British Antarctic Survey

Cruise Report

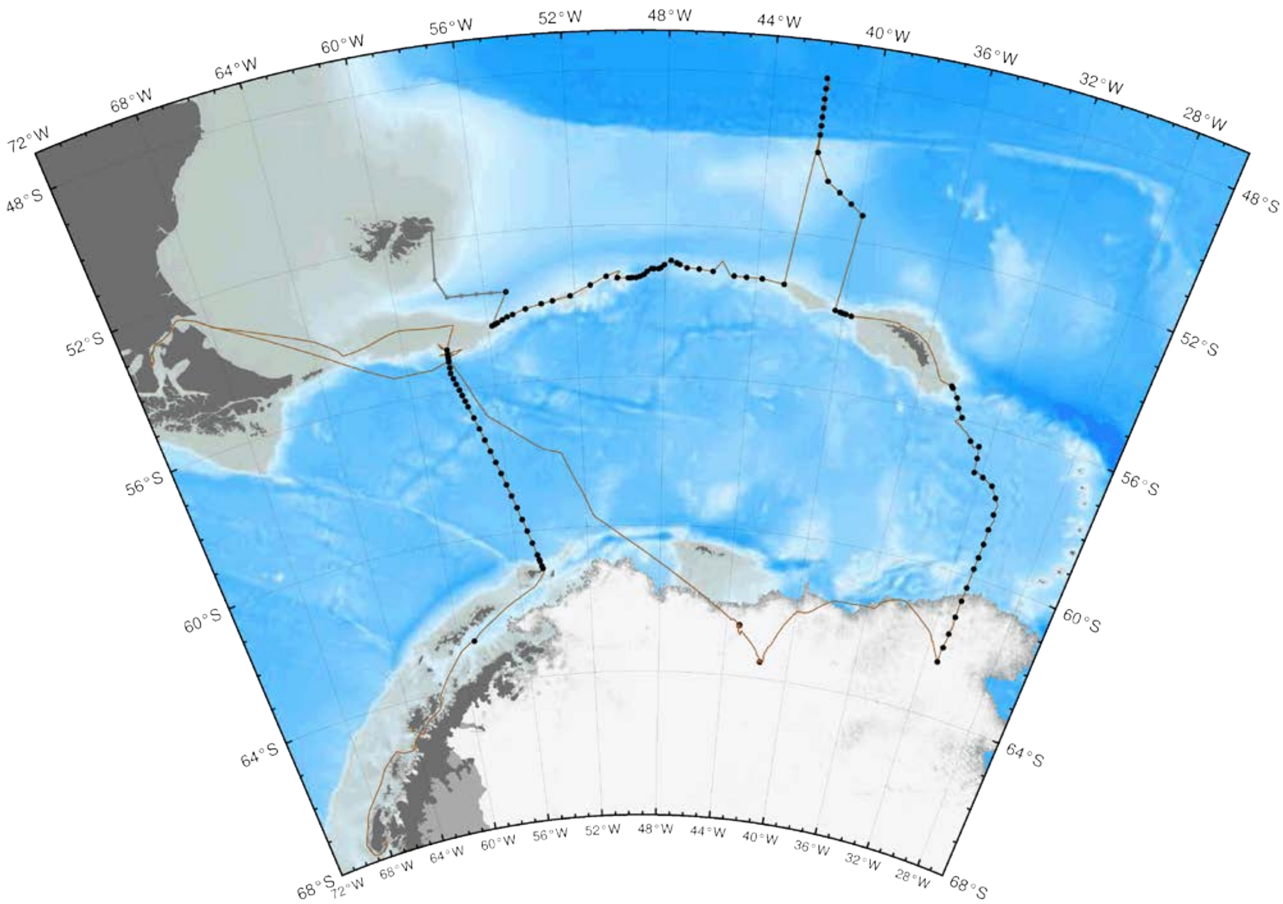
JR299: Scotia Sea circumnavigation and DIMES UK5

8th March to 29th April 2014

PSO: Andrew Meijers

RRS James Clark Ross

Completed 17th Nov 2014



Frontispiece: JR299 cruise track

Acknowledgements:
It is a pleasure to thank some of the many people and groups that helped to make the great success that it was. Particular thanks are owed to Jerry Burgan and the officers and crew of the JCR, for keeping us moving in the right direction, often in marginal and trying conditions while keeping us safe, fed, and happy. Thanks also to Brian King, and Andreas Thurnherr for a remarkable level of assistance from shore with technical and computing matters relating to the LADCP/VMADCP, despite weekends, bank holidays and travels of their own.

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1 Introduction

Andrew Meijers

1.1 Synopsis

The voyage JR299 on the RRS James Clark Ross was an amalgamation of the following cruises: JR293, JR272c and JR273b. It included a three day extension in which to turn around two Lamont-Doherty Earth Observatory (LDEO) moorings in the Weddell Sea. JR299 also represents the final voyage of the Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean (DIMES) project that began in 2009. The major field work component of DIMES consisted of five voyages by US collaborators and five (and a half) UK led voyages investigating the spread of a chemical tracer dye release through Drake Passage as well as other observations of internal ocean mixing in the South East Pacific and Scotia Sea. Because of this JR299 was also designated DIMES UK5.

Due to logistical constraints JR299 was split into two parts. The first was a leg from the BAS Rothera base on Adelaide Island on the Antarctic Peninsula that departed on the 9th of March and proceeded north along the coastline, undertook a CTD and VMP transect of SR1b (JR293) across Drake Passage from Elephant Island to Burdwood Bank, and finished at Punta Arenas on the 24th of March. Personnel were disembarked here, notably all those associated with the VMP, and the ship resupplied and refuelled.

The second leg was conducted from Punta Arenas (31st March) to Stanley (27th April) in the Falkland Islands. Four CTD stations were occupied on the northern end of SR1b, missed on the first leg due to poor weather, before the ship proceeded south to the Weddell Sea to turn around the LDEO moorings. One was recovered while the second could not be due to ice, but its replacement was deployed nearby. The ship then steamed to the southern end of the JR272c leg (repeat CTD section A23). The southernmost CTD stations were inaccessible due to heavy sea ice, but the remainder of the section north to South Georgia was completed. This section was slightly different to previous occupations of A23 in that CTD stations were shifted by small amounts so as to sample the deepest bathymetry in the region. Upon reaching South Georgia the ship occupied CTD stations following the North Scotia Ridge westward (JR273b) to Stanley (April 27th). This leg included a diversion northward into the Argentine Basin in order to repeat CTD stations occupied the previous year as part of the DIMES tracer release experiment.

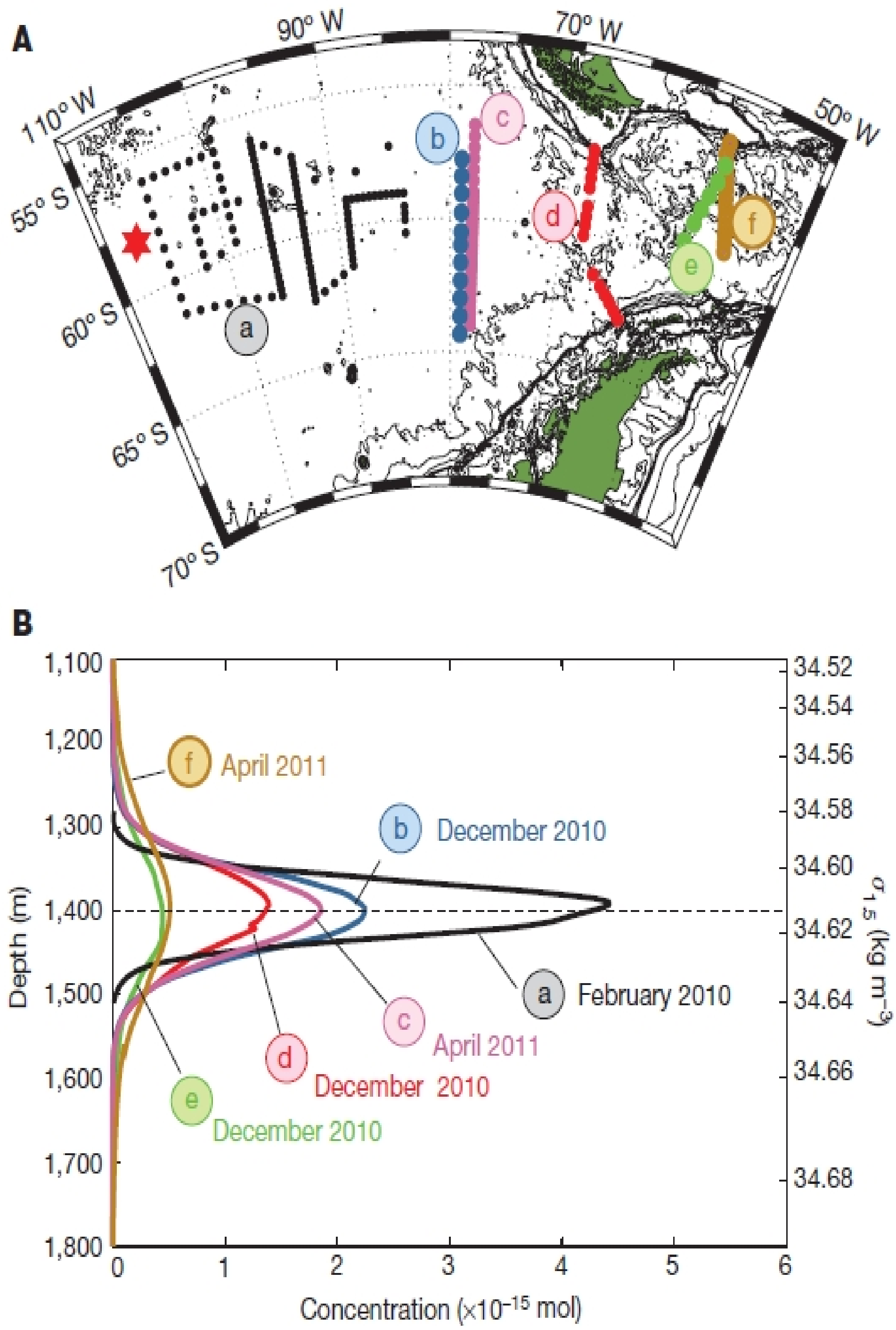
Cruise overview and rationale:
The combination of the three discrete cruise elements JR293, JR272c and JR273b follows the BAS policy of giving each element of work its own unique identifier, so that such units can be moved within or between seasons or repeated without needing to renumber the whole schedule. However, the scientific goals and modus operandi were strongly related across these cruises, and each was conducted collaboratively and seamlessly with largely the same scientific party on board, and were therefore collected under the overarching title JR299. The elements of work and their motivations are outlined below.

i) DIMES:

This was the 5th and final UK voyage to be conducted as part of the DIMES programme. DIMES is a joint UK and US project, funded by the National Science Foundation in the US and NERC in the UK. The objective of DIMES is “to test and, if necessary, redefine the present paradigm of Southern Ocean mixing by obtaining the first systematic measurements of mixing processes in two contrasting regimes (the SE Pacific and the SW Atlantic) of the Antarctic Circumpolar Current (ACC)”. The methods used are (1) the release of an inert chemical tracer, CF3SF5 (tri-fluoromethyl sulphur pentafluoride) in the SE Pacific sector west of Drake Passage and following its dispersion horizontally and laterally as it transits the SE Pacific, Drake passage and the Scotia Sea, (2) The use of fine structure and microstructure measurements from LADCP, CTD and free-falling microstructure probes, (3) the deployment of a substantial array of moorings in the east of Drake Passage to observe the relationship between eddy activity, internal wave activity and vertical and horizontal mixing (4) the release of numerous floats, both neutral density type RAFOS floats and surface drifters and (5) interpretation of model data. As shown in Figure 1.1 the DIMES tracer has progressively spread along the ACC from its initial release point, and spreading both horizontally and vertically and giving an indication of the mixing rate in both of these axes.

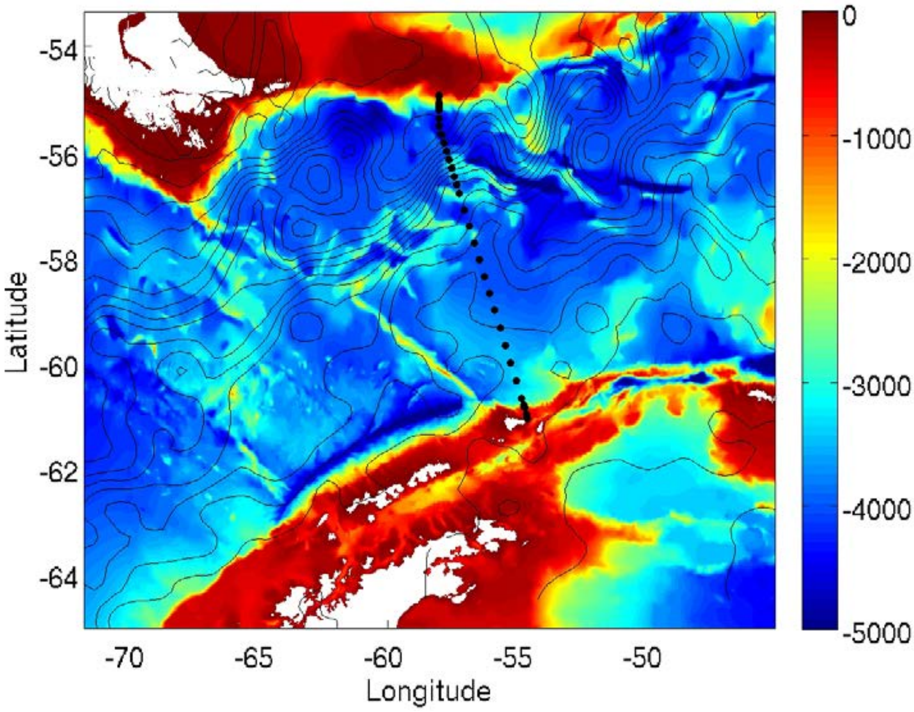
At the time of UK5 the tracer centre of mass was predicted to have passed through the Scotia Sea, and so only the tail end of the tracer patch was expected to be sampled at SR1b and the North Scotia Ridge. JR299 has taken one final snapshot of the distribution of the tail end of the of DIMES tracer within the Scotia Sea, and the opportunistic occupation of Argentine Basin stations with significant tracer signals gives an indication of its concentration significantly further downstream.

Figure 1.1: a) Schematic showing passage of DIMES tracer from initial release through Drake Passage and into the Scotia Sea and subsequent DIMES sampling voyages. b) indicates the vertical spread and the reduction of the mean tracer concentration peak observed on these voyages.



ii) JR293 (SR1b):
In seventeen of the last twenty southern seasons (1993/94 to 2012/13) a full-depth CTD section has been occupied on the SR1 and SR1b sections across Drake Passage, by the combined efforts of PIs from NOCS and BAS. This is one of a small number of repeat hydrographic sections established during WOCE which has multiple high-quality occupations. The work is a key UK contribution to CLIVAR, and the section has been identified as an important one to be maintained in the sustained ocean observation system (SOOS).

Figure 1.2: Drake Passage bathymetry showing JR299 CTD stations occupied along SR1b. Colourscale gives depth in m while contours indicate SSH on March 17, 2014. The kink at approximately 55.5S is in order to avoid the Argentinian EEZ.



The scientific objectives of the SR1b section include:

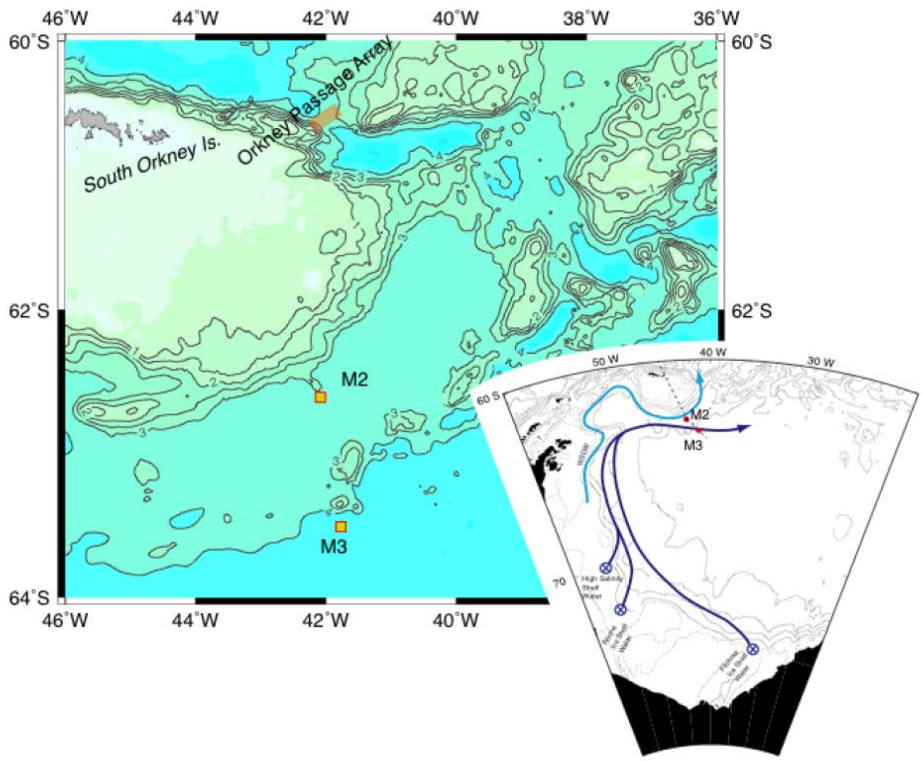
- To observe the location of the surface and subsurface manifestations of the Polar and SubAntarctic Fronts;
- to observe the deep temperature distribution;
- to measure the baroclinic and barotropic transport of the ACC at Drake Passage;
- to determine the interannual variability by comparison with previous datasets;
- to relate these measurements to continuous time series from moorings maintained by NOCL;
- and to relate these measurements to surface SST and SSH data acquired by satellites.

The sustained nature of the SR1b section mean that the time trends of the above parameters can be detected and linked with large scale climate forcing and other long term trends.

In addition to adding to the SR1b hydrographic time series described above, JR299 also included the use of a vertical microstructure profiler along the section to measure small scale water column turbulence and mixing, as well as the measurement of CFC/SF6 tracers to estimate water mass ages and mixing, the DIMES tracer (see above), DIC and for the first time ever, barium.

iii) LDEO Weddell Sea moorings:
The Lamont-Doherty Earth Observatory (LDEO) acts in collaboration with BAS in order to maintain a series of mooring arrays south of the South Orkneys and in the deep Orkney passage immediately to the island's east. The goal of these moorings is to observe the properties of the Weddell deep and bottom waters as they exit the Weddell system to contribute to the world's deep ocean basins. Observations of this type are essential to understanding the oceanic component of the climate system, especially the exchange of heat and fresh water between the poles and equator. The data obtained over the course of a decade and more can be used to better understand deep water formation and long term changes in ocean circulation and their relation to the climate system. To obtain the necessary measurements, this project maintains an array of oceanographic moorings south of the South Orkney Islands in the Northwest Weddell Sea to provide a time series of the combined outflow (currents and temperature/salinity) of Antarctic Deep and Bottom Water drawn from various sites within the Weddell Sea. The observation sites were selected to monitor the integrated properties of the outflowing deep and bottom waters after they have traversed the key formation sites in the western Weddell Sea.

Figure 1.3: LDEO M2 and M3 mooring locations and schematic showing the export pathways from the Weddell Sea and their route across the mooring locations.



