/9.60 V
Voltage on redeployment (D/PP3) – Duracell procell	9.65 V/9.52 V	9.65 V/9.50 V
Diagnostic delay on redeployment	15336 ms	15316 ms

Instruments on coast/slope moorings:

Coast: (anchor dropped 06:31, 4/2/2007)

RDI Workhorse Sentinel ADCP #8026 (missing serial no. on case)

Memory: 2 GB (2*1GB Sandisk Extreme III CF cards in adapters)

1 ping per ensemble, cell size 2 m, 90 bins, ensemble interval 1 minute

Deployment commands sent at 01:00:22, 4/2/2007. Pinging confirmed.

Release: AR861 #564, INT: 15D9, REL: 1555

Slope north: (anchor dropped 22:46, 4/2/2007)

SBE37-SM #4832, logging interval 300 s (5 minutes), starting 22:00 on 5/2/2007

Release: AR861 #563, INT: 15D8, REL: 1555

Slope south: (buoy dropped 01:08, 5/2/2007)

SBE37-SM #4833, logging interval 300 s (5 minutes), starting 22:30 on 4/2/2007

Release: AR861 #567, INT: 15DC, REL: 1555

S4: (anchor dropped 15:26, 6/2/2006)

RCM11 #593, DSU #15237, 1 hour interval, started at 03:00 on 5/2/2007

7 channels: signal strength/tilt on chs. 6 & 7.

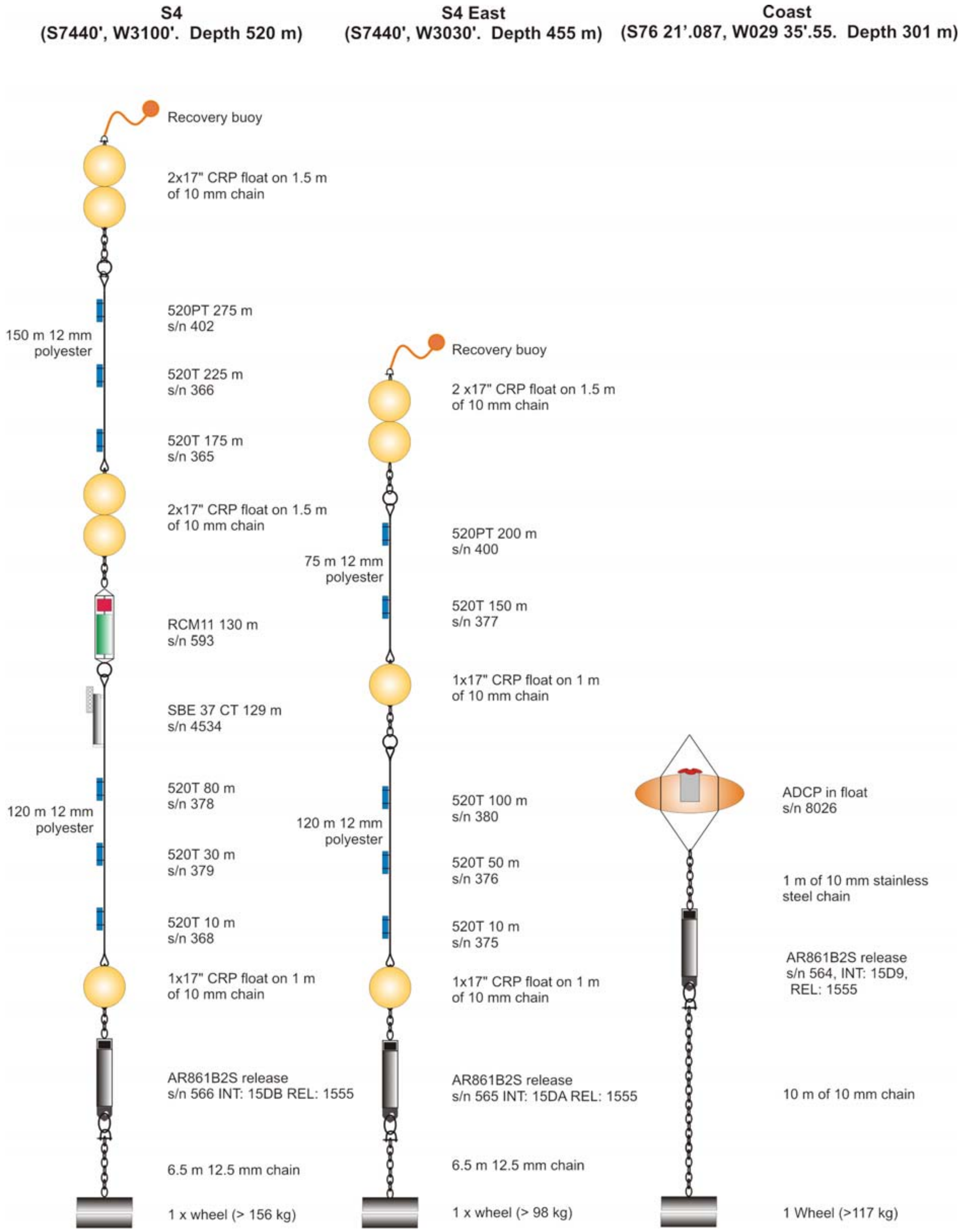
Conductivity range: 26.0-29.0 mS/cm with rollover.

Word count increased from 173 to 180 at 02:00:07 on 6/2/2006.

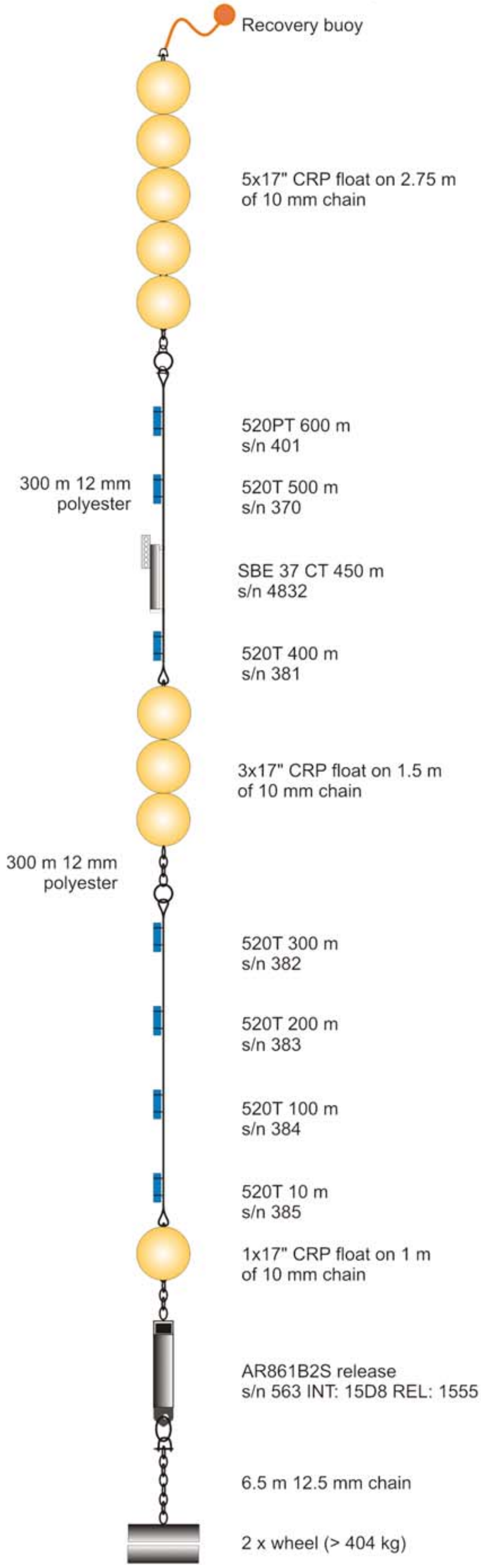
SBE37-SM #4834, logging interval 300 s (5 minutes), starting 00:00 on 5/2/2007.