The moorings sites are visited approximately every 2 years, with ship time made available under the auspices of an Agreement of Cooperation between LDEO and the BAS. The agreement provides for sharing of equipment, personnel and data between LDEO and BAS, with BAS providing the ship time to do so. The two moorings, M2 and M3 were deployed in March 2011, and were nearing the end of their battery lives. Data logging for both arrays was expected to fail in 2014, while the release batteries are expected to fail in 2015. It was expected that JR281 would turn these moorings around in the 2012/13 season, but extremely heavy sea ice meant that this was not possible. Three days of time saved on JR281 was allocated to JR299 in order to turn the moorings around, with a high priority attached to achieving this goal due to the expected battery failures before another attempt may be made.

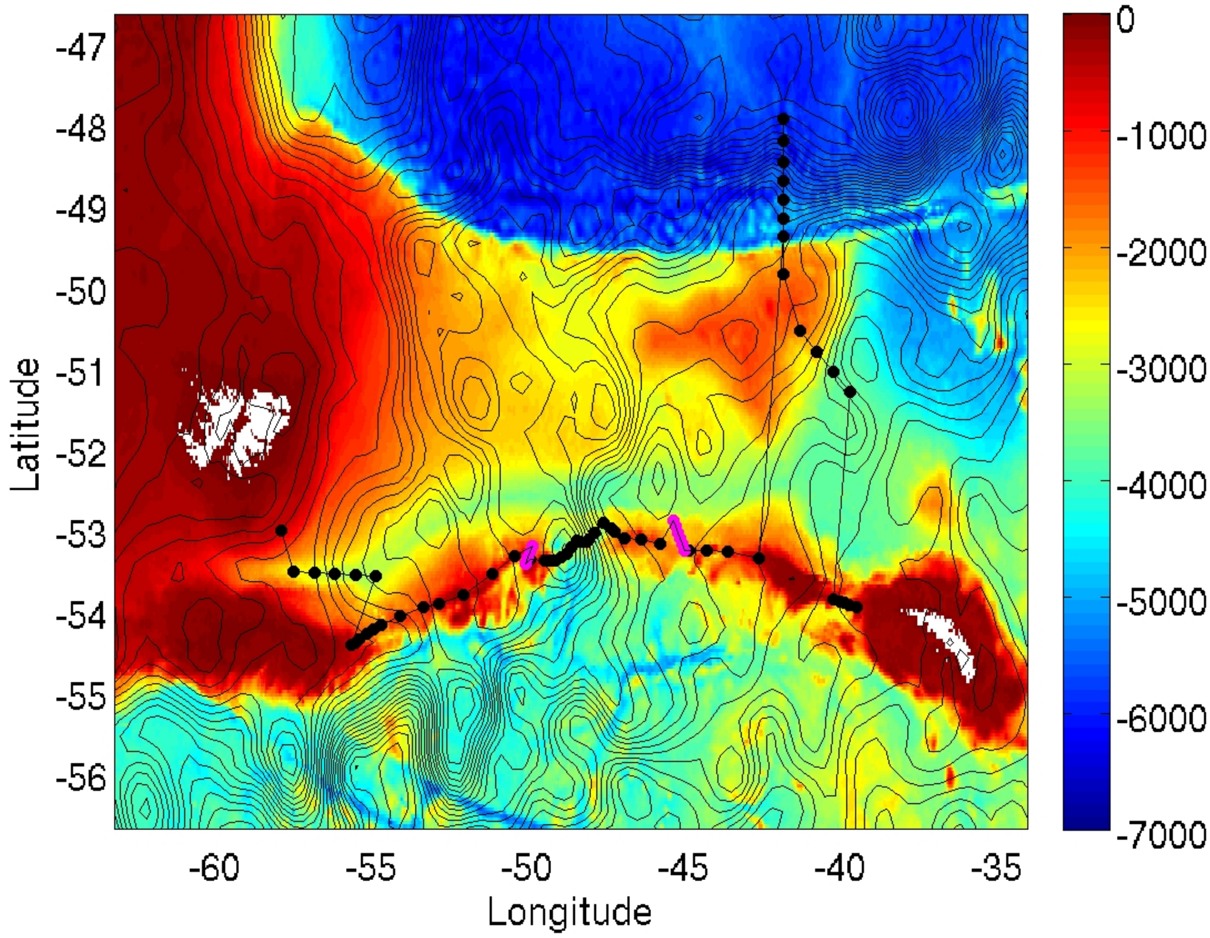
iv) 272c (A23):
In 1995, WOCE section A23 was conducted from RRS James Clark Ross, running from Antarctica (Weddell Sea coastline) northward to Brazil. The part of this section in the eastern Scotia Sea has been repeated six times since, in 1999 (also from JCR), and in 2005 and 2013 (by the US CLIVAR repeat hydrography/CO2 program), on ANDREX 2010 and by JR272a and JR281 in 2012 and 2013 respectively. A number of works have highlighted the usefulness of this section in determining and understanding the changing characteristics and circulation of AABW as it flows from the Weddell Sea through the Scotia Sea, en route to becoming the abyssal layer of the overturning circulation in the Atlantic. Accordingly, the BAS Polar Oceans programme secured ship time to repeat this section, extending also into the northern Weddell Sea to capture the AABW in the boundary current of the Weddell Gyre as it flows eastward along the southern edge of the South Scotia Ridge. The presence of tracer groups from UEA, UoE, UoC and WHOI onboard also offered the opportunity to work collaboratively to measure a range of other parameters (in addition to standard hydrographic parameters) along this section.

Because CFC samples were taken on JR299 the positions of CTD stations were altered from the A23 repeat track slightly in order to sample the water trapped within deep topographic trenches along and near to the section. Weddell Sea Deep Water is flushed periodically into the Scotia Sea through the Orkney Passage. As it is too dense to escape northwards it settles within the deepest bathymetric depressions. If a second flushing event then occurs, but is not dense enough to displace the earlier water within the depressions, a sharp water mass age (and usually T-S) gradient can occur near the bottom. CFC measurements can then be used to put lower limits on deep mixing rates based on the age gradient between the trapped and overlying WSDW. To maximise the chance of seeing such features the A23 station plan was altered slightly so as to sample the deepest regional bathymetric features. As with the SR1b section DIC, nutrient and barium samples were also taken in addition to CFCs.

v) JR273b (North Scotia Ridge):
A repeat hydrographic section along the ridge crest of the North Scotia Ridge was conducted, running between the Falklands and South Georgia. The intention was to determine the interannual variability in water masses and fluxes across this line, which is a major topographic obstacle in the path of the Antarctic Circumpolar Current. As for the SR1b

and A23 sections DIMES, CFC/SF6, DIC, nutrients and barium samples were collected in order to better understand the sources of the waters measured, and their climatic implications via e.g. influencing the global carbon cycle. The position of this line downstream of the SR1b section, on the other side of the Scotia Sea, allows the spatial evolution of the water masses of the ACC to be examined. In the case of DIC and barium this will be the first time this has been achieved. In addition this line was conducted previously in 2005 and 2013, so changes in water mass composition over these times will be interpreted in the context of known climate variability.

Figure 1.4: Bathymetry map of the North Scotia Ridge (m) showing stations occupied on JR299. Black circles indicate CTD station while mauve circles are drifter deployments. Contours give SSH at 21-April-2014.



Combined voyage rational:
Although they form separate units of work these sections serve to effectively encompass the South Scotia Sea. Each line has been conducted previously, so changes in water mass composition may be interpreted in the context of known climate variability and will allow the determination of the interannual variability in water masses and fluxes across the region, where sit the major topographic obstacles in the path of the Antarctic Circumpolar Current. Therefore, merging the three separate cruises has allowed us to make measurements of the DIMES tracer, CFCs & SF6, DIC, Nutrients and Barium at each work element at almost no extra cost overall. This effectively closes the Scotia Sea ACC budgets and significantly improves the spatial coverage and scientific usefulness of each of these observations. This is particularly critical for the DIMES tracer which, five years after its initial release, is approaching the limit of detectability. Conducting these work elements together provides an extremely valuable snapshot of the spatial distribution of the tracer, as well as ensuring that the maximum possible sampling occurs before the tracer dissipates below the level of detectability.

The disadvantage of such efficient combination of separate work units is that when resources are allocated inflexibly for only one unit of work then logistical problems can arise. Such a problem occurred during the planning of JR299 when it was realised that VMP technician time had been allocated for only one of the cruise elements (a total of 12 days), without the understanding that the voyage science time would be a total of 36 days due to the combination of elements. This was discovered late in the piece and so in order to accommodate the essential technicians and instruments the voyage plan was substantially modified. Originally slated for 36 days, departing Punta Arenas and returning to Stanley, the voyage was instead shifted to begin from Rothera in order to pick up the technicians at the end of their previous voyage to Pine Island Glacier. The voyage then occupied the SR1b section, using the full 12 days of allocated VMP technician time and called at Punta Arenas to disembark the technicians and instrumentation. The remainder of the planned work was then completed. This complication in planning led to substantially harder cargo and PAX logistics and a significantly lengthened overall voyage for many participants (52 days) with attendant fuel and personnel costs.

1.2 Cruise participants

Table 1.1: Scientific party

Name	Institute	Primary Responsibility
Whole voyage		
Andrew Meijers	BAS	Principle Scientist
Ellen Bazeley-White	BAS	Data Manager
Michael Boniface	UoE	Technician CFC/DIMES
Jesse Cusack	UoS	CTD ops
Brian Guest	WHOI	Technician DIMES/Moorings
Ewa Karczewska	BAS	CTD ops
Jim Ledwell	WHOI	DIMES leader/Lab manager
Oliver Legge	UEA	DIC/Nutrients/Dissolved oxygen
Philip Mele*	LDEO	Moorings/LADCP processing/CTD ops
Thomas Millgate*	BAS	CTD ops
Siobhan Moran	UEA/UoE	CFC leader/DIMES
Kimberly Pyle	UoC	Barium
Heather Regan	BAS	CTD ops/processing
Hugh Venables*	BAS	CTD leader/processing
Xiaolong Yu	UoS	CTD ops
Leg 1 only		
Michael Meredith*	BAS	CTD ops
Katy Sheen	UoS	VMP operations
Alex Forryan	UoS	VMP operations
Paul Provost	NMF	VMP technician/operations
John Wynar	NMF	VMP technician/operations
Mark Preston	BAS	AME support
Jeremy Robst	BAS	IT support
Leg 2 only		
Seth Thomas	BAS	AME support
Peter Lens	BAS	IT support

* Watch leader
BAS: British Antarctic Survey
UoS: University of Southampton
UEA: University of East Anglia
UoE: University of Exeter
UoC: University of Cardiff
WHOI: Woods Hole Oceanographic Institute
LDEO: Lamont-Doherty Earth Observatory
NMF: National Marine Facilities

Table 1.2: James Clark Ross officers and crew:

Name	Role
Whole voyage	
Michael (Jerry) Burgan	Master
Timothy Page	Chief Officer
Philippa Bowden	2nd Officer
Greg Johnston	3rd Officer
Michael Gloistein	ETO comms
Duncan Anderson	Chief Engineer
Marc Laughlan	2nd Engineer
Christopher Mannion	3rd Engineer
Hazel Woodland	Ship's Doctor
Craig Thomas	Deck Engineer
Eric Jenkins	ETO
Richard Turner	Purser
David Peck	Bosun/Science operations
Albert Bowen	Bosun
George Dale	Bosun's Mate
Ian Raper	AB
Francisco Hernandez	AB
Sheldon Smith	AB
Richard Robinson	AB
Alfred Velloza	AB
Gareth Wale	Motorman
Glyndor Henry	Motorman
Samuel Borne	Chief Cook
John Pratt	2nd Cook
Nicholas Greenwood	Snr Steward
Graham Raworth	Steward
Rodney Morton	Steward
Daniel Golgan	Steward
1st leg only	
Andrew Smith	2nd Engineer
2nd leg only	
Andrew Balogh	Acting 3rd Engineer

1.3 Principal Scientist's Narrative

Monday 3rd March 2014: UK participants arrive at Punta Arenas after long flight. Other participants already arrived ready for am Dash-7 flight onward to Rothera on the 4th. Unfortunately voyage critical member Jim Ledwell has been delayed coming from Hawaii. A narrow weather window exists for Tuesday, but we must first wait for Jim.

Tuesday 4th March 2014: Weather window for Dash-7 flight in the morning is good, but unfortunately it closes at around the same time Jim arrives from the US. We sit tight for the day.

Wednesday 5th March 2014: Morning briefing is disappointing, heavy mank around Rothera and we must wait again. General tourism around Punta, Magellan Square and the cemetery are popular. Jim's luggage catches up with him in the evening, and he is spared the embarrassing clothing that others have been out purchasing for him.

Thursday 6th March 2014: Another morning letdown on the weather front. Howling wind in Punta makes tourism less appealing. Beginning to think we may spend the winter here. Evening news perks everyone up though, it seems likely we'll get away in the morning!

Friday 7th March 2014: C/P Allan Meredith delivers the good news, and we are on the Dash at 7 am. Flight is uneventful and we arrive at a newly snow decorated Rothera in time for lunch. Base extremely welcoming. Hugh Venables has been waiting for us, and gives a terrific evening tour around the point. JCR on schedule to arrive tomorrow.

Saturday 8th March 2014: The base kindly organises morning ice canyoning expeditions, a breathtaking experience. JCR arrives exactly on schedule at 1000L and begins unloading operations. Catch outgoing IStar expedition, but handover is limited to the walk from JCR to Dash-7. All science party board in good order and undergo induction. Lots of box handling trying to get cargo stored after much IStar kit (and beer) unloaded at Rothera and JR299 cargo brought on aft deck.

Some problems: Kimberly Pyle has found that the three ship fume cabinets are unsuitable for her needs (apparently they suck, not blow). Expert opinions sought from the UK, but it seems we will manage. A bigger problem is that one of the WHOI boxes has not arrived, containing amongst many other things 20L of isopropyl alcohol, critical for cooling the GC. 3L located on base, but is spoken for. Much debate over the merits of 'acquiring' it, but a phone call to Palmer Station finds 5L there. Probably enough for SR1b needs. Jim Ledwell is experimenting with stretching 5L far enough, so hopefully it will not affect ops. Sea ice conditions in Weddell Sea near moorings intended for the second leg are increasingly threatening. Master is happy to divert to them, but discussion with Cambridge is required report calls and slippages. Mood of science party is very positive. Ship scheduled to depart today, but Master calls a 12 hour delay, as the officers and crew are in desperate need of a break.

Sunday 9th March 2014: Depart Rothera at 0900L. Said goodbye to Rothera BC Mike Brian and thanked him for their help. Ropes cast off and ship moved away from Rothera approx 3 nm ESE to clear sea ice and emergency muster drill sounded. All scientists present and correct and managed to find their way into the lifeboats for the second time in two days. Ship's boats are tested at this stage, with curious Minke whales following one around. Large problem occurs when aft 10T crane jams, and the problem becomes increasingly frustrating as day goes on. Without this crane safely stowed the ship is not seaworthy and we cannot proceed. Attempts are made to detach the motor from the crane so that it can be manually rotated, but bolt heads prove to be rusted on and shearing them off is a risk. Progress is made but is slow and work is eventually called off at approx 2200L due to cold and dark. Will resume at 0700L tomorrow.

Monday 10th March 2014: Awoke to overcast conditions with pressure dropping and wind picking up. Science party continue with yesterday's setting up work. Hugh V is happy with data streams into the NOC pstar box and practices processing of daily underway streams. He later leads new students (and Mike M and Andrew M) through salinometer operations. The students put their new knowledge to work on RaTS samples from this summer. Mobilisation continues and most people settling in well. CFC sampling process discovered to be a bit fraught, as the glass beakers used to surround the overflowing sample bottle appear very fragile, and the copper tubing makes for inflexible sampling. Ideas are sought and a temporary fix of wrapping the glass beakers in rope for protection and grip is decided on. Heavy seas and crowded CTD frames may yet make this impractical, but we can only see. Deck crew get the slewing motor off and manage to (impressively) manhandle and winch the crane into a stowed position and we are underway shortly after 1100L. Master pushes the ship to an impressive 14 kts sog to make up for some lost time, but upon rounding Adelaide island the winds pick up to 35 kts and seas to 3-4 m. Slowed to 7-9 kts on run towards Vernadsky at times due to poor visibility. A pity to miss the scenery on the run up. Sea ice update isn't good, ice edge has reached the southern mooring. Weather for next 72 hours is strengthening northerlies, so these may push the ice south and allow us to have a crack, but if it does not respond we will probably push on to Punta. Good news from BAS ops is they are happy to accommodate this.

Tuesday 11th March 2014: Awoke to a brighter day and smooth seas. Ship had made good time overnight and Vernadsky reached shortly after 1000L. First officer Tim took the tender in to deliver the requested data logger, and reported that the Ukrainian flag was still flying the right way up, so the base at least seems to have avoided the troubles at home. Departed Vernadsky and made good time despite limited visibility up Lemaire Channel. Spectacular cliffs looming above the narrow channel appear in the mist, and a small group of Minke Whales make for perfectly moody photos. Call at Palmer for exchange of RaTS d18O for DIC samples and the emergency isopropyl alcohol is exchanged for some Scottish alcohol; they appear to be getting the better deal. Palmer very welcoming, but after some reciprocal tours of ship and base the JCR is underway again by 1830L. Have found some unexpected ARGO floats in the rough workshop, and have received word that we are allowed to deploy them. A nice bonus to the planned drifter array. Numerous problems for coming sampling tomorrow. VMP is sending unusual emergency release signals, resulting in whole unit being stripped down. A call to manufacturers reveal it is ok, but in any event other problems are found and isolated. Tethered VMP is giving bad data again, as it did towards the end of IStar. Hopefully retermination will help. Tough call required tomorrow afternoon. To go east to the moorings early or not. Sea ice has stopped advancing, but has not yet responded to winds. Tomorrows obs will help, but unless substantial southward ice movement happens it will not be conclusive.

Wednesday 12th of March 2014: Thick manky fog all day, but only moderate winds and settled seas, so progress is relatively quick, though potential good views of Deception Island are not achieved. Many tourist ships (and HMS Protector) passed in the fog, but none sighted. Ice charts from the last 48 hours indicated that the ice edge has moved back very slightly from the southern LDEO mooring, but only a little considering the consistent pounding by northerly winds. The coming shift to weak southerlies in 36-72 hours combined with the news that the moorings only have one beacon between them, and no lights makes the call certain; we cannot risk a definite setback of 5+ days for a chance of retrieving the moorings that is only slightly better than our chance in a few weeks. Sample training with dummy water ahead of test stations. Lots of enthusiastic bright orange people in the bottle annex. The joie de vivre of standing in a cramped, cold and wet room will fade linearly with their brand new high vis clothes. Over ~1500 m water at 1400L. Ship is hove to and the CTD hits the water for the first test cast. Primary temp sensor is miles off, and needs to be replaced, but otherwise the CTD performs well. LADCP master/slave conflict is fixed by using a dedicated PC for each up down head. CTD on deck and Jim and Brian teach DIMES tracer sampling, and sals taken. VMP on rope down to 100m, performs well. USBL works a treat too. CTD back in water in same location, new primary temp behaves. VMP into water when CTD back up to approx 500m. Whales make appearance, 2-4 Fin and 2 Humpbacks, humpbacks particularly close. Circle around the ship for some time to distract and amaze the large congregation forming in the UIC winch annex. Will have to thin out social gatherings here as Dave the Bosun Sci. winch operator was biting his tongue in frustration at the crowd. Next test cast is sampled for CFCs. Very slow going, mainly due to CFC flow glacial pace and the delicate nature of the beakers. Takes close to two hours to sample the CTD, far too slow for shallow dips, and pushing it for deeper ones. Want to improve CFC sampling asap, either with more samplers or better technique. d18O of opportunity also sampled here. The Bransfield Strait may reveal interesting overflow waters from Weddell Sea.