Release: AR861 #566, INT: 15DB, REL: 1555

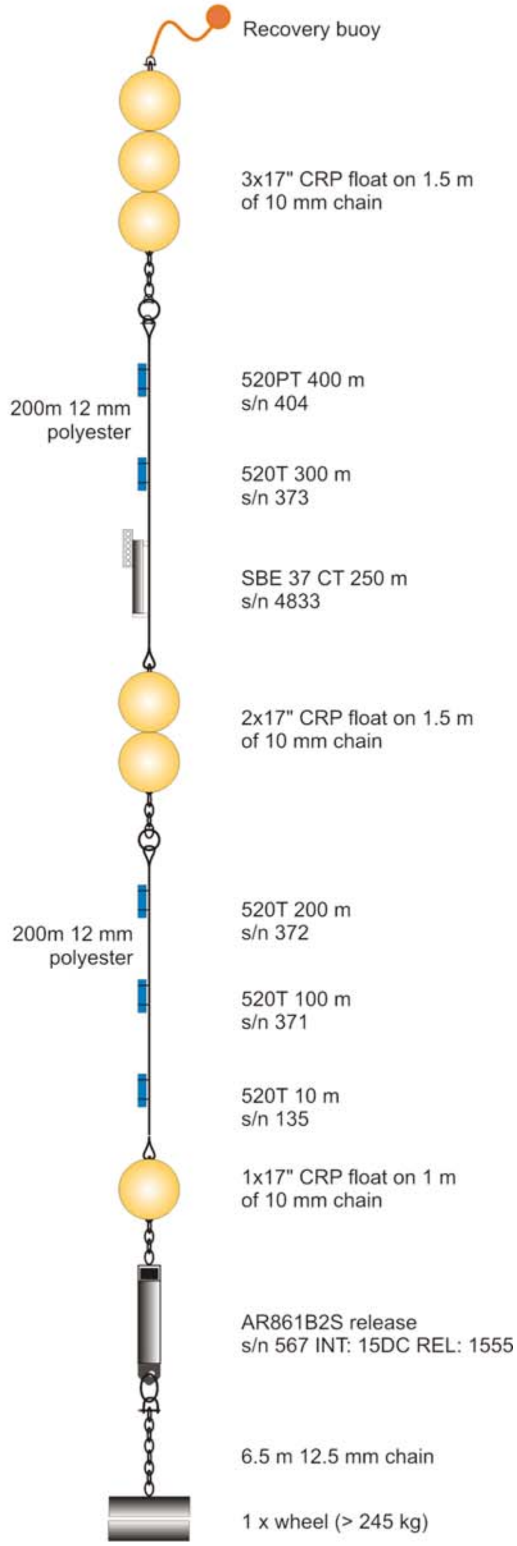
FOCAS moorings, as deployed:



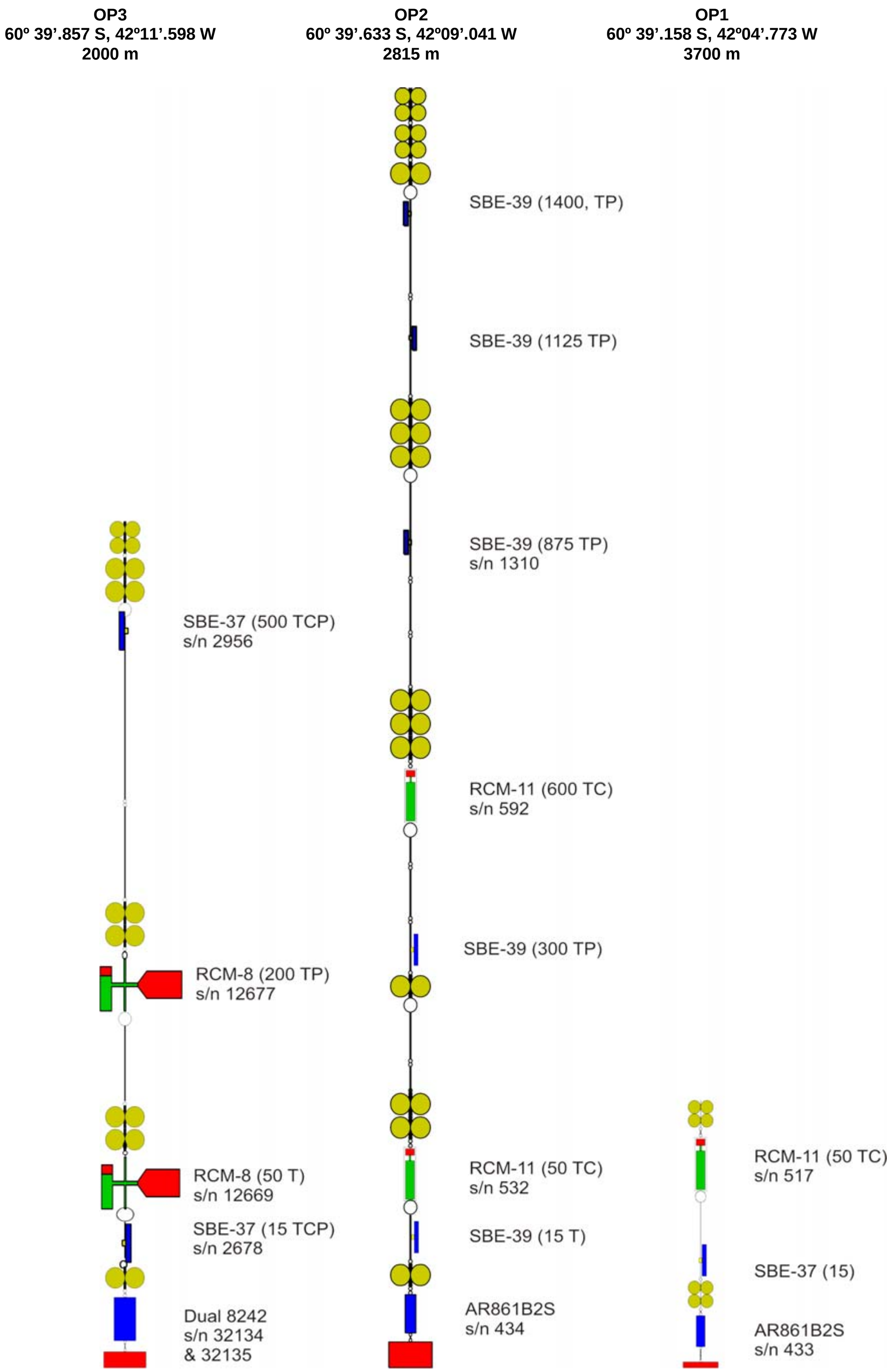
Slope North
(S74 35'.628, W029 26'.446. Depth 965 m)
Anchor last (2242Z 4/2/2007)