<u>Thursday 13th of March 2014</u>: Exhausting day. First day of proper science is both very successful and extremely hectic. Continued sea mists today, but sea state is fine. GC appears to be running well based on processing of test station. Arrive on first SR1b station at just after midday. No VMP on first, very shallow station and reduced bottle count makes CFC sampling fairly straightforward. On next two stations VMPs are launched shortly after the start of the CTD cast, and work extremely well. Katy processes VMP data quickly, and reports very high mixing over the slope on stations 4 & 5. Interesting to note, and is accompanied by thick homogeneous layers at the bottom, several 100 m thick. Decision is made to CFC sample station 6 (fourth one into section) due to unusually thick bottom layer. Mike, Katy, Siobhan and myself quite excited at a genuine science result early on. Appears to be a transient gravity driven plume of dense water, associated with very high mixing. Possibly. Mike is looking over old SR1b records for similar events...perhaps we are seeing one for the first time? LADCP continues to be a pain. Master head needs restarting several times on early stations, and on station 7 the slave head decides to produce errors during initialisation and is turned off for this cast.

<u>Friday 14th of March 2014</u>: Awoke to some bright thing in the sky. Unusually high visibility too. Very nice change from oppressive fog. CTDs have fallen into a nice rhythm and people seem to be settled into a routine. LADCP continues to be contrary on startup. Upward looking head fails startup check with unusual error. Midday cast goes in without it, but downward head should be enough. Mark replaces the head and on the next start it works ok, though with a restart required during startup due to comms error? BAS AME much perturbed by how intransigent the heads and cables are being. VMP behaving well, though the USBL seems to lose, and then reacquire on upcast, the instrument at about 2600 m.

Saturday 15th of March 2014: Relatively calm day, good visibility and light winds, though still overcast. Everything proceeding apace this morning. LADCP continues to give problems, although data quality has not been compromised yet. Upward head often needs restarting on casts, or does not pass pre deployment test. Star cable suspected of driving the error, but Mark cannot find a spare on the ship. Steadily breaking our 8 CFC beakers, and are down to 6 now. GC working well, though produces constant small problems. Blown O rings, shorted fuses, broken switches. Hopefully it holds together! Just starting to see below surface DIMES peaks.

Sunday 16th of March 2014: Glorious sunshine this morning, and calm seas. Everyone very cheered and some sunbathing goes on on the monkey island. CTDs proceeding well and we decide to spend the extra allocated VMP time on a high resolution horizontal section across the unusually strong combined PF/SAF and we manage to shoehorn in 7 extra VMPs and about 10 tethered VMP dips into the plan. It should be a very interesting section scientifically if we can pull it off, and will be the highest horizontal resolution achieved in the region. DIMES tracer beginning to appear, though it is a very weak signal.

Monday 17th of March 2014: A very tough day. It begins with the VMP team sheepishly admitting to 'touching bottom' overnight. Perhaps this was caused by a slightly mis calibrated EM122, which hasn't had its water temp profiles updated for the approach of the PF, or maybe by sloped topography that wasn't scanned by the swath as we approached from the south. In any event there is no obvious damage and it is giving good data and behaving. CTD cast 21 is abandoned due to obviously wrong pressure readings. Problem diagnosed as a loose cable, but it cannot be relaunched past a quick 500 m test dip as the VMP is in the water already. No big loss on the CTD as we are still south of the PF and this was the first of the 'bonus' hires CTD stations. Simultaneously the tethered VMP plays up and when powered up it refuses to communicate. Testing shows the fish to be ok, so the problem lies in the cable somewhere. At this point more problems crop up; the VMP-5500 is late coming up. Stressful hours tick by before it is finally sighted more than 3 hours late. Numerous failsafes failed and it must have eventually released its weights on battery failure after sitting on the bottom for at least two hours. Once recharged it still refuses to talk, and a day of trying every possible solution eventually diagnoses a fried and irrecoverable CPU. No spares on board mean the VMP must be retired. Scientifically this is all very frustrating; the microstructure instruments performed well all the way through the dynamically bland subpolar zone, and now both have failed simultaneously on the station immediately south of the combined 'superfront'. To make matters worse the weather is slowly deteriorating.

Tuesday 18th of March 2014: A better day today; moderately sunny although the winds are picking up. The tethered VMP is resurrected by chopping out approx 200 m of cable. The loss of the VMP-5500 means all the intermediate tethered VMP stations at 5nm are abandoned, and instead we have CTDs and tethered VMPs at 10nm spacing instead of the usual SR1b 20nm. The alternate DIMES/CFC stations means that they both will have regular resolution SR1b lines, and double the usual LADCP/CTD coverage.

Wednesday 19th of March 2014: Winds have ominously jumped to 25kts. Early stations go smoothly and the first oxygen samples are taken, in the hope of calibrating the CTD instrument. Tethered VMP performs well on the first few stations of the day and then produces more problems. Disassembled and then re assembled, and it behaves, though one station is missed. Winds continue to rise, and around 1700L we pull in the CTD and it is too

lumpy to risk the TVMP for such a deep station. Seas continue to rise and wind is gusting over 40kts and so ship is hove to for the night on the site of the next station.
Thursday 20th of March 2014: Weather day spent drifting backwards and forwards across Argentine EEZ. Weather easing as of 0035L on 21st. Hoping for work by midday tomorrow.
Friday 21st of March 2014: Nothing achieved today. Waves and wind just as bad this morning, though easing later on. Still not enough to work with though and at 1600L we start gingerly edging our way back to PA with five slope SR1b stations uncompleted, though all those deeper than 2000m are completed.
22nd-31st of March 2014: Crawl back towards PA in very lumpy seas. Arrive at planned bunkering at Cabo Negro terminal on 24th, but high winds prevent docking. Eventually decamp to PA terminal and moor on 25th. Scientists roam the streets and many take the opportunity to visit the immensely impressive Torres Del Paine national park to experience driving rain and high winds on land for a change. Bunkering successful on the 30th and we head back east towards the missed SR1b stations.
Tuesday 1st of April 2014: Day 23 at sea. Food low, water low. Forced to eat one of the students. Morale improved noticeably.
Tuesday 1st of April 2014: Actual first of April. Weather at north end of SR1b not much different to how it was left; grey skies and high winds. Continuous rolling has several people feeling grey, and has broken yet more glassware; down to 4 CFC beakers now. Winds up to 40kt but we go ahead on deployment. Four CTDs are done, each one a struggle against the weather, which is dumping large amounts of water on the deck, flooding the water bottle annex and filling boots even with the door closed. First CTD is standard CFCs, the next two are combined CFC/DIMES while the last one is a repeat of the last station on the previous section for continuous geostrophic calculation, so oxygens are taken instead. Finish ahead of schedule, so a good day for science at last! Retire to the bar for tea and medals after the final sampling.
2nd-3rd of April 2014: Steaming days heading south to M2 mooring. Nervously watching daily ice reports showing advancing ice covering M3 and approaching M2.
Friday 4th of April 2014: Mooring M2 today. We approach the mooring site in moderate sea ice conditions. Some nerves about releasing the mooring with fairly substantial ice flows about, but the bridge is confident and so the release codes are sent. Eventually spotted amid dense pancake ice and a very professional pickup is effected. Deck work successfully recovers it in <-20 conditions with a serious wind chill, resulting in minor frost nip casualties. CTD follows and oxygens along with some calibration CFC values are taken. So cold in water bottle annex that spigots freeze and heaters and hot water baths are needed to open up water flow. Heave to in heavy ice after dark and planned CTD cannot be carried out as the gantry hydraulics cannot operate in such cold conditions.
Saturday 5th of April 2014: Head south to M3, 100% ice coverage but not terribly thick and so about 60nm is covered in 10 hours. Extremely cold and ice steam is seen rising wherever water is open and new frost flowers glisten in the bright sun. Large patches of thin ice that moorings could punch their way through are seen in places, and we are hopeful one may sit over the M3 site. This is not to be when we arrive however, but we make the best of the situation by making a hole in the ice with the ship and deploying the replacement mooring about 1500m SE of the old M3. Hopefully this means there will be no gap in the data when the old ones loggers go flat, and someone will be able to come back and pick it up next year if the release batteries hold out. Mooring deployed slightly deeper than optimal (4620m,

instead of 4550m), but worsening conditions means it must be deployed now or never. Extremely cold work on deck again for several hours. Doctor Hazel is extremely conscientious with rotations of workers, and supplying constant fresh gloves and hot drinks. Despite not getting M3 back we consider it a win under the conditions, largely thanks to excellent support from officers and crew. Many seals, whales and penguins seen, including a lone Emperor. CTD after dark samples CFCs in the interesting WSBW export flow.
Sunday 6th April 2014: Very poor visibility, practically blind due to whiteout and 40+kt winds. Gradual improvement over the day spent extracting ourselves from the ice toward the NE. Some excitement when Ollie discovers a burst water pipe in the bio lab. Fortunately no damage to science equipment, but the bulkhead is dripping. Cold continues to cause problems with the milli-Q tanks, which have frozen, Deck Engineer Craig attempting to fix. End day in clear water NE of M3, heading east along ice edge towards A23.
Monday 7th April 2014: Better weather today. Wind easing and visibility good, though still overcast in general. Make good progress in calm open water north of ice. As we approach A23 we head into the light edge of the pack, aiming for the northernmost of the deep A23 Weddell stations. Nothing but a blanket of pancake ice as far as the eye can see, with occasional cathedral size bergs. Oddly no bergy bits or other dangerous obstacles, so excellent progress initially. Prompts a further turn south to aim for the 'kink' station in A23 (62.5S) to give us two deep (>4000m) stations. milli-Q supply defrosted today so oxygen samples can be run. Oxygen probe appears to have been damaged by cold at M2/M3 stations. Watches resumed and the first station reached in thickening ice and a bumpy ride. CTD deployment a trial: roller door jammed in the cold, CTD was exposed for too long while the door was fixed and consequently the primary cell froze up. Brought back on board, and Seth and PSO defrosted by hand warming and filled primary with salt waters. Problem with wire sheath. Finally all issues resolved and CTD deployed approx 1.5 hours after arrival at the station. CTD operations from the 'external room' water bottle annex in persistent extreme cold are a pain in the arse.
Tuesday 8th April 2014: Fair weather today, but still overcast. Hove to on station overnight due to probably the thickest ice we have yet encountered. Moderately ridged pack, though with enough leads to ensure that we aren't slowed down too much once we get underway at first light. Impressive iceberg fields, some tabular bergs probably kms long and 100 m high. Three CTDs done, including an oxygen cal. Oxygen probe on CTD replaced. One CTD has to be pulled back aboard due to frozen probes and the pump not starting. Have instituted flushing primary and secondary probes with salt water immediately before deployment to try to lower the risk of this happening. Seemed to work well on last CTD of the day.
Wednesday 9th April 2014: Another fair weather day though still overcast. Winds increasing to the west, but no problems yet. Carried on through the night with CTDs. Warming weather and less sea ice means that the icing problems with CTD/bottles are gone. Edge of sea ice reached at second CTD station of the day. Dozens of humpbacks, many of which came to inspect the ship. Scratches noted on upper LADCP head, probably from top of garage. Lowered within frame to protect it, doesn't appear to have affected data quality. Leaning towards not stopping at S. Georgia as we could easily lose a couple of days to weather and quickly become behind. Will be hard to break to the first timers, but that's life, the science comes first.

Thursday 10th April 2014: Winds increasing, along with the swell, but nothing too serious yet. No major incidences. Ropes put on CTD niskins after some knocked loose on recovery. 'Station 88' sampled today, and disappointingly there is no obvious remnant WSDW bottom layer in TS. Heavily CFC sampled anyway. Last hopes for Mike's mysterious bottom layer lie with shifted A23 trench stations tomorrow. Fingers continue to be crossed.
Friday 11th April 2014: Winds increasing, along with the swell, getting quite bad towards the evening. Sampling in foot deep water sloshing backwards and forwards. Press on anyway. Extra swell appears to have freed some extra water which refloods Bio lab room, but doesn't otherwise cause any damage. Niskin 6 was almost lost, and it was found dangling on the return of the morning CTD. Brian Guest's foresight in lashing them to the frame yesterday immediately rewarded. Some slight deviations in course to aim for deepest trenches in the region. Despite this no unusual bottom water signatures are found. Disappointing.
Saturday 12th April 2014: Extreme weather day. Laid up overnight and managed a CTD at first light, but afterwards barometer plummets and winds pick up. Very strong winds from NW that exceed 40kts for hours, picking up to over 55kts for some time in afternoon. Breaks 64kts around evening, so is technically a force 12 gale (hurricane!). Very impressive rolling waves, completely swamping the deck, and some even hit the UIC windows. No work at all, and tiring for everyone. Fortunately waves and wind are coming from our direction of heading, but even so as night falls we have to drop a station, as getting back to it would require too much back tracking. No huge loss, but a little annoying. No work tonight. No sleep either.
Sunday 13th April 2014: Work restarts around dawn, although the deployment was quite hairy due to substantial wave sets. Wind and swell drop through the day, and sun comes out. Work continues at a good pace and we finish A23 at around 2200L. We have lost around 24 hours to weather yesterday, necessitating the dropping of the S. Georgia stop.
Monday 14th April 2014: Moderate overcast and lovely calm seas. South Georgia spectacular to the south with peaks appearing and disappearing in the clouds. Pull into Bay of Isles around 1000L, passing Albatrosses nesting appropriately on Albatross Island. BBQ on rear deck for lunch. Excellent homemade burgers, and PSO cannot resist the call of the BBQ, and pushes purser Rich off the tongs. A bit of R&R in a magnificent setting puts everyone at ease and a good mood pervades as we push off at 1600L. Cloud lowers fast and all view is lost of the island at dusk. VMADCP turned onto bottom track for passage past SG, so hopefully some good calibration data will be forthcoming.
Tuesday 15th April 2014: CTDs in Black Rocks passage commence around midnight and a great effort by all sees all five sampled by 1200L. Reduced CFC and no carbon/nutrients on the middle and last cast help speed things up. Ollie and Kim are now conserving barium, nutrient and DIC bottles in order to have enough left over to sample Shag Rocks Passage effectively. Efficient sampling by all and hard hours processing by them means they have taken much better sections than otherwise might have been hoped. Oxygen calibration produced for start and end of A23, with lines that comfortingly lie almost on top of each other. Oxygen data from A23 is therefore good to use. Hard graft by Ollie paying off.
Wednesday 16th April 2014: Heavy fog day, but otherwise calm and easy weather day, if boring. DIMES Arg. Basin stations begun overnight. Looking at the narrowly spaced front and 5 stations across it lead us to drop one of the shallow stations over Maurice Ewing Bank, and add three into the middle of the SAF. Unsure if the DIMES team can handle the processing

backlog from such narrow spacing. It will come down to whether or not they can get away with single bottles, or if the double sparge and trap technique needs to be continued. Peaks looking good, but still marginal. VSAT goes down for around 6 hours leading to a properly cut off, if brief, Antarctic experience. Email withdrawal suffered by several under 30s on board.

Thursday 17th April 2014: Woken at 5am by phone call announcing that heavy seas are preventing CTD. Hugh V suggests skipping alternate stations northwards, and getting those missed on the southward leg. Good idea leads to no lost time on station and extra processing time for the GC team. Daylight brings glorious sunshine and dropping winds. Deep stations over Argentine Basin bring polystyrene cups out of the woodwork again. Jim getting good DIMES data with single bottles, meaning the team will not fall too far behind in processing samples, though they are still working the GC 24/7 in 12 hour shifts. Encounter SAF with water temps greater than 12 degrees. Very strong currents >3 kts encountered around 1800L, leading to long CTD wire leads and wire chasing of >10 km in evening station, which is almost 6 km deep.

Friday 18th April 2014: Morning brings bright sunshine and glassy seas. It actually feels warm outside and a spate of sunbathing breaks out. Overnight the deepest (6070m) and most northerly (47' 56.5"S) CTD station was occupied and we head south again. Very sharp SAF and SST drops over 6 degrees in the space of 1nm. Two more deep stations today, and the last of the Arg. Basin stations will be reached around midnight local. Jim reports less tracer to the north, so there is hope for a good lateral spread in the concentration. Some small worries, occasional CTD data errors (2) on each deep station, though improving to the south, and the bolts on one of the CTD winch pulleys work their way loose leading to terrible racket. Tightened, but needs monitoring.

Saturday 19th April 2014: Grey day, but generally mild. Last Argentine basin CTD finished in the early AM. Steaming south all day otherwise. Sals lab a bit cold, so Marc is requested to bring it up to temp. Tom M. organises a good quiz night. As is traditional by now the PSO's team wins, bringing with it the fabulous prize of a round of drinks. Questions are asked regarding impartiality.

Easter Sunday 20th April 2014: Overnight visitations of the rabbity kind are discovered on cabin doorsteps. NSR CTDs began again overnight and four are completed before 1700L, when a short NWW diversion is undertaken in order to deploy six sets of drifters. The drifter array is placed according to altimetric analysis done by J-B Sallee at L'OCEAN in order to place clusters of floats at a hyperbolic point in SSH, and hopefully ensure interesting short timescale separation due to submesoscale eddies. All floats deployed in good order, amid a beautiful sunset and clear skies. Much enjoyment had writing names on the floats before deploying.

Monday 21st April 2014: Another day of blessedly calm seas and good progress. CTDs proceed well through the day and the first three of eight met office ARGO floats are deployed. These are presunk to ensure they do not drift far after deployment. Some small problems with the slave LADCP head, as it is splitting cast files into two or three, but Phil and Andreas Thurnerr (remotely) are on the case. Some o-rings on the CTD replaced by Seth and Brian overnight too. Good progress means that it is beginning to look like our spare time might actually be used for some extra science in the Falkland Trough.

Tuesday 22nd April 2014: Grey skies overhead, winds rising a little but still comfortably workable. Stations continue overnight smoothly. LADCP issues appear to have been solved by clearing the instrument's memory of past casts. At 1700L a stop to work is called until 2100L, as the DIMES processing team have been working solidly around the clock for several days. The GC needs some essential maintenance, as does the team itself. This completed, work proceeds apace. With good progress on stations and a clear weather forecast we set an arrival date a day early into the Falklands, 0900L at FIPASS. GC team need as much time in port as possible to pack their instrument up for shipping, as do the CFC and DIC teams with their samples.

Wednesday 23rd April 2014: High overcast, moderate northerlies. Large pod of pilot whales come to visit during CTDs. Progress overnight is good and the busy patch off Shag Rocks Passage is completed in good time. Second drifter array is executed well (4 stations), with all instruments going in without a problem. Attrition has finally worn us down to one (of eight) remaining CFC beaker. We had hoped to last the whole voyage, but it seems alternatives must now be sought as at least two are needed for efficient sampling. No metal or glassware of a suitable volume and cleanliness can be found. A plastic jug from the galley is instead used and trials well, only time and CFC processing will tell us if it has contaminated the samples. Shallow stations allow multi-niskin trips to test for sampling bias. Samplers now look suspiciously like they are making margaritas while around the rosette.