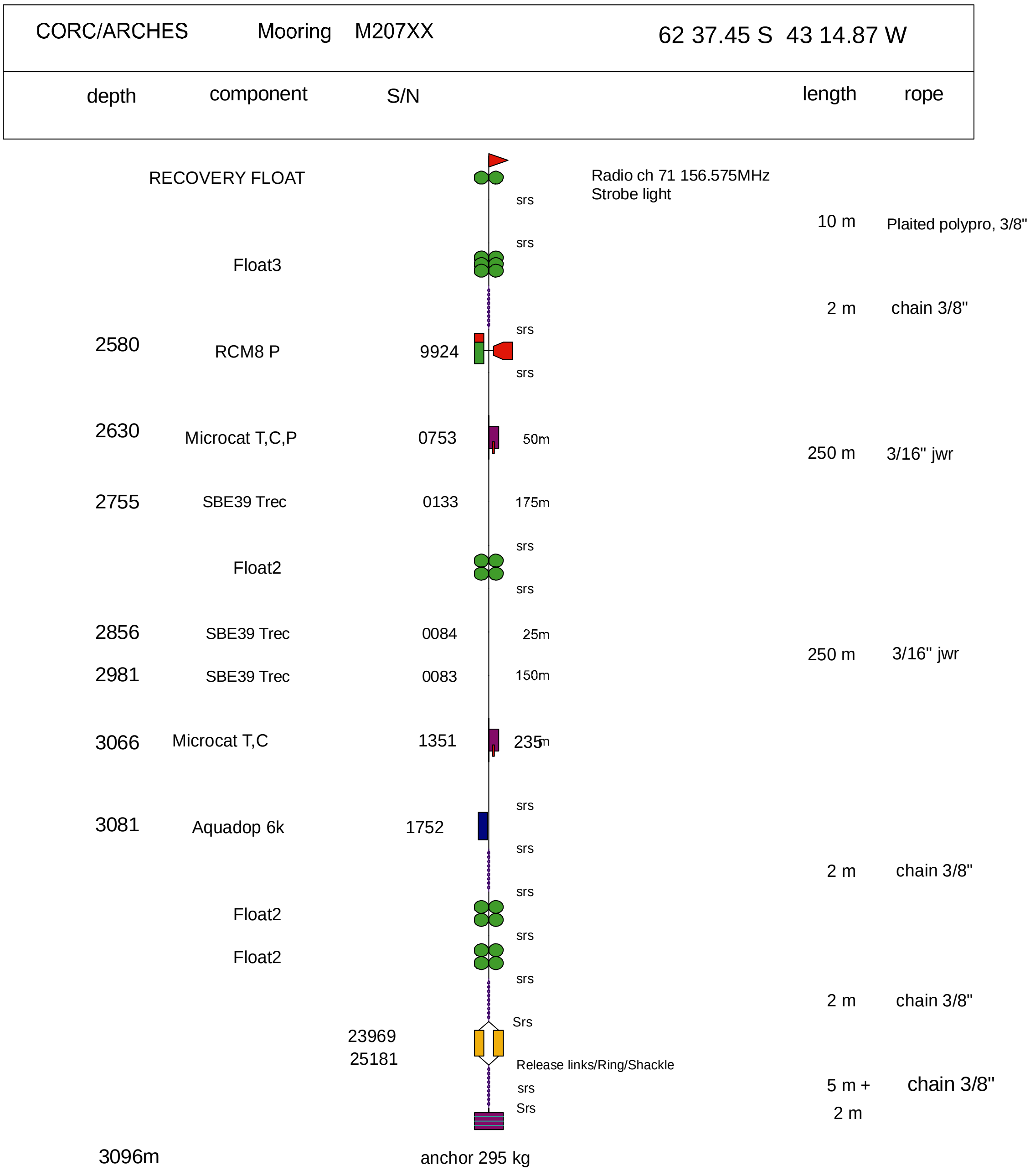
Slope South
(S74 37'.049, W029 31'.799. Depth 817 m)
Anchor first (0108Z 5/2/07)



LTMS Orkney Passage moorings, as deployed:



Mooring M2, as deployed.



	ANCHOR DROP
POSITION:	62 37.45S 43 14.87W
DATE / TIME:	28 Jan 2007
DEPTH:	3096m

Hardware: srs - 1/2" shackle/ 5/8" pear link/ 1/2" shackle

SrS - 5/8" shackle/ 5/8" pear link / 5/8" shackle

CORC-ARCHES M3 Mooring, as recovered.

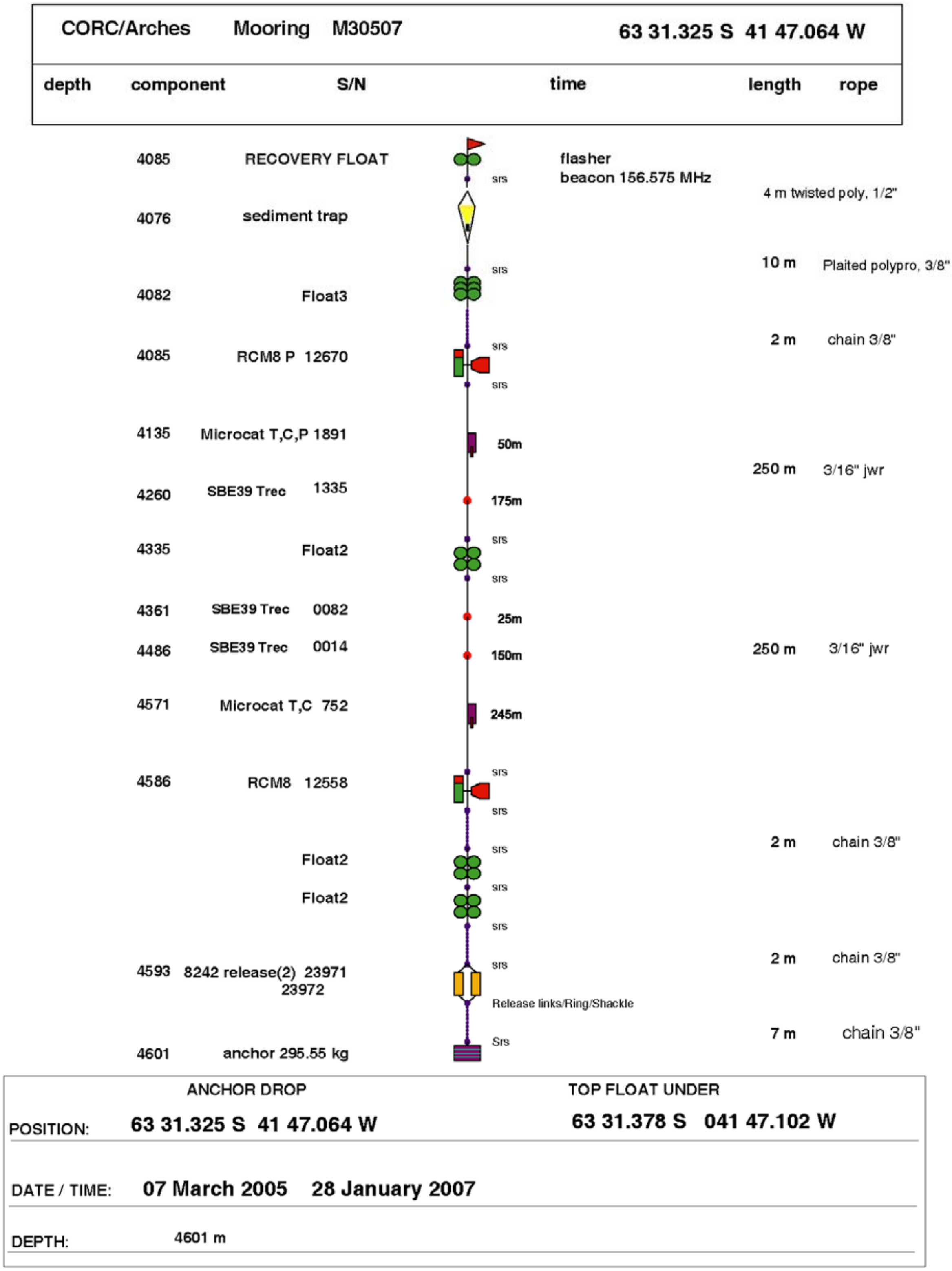
CORC/Arches	Mooring	M30507		63 31.325 S 41 47.064 W	
depth	**component**	**S/N**	**time**	**length**	**rope**
4085	RECOVERY FLOAT		flasher beacon 156.575 MHz		
					4 m twisted poly, 1/2"
4076	sediment trap				
				10 m	Plaited polypro, 3/8"
4082	Float3				
				2 m	chain 3/8"
4085	RCM8 P	12670			
4135	Microcat T,C,P	1891			
				250 m	3/16" jwr
4260	SBE39 Trec	1335			
4335	Float2				
4361	SBE39 Trec	0082			
4486	SBE39 Trec	0014		250 m	3/16" jwr
4571	Microcat T,C	752			
4586	RCM8	12558			
				2 m	chain 3/8"
	Float2				
	Float2				
				2 m	chain 3/8"
4593	8242 release(2)	23971 23972			
				7 m	chain 3/8"
4601	anchor 295.55 kg				

	ANCHOR DROP	TOP FLOAT UNDER
POSITION:	63 31.325 S 41 47.064 W	63 31.378 S 041 47.102 W
DATE / TIME:	07 March 2005	28 January 2007
DEPTH:	4601 m	

Hardware: srs - 1/2" shackle/ 5/8" pear link/ 1/2" shackle

SrS - 5/8" shackle/ 5/8" pear link / 5/8" shackle

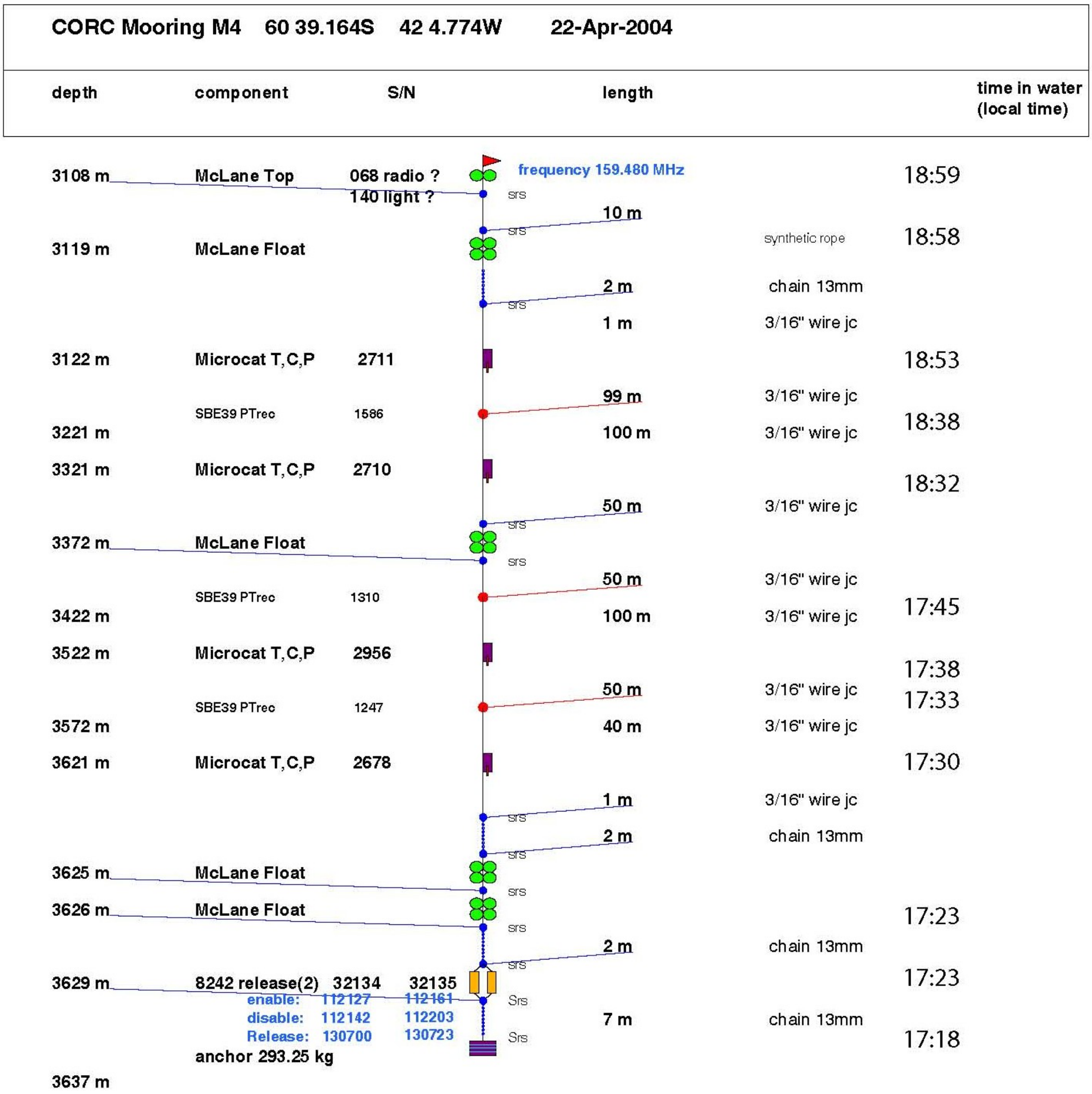
CORC ARCHES M3 mooring as deployed.



Hardware: srs - 1/2" shackle/ 5/8" pear link/ 1/2" shackle

SrS - 5/8" shackle/ 5/8" pear link / 5/8" shackle

CORC-ARCHES M4 mooring, as recovered:



	Top float released	
Position	60 39.164’ S	42 4.774’ W
Date/Time	22 April 2004 22:59 GMT	
Depth	3637m	

Appendix E Deployment of sound sources

An important aspect of the deployment of the sound sources is to determine the precise timing of the 80-second "pongs", before the moorings are deployed. To do this, the sources are initialised and the once daily pongs are monitored. This was straightforward for ROSO 27, as the pong could normally be clearly heard above the ship noise. This was not the case, however, for ROSO 31. The transmission power was therefore increased to 50% of maximum. Then the pongs could be heard, though not as clearly as for ROSO 27 (which was transmitting at the standard 30% maximum for deck-testing).