Thursday 24th April 2014: Another day of blessedly good weather; sunshine with intermittent sea fogs. CTDs continue well, although Niskin 2 has some leakage problems forcing the bottom seal to be replaced. Now we are entering the small gap in NSR near the Falklands Plateau the DIMES tracer depth appears to be largely below the level of bathymetry, and there is almost no signal. Great weather and efficient ship handling has led us to a day of 'spare' time. It is decided that this will be used on the western end of the Falkland Trough, in water deeper than 2000 m in the hope of finding trapped DIMES tracer.

Friday 25th April 2014: North Scotia Ridge is completed overnight and our last CFC station taken. We move onto 5 'bonus' DIMES stations running along the deepest section of the Falkland Trough, across the current flow and up onto the shelf. Here we hope to observe large DIMES vertical spreads, as was found on JR281. The third station in the sequence also includes d18O/DIC/nutrient sampling in order to provide boundary conditions for the project of Jenny Roberts (BAS/Cambridge) who is examining the isotopic composition of bottom cores taken on the shelf immediately to the North West. Weather still good, though winds increasing a little leading to perfect W. Albatross watching conditions.

Saturday 26th April 2014: Last of the bonus section stations completed in the early morning and we head north towards Stanley. Jim Ledwell appropriately takes the final DIMES sample after 10.5 voyages. Ollie has completed his final oxygen calibration and it looks good, when compared with the end of the A23 section, suggesting that the CTD oxygen probe values for NSR are calibrated. One last stop is made for a d18O profile over Jenny Roberts site of interest (a sediment core on the shelf at 600 m), and although the wind and sea state is increasing we manage to get the CTD in the water. One final round of sampling and then everyone retires for a well earned refreshment at the end of cruise party.

Sunday 27th-Monday 28th April 2014: Arrive at Stanley and work at demobilisation, much packing and cleaning, but all proceeds well with many hands making (relatively) light work. The GC takes a lot of packing and heavy lifting, and the DIC and CFC/SF6 samples take a significant amount of time to organise and pack away, but all squared away by Monday afternoon. A highly successful cruise overall.

Table 1.3: Summary of activities during JR299

Start Date	End Date	Station Numbers	Notes
02/03/2014	08/03/2014	N/A	UK contingent departed UK, 4 nights in Punta Arenas, 1 night at Rothera research base
08/03/2014	12/03/2014	N/A	Departed Rothera research base and worked north up Antarctic Peninsula, delayed due to inoperable aft crane, data logger delivered to Vernadsky Base and stopped at Palmer Station on 11th March 2014
12/03/2014	19/03/2014	1 - 38	Test stations and SR1 south to north until weather deteriorated
19/03/2014	30/03/2014	N/A	Break in science due to bad weather, staff changes at Punta Arenas, bunkering and back to SR1 transect
01/04/2014	02/04/2014	39 - 42	Completion of SR1
02/04/2014	04/04/2014	N/A	Steaming to mooring sites – operating in sea ice
04/04/2014	06/04/2014	43 - 44	Mooring sites – operating in sea ice
06/04/2014	08/04/2014	N/A	Steaming to the workable bottom of A23, the bottom of the transect was in ice
08/04/2014	14/04/2014	45 - 67	A23 south to north
14/04/2014	15/04/2014	N/A	Steaming to South Georgia, on DP in Bay if Isles and steaming to North Scotia Ridge
15/04/2014	-	68 - 72	North Scotia Ridge
15/04/2014	16/04/2014	N/A	Steaming to Argentine/Falkland Basin
16/04/2014	19/04/2014	73 - 84	Argentine/Falkland Basin
19/04/2014	20/04/2014	N/A	Steaming to North Scotia Ridge
20/04/2014	26/04/2014	85 - 134	North Scotia Ridge
26/04/2014	-	135	GC528 and to Stanley, Falkland Islands
27/04/2014	28/04/2014	N/A	Arrival at Stanley and alongside at FIPASS
29/04/2014	30/04/2014	N/A	Science party flew from Falklands to UK

1.4 Outreach

Under the initiative of Katy Sheen funding was awarded by NERC and BAS directly to produce an outreach video illustrating life at sea and giving background of oceanographic research suitable for distribution to school age children.

Katy Sheen and Siobhan Moran collected interviews, footage and stills during the course of the voyage, as well as creating a stop motion animation of the voyage track and CTD and VMP operations. After the voyage the raw footage was edited by Fereday Films to produce a 15 minute short film.

This may be viewed here:
http://vimeo.com/97260669

Or directly downloaded from:
https://mega.co.nz/#!0UZljQaC!F7xMJSzOj8D2v71bydDvpD9btNg3A1Is5pt6orJFke8

A two minute promo was also produced:
https://www.youtube.com/watch?v=ViYA2mBIpEw

Direct download:
https://mega.co.nz/#!pIRznDAR!YW4rmxsQEieJnCFIxdkj83FKzrgu7E8whPRMDLhr8Hg

During and following the cruise a blog was also maintained. Again this was mainly motivated and led by Katy and Siobhan, although there were many guest contributors.

http://www.adropinthesouthernocean.blogspot.co.uk

Further details of the DIMES project, including publications and data, may be accessed at:
www.dimes.ucsd.edu

2 CTD sampling

Hugh Venables & Heather Regan

2.1 CTD Sensors, Deployment and Data Acquisition

2.1.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. 38 casts were carried out in total, as part of a repeat CTD transect from the Weddell Sea towards South Georgia (see A23, Albatross and Andrex reports), at the deployment of a mooring, at gravity coring stations (see JR254 report) and as a survey of Cumberland Bay.

2.1.2 CTD instrumentation and deployment

An SBE32 carousel water sampler, holding 24 12-litre niskin bottles, an SBE9Plus CTD and an SBE11Plus deck unit were used. The SBE9Plus unit held dual SBE3Plus temperature and SBE4 conductivity sensors and a *Paroscientific* pressure sensor. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, and time, bottle position and temperature are stored, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included an altimeter, a fluorometer, two oxygen sensors, a photosynthetically active radiation (PAR) sensor and a transmissometer. The altimeter returns real time accurate measurements of height off the seabed within approximately 100m of the bottom. This allows more accurate determination of the position of the CTD with respect to the seabed than is possible with the Simrad EA600 system, which sometimes loses the bottom and, in deep water, often returns depths that are several tens of metres deeper than the true bottom location.

A fin attached to the CTD frame reduced rotation of the package underwater. The CTD package was deployed from the mid-ships gantry on a cable connected to the CTD through a conducting swivel.

CTD data were collected at 24Hz and logged via the deck unit to a PC running Seasave, version 7.21d (Sea-Bird Electronics, Inc.), which allows real-time viewing of the data. The procedure was to start data logging, deploy the CTD, then stop the instrument at 10m wireout, where the CTD package was left for at least two minutes to allow the seawater-activated pumps to switch on and the sensors to equilibrate with ambient conditions. The pumps are typically expected to switch on 60 seconds after the instrument is deployed.

After the 10m soak, the CTD was raised to as close to the surface as wave and swell condition allowed and then lowered to within 10m of the seabed. Bottles were fired on the upcast, where the procedure was to stop the CTD winch, hold the package *in situ* for a few seconds to allow sensors to equilibrate, and then fire a bottle. The sensor averages these readings to produce one value for each bottle fire. Short times between firing pairs of bottles sometimes led to no SBE35 readings for the second bottle of the pair.

Salinity samples were taken from the mixed layer and other depths with low vertical salinity gradient to calibrate the CTD conductivity and salinity.

2.1.3 Data acquisition and preliminary processing

The CTD data were recorded using Seasave, version 7.21d, which created four files:

jr299_[NNN].hex	binary data file
jr299_[NNN].XMLCON	ascii configuration file with calibration information
jr299_[NNN].hdr	ascii header file containing sensor information
jr299_[NNN].bl	ascii file containing bottle fire information

where NNN is the CTD number (column 1 in Table Ocea.1). The *.hex* file was then converted from binary to ascii using the SBE Data Processing software *Data Conversion* module. The output was a file named *jr299ctd[NNN].cnv*. Raw data were copied to the unix drive before preliminary processing with SBE data processing modules. Once completed, the processed data were also copied to unix for data security and further processing. The *Data Conversion* module calculates parameters using the coefficients detailed in the raw CTD XMLCON files as follows:

Pressure:

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

where *P* is the pressure (dbar), *T* is the pressure period in µsec, $D = D_1 + D_2U$, $C = C_1 + C_2U + C_3U$ and $T_0 = T_1 + T_2U + T_3U_2 + T_4U_3 + T_5U_4$ are calculated from the coefficients detailed in the raw CTD XMLCON files, where *U* is the temperature in ˚C.

Conductivity:

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

where *cond* is the conductivity in Sm^{-1}, *p* is pressure, *t* is temperature, *δ* = CTcor and *ε* = CPcor. All coefficients can be found in the raw CTD XMLCON files.

Temperature:

$$temp(ITS90) = \frac{1}{\left\{g + h\left[\ln(f_0/f)\right] + i[\ln^2(f_0/f)] + j[\ln^3(f_0/f)]\right\}} - 273.15$$

Where the temperature, *temp*, is measured in ˚C, *g*, *h*, *i* and *j* are coefficients detailed in the raw CTD XMLCON files and *f* is the frequency output by the sensor.

Oxygen:

$$oxy = \left(Soc(V + Voffset)\right)e^{Tcor.T}Oxsat(T,S)e^{Pcor.P}$$

where *oxy* is dissolved oxygen in ml/l, *V* is the voltage output from the SBE43 sensor, *Oxsat* is oxygen saturation (ml/l), a function of temperature, *T*, salinity, *S*, and pressure, *P*, and the remaining coefficients are detailed in the raw CTD XMLCON files.

PAR: $$PAR = \left(\frac{multiplier.10^{9}.10^{(V-B)/M}}{C} \right) + offset$$

where *V*, *B*, *M*, *offset*, *multiplier* and *C*, the calibration constant are detailed in the raw CTD XMLCON files.

Fluorescence: $$flsc = \frac{slope(10e^{(V/slope\ factor)} - 10e^{VB})}{10e^{V1} - 10e^{Vacetone}} + offset$$

Where *flsc* is measured in µg/l, *V* is the fluorometer output voltage and the remaining coefficients can be found in the raw CTD XMLCON files.

Transmission: $$Light\ transmission = M.output\ voltage + B$$

where light transmission is measured in % and *M* and *B* are derived from measured voltages through air and water in light and darkness, and can be found in the raw CTD XMLCON files.

The SBE Data Processing *Cell thermal mass* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This reads in the *jr299ctd[NNN].cnv* file and re-derives the pressure and conductivity, taking into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output is another ascii file, named as *jr299ctd[NNN]_ctm.cnv*. The correction applied to the CTD data is detailed below:

Corrected conductivity = conductivity + ctm

where

$$ctm = -1 \times \left(\frac{1-5\alpha}{2s\beta+4} \right) \times ctm_0 + \frac{2\alpha}{s\beta+2} \times 0.1(1+0.006[T-20]) \times \Delta T$$

and *s* is the sample interval, *T* is temperature, ctm_0 is the uncorrected cell thermal mass, α = 0.03 and β = 7.0.

2.1.4 SBE35 high precision thermometer

Data from the SBE35 thermometer were usually uploaded using the *SeaTerm* program.

Click connect (with deck unit on)
ds (to check data status)
Click upload and enter filename
When download complete, copy to unix drive, check contents, split into separate casts if necessary
samplenum=0
Click disconnect
Switch off deck unit

Once the readings had been written to an ascii file (named *sbe35_jr299_NNN.asc*), the file was opened and the contents checked to make sure the correct number of readings had been stored. The memory of the SBE35 was then cleared using the '*samplenum=0*' command.

2.1.5 Salinity samples

At each CTD station 24 niskin bottles were closed at up 11 distinct depths. Up to ten salinity samples were taken (thermocline samples were also taken for organic geochemistry but these were from depths with significant salinity gradient). Sampling, storage and analytical procedures were as per those described in Chapter 3 (Underway).

Once analysed, the conductivity ratios were entered by hand into *jr299_master.xls*, converted to salinities and used for further CTD data processing.

2.2 CTD data processing

CTD data were processed using mstar scripts (collectively called Mexec) written by Brian King. They were run on Nosea2, a linux workstation. Since JR272, the Mexec code has been updated. This is largely internal changes requiring quick modifications to any old scripts used.

M_setup_*** - roots and global variables (ship, cruise etc.)

Files in ../ctd relative to processing scripts unless stated

Mstar processing route:

ctd_all_part1_jr299 – includes:
msam_01 and **mdcs_01** (these can be created in advance but processing was fast enough for this not to be necessary)
mctd_01 ctd_jr299_NNN_ctm – > ctd_jr299_NNN_raw.nc
Reads in CTD *ctm.cnv data and gives it a dataname. No need to tell it how CTD is setup – works that out by comparing .cnv file with list of SBE output variables. Replaces special characters in name such as '/'. Writes list of SBE programs run on data into comments.
mctd_02a ctd_jr299_NNN_raw.nc (then archived) –> ctd_jr299_NNN_24hz.nc
Renames variables (from SBE names to usual names, via reference to a .csv file). Write-protects *_raw.nc and copies to *_24Hz.nc which is working version.
mctd_02b ctd_jr299_NNN_24hz.nc –> ctd_jr299_NNN_24hz.nc
Applies oxygen hysteresis correction
mctd_02c ctd_jr299_NNN_24hz.nc -> ctd_jr299_NNN_24hz_fr.nc
Calls hfallrate, which is a matlab equivalent of loopedit. It creates a NaN/1 flag variable where 1 is good (so variable.*Flag leaves good data). Bad is defined as the initial soak (which it identifies and asks for confirmation), times when the CTD package is above a previously reached depth or when the CTD package speed is <0.25 m/s downwards. It only flags data bad if >=2 consecutive points are considered bad, to allow for noise in the speed calculation

at 24Hz. Datacycle for start of downcast is confirmed with user input and written to dcs_jr299_NNN.nc from where it is read on post-processing without the need for user input.
mctd_02d ctd_jr299_NNN_24hz_fr.nc-> ctd_jr299_NNN_24hz_fr_app2.nc
Applies the fallrate flag to appropriate CTD variables
End of ctd_all_part1

ctdcheckplot299 Program to plot the 24Hz profiles and T/S plots (salinity calculated locally as not in main files by this stage) to allow for visual checking before further processing and averaging.

mplxyed Interactive editing if needed, ctd_jr299_NNN_24hz_fr_app.nc –> ctd_jr299_NNN_24hz_fr_app.nc Conductivity spikes were present in almost all casts for both conductivity sensors, as in previous cruises.

ctd_all_part2_jr299

mctd_03_jr299 ctd_jr299_NNN_24hz_fr_app.nc –> ctd_jr299_NNN_1hz.nc + ctd_jr299_NNN_psal.nc + ctd_jr299_NNN_24hz_psal.nc
Average to 1hz – used for LADCP processing. Also calculates salinity and depth and adds to 24hz which is used for further processing and averaging (rather than going through 1hz data). As navigation data is now written to the CTD files, depths can be calculated in the initial processing.
mdcs_02 ctd_jr299_NNN_psal.nc –> dcs_jr299_NNN.nc (again)
Finds bottom of cast and adds it to datacycle file (requires pressure spikes to have been dealt with first)
mdcs_03 user input –> dcs_jr299_NNN.nc (again)
Mlists end of cast to allow user to select, copy and paste the scan number of the end of cast (last good conductivity).
mctd_04 dcs_jr299_NNN.nc+ ctd_jr299_NNN_psal.nc–>ctd_jr299_NNN_2db.nc
Use start, bottom and stop data cycles to split cast and average to 2dbar.
mfir_01 -> fir_jr299_NNN_bl.nc
Read in .bl file
mfir_02 fir_jr299_NNN_bl.nc + ctd_jr299_NNN_1hz.nc -> fir_jr299_NNN_time.nc
Merge times from CTD into fir file
mfir_03 fir_jr299_NNN_time.nc+ ctd_jr299_NNN_psal.nc -> fir_jr299_NNN_ctd.nc
Merge upcast data into fir file.
mfir_04 fir_jr299_NNN_ctd.nc-> sam_jr299_NNN.nc
Pastes fir data into sam file
mdcs_pos dcs_jr299_NNN.nc -> dcs_jr299_NNN_pos.nc
Written on cruise to capture lat and lon at start, bottom and end and also depth and altimeter at bottom. Can be used to write out main part of cruise report table (JR299bot2excel.m)

No winch data was read in (but it was logged from the SCS system).

end of ctd_all_part2

ctd_all_part3 – not needed for navigation data (as in JR272) as this was written directly to CTD files at the deck unit and used in part2.

It was reintroduced as a means of improving cleaning of conductivity spikes, and to create cleaned 24Hz and 2db files (down and up). The route was to run mplxyed again, but with psal 1 or 2 against the appropriate temperature. The T/S plots make small spikes much more obvious (large spikes that span to other parts of the T/S plot are removed between part 1 and 2). After these are cleaned out of psal1/2 the gaps are transferred to cond1/2 (as that will be calibrated) and potemp and density calculated (to be re-done after calibration).

Due to an earlier coding error, the preferred variable temp and cond (1 or 2, as selected in mctd_sensor_choice) didn't have the fallrate filtering applied. To fix this, temp_clean and cond_clean variables were copied over at the end

end of ctd_all_part3

ctd_all_part4_jr299 – to be run once salinity data are available (can be before or after part3). Written to loop through CTD casts where bottle files are available. Includes:

msal_01 sal_ jr299_NNN.txt->sal_ jr299_NNN.nc
Reads in bottle salinities from csv file (format one row per sample; station,bottle,salinity)
msal_02 sal_ jr299_NNN.nc-> sam_jr299_NNN.nc
Paste sal into sam
msbe_01/02, do same as above for sbe35 temperatures
msam_02 sam_jr299_NNN.nc –>sam_jr299_NNN_resid.nc
Calculate residuals between samples and ctd bottle averages

2.2.1 CTD and underway calibration

CTD data are used for underway data calibration (together with salinity samples taken from the underway supply). In total, 2370 SBE35 temperature data points were recorded as Niskin bottles were closed, with 1540 of these being deeper than 500m. 1063 salinity samples were *successfully* analysed from CTD sampling, with 786 of these being from deeper than 500m. 105 underway salinity samples were taken and c.200 intersections between underway and 7m CTD values were used, using the _2db (down) and _2up (2db up) files.

The order of calibration, following reading in bottle data above, is:

CTD:

Find calibration for CTD temperature using SBE35 temperatures (**JR299cal_ctdtmp.m**).

On JR299 the calibration for temp1 was:

Sensor 1

```
bin_press = [-10 0 2400 6200 10000];
bin_offset = [-0.00185 -0.00185 -0.00145 -0.0019 -0.0019];
tempadj = interp1(bin_press,bin_offset,press);
tempout = tempout+tempadj;
```

Sensor 2

```
bin_press = [-10 0 6200 7000 10000];
bin_offset = [-0.0019 -0.0019 -0.00035 -0.00035  -0.00035];
tempadj = interp1(bin_press,bin_offset,press);
tempout = tempout+tempadj;
```

*Figure 2.1: Temp 1. Left: data binned into 500m bins (and top 60m) and filtered through a series of keeping data within median +/- n*standard deviation (mean gives a similar result but converges more slowly). Ten loops, with n= [4 3 3 2 2 2 2 2 2 1.5] were used, though using median rather mean probably means that fewer would be sufficient. The mean (+/- 1 standard deviation) is plotted, along with the average pressure for the data points used in the averaging). The line is fitted by eye. Right: the same line on the full data.*

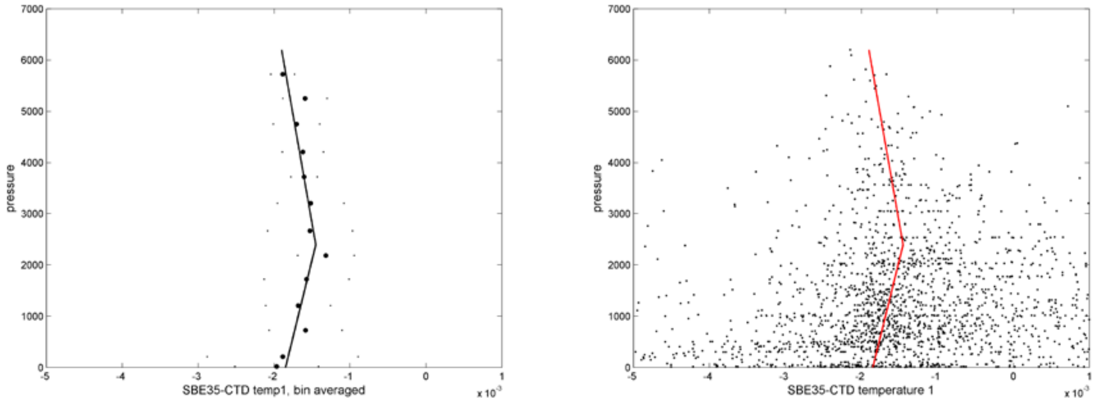
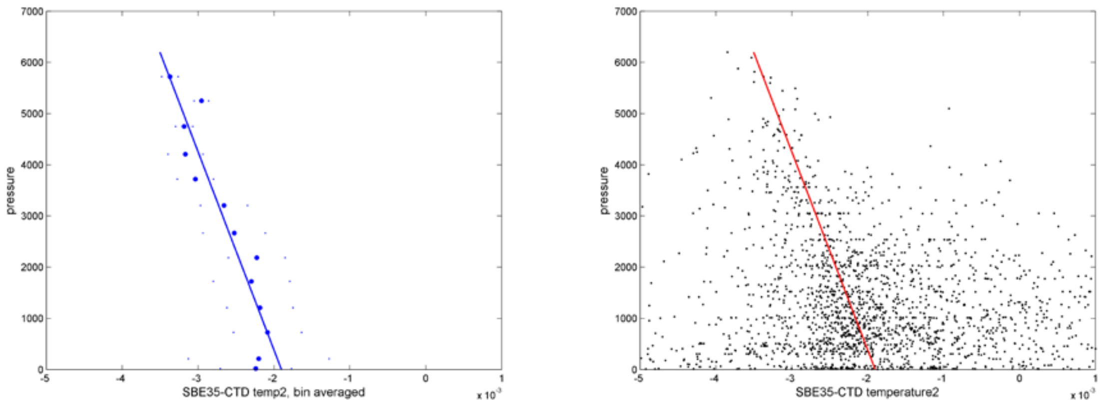


Figure 2.2: As above, for Temperature 2



Back calculate bottle conductivity, after applying a local temperature calibration to bottle data, and find conductivity calibrations (**JR299cal_ctdtmp.m**)
On JR299 the conductivity calibration was
Sensor 1:

```
stn <= 36
bin_press = [-10 0 4000 7000 10000];
bin_offset = [0.0007 0.0007 -0.001 -0.001  -0.001];
condadj = interp1(bin_press,bin_offset,press);
condout = condout+condadj;

stn >= 37 % slight change after freezing sensor at start of cast 37
bin_press = [-10 0 4000 7000 10000];
bin_offset = [0.0032 0.0032 0.0015 0.0015  0.0015];
condadj = interp1(bin_press,bin_offset,press);
condout = condout+condadj;
```

Sensor 2:

```
stn <= 36
bin_press = [-10 0 4000 7000 10000];
bin_offset = [0.0012 0.0012 -0.0003 -0.0003  -0.0003];
 condadj = interp1(bin_press,bin_offset,press);
condout = condout+condadj;

stn >= 37 % slight change after freezing sensor
bin_press = [-10 0 4000 7000 10000];
bin_offset = [0.001 0.001 0.001 -0.0005  -0.0005];
condadj = interp1(bin_press,bin_offset,press);
condout = condout+condadj;
```

Calibrations were not applied to the data as of the end of the cruise due to the last CTD being very close to the Falklands and the back-up deadline. Calibrated data, applied after the voyage ended, are now available.

Calibrations should be checked to make sure calibrations have been applied in the correct direction and that calibrated salinity looks good against bottle data (if it doesn't then either messed up cond calibration or there is a problem with the pressure sensor, but latter would need to be large).

Oceanlogger (JR299ctd7m.m)

Take 7m values from CTD 2db files down (_2db) and up (_2up) and a time for merging

Merge with oceanlogger data to get temperature and salinity differences.

Read in underway salt samples

Apply calibrations. Underway salt calibrations:
Underway temperature (underway+y is calibrated temperature)

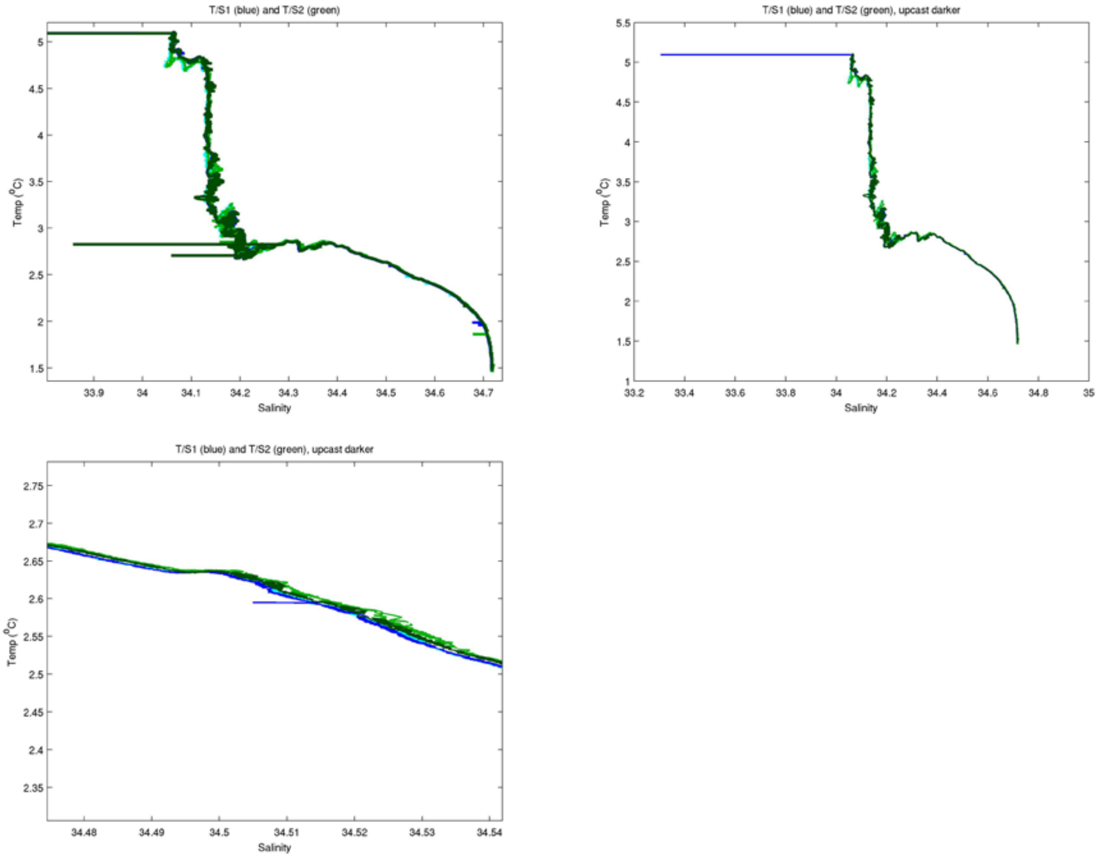
```
 x0=5900000; x1=8150000; x11=8500000; x2=10025000;
 x=x0:x2;
y0=-0.041; y1=-0.021; y11=-0.065; y2=-0.02;
m0=(y1-y0)/(x1-x0); m1=(y11-y1)/(x11-x1); m2=(y2-y11)/(x2-x11);
c0=-m0*x0+y0; c1=-m1*x1+y1; c2=-m2*x11+y11;
y=x*NaN;
y(x>x11&x<x2)=m2*x(x>x11&x<x2)+c2;
y(x>x1&x<x11)=m1*x(x>x1&x<x11)+c1;
y(x>x0&x<x1)=m0*x(x>x0&x<x1)+c0;
```

Underway salinity: (underway+y is calibrated salinity)

```
x0=5900000; x1=7150000; x11=7700000; x2=10025000;
x=x0:x2;
y0=0.020; y1=0.03; y11=0.02; y2=0.037;
m0=(y1-y0)/(x1-x0); m1=(y11-y1)/(x11-x1); m2=(y2-y11)/(x2-x11);
c0=-m0*x0+y0; c1=-m1*x1+y1; c2=-m2*x11+y11;
y=x*NaN;
y(x>x11&x<x2)=m2*x(x>x11&x<x2)+c2;
y(x>x1&x<x11)=m1*x(x>x1&x<x11)+c1;
y(x>x0&x<x1)=m0*x(x>x0&x<x1)+c0;
```

Calibrations will be applied after the cruise **mocl_cal_299.m**

Figure 2.3 Example plots for explanation of processing steps
Conductivity spikes. *T/S plots from CTDcheckplot (top left) and CTDcheckplot_24updn (top right). The former shows spikes crossing other bits of the T/S plot. These should be cleaned in mplxyed (cond against scan) before part2. The smaller spikes can be cleaned this way, but they are hard to find in plots against scan. Cleaning after part2 with a T/S plot is easy (bottom left) and catches any surface issues from recovery. Once salinity is cleaned, the gaps need to be moved across to conductivity, or they will not make it to calibrated variables.*

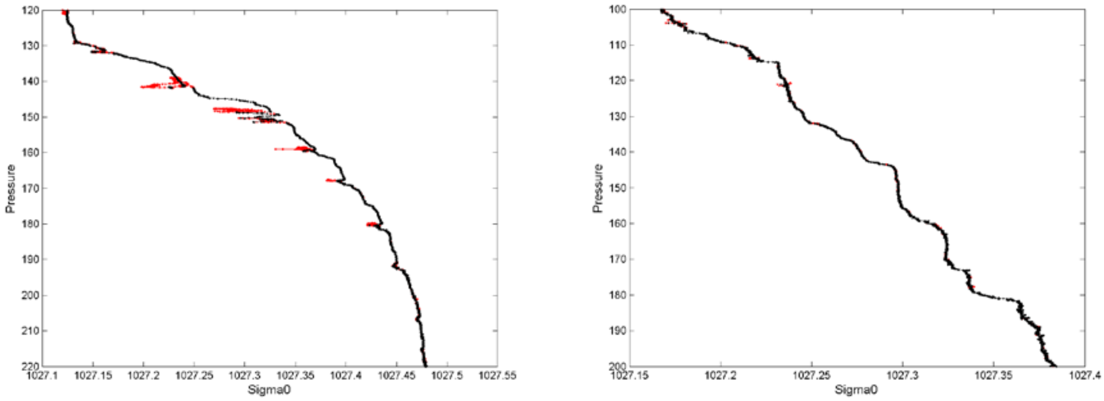


The spikes are all similar, being a reduction of conductivity for one to three points (exceptionally four and some longer, different-looking oddities of ten or more points).

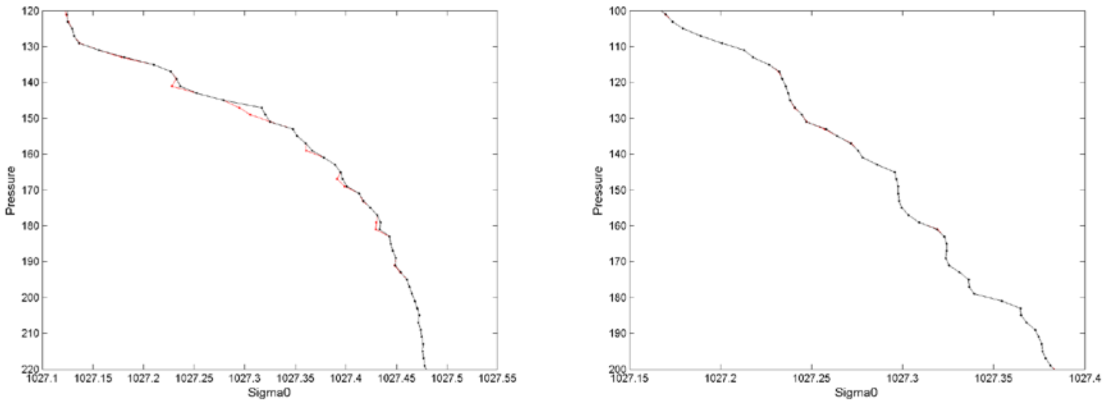
Fallrate
The following figures illustrate casts done in very rough conditions (left) with considerable ship roll (on the limit for deploying the CTD) and in the calm conditions of Drake Passage (right). The red dots are those removed by the fallrate filtering in part1 (a matlab equivalent of the seabird loopedit program). They removed as they are due to the CTD wake catching up with the sensors when the CTD slows down or starts going up. This clearly improves the data quality.

The few remaining dots could be removed with more aggressive filtering but this would likely increase the number of false positives (which are otherwise at acceptably low levels (right plots). Probably the best improvement would be to remove 'isolated' points in a set of removed points and to extend long periods of removed points by a few points. As the averaging is direct from 24Hz to 2db (rather than via 1Hz) these few remaining points have relatively small effect on the bin averaged 2db value. The 1Hz files that are calculated are from non-filtered data, to avoid gaps.

Figure 2.4: CTD fallrates, under (left) rough conditions with high ship roll, vs calm conditions (right).



24Hz, very bouncy and very calm



2db, showing that apparent density overturns can be created (avoided)

Table 2.1: CTD Table

Event no	Station no	CTD no	Month	Day	Time (in, bottom, out) (GMT)	Latitude	Longitude	Depth (m)	Type	Notes
			3	12	17:08:31	-62 45.92	-59 06.57			Bad T1
2	1	1	3	12	17:34:29	-62 45.92	-59 06.58	1423	Test	
			3	12	18:27:10	-62 45.92	-59 06.57		Dimes	
			3	12	19:47:09	-62 45.91	-59 06.57			New T1
4	2	2	3	12	20:11:39	-62 45.91	-59 06.57	1424	Test	
			3	12	20:52:07	-62 45.91	-59 06.57		Chem	
			3	13	15:27:51	-61 02.92	-54 35.31			DP
6	3	3	3	13	15:35:59	-61 02.92	-54 35.28	361	Chem	Start
			3	13	15:52:36	-61 02.92	-54 35.28			
			3	13	17:06:10	-60 58.94	-54 37.74			
7	4	4	3	13	17:18:09	-60 58.94	-54 37.74	574	Phys	
			3	13	17:41:51	-60 58.94	-54 37.74			
			3	13	19:32:01	-60 50.99	-54 42.78			
9	5	5	3	13	19:52:27	-60 50.99	-54 42.78	1033	Chem	
			3	13	20:34:10	-60 50.99	-54 42.78		D3	
			3	13	22:05:45	-60 49.99	-54 43.30			
11	6	6	3	13	22:37:49	-60 49.99	-54 43.30	1782	Chem	
			3	13	23:25:07	-60 49.99	-54 43.31			
			3	14	00:52:07	-60 48.03	-54 44.30			
13	7	7	3	14	01:39:57	-60 48.03	-54 44.31	2591	Chem	
			3	14	02:47:48	-60 48.03	-54 44.31			
			3	14	04:50:28	-60 40.03	-54 49.47			
15	8	8	3	14	05:43:48	-60 39.82	-54 49.12	3066	Dimes	
			3	14	07:08:35	-60 39.61	-54 48.73			
			3	14	10:42:04	-60 19.96	-55 01.90			
17	9	9	3	14	11:40:52	-60 19.78	-55 01.90	3424	Chem	
			3	14	13:02:59	-60 19.43	-55 01.91			
			3	14	16:21:52	-59 59.85	-55 14.44			
18	10	10	3	14	17:21:15	-59 59.84	-55 14.47	3492	Dimes	
			3	14	18:50:58	-59 59.85	-55 14.52			
			3	14	21:39:18	-59 40.03	-55 26.69			
20	11	11	3	14	22:41:06	-59 40.02	-55 26.64	3665	Chem	
			3	15	00:04:42	-59 40.02	-55 26.64		D3	
			3	15	04:22:43	-59 19.99	-55 38.88			
22	12	12	3	15	05:27:26	-59 19.94	-55 38.70	3750	Dimes	
			3	15	06:58:25	-59 19.91	-55 38.32			
			3	15	10:18:27	-59 00.01	-55 51.35			
23	13	13	3	15	11:22:30	-59 00.01	-55 51.35	3766	Chem	
			3	15	12:51:39	-59 00.02	-55 51.36		D3	
			3	15	15:46:02	-58 40.99	-56 03.34			
25	14	14	3	15	16:50:13	-58 41.04	-56 03.39	3743	Dimes	
			3	15	18:25:20	-58 41.16	-56 03.52			
			3	15	22:03:01	-58 22.00	-56 15.01			
27	15	15	3	15	23:09:05	-58 22.00	-56 15.01	3884	Chem	
			3	16	00:45:53	-58 22.00	-56 15.00		D3	
			3	16	04:33:45	-58 02.94	-56 26.90			Spooling probs, stops on downcast
28	16	16	3	16	06:05:12	-58 03.01	-56 26.78	3948	Dimes	
			3	16	07:54:12	-58 03.01	-56 26.78			
			3	16	10:47:26	-57 44.01	-56 38.41			
30	17	17	3	16	11:47:25	-57 43.95	-56 38.07	3444	Chem	
			3	16	13:08:10	-57 43.86	-56 37.95		D3	
			3	16	16:39:10	-57 24.86	-56 50.40			
32	18	18	3	16	17:38:10	-57 24.80	-56 50.34	3427	Dimes	
			3	16	19:06:44	-57 24.64	-56 50.15			
			3	16	21:53:18	-57 06.02	-57 02.14			
33	19	19	3	16	23:03:23	-57 06.02	-57 02.14	4214	Chem	
			3	17	00:41:17	-57 06.02	-57 02.14		D3	
			3	17	03:35:29	-56 47.04	-57 13.81			back down for bottle 3
35	20	20	3	17	04:28:56	-56 46.97	-57 13.91	3077	Dimes	
			3	17	06:03:42	-56 46.82	-57 13.91			