Unfortunately, the delay while sorting out the ROSO31 problem meant that only one determination could be made of the time of transmission.

The times given below are true UTC, that is, not GPS time.

ROSO 27

Date	Time of pong
27/1/07	00:41:48 UTC
28/1/07	00:41:49 UTC
29/1/07	Ship too noisy to hear pong
30/1/07	00:41:49 UTC

Deployment (30/1/07)

0211	65° 31.855 S	037° 09.354 W;	Heading 175° (T)	4754 m
0211	12 buoys deployed; XT6000 (S/N 51306) activated			
0214	XT6000 deployed			
0230	65° 32.318 S	037° 09.118 W;	Heading 175° (T)	4753 m
0237	Swivel, ROSO 27, Swivel deployed			
0245	65° 32.469 S	037° 08.930 W;	Heading 175° (T)	4753 m
0300	65° 32.746 S	037° 08.708 W;	Heading 175° (T)	4753 m
0311	Buoy deployed			
0315	65° 32.95 S	037° 08.5 W;	Heading 174° (T)	4753 m
0330	65° 33.55 S	037° 08.2 W;	Heading 174° (T)	4752 m
0336	Buoy deployed			
0345	65° 33.626 S	037° 07.951 W;	Heading 173° (T)	4752 m
0356	Buoy deployed			
0400	65° 34.242 S	037° 07.604 W;	Heading 173° (T)	4751 m
0414	Buoy deployed			
0414	SBE37 (SN 221) Plugs out; deployed; swivel, release (S/N 774) deployed			
0416	Sinker weight deployed			
0416	65° 34.513 S	037° 07.326 W;	Heading 173° (T)	4751 m

Depths given above are echosounder depths using 1500 m s^{-1}.
Actual water depth using CTD calibration for speed of sound = 4715 m

Rope lengths used beneath sound source: 10, 50, 100, 200, 500 x 7
Lengths of buoy and other elements (25 m)

Therefore, predicted depth of ROSO 31 = 830 m.

ROSO 31

28/1/07	Finally heard test pong at 50% full power
29/1/07	Ship too noisy to hear pong
30/1/07	Missed pong (deploying ROSO 27)
31/1/07	01:00:06 UTC

Deployment (31/01/07)

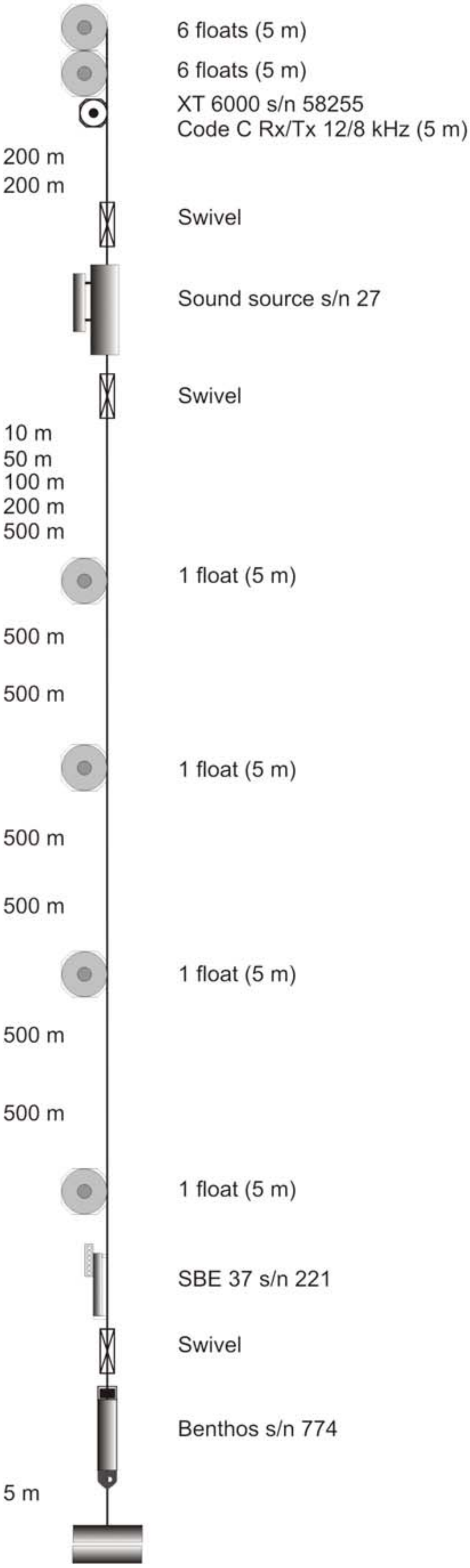
0444	68° 58.435 S	034° 02.111 W;	Heading 170° (T)	4489 m
0444	12 buoys and XT6000 (activated) deployed			
0500	68° 58.921 S	034° 01.758 W;	Heading 174° (T)	4489 m
0504	Swivel, ROSO 31, swivel deployed			
0508	Buoy deployed			
0515	68° 59.122 S	034° 01.572 W;	Heading 167° (T)	4489 m
0530	68° 59.382 S	034° 01.215 W;	Heading 172° (T)	4489 m
0541	Buoy deployed			
0545	68° 59.808 S	034° 00.822 W;	Heading 172° (T)	4489 m
0556	Buoy deployed			
0600	69° 00.255 S	034° 00.481 W;	Heading 172° (T)	4488 m
0612	Buoy deployed			
0612	SBE17 (S/N 217, plugs out) deployed			
0612	Swivel, release (S/N 779) deployed			
0615	Sinker weight deployed			
0615	68° 00.672 S	034° 00.152 W;	Heading 172° (T)	4489 m

Depths given above are echosounder depths using 1500 m s^{-1}.
Actual water depth using CTD calibration for speed of sound = 4443 m

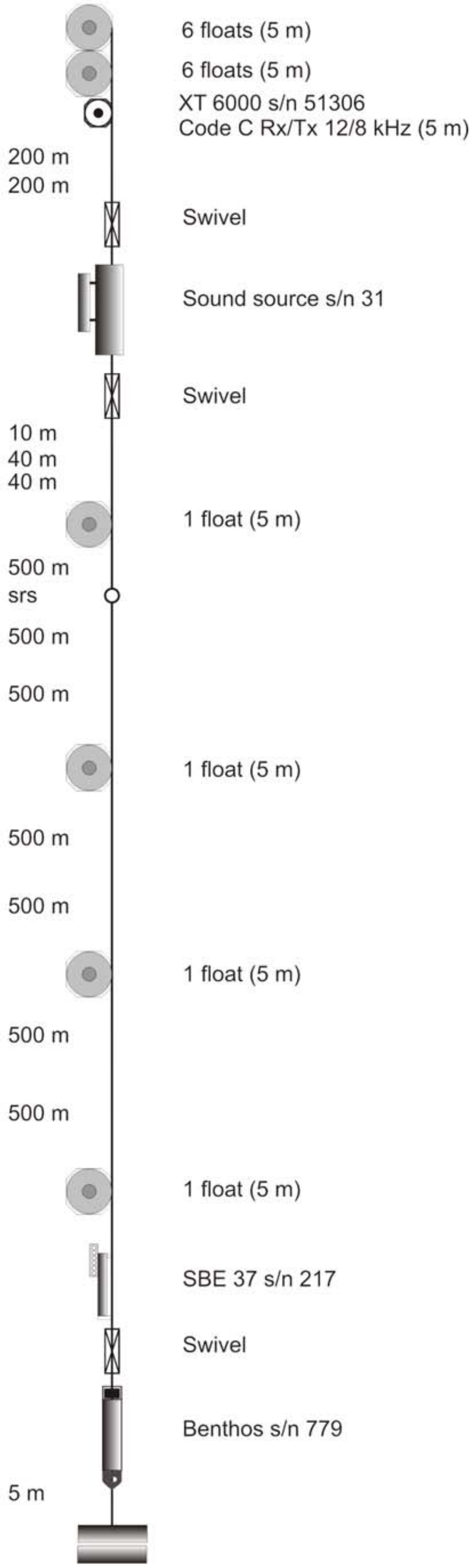
Rope lengths used beneath sound source: 10, 40, 40, 500 x 7
Lengths of buoy and other elements (25 m)

Therefore, predicted depth of ROSO 31 = 828 m.

Mooring W8
Depth 4715 m
Release: 65 34.513 S 037 07.326 W



Mooring W7
Depth 4443 m
Release: 68 00.672 S 034 00.152 W

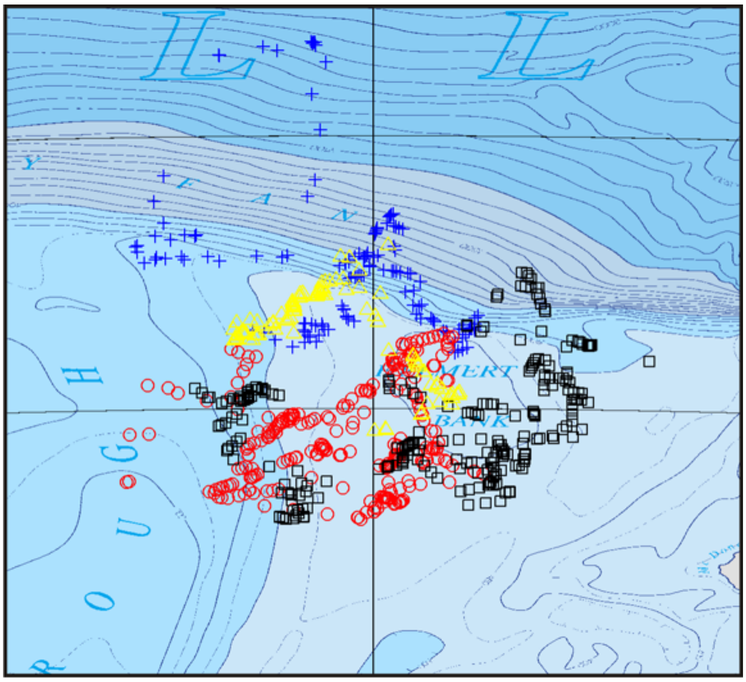


Appendix F Seal capture data and initial data from tags

Location	60 41.795 S 45 36.196 W		74 42.81 S 030 37.04 W		74 45.30 S 031 00.40 W		74 42.91 S 030 58.56 W		74 55.41 S 029 52.80 W	
Date	28-Feb-07		12-Feb-07		12-Feb-07		12-Feb-07		13-Feb-07	
Species	Elephant seal		Weddell seal		Weddell seal		Weddell seal		Weddell seal	
Sex	Male		Female		Male		Male		Female	
Zoletil (cc)	3	1	1.8	0.3	1.7	0.3	1.6	0.2	1.6	0.3
Time (UTC)	1503	1508	1144	1220	1618	1633	1908	1938	0333	0400
Degree immob.	3	2	3	3	3	3	3	3	3	3
Weight (kg)	520 (from length & girth)		321		258		237		229	
Girth (cm)	212		173		160		158		179	
Length (cm)	282		222		230		209		315	
Tag body no.	10592		10586		10584		10488		10578	
Notes	Sub-adult male elephant seal captured at Mirounga Flats, Signy Island. Equipped with CTD-SRDL with faulty real-time clock. Has software fix to deal with random 4-hr jumps in time"		Adult female Weddell seal captured on pack ice in the southeastern Weddell Sea, close to breathing hole. Ice conditions: Tight rotten pack. Weather: overcast, calm		Adult male Weddell seal captured on large ice floe in the pack ice in the southeastern Weddell Sea. Ice conditions: Tight, slightly rotten pack. Weather: sunny, calm				Adult female Weddell seal captured on pack ice in the southeastern Weddell Sea, close to breathing hole. Ice conditions: Pack ice with large, solid floes. Weather: Ice mist but clear overhead, calm	

Sample data from seal tags

Figure F1



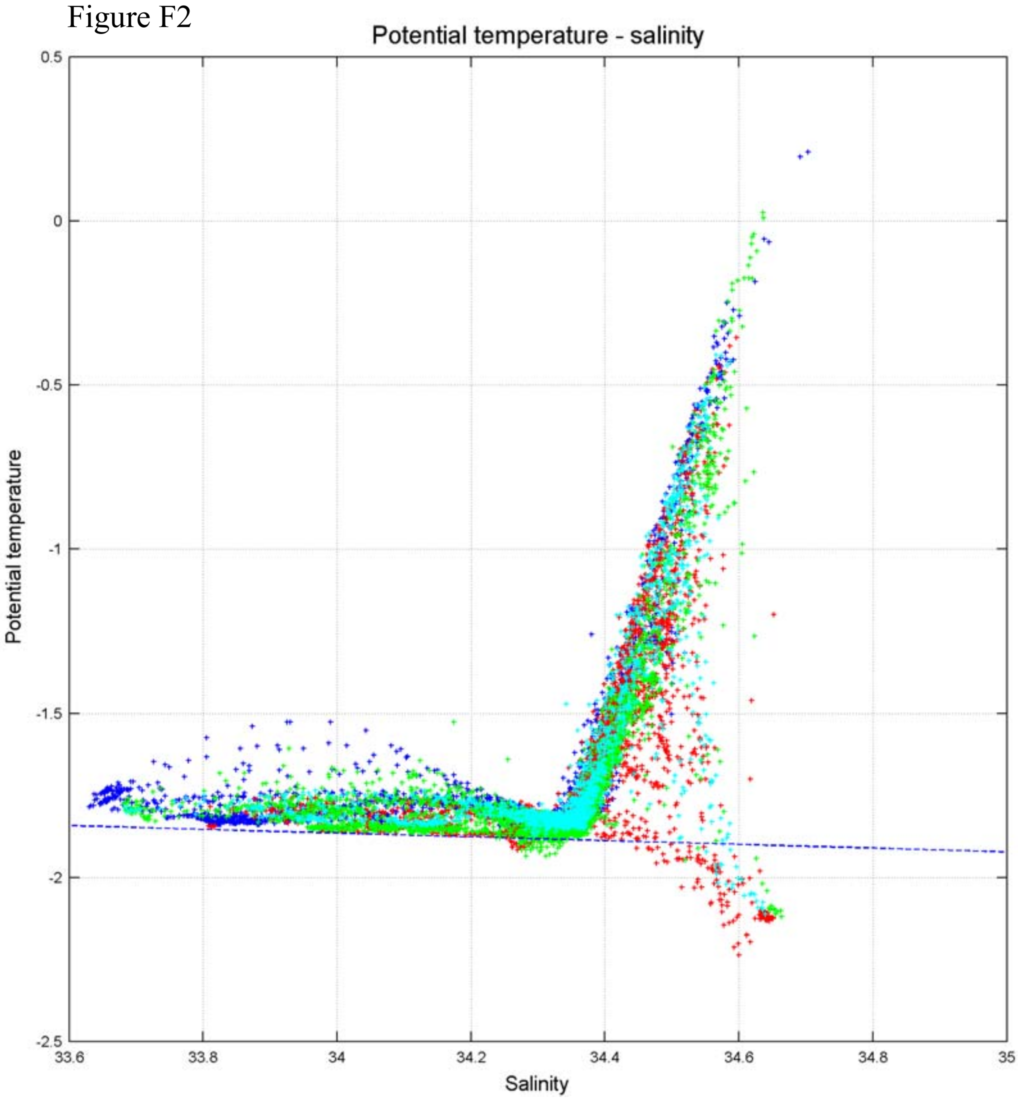
Upper figure shows locations for Weddell seal profiles up until 2nd April 2007.