38	22	21	no CTD due to equipment failure							no pumps, then no pressure
			3	17	17:55:10	-56 27.95	-57 25.43			
39	24	22	3	17	18:59:02	-56 28.04	-57 25.47	3821	Dimes	
			3	17	20:15:59	-56 28.04	-57 25.47			
			3	17	21:40:52	-56 18.49	-57 31.45			
40	26	23	3	17	22:37:11	-56 18.25	-57 30.03	3250	Chem	
			3	17	23:57:51	-56 17.90	-57 28.29		D3	
			3	18	01:30:31	-56 09.09	-57 37.11			
41	28	24	3	18	02:38:49	-56 08.73	-57 34.06	3407	Dimes	
			3	18	04:04:02	-56 08.44	-57 30.96			
			3	18	05:41:28	-55 59.59	-57 42.89			
42	30	25	3	18	06:59:02	-55 58.99	-57 39.65	4194	Chem	
			3	18	08:43:10	-55 58.25	-57 36.06		D3	
			3	18	10:18:13	-55 49.97	-57 49.09			
43	32	26	3	18	11:43:51	-55 49.06	-57 46.94	4761	Dimes	
			3	18	13:28:35	-55 48.23	-57 44.81			
			3	18	15:01:30	-55 40.49	-57 54.42			
44	33	27	3	18	16:15:47	-55 40.02	-57 53.15	4381	Chem	
			3	18	18:01:51	-55 39.97	-57 51.33		D3	
			3	18	20:35:54	-55 31.10	-57 59.95			
46	34	28	3	18	21:46:18	-55 31.15	-57 59.99	4214	Dimes	
			3	18	23:11:41	-55 31.14	-57 60.00			
			3	19	01:48:33	-55 22.10	-57 59.96			
48	35	29	3	19	03:01:19	-55 22.10	-57 59.96	4246	Chem	
			3	19	04:46:09	-55 22.10	-57 59.97		D3	
			3	19	07:29:48	-55 12.85	-57 59.97			
50	36	30	3	19	08:38:00	-55 12.85	-57 59.97	3950	Dimes	
			3	19	10:18:54	-55 12.85	-57 59.97			
			3	19	12:17:49	-55 10.29	-57 59.83			
52	37	31	3	19	13:10:13	-55 10.29	-57 59.86	3098	Chem	
			3	19	14:25:12	-55 10.39	-57 59.68		D3	
			3	19	16:27:47	-55 07.27	-57 59.96			To Punta
54	38	32	3	19	17:15:22	-55 07.25	-57 59.97	2787	Dimes	Arenas
			3	19	18:28:43	-55 07.27	-57 60.00			
			4	1	15:00:03	-54 53.61	-58 00.01			
55	39	33	4	1	15:09:59	-54 53.61	-58 00.01	499	Chem	Tubes
			4	1	15:34:58	-54 53.61	-58 00.01			restartSR1b
			4	1	16:48:50	-55 00.06	-58 00.18			
56	40	34	4	1	17:15:46	-55 00.06	-58 00.18	1530	Dimes	
			4	1	17:58:52	-55 00.06	-58 00.18		Chem	
			4	1	19:23:49	-55 04.49	-57 59.95			
57	41	35	4	1	20:03:02	-55 04.49	-57 59.95	2331	Chem	
			4	1	20:59:09	-55 04.49	-57 59.94		Dimes	
			4	1	22:17:37	-55 07.27	-57 59.94			DP
58	42	36	4	1	23:04:18	-55 07.27	-57 59.95	2783	Oxygen	End
			4	2	00:03:02	-55 07.27	-57 59.95			
			4	4	17:01:33	-62 35.52	-43 12.95		Mooring	
60	43	37	4	4	17:51:20	-62 35.01	-43 12.66	2921	Dimes	Freezing
			4	4	19:11:13	-62 34.29	-43 11.86		Oxygen	
			4	5	23:42:40	-63 32.78	-41 45.08		Mooring	
63	44	38	4	6	00:58:14	-63 33.27	-41 44.91	4560	Dimes	
			4	6	03:06:21	-63 34.41	-41 44.49			
			4	8	03:31:21	-62 29.08	-31 15.17			
64	45	39	4	8	04:51:12	-62 28.78	-31 14.97	4721	Chem	A23 start
			4	8	06:44:56	-62 28.15	-31 14.62			
			4	8	12:39:37	-62 03.69	-31 11.01			
65	46	40	4	8	13:59:40	-62 03.53	-31 11.94	4839	Chem	
			4	8	15:52:30	-62 03.40	-31 12.31			
			4	8	19:37:13	-61 39.71	-31 06.52			
66	47	41	4	8	20:32:49	-61 39.35	-31 06.00	3359	Dimes	
			4	8	21:44:33	-61 38.70	-31 05.40		Oxygen	
			4	9	01:15:55	-61 10.14	-31 02.92			
67	48	42	4	9	02:13:57	-61 09.72	-31 03.07	3411	Chem	
			4	9	03:38:06	-61 09.19	-31 03.00		D3	
			4	9	08:26:16	-60 42.01	-31 00.04			
68	49	43	4	9	08:55:44	-60 42.05	-30 059.93	1639	Dimes	
			4	9	09:50:51	-60 42.16	-30 059.57			

			4	9	12:46:49	-60 18.94	-30 57.23			
69	50	44	4	9	13:33:47	-60 18.96	-30 57.34	2786	Dimes	Frozen
			4	9	14:49:09	-60 18.92	-30 57.51			
			4	9	18:38:38	-59 45.94	-30 54.35			
70	51	45	4	9	19:42:04	-59 45.97	-30 54.32	3783	Chem	Frozen, CTD out
			4	9	21:03:27	-59 45.97	-30 54.32		D3	
			4	9	23:32:00	-59 26.15	-30 51.42			
71	52	46	4	10	00:29:44	-59 26.14	-30 51.42	3399	Chem	
			4	10	01:49:02	-59 26.14	-30 51.41		D3	
			4	10	04:43:18	-59 03.06	-30 49.40			
72	53	47	4	10	05:37:22	-59 03.03	-30 49.76	3114	Dimes	
			4	10	06:53:10	-59 03.02	-30 49.81			
			4	10	09:48:09	-58 38.11	-30 49.44			
73	54	48	4	10	10:48:19	-58 38.12	-30 49.46	3511	Chem	
			4	10	12:11:56	-58 38.12	-30 49.45		D3	
			4	10	15:03:52	-58 12.71	-30 49.07			
74	55	49	4	10	16:10:26	-58 12.77	-30 49.29	3993	Chem	
			4	10	17:51:24	-58 12.78	-30 49.31		D3	
			4	10	20:46:59	-57 46.19	-30 58.11			
75	56	50	4	10	21:48:44	-57 46.14	-30 58.11	3714	Dimes	
			4	10	23:13:24	-57 46.14	-30 58.11			
			4	11	01:43:12	-57 29.31	-31 19.71			
76	57	51	4	11	02:46:04	-57 29.31	-31 19.71	3684	Dimes	
			4	11	04:14:51	-57 29.31	-31 19.71			
			4	11	06:50:07	-57 20.39	-31 53.41			
77	58	52	4	11	07:51:49	-57 20.39	-31 53.41	3593	Chem	
			4	11	09:17:49	-57 20.38	-31 53.41		D3	
			4	11	11:38:56	-57 16.67	-32 22.39			
78	59	53	4	11	12:45:29	-57 16.67	-32 22.40	4007	Chem	
			4	11	14:22:19	-57 16.67	-32 22.40		D3	
			4	11	17:07:34	-56 53.37	-32 25.80			
79	60	54	4	11	18:00:28	-56 53.37	-32 25.80	3097	Dimes	
			4	11	19:14:38	-56 53.38	-32 25.80			
			4	11	21:48:17	-56 34.60	-32 30.44			
80	61	55	4	11	22:55:37	-56 34.60	-32 30.43	4026	Chem	
			4	12	00:26:55	-56 34.62	-32 30.41		D3	
			4	12	07:52:04	-56 29.68	-32 58.35			
81	62	56	4	12	08:57:24	-56 29.70	-32 58.37	3808	Dimes	
			4	12	10:29:48	-56 29.70	-32 58.37			
			4	13	09:20:47	-55 57.49	-33 39.57			
82	63	57	4	13	10:16:06	-55 57.32	-33 39.56	2843	Dimes	Bouncy, not up after soak
			4	13	11:28:17	-55 56.97	-33 39.54			
			4	13	13:35:45	-55 44.38	-33 57.03			
83	64	58	4	13	14:37:34	-55 44.38	-33 57.03	3697	Chem	
			4	13	16:09:50	-55 44.38	-33 57.03		D3	
			4	13	18:02:06	-55 29.05	-34 07.90			
84	65	59	4	13	18:44:10	-55 29.08	-34 08.00	2451	Dimes	
			4	13	19:46:12	-55 29.08	-34 08.01			
			4	13	21:39:54	-55 15.59	-34 26.61			
85	66	60	4	13	22:06:49	-55 15.57	-34 26.62	1503	Chem	
			4	13	22:42:21	-55 15.57	-34 26.62		D3	
			4	13	23:57:20	-55 12.90	-34 30.42			
86	67	61	4	14	00:08:19	-55 12.90	-34 30.42	531	Barium	A23 End
			4	14	00:31:06	-55 12.90	-34 30.42			
			4	15	04:43:10	-53 57.23	-39 38.56		CFC	NSR
87	68	62	4	15	04:54:07	-53 57.23	-39 38.59	467	Barium	Start
			4	15	05:15:06	-53 57.25	-39 38.69			
			4	15	06:46:20	-53 55.60	-39 53.52			
88	69	63	4	15	07:09:34	-53 55.62	-39 53.55	1251	Dimes	
			4	15	07:48:12	-53 55.62	-39 53.55			
			4	15	09:01:39	-53 54.77	-40 02.81			
89	70	64	4	15	09:37:41	-53 54.78	-40 02.80	2086	CFC	
			4	15	10:34:40	-53 54.77	-40 02.81		Dimes	
			4	15	11:34:03	-53 53.94	-40 09.34			
90	71	65	4	15	11:57:37	-53 53.94	-40 09.35	1264	Dimes	
			4	15	12:44:04	-53 53.94	-40 09.34			
			4	15	14:00:05	-53 52.25	-40 22.93			NSR
91	72	66	4	15	14:10:27	-53 52.25	-40 22.92	483	CFC	Pause

			4	15	14:31:02	-53 52.25	-40 22.92			
92	73	67	4	16	06:04:01	-51 18.69	-39 51.03	3756	Dimes	AB
			4	16	07:08:54	-51 18.60	-39 50.99			Start
			4	16	08:42:12	-51 18.60	-39 50.99			
93	74	68	4	16	11:36:11	-51 03.55	-40 23.28	3715	Dimes	
			4	16	12:38:38	-51 03.42	-40 23.26			
			4	16	14:03:39	-51 03.42	-40 23.25			
94	75	69	4	16	16:55:25	-50 48.59	-40 55.45	2291	Dimes	
			4	16	17:34:25	-50 48.59	-40 55.44			
			4	16	18:41:05	-50 48.59	-40 55.45			
95	76	70	4	16	21:36:11	-50 33.58	-41 27.72	1845	Chem	
			4	16	22:07:16	-50 33.60	-41 27.74			
			4	16	22:53:25	-50 33.60	-41 27.74			
96	77	71	4	17	04:06:45	-49 51.13	-42 00.00	1779	Dimes	
			4	17	04:38:18	-49 51.09	-42 00.00			
			4	17	05:37:27	-49 51.09	-42 00.00			
97	78	72	4	17	10:34:29	-49 09.83	-41 59.89	4861	Dimes	
			4	17	11:56:28	-49 09.90	-41 59.96			
			4	17	13:43:56	-49 09.90	-41 59.96			
98	79	73	4	17	16:43:55	-48 42.42	-41 59.93	5697	Dimes	
			4	17	18:18:12	-48 42.42	-42 0.000			
			4	17	20:14:33	-48 42.42	-42 0.000			
99	80	74	4	17	22:58:19	-48 12.56	-41 59.91	5962	Dimes	
			4	18	00:40:58	-48 12.56	-41 55.86			
			4	18	02:46:44	-48 11.98	-41 51.02			
100	81	75	4	18	04:49:41	-47 56.45	-42 00.04	6063	Dimes	
			4	18	06:36:51	-47 56.68	-41 058.47			
			4	18	08:59:06	-47 56.80	-41 056.01			
101	82	76	4	18	12:23:26	-48 28.59	-41 59.87	5755	Dimes	
			4	18	14:00:11	-48 28.39	-41 58.17			
			4	18	16:13:31	-48 28.16	-41 55.83			
102	83	77	4	18	19:30:45	-48 56.23	-42 00.03	5337	Dimes	
			4	18	20:58:25	-48 56.23	-41 060.0			
			4	18	23:21:28	-48 56.23	-41 060.0			
103	84	78	4	19	02:42:16	-49 23.69	-42 00.03	5200	Dimes	AB
			4	19	04:11:35	-49 23.70	-42 00.02			End
			4	19	06:15:56	-49 23.69	-42 00.04			
104	85	79	4	20	05:44:14	-53 21.56	-42 46.30	482	CFC	NSR
			4	20	05:54:23	-53 21.51	-42 46.29		Barium	Resume
			4	20	06:17:25	-53 21.48	-42 46.29		Nutrients	
105	86	80	4	20	10:11:31	-53 16.29	-43 45.07	1385	Dimes	
			4	20	10:36:29	-53 16.29	-43 45.03			
			4	20	11:26:17	-53 16.29	-43 45.03			
106	87	81	4	20	14:17:46	-53 16.00	-44 26.64	1048	CFC	
			4	20	14:36:32	-53 16.00	-44 26.64		Barium	
			4	20	15:10:32	-53 16.00	-44 26.64		Nutrients	
107	88	82	4	20	17:32:03	-53 15.48	-44 59.51	1862	Dimes	
			4	20	18:03:30	-53 15.48	-44 59.52			
			4	20	18:59:07	-53 15.48	-44 59.52			
118	95	83	4	21	01:04:05	-53 10.51	-45 54.87	1512	Chem	
			4	21	01:30:52	-53 10.51	-45 54.87		D5	
			4	21	02:17:25	-53 10.51	-45 54.87			
119	96	84	4	21	05:20:23	-53 07.53	-46 31.58	1389	Dimes	
			4	21	05:46:02	-53 07.53	-46 31.59			
			4	21	06:36:17	-53 07.53	-46 31.58			
120	97	85	4	21	08:59:35	-53 06.42	-47 03.32	1223	Chem	
			4	21	09:22:01	-53 06.43	-47 03.26			
			4	21	10:01:53	-53 06.43	-47 03.25			
121	98	86	4	21	11:42:02	-53 01.44	-47 22.55	1959	Dimes	
			4	21	12:15:31	-53 01.47	-47 22.53			
			4	21	13:12:47	-53 01.47	-47 22.54			
122	99	87	4	21	14:28:01	-52 59.55	-47 30.12	2479	Chem	
			4	21	15:11:39	-52 59.55	-47 30.12			
			4	21	16:24:27	-52 59.55	-47 30.12			
124	100	88	4	21	17:48:51	-52 55.51	-47 44.97	2965	Dimes	
			4	21	18:38:20	-52 54.80	-47 45.37		Barium2	
			4	21	19:50:36	-52 53.86	-47 45.91			
126	101	89	4	21	21:31:51	-53 02.43	-48 02.72	3044	Chem	
			4	21	22:23:10	-53 01.58	-48 03.08			

			4	21	23:35:14	-53 00.61	-48 03.55			
			4	22	00:59:48	-53 07.15	-48 11.49			
127	102	90	4	22	01:46:22	-53 06.61	-48 11.57	2645	Dimes	
			4	22	02:55:26	-53 05.87	-48 11.70			
			4	22	03:57:06	-53 08.66	-48 16.75			
129	103	91	4	22	04:42:16	-53 07.94	-48 16.80	2581	Chem	
			4	22	05:57:37	-53 06.87	-48 16.85			
			4	22	07:25:04	-53 08.79	-48 30.01			
131	104	92	4	22	08:13:57	-53 08.05	-48 29.89	2724	Dimes	
			4	22	09:23:47	-53 07.13	-48 29.78			
			4	22	10:17:15	-53 08.58	-48 35.89			
132	105	93	4	22	11:00:10	-53 08.04	-48 35.57	2437	Chem	
			4	22	12:07:19	-53 07.37	-48 35.09			
			4	22	13:30:12	-53 12.90	-48 47.00			
134	106	94	4	22	14:15:53	-53 12.65	-48 46.52	2628	Dimes	
			4	22	15:24:34	-53 12.16	-48 45.96			
			4	22	16:37:07	-53 17.91	-48 55.48			
136	107	95	4	22	17:30:53	-53 17.73	-48 55.21	3173	Chem	
			4	22	18:49:47	-53 17.45	-48 54.71			
			4	23	00:07:40	-53 20.73	-49 06.23			
138	108	96	4	23	00:59:40	-53 20.67	-49 06.24	2883	Dimes	
			4	23	02:05:15	-53 20.67	-49 06.25			
			4	23	03:21:15	-53 22.73	-49 16.16			
139	109	97	4	23	04:05:59	-53 22.74	-49 16.16	2592	Chem	
			4	23	05:18:07	-53 22.47	-49 16.32			
			4	23	06:33:09	-53 22.77	-49 27.39			
141	110	98	4	23	07:06:30	-53 22.77	-49 27.39	1891	Dimes	
			4	23	08:03:43	-53 22.77	-49 27.39			
			4	23	09:07:48	-53 23.20	-49 31.83			
142	111	99	4	23	09:34:14	-53 23.20	-49 31.83	1477	Chem	
			4	23	10:21:09	-53 23.20	-49 31.83			
			4	23	11:22:08	-53 23.46	-49 37.38			
143	112	100	4	23	11:41:07	-53 23.46	-49 37.38	1001	Salts	
			4	23	12:10:43	-53 23.46	-49 37.38			
			4	23	14:19:49	-53 22.70	-50 05.69			
144	113	101	4	23	14:38:09	-53 22.70	-50 05.69	955	Chem	
			4	23	15:07:53	-53 22.70	-50 05.69			
			4	23	20:18:53	-53 20.03	-50 35.07			
151	118	102	4	23	20:28:04	-53 20.03	-50 35.07	503	Salts	
			4	23	20:42:52	-53 20.03	-50 35.07			
			4	24	00:02:50	-53 33.11	-51 17.95			
152	119	103	4	24	00:20:47	-53 33.11	-51 17.95	971	Chem	
			4	24	00:47:46	-53 33.11	-51 17.94			
			4	24	04:52:12	-53 48.55	-52 12.38			
153	120	104	4	24	05:08:41	-53 48.48	-52 12.39	824	Salts	
			4	24	05:33:43	-53 48.48	-52 12.39			
			4	24	08:53:58	-53 54.83	-53 00.43			
154	121	105	4	24	09:04:50	-53 54.84	-53 00.47	502	Chem	
			4	24	09:28:42	-53 54.95	-53 00.73			
			4	24	11:42:17	-53 58.12	-53 30.80			
155	122	106	4	24	12:01:14	-53 58.07	-53 30.72	997	Dimes	
			4	24	12:37:43	-53 58.07	-53 30.72			
			4	24	15:44:30	-54 04.22	-54 14.66			
156	123	107	4	24	16:12:30	-54 04.14	-54 15.04	1502	Chem	
			4	24	16:54:25	-54 04.01	-54 15.72			
			4	24	19:28:53	-54 11.06	-54 50.22			
157	124	108	4	24	19:53:58	-54 11.04	-54 50.44	1475	Dimes	
			4	24	20:27:56	-54 10.94	-54 50.92			
			4	24	21:49:54	-54 13.78	-55 05.71			
158	125	109	4	24	22:23:21	-54 13.78	-55 05.71	1917	Chem	
			4	24	23:16:40	-54 13.78	-55 05.71			
			4	25	00:38:13	-54 17.77	-55 19.35			
159	126	110	4	25	01:07:48	-54 17.77	-55 19.35	1690	Salts	
			4	25	01:45:29	-54 17.77	-55 19.35			
			4	25	03:09:26	-54 21.75	-55 33.23			
160	127	111	4	25	03:35:17	-54 21.76	-55 33.19	1463	Oxygen	
			4	25	04:20:58	-54 21.81	-55 32.54			
			4	25	05:51:37	-54 23.64	-55 40.53			
161	128	112	4	25	06:11:33	-54 23.65	-55 40.55	1023	Chem	

			4	25	06:47:23	-54 23.66	-55 40.55			
			4	25	07:42:26	-54 25.50	-55 49.16			NSR
162	129	113	4	25	07:52:54	-54 25.50	-55 49.16	542	Salts	End
			4	25	08:13:09	-54 25.51	-55 49.16			
			4	25	14:36:29	-53 34.30	-55 01.83			Falkland
163	130	114	4	25	15:31:37	-53 34.30	-55 01.83	3263	Dimes	Trough
			4	25	16:51:22	-53 34.30	-55 01.84			
			4	25	19:34:02	-53 33.52	-55 41.06			
164	131	115	4	25	20:27:25	-53 33.52	-55 41.06	3175	Dimes	
			4	25	21:33:44	-53 33.52	-55 41.07			
			4	26	00:16:38	-53 32.76	-56 20.34		Dimes	
165	132	116	4	26	01:07:17	-53 32.76	-56 20.34	2983	Carbon	
			4	26	02:18:54	-53 32.76	-56 20.35		O18	
			4	26	05:11:47	-53 32.03	-56 59.55			
166	133	117	4	26	06:00:28	-53 32.02	-56 59.54	2796	Dimes	
			4	26	07:16:33	-53 32.09	-56 59.55			
			4	26	10:12:35	-53 31.25	-57 38.76			
167	134	118	4	26	10:55:48	-53 31.26	-57 38.78	2565	Dimes	
			4	26	12:08:51	-53 31.25	-57 38.78			
			4	26	16:37:14	-53 00.90	-58 02.30		Carbon	GC528
168	135	119	4	26	16:48:15	-53 00.90	-58 02.30	593	Barium	Core site
			4	26	17:14:19	-53 00.90	-58 02.30		O18	

2.3 CTD Sampling

Table 2.2: Counts of CTD sampling types. There were 119 CTD events but CTD021 wasn't sampled. Note that these are just CTD cast counts, not counts of individual bottle samples.

CTDs	**CFC**	**DIMES**	**O18**	**O2**	**Carbon**	**Barium**	**Nitrate**	**Silicate**	**Salts**
118	**52**	**81**	**3**	**6**	**48**	**48**	**51**	**51**	**116**

3 Salinometer

Heather Regan

For JR299, between 6 and 12 salt samples were taken from every CTD cast (except 37) by rinsing bottles 3 times and then filling up to the neck. The number taken was dependent on the depth of the cast; shallower casts with fewer bottles fired at depths with small salinity gradients had less bottles since large gradients could cause anomalous results in the later calibration. They were then run through a Guildline Autosal 8400B salinometer. The Guildline Autosal 8400B measures the conductivity of a water sample with very high precision, in a water bath of known temperature. The readout is given as twice the conductivity ratio between the sample and standard seawater with salinity 35 at 20 degrees, and 1 atm. pressure. The instrument (S/N 68959) was inherited from the previous ISTAR cruise (REF) and restandardised at the beginning; the backup salinometer was not used. During the cruise, bottles of standard seawater were analyzed at intervals of approx. 24 samples, with corrections applied to the intermediate measurements. Standard procedure was to invert each sample/standard bottle a few times in order to mix the contents but avoid the introduction of a large number of air bubbles into the sample. Before the analysis of each sample, the system was flushed (i.e. flooded and drained) three times with the sample, before the readings were taken, as per the standards. At least three readings were taken from each sample bottle. Care was taken to allow sufficient time for the readout value to stabilise on a final value. Several readings were performed until the value was determined with sufficient certainty: ±0.00002 in the readout or ±0.00001 in the ratio, equivalent to approx. 0.0003 salinity, which is less than the accuracy of the CTD salinity measurements. The mean reading was used. From these conductivity ratios, the practical salinity of the sample could be calculated using the equation of state from UNESCO (1978). The measurements were loaded into an Excel spreadsheet, where salinities were calculated; text files with station number, Niskin bottle number, and salinity were exported for use in the CTD data processing.

Before the salinometer was used, the thermometers in the salinometer room were moved. This is because they were previously all at ceiling height and one was under a lamp, giving unrepresentative readings of the overall room temperature. They were repositioned so that one was at ceiling height but away from lamps, one was positioned on top of the unused salinometer, and one was at desk height. Each crate of bottles was rinsed thoroughly with milliQ and any salt residue removed, since some salt water had been left in some upside down bottles without stoppers and resulted in crystals forming on and around the cap. Stoppered bottles with samples were left upside down and then left upright after processing. When a crate was full of samples ready to be analysed, it was left in the salinometer room for at least 24 hours to acclimatise to the room temperature which was known (kept as close to 24 degrees as possible so that it was the same as the water bath). Other cruise scientists were instructed not to use the salinometer room as a thoroughfare to prevent a draught from adjacent rooms which could compromise a constant room temperature.

While the salinometer was not being used, it was flushed with and then left in milliQ. Before each use, an old standard was run before a new standard since the milliQ was reducing the readings of the standard too much and making them useless. Ocean Scientific International Ltd (OSIL) standard seawater was used to provide calibration readings in regular intervals: before each crate of 24 salt water samples and after each crate so that corrections can be applied to the intermediate measurements. OSIL standard seawater of the batch P155 was used. The instrument was standardized (black dial with locking ring) with a standard from the P155 batch at the beginning of the cruise and then locked into position. Nothing was changed with the instrumentation subsequently (e.g. no change in water bath temperature or water bath replacement) that it was not necessary to re-standardize at any point during the cruise. The water bath was kept at a constant temperature of 24°C during the entire cruise. The standards were kept in the salinometer room so that their temperature was kept constant, as with the salt samples.

On a few occasions the temperature of the salinometer room changed dramatically. This happened mainly due to a reaction to rapid temperature differences when travelling into or out of ice or warm (>10°C) water, and once when the heating was turned down in that room instead of the UIC. When it overheated the room door was propped open to maintain the temperature and make the salinometer room more comfortable to run samples in. A big temperature difference between the room and the salinometer was evident in the salt samples, with more bubbles appearing; this was overcome by additional flushing. It also meant that instead of the three readings being within 0.0002, they were sometimes increasing over the three samples with a range of over 0.0005. When this occurred, the sampling was halted, temperature changed and then given a further 24 hours to acclimatise before resuming. The temperature was monitored at least as regularly as the frequency of underway samples being taken. Overall the salinometer performed well (that is, it could maintain water bath temperature of 24°C) with the room temperature, at desk level, between 21°C and 24.6°C.

A total of 1063 CTD samples plus a further 105 underway samples were analyzed during the cruise, excluding standards. During the cruise a total of approximately 80 P-series standards from batch P155 (*use by* date 19/09/2015) were used.

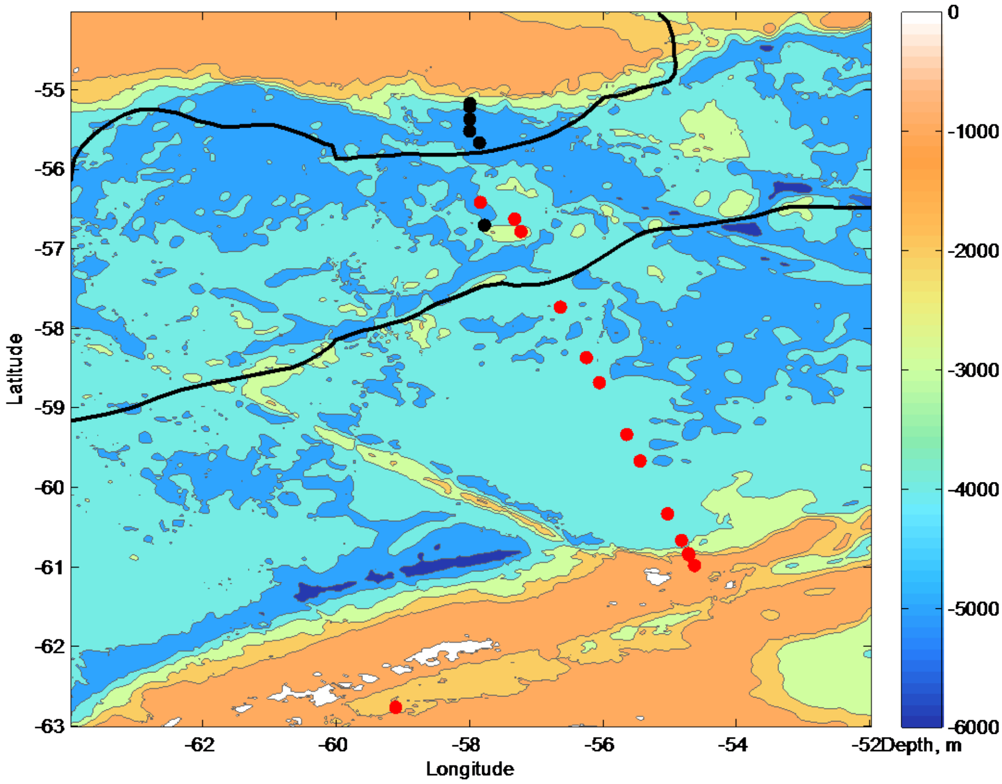
4 Microstructure profilers

Katy Sheen, Alex Forryan, Paul Provost and John Wynar

4.1 Overview

Two vertical microstructure profilers manufactured by Rockland Scientific International (the tethered VMP-2000 and the untethered VMP-5500) were used during the SR1b leg of the JR299 cruise. Both instruments measured profiles of temperature and velocity microstructure (i.e. on the length scales of dissipation of turbulent flows, typically a few millimetres to tens of centimetres), from which the rates of dissipation of turbulent kinetic energy (ε) and temperature variance (χ) are estimated using methodology based on Oakey (1982); and finescale temperature, salinity and pressure with a Seabird CTD mounted on each instrument. Though the preference was to use the non-tethered VMP-5500 profiler due to a problem with the instruments computer board half way through the section, the VMP-2000 was used for the last few casts. The central goal of the microstructure element of JR299 was to investigate the small- and finescale processes influencing the Antarctic Circumpolar Current as it flows through Drake Passage, in part to compare to DIMES-tracer estimates and to previous microstructure occupations of the section.

Figure 4.1: Location of microstructure casts conducted during JR299. Red circles show VMP-5500 stations, blue circles show VMP-2000 stations. Black lines show approx. Polar Front and Sub-Antarctic Front (Orsi 1995)



A total of 14 untethered and 6 tethered microstructure profiles were obtained during JR299, 18 of them in conjunction with standard CTD stations (see Figure 4.1 and Tables 4.1 and 4.2). All but the first of these stations were conducted along the north-south SR1b repeat section. The first 14 stations were conducted with the VMP-5500. To allow for battery recharging (which typically 2/3.5 hours after one/two successive casts), the general mode of deployment was to deploy the VMP during two out of every three CTD stations. The VMP-5500 broke down after cast 22, diagnosed as a failure with the PC-104 computer board (see comments at end). As we did not have a spare on board (this is recommended for future cruises) it was not possible to continue using the untethered instrument. The USBL beacon on the VMP-5500 provided an effective method of tracking and finding the instrument, although it did often loose communication at depths greater than about 2500 m. An iridium beacon was also used instead of the light for casts deployed and recovered during daylight. Other minor problems with the VMP-5500 include: at the start of the cruise, the weight release battery in the VMP-5000 instrument was replaced, probably damaged because it had been left to run flat during an extended period in the previous cruise; n station 20, the VMP-5000 did not release on fall rate, as opposed to pressure, and it is suspected that it hit the seabed, although no visible damage to the probes or profiler was observed on its return. The computer board appears to have broken before cast 22, as initially the instrument went into weight release mode (as opposed to dive mode) once the shorting plug was turned on. The weight release on this cast probably happened due to the firmware timeout logic, as the instrument was about two hours late in surfacing.
In general, the VMP-2000 proved to be a reliable instrument, although some problems were encountered with damage to the cable, where bad data buffers were reported. This problem was fixed by cable repair or reducing the 'manchester communication rate' of the instrument.
The last few stations of the SR1b repeat line had to be skipped due to excessive swell and having to return to Punta Arenas for crew swap-over.

Table 4.1: VMP-5500 deployments during JR299.

Station	**Latitude**	**Longitude**	**Date/Time**	**Max Press.**	**Comments**
1	62 45.92 S	59 6.572 W	12-03-2014 18:45	100 db	Tethered test dip
2	62 45.92 S	59 6.572 W	12-03-2014 20:44	1172 db	First free-fall dip
4	60 58.89 S	54 37.825 W	13-03-2014 17:10	547 db	New sh1 (sn 712). 1 kg of weight added to increase fall rate to 0.53 m/s (was a bit slow in cast 2)
5	60 50.98 S	54 43.78 W	13-03-2014 19:50	962 db	
6	60 49.9 S	54 43.3 W	13-03-2014 23:23	1418 db	
8	60 40.026 S	54 49.494 W	14-03-2014 04:30	3047 db	
9	60 19.946 S	55 01.911 W	14-03-2014 10:23	3398 db	

11	59 40.03 S	55 26.76 W	14-03-2014 21:29	3691 db	replaced sh2 post dive
12	59 19.969 S	55 37.71 W	15-03-2014 04:04	3743 db	sh1 broken on recovery
14	58 40.989 S	56 03.34 W	15-03-2014 15:33	3755 db	
15	58 22.004 S	56 15.00 W	15-03-2014 21:55	3884 db	
17	57.44029 S	56 38.462 W	16-03-2014 09:35	3376 db	
18	57 24.860 S	56 50.410 W	16-03-2014 15:50	3388 db	No data from temp probe 2 (nothing bad in cal.txt before cast) NOTE – Found that one of the brushes was attached the wrong way for all previous casts. Fixed after station 18. Swap T1 only T2, and put a new probe in T1. Probe T2 was in very loosely.
20	56 47.03 S	57 13.08 W	17-03-2014 03:17	3136 db	Bounced off the seabed
22	56 37.47 S	57 19.67 W	17-03-2014 09:58	???? db	Ooopse ... On-board computer failure shortly after deployment. Weights released by firmware after 4.5 hrs. Data to only ~ 1800 m depth.

Table 4.2: VMP-2000 deployments during JR299.

Station	**Latitude**	**Longitude**	**Date/Time**	**Cast**	**Max Pressure**	**Comments**
21	56 42.75 S	57 46.74 W	17-03-2014 07:36	1	1744 db	Bad buffers on recovery.
33	55 39.96 S	57 51.3 W	18-03-2014 18:21	1	742 db	~1400 m wire out. Strong current T2 replaced post-cast.
34	55 31.14 S	58 00.00 W	18-03-2014 23:27	1	968 db	
35	55 22.092 S	56 00.07 W	19-03-2014 05:03	1	1228 db	
36	55 12.85 S	57 59.98 W	19-03-2014 10:36	1	1194 db	
37	55 90.38 S	57 59.69 W	19-03-2014 14:43	1	1101 db	Bad buffers again on upcast

4.2 VMP-5500 deployment, recovery and winch operation

Thanks to the efforts of the NMF Technicians and the JCR Deck Crew, deployment and recovery of the VMP went smoothly. All deployments were made using the ship's rear aft Effer crane, with the instrument hoisted by a sling around the tail bale. It was released in the water using a 'sea catch'. The VMP was recovered using hooked poles fitted with releasing recovery lines and craned aboard by its bale using the starboard midships winch and gantry. Apart from the reduced vessel motion at midships, this location also kept the profiler away from thruster wash and prevented it going out of sight under the stern flare. The NOCS VMP was stored in the ship's wet lab on an aluminium frame trolley, that supports a half section of plastic drain pipe fitted with foam. Deployments and recoveries were made from this cart. Further technical details of deployment and recovery are given on the attached BAS Guidance Notes. It is strongly recommended that a better system of deployment is sought, as a large amount of weight has to be borne by the two deck crew during deployment.

4.3 VMP-2000 deployment, recovery and winch operation

The VMP was carried out on to deck and placed on stands. The slack wire was wound tightly back on to the winch to remove the hazard of loose wire on the deck. The VMP was attached to the crane using a quick-release mechanism and then craned over the side, in to the sea and released, the remaining slack wire again being wound on to the winch. The profiler was held at the surface until given the go-ahead by the person operating the recording computer. Once that message was received the operator veered the winch and adjusted its speed and that of the line puller to ensure that the profiler was freefalling at its terminal velocity. Veering was halted occasionally to read the length of wire-out on the cable until the pre-determined depth was reached. At this point the winch was stopped until the profiler attained its maximum depth. The profiler was then hauled back to the surface, the computer operator giving warning when it was nearing the surface so that the winch speed could be reduced for recovery. As soon as the profiler came within reach it was re-attached to the crane and hauled up on deck and laid back on its stands, all the time paying out sufficient wire to achieve this. If required, enough wire was paid out to allow the profiler to be taken into the lab.

4.4 Data processing

All processing scripts used on this cruise were adaptations of those used in previous VMP cruises by the NOCS group. All processing steps and calculations remain the same as described in previous cruise reports (Naveira Garabato, 2009; Meredith, 2011; Watson, 2011; Sallée, 2013). A summary of the processing steps is given below:

Function	Description
vmp_read_odas	Reads in the VMP datafile and produces two matlab files, one containing the raw un-calibrated VMP data, the other containing the extracted downcast data with all calibrations supplied in the setup.cfg file applied ('_cdc.mat').
vmp_firstlook	Produces a series of diagnostic plots for the raw un-calibrated VMP

	data.
vmp_process_seabird	Processes the VMP seabird data and applies various corrections. Output is saved as a separate matlab file ('_CTD.mat').
vmp_process_micro	Processes the VMP microstructure shear, temperature and conductivity. Microstructure temperature and conductivity are calibrated by regressing against the processed VMP seabird temperature and conductivity. Output is saved as a separate matlab file ('_Micro.mat').

A list of the sensors used during JR299 for the VMP-5500 and VMP-2000 is given in Tables 4.3 and 4.4, respectively.

Table 4.3: VMP-5500 sensors used during JR299

She1	She2	Temp1	Temp2	uCond	SBET	SBEC	Date	Comments
M401	M540	T619	T614	C99	03 4969	04 3490	26-1-2014	Temp1 found to be completely dead after station 2
		T356					01-2-2014	
		T765	T766					Swapped with VMP-2000
M401	M540	T765	T766	C99	03 4960	04 3490	10-03-2014	START OF JCR299
M712							12-03-2014	sh1 looked noisy & reading low swapped post station 2
	M713						15-03-2014	replaced post station 11 (both looked to be very low)
M399							15-03-2014	sh1 broken on recovery station 12
		T615	T765				16-03-2014	No readings from T2 on recovery. (swap T1 to T2, and put new probe in T1).

Table 4.4: VMP-2000 sensors used during JR299

Station	Latitude	Longitude	Date/Time	Cast	Max Pressure	Comments
21	56 42.75 S	57 46.74 W	17-03-2014 07:36	1	1744 db	Bad buffers on recovery.
33	55 39.96 S	57 51.3 W	18-03-2014 18:21	1	742 db	~1400 m wire out. Strong current T2 replaced post-cast.
34	55 31.14 S	58 00.00 W	18-03-2014 23:27	1	968 db	

35	55 22.092 S	56 00.07 W	19-03-2014 05:03	1	1228 db	
36	55 12.85 S	57 59.98 W	19-03-2014 10:36	1	1194 db	
37	55 90.38 S	57 59.69 W	19-03-2014 14:43	1	1101 db	Bad buffers again on upcast

An illustration of the data collected is given in Figures 4.2-4.6, which display the distributions of ε, χ along the SR1b section.

Figure 4.2: Log10(ε) in W kg-1 and averaged into 50 m depth bins for the SR1b section.