Lower figure shows T-S data from all seal profiles, different colours representing different tags.

Next page: T-S data and profiles for each seal from data to April 2nd 2007.

Salinities have been offset so that the Winter Water salinity matches that observed in the area during the cruise using the shipboard CTD.

Figure F2



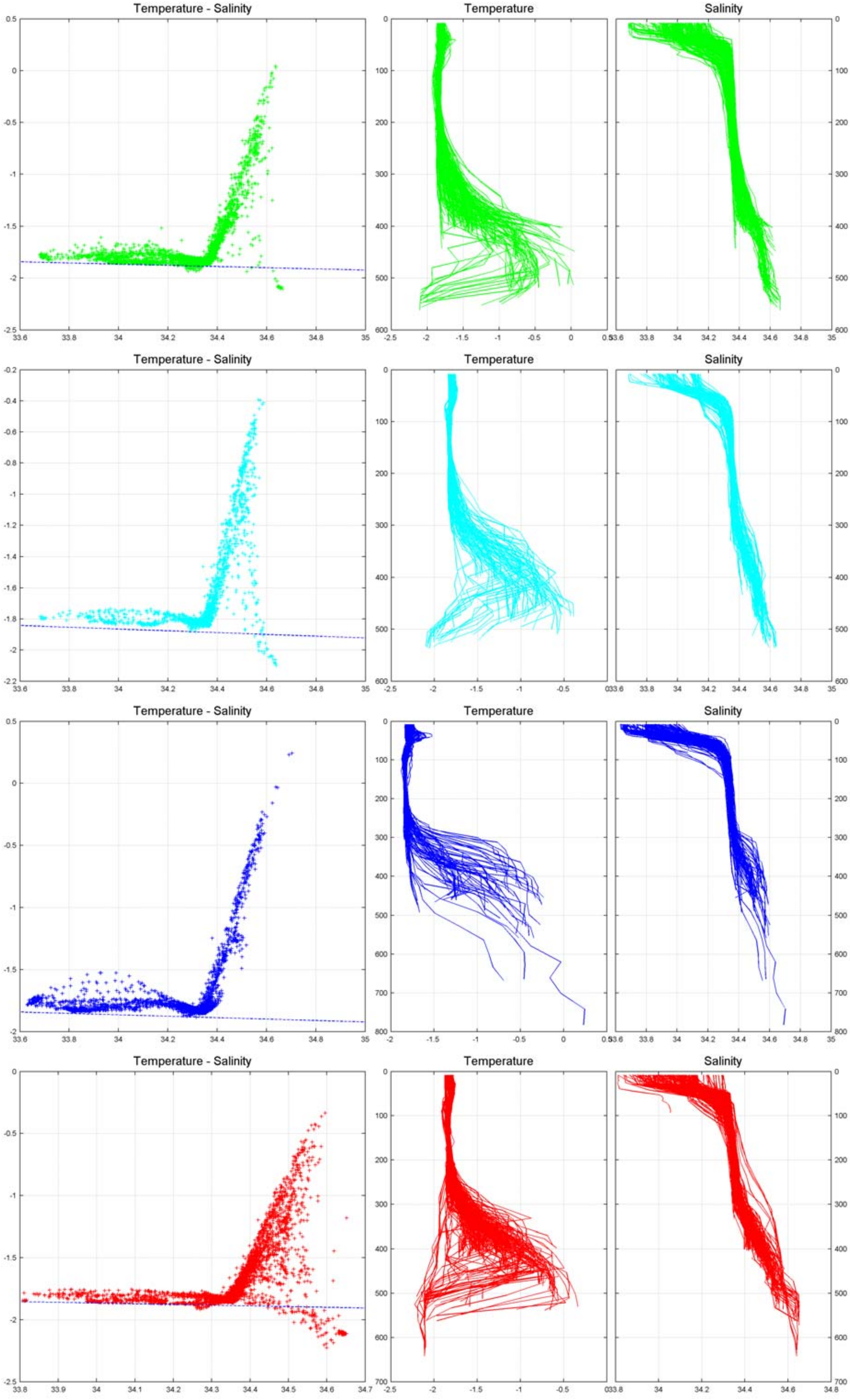

Temperature - Salinity
Temperature
Salinity
Temperature - Salinity
Temperature
Salinity
Temperature - Salinity
Temperature
Salinity
Temperature - Salinity
Temperature
Salinity

Figure F3

Appendix G CPR deployment logs

Falkland Islands to Bird Island

Time	Latitude	Longitude	Wind Dir.	Wind Speed	Sea Temp.	Air Temp.	SMG	CMG
2155	52°04′.1S	055°01′.9W	SW	35K	7.1°			
2300	52°05′.2S	054°44′.6W	230°	36K	7.1°	5.8		
19/01/2007								
0000	52°06′.9S	054°26′.2W	220°	25K	6.8°	5.5°		
0100	52°09′.3S	054°08′.7W	220°	28K	6.6°	5.1°		
0200	52°11′.7S	053°50′.8W	220°	30K	6.2°	5.2°		
0300	52°14′.2S	053°34′.4W	210°	28K	6.5°	4.9°	11.0K	102°
0400	52°16′.6S	053°17′.1W	225°	32K	7.1°	4.6°		
0500	52°19′.1S	053°00′.1W	215°	30K	7.2°	4.9°		
0600	52°21′.4S	052°43′.5W	210°	30K	6.6°	3.8°		
0700	52°23′.7S	052°26′.6W	210°	30K	6.8°	4.0°	10.7K	103°
0800	52°26′.0S	052°09′.0W	215°	32K	6.9°	4.1°		
0900	52°28′.7S	051°49′.6W	200°	28k	6.8°	4.6°		
1000	52°30′.5S	051°27′.0W	190°	28K	6.8°	5.5°		
1100	52°33′.5S	051°14′.2W	190°	26K	6.8°	5.5°	11.3K	103°
1200	52°35′.8S	050°57′.1W	180°	26K	6.8°	5.6°		
1300	52°37′.9S	050°40′.1W	180°	26K	6.8°	5.8°		
1400	52°40′.4S	050°22′.4W	180°	26K	5.8°	5.4°		
1500	52°42′.8S	050°05′.8W	180°	26K	5.5°	5.4°	10.6K	103°
1600	52°44′.8S	049°50′.0W	180°	28K	5.1°	5.6°		
1700	52°47′.2S	049°34′.9W	180°	29K	5.4°	4.9°		
1800	52°49′.2S	049°19′.3W	180°	28K	5.4°	5.4°		
1900	52°50′.9S	049°04′.5W	170°	28K	5.3°	5.5°	9.5K	102°
2000	52°53′.1S	048°48′.4W	180°	30K	5.4°	5.4°		
2100	52°55′.1S	048°31′.5W	175°	30K	4.9°	5.2°		
2200	52°58′.1S	048°13′.6W	175°	30K	4.9°	4.6°		
2300	53°01′.1S	047°56′.3W	170°	30K	4.9°	4.9°	10.6K	104°
20/01/2007								
0000	53°02′.9S	047°40′.0W	190°	28K	5.4°	5.0°		
0100	53°04′.5S	047°25′.4W	190°	26K	4.9°	4.7°		
0200	53°06′.9S	047°09′.0W	190°	26K	5.1°	4.2°		
0300	53°09′.2S	046°52′.7W	200°	25K	5.3°	4.3°	9.8K	102°
0400	53°11′.3S	046°36′.6W	210°	24K	5.2°	4.4°		
0500	53°13′.5S	046°19′.8W	215°	26K	5.0°	4.5°		
0600	53°15′.8S	046°03′.1W	220°	24K	5.2°	4.3°		
0700	53°17′.9S	045°46′.4W	200°	24K	4.8°	4.1°	10.3K	103°
0800	53°20′.2S	045°28′.8W	225°	30K	4.8°	4.2°		
0900	53°22′.1S	045°12′.8W	220°	28K	4.8°	3.9°		
1000	53°24′.6S	044°54′.9W	220°	32K	4.8°	3.9°		
1100	53°26′.9S	044°38′.2W	220°	30K	4.8°	3.9°	10.5K	102°
1200	53°29′.6S	044°19′.9W	220°	26K	4.7°	3.9°		
1300	53°32′.1S	044°02′.1W	220°	23K	4.6°	3.6°		
1400	53°34′.7S	043°43′.0W	220°	23K	4.1°	4.7°		
1500	53°36′.9S	043°26′.3W	220°	23K	4.4°	4.0°	11.0K	103°
1600	53°39′.2S	043°08′.0W	200°	26K	4.8°	4.6°		
1700	53°41′.6S	042°50′.3W	200°	24K	4.7°	4.6°		
1800	53°44′.0S	042°32′.0W	210°	24K	4.5°	4.3°		
1900	53°46′.6S	042°14′.3W	220°	24K	4.5°	4.2°	11.0K	103°
1934	53°48′.1S	042°06′.8W	210°	26K	4.5°	3.1°	CPR REMOVED	

South Orkney Islands to Falkland Islands

Time	Latitude	Longitude	Wind Dir.	Wind Speed	Sea Temp.	Air Temp.	SMG	CMG
1210	59°29′.663S	048°02′.206W	210°	30K	-4.4°	1.1°		
1300	59°23′.1S	048°12′.3W	250°	26K	-4.0°	1.6°		
1400	59°14′.3S	048°25′.5W	240°	28K	-3.9°	1.6°		
1500	59°06′.0S	048°38′.1W	250°	32K	-3.5°	2.4°	10.9K	323°
1600	58°57′.9S	048°50′.5W	220°	28K	-3.4°	2.1°		
1700	58°49′.1S	049°01′.5W	225	26K	-3.4°	2.0°		
1800	58°40′.7S	049°14′.4W	220°	30K	-3.0°	1.8°		
1900	58°32′.5S	049°26′.9W	225°	26K	-2.9°	2.0°	11.0K	323°
2000	58°23′.9S	049°39′.4W	227°	32K	-2.7°	1.4°		
2100	58°14′.8S	049°52′.5W	240°	24K	-2.6°	0.8°		
2200	58°06′.5S	050°04′.6W	220°	28K	-2.1°	1.4°		
2300	58°00′.0S	050°13′.7W	210°	30K	-2.1°	1.4°	10.2K	323°
05/03/2007								
0000	57°51′.8S	050°25′.5W	200°	26K	-1.7°	2.8°		
0100	57°44′.2S	050°36′.3W	220°	24K	-1.8°	2.8°		
0200	57°36′.1S	050°47′.8W	210°	24K	-1.7°	2.3°		
0300	57°27′.4S	051°00′.4W	210°	22K	-1.4°	2.2°	10.2K	323°
0400	57°19′.1S	051°11′.6W	218°	20K	-1.1°	2.7°		
0500	57°10′.5S	051°23′.6W	210°	16K	-1.1°	3.4°		
0600	57°01′.9S	051°35′.6W	215°	16K	-1.1°	3.4°		
0700	56°53′.3S	051°47′.5W	215°	18K	-0.5°	3.0°	11.5K	323°
0800	56°44′.8S	051°59′.4W	205°	12K	-0.4°	2.6°		
0900	56°36′.5S	052°10′.7W	170°	12K	-0.4°	3.0°		
1000	56°25′.8S	052°25′.5W	170°	14K	-0.1°	4.2°		
1100	56°17′.4S	052°37′.0W	160°	12K	-0.0°	4.1°	11.3K	323°
1200	56°08′.9S	052°48′.7W	150°	12K	0.4°	4.5°		
1300	56°00′.7S	052°59′.7W	150°	14K	0.3°	5.4°		
1400	55°52′.0S	053°11′.5W	140°	20K	0.9°	6.3°		
1500	55°44′.6S	053°21′.5W	130°	20K	1.0°	6.6°	10.3K	323°
1600	55°36′.4S	053°32′.4W	150°	20K	1.7°	6.6°		
1700	55°28′.8S	053°42′.5W	160°	20K	1.2°	6.6°		
1800	55°20′.6S	053°53′.5W	170°	23K	2.0°	6.6°		
1900	55°11′.5S	054°05′.7W	180°	30K	2.2°	5.7°	10.4K	323°
2000	55°03′.7S	054°16′.0W	185°	34K	2.2°	5.6°		
2100	54°55′.8S	054°26′.3W	170°	26K	1.0°	6.0°		
2200	54°48′.1S	054°36′.5W	170°	18K	1.9°	6.2°		
2300	54°40′.4S	054°46′.6W	200°	22K	2.4°	6.4°	9.8K	323°
06/03/2007								
0000	54°31′.2S	054°58′.7W	190°	30K	1.7°	6.7°		
0100	54°22′.8S	055°09′.6W	200°	30K	1.8°	6.6°		
0200	54°14′.4S	055°20′.5W	200°	28K	2.1°	6.5°		
0300	54°05′.8S	055°31′.7W	200°	20K	2.5°	6.4°	10.9K	323°
0400	53°56′.4S	055°43′.6W	200°	20K	2.5°	6.4°		
0500	53°47′.2S	055°55′.5W	160°	14K	3.0°	6.4°		
0600	53°38′.0S	056°07′.2W	185°	24K	3.0°	6.4°		
0700	53°28′.7S	056°18′.8W	225°	24K	3.5°	6.1°	12.0K	323°
0800	53°20′.9S	056°28′.6W	225°	30K	2.4°	6.5°	10.0K	
0900	53°14′.1S	056°37′.2W	241°	34K	3.5°	7.0°	8.8K	
1006	53°08′.125S	056°44′.655W	CPR REMOVED				7.0K	