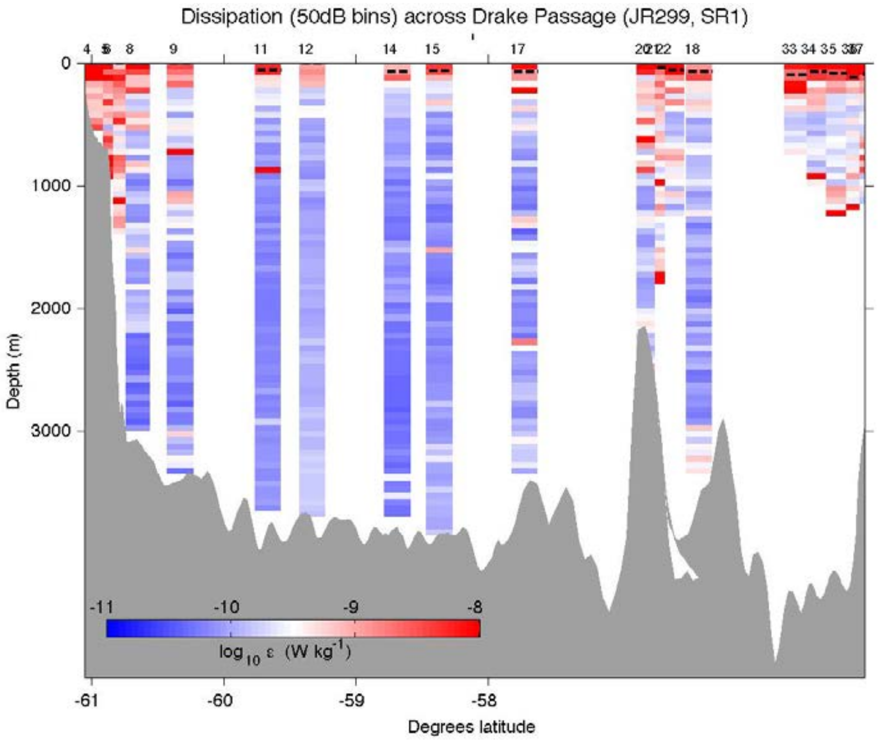


Figure 4.3: Vertical black stick plots show log10(ε) in W kg-1 for the SR1b section, with temperature contoured in the background.

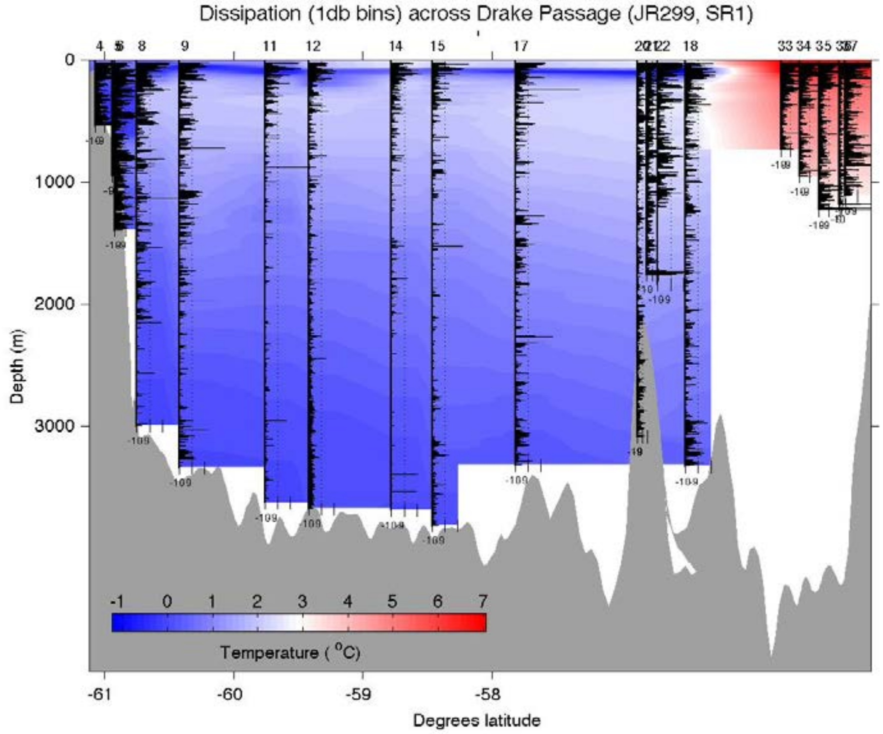


Figure 4.4: Log10(Kt) in m2s-1 for the SR1b section.

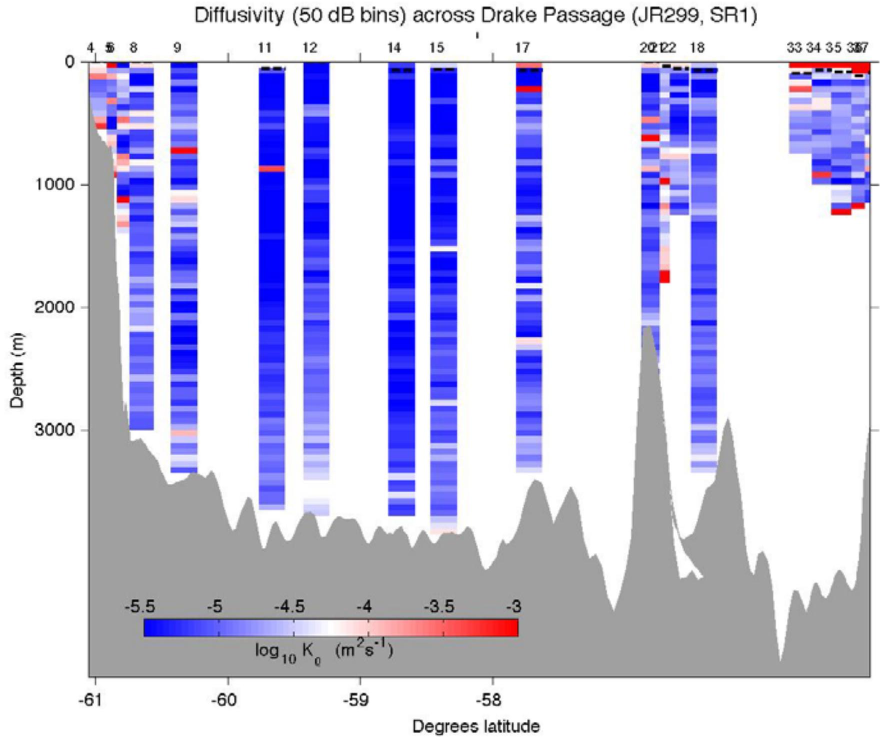


Figure 4.5: Log$_{10}$(χ) in $^{o}C^{2}s^{-1}$ and averaged into 50 m depth bins for theSR1b.

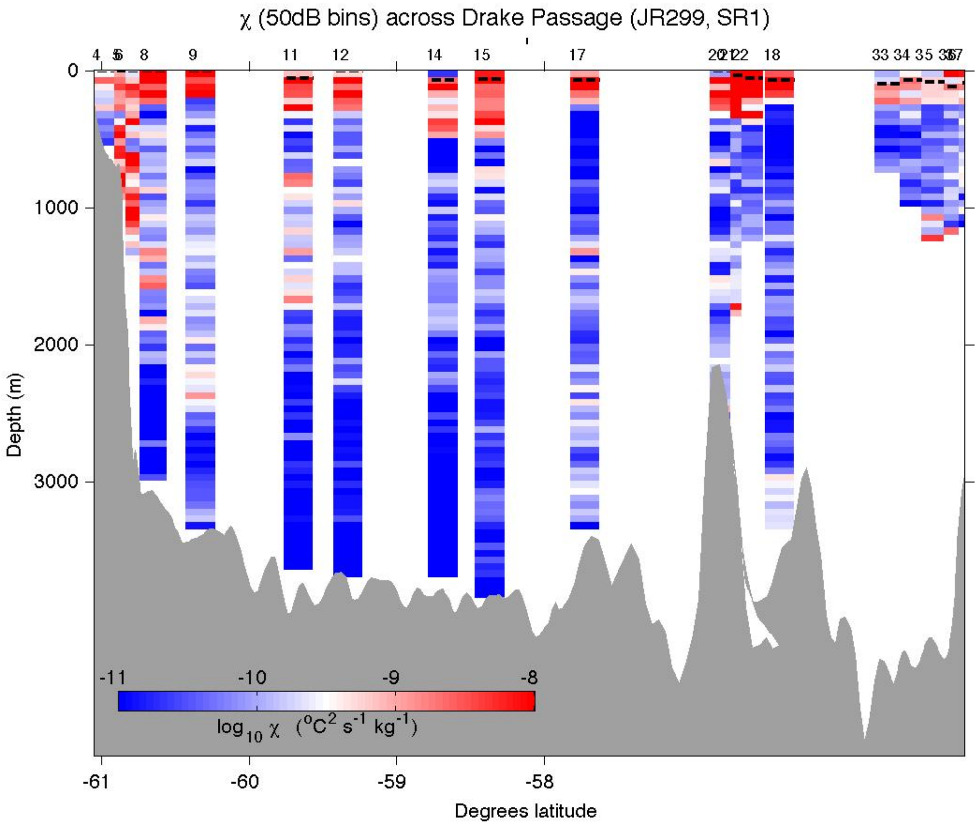
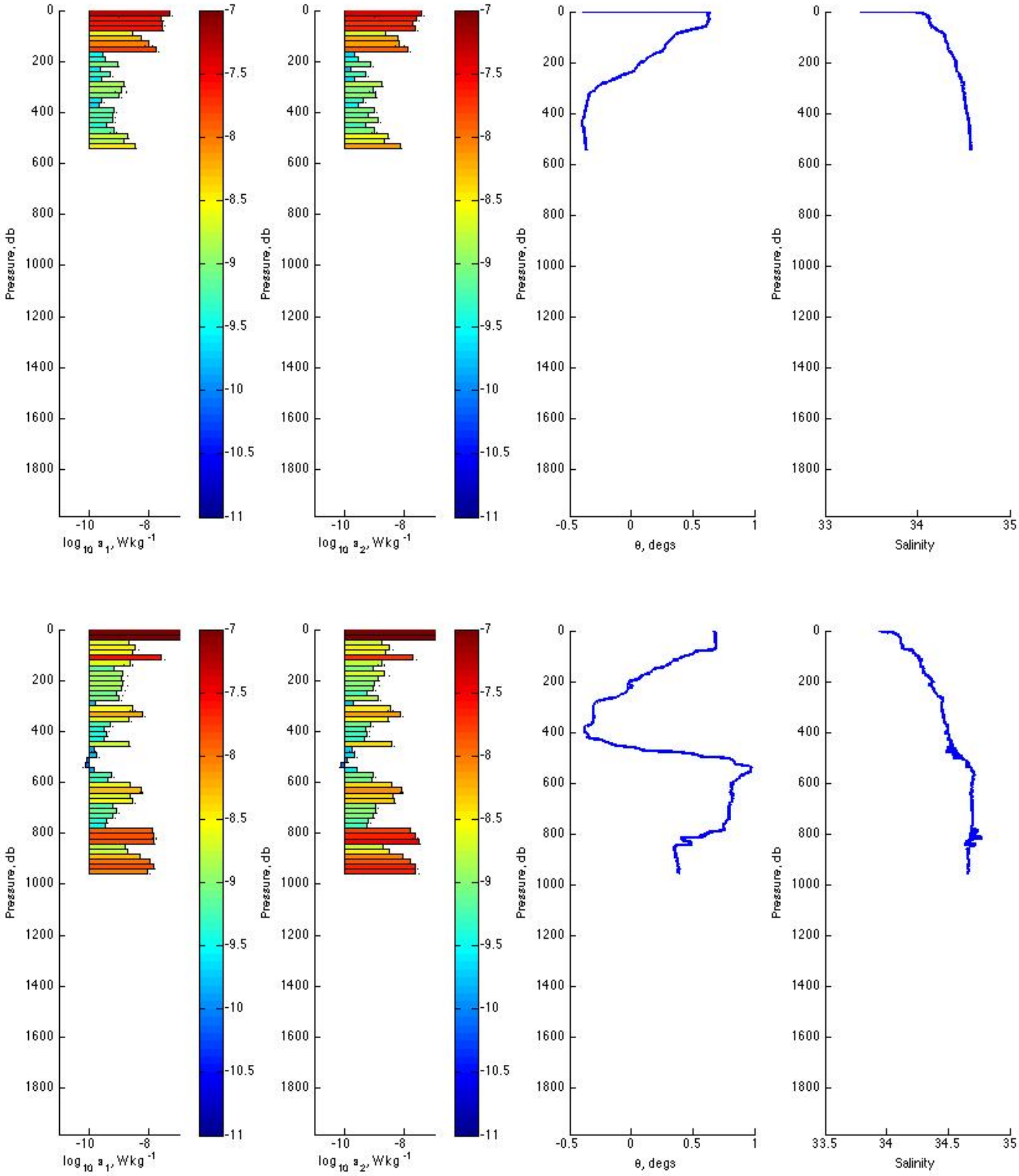
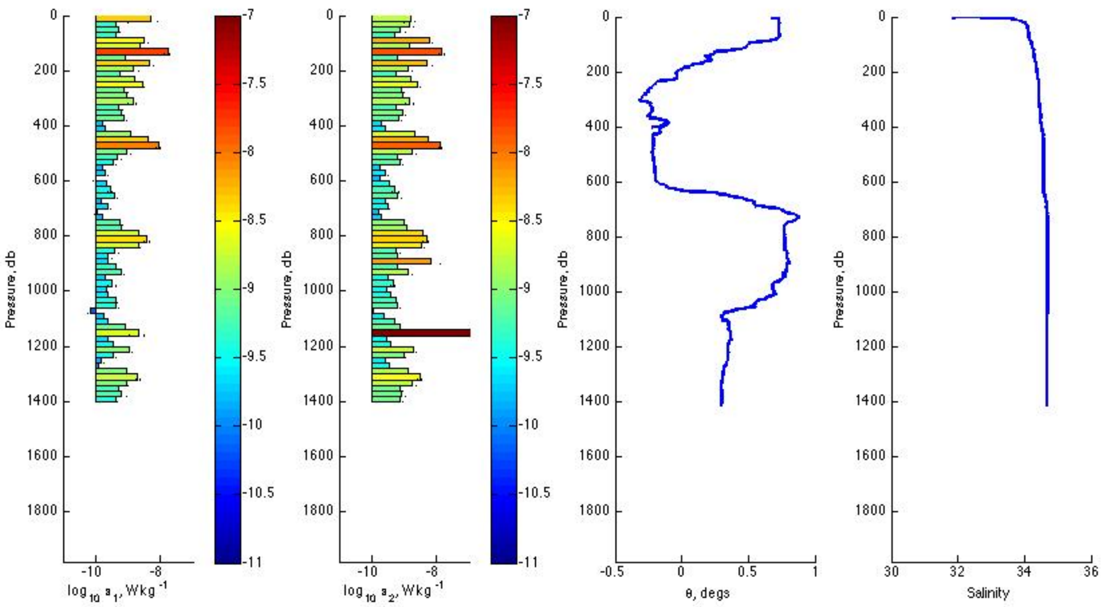
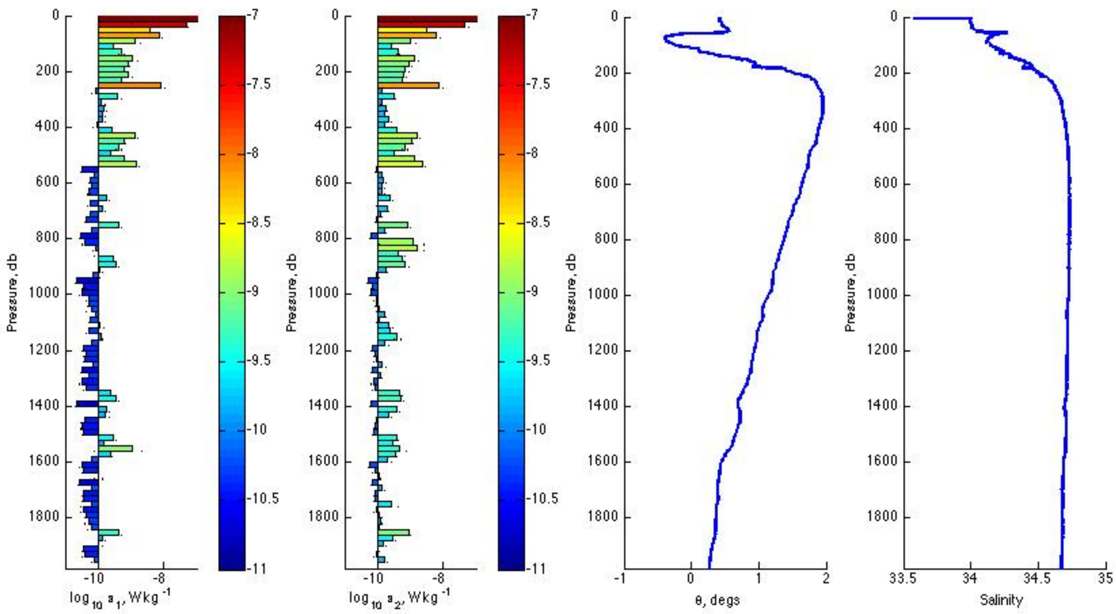


Figure 4.6(a-d): Dissipation along slope on SR1b, stations 4, 5, 6 and 8. Left hand panels show log10(ε) in W kg-1 for the two shear probes. Right hand panels show temperature and salinity from VMP seabird.




Pressure, db
log10 ε1, Wkg -1
log10 ε2, Wkg -1
θ, degs
Salinity


Pressure, db
log10 ε1, Wkg -1
log10 ε2, Wkg -1
θ, degs
Salinity

4.5 VMP-5500 and 2000 operators instructions and logsheets

VMP – 5500 Dive LOG JR299 / DIMES

DEPLOYMENT

Station number:
Date (JD/year):
Time weight release battery on:
Acoustic depth (m):
On deck pressure (db):
Assumed fall rate (m/s)
Bottom press (db):
Specified max press (db) **:
Specified max time (s) **:
Estimated dive time to bottom of cast (s):
Estimated time to surface:
Main battery voltage (V) >12 V:
Dive start time (GMT):
Release time (GMT):
Deployment position:

COMMENTS: (i.e. data files deleted/shear probe changed/problems with deployment)

RECOVERY (JR299 / DIMES)

Station number:
Date and time on deck (JD / GMT):
Recovery position:
Post-dive main battery voltage (V):
Time charging started (GMT):
Time charging ended (GMT):
Name of data file:
Method of dive end:
Max. pressure of dive (db):

COMMENTS:

VMP Deployment/Recovery Checklist JR299 / DIMES

Deployment

Laptop - ~30 minutes prior to launch:

1. New Log Sheet
2. Plug in VMP and connect the Ethernet cable. Turn the instrument on (shorting plug) and start weight battery charge (20-30 minute charge)
3. Connect to the instrument, in terminal window (* **):
   a. **telnet 192.168.2.2**
   b. login: **root** / password: **rglr0x**
4. Check file space on instrument, type "**df -h**". In "*root/data*" there should be **~100,000 KB per 1000m**
5. Check channels, get deck pressure, in terminal window:
   a. **odas4ir –f setup.txt –c all –s 1024 > cal.txt**, check values look sensible (cat cal.txt)
   b. **odas4ir –f setup.txt**, record on "On-deck press P_{deck} in log sheet
6. Calculate max pressure and time for deployment, in Matlab:
   a. **calculate_max_press_and_time2 *****
   b. Record "*Bottom press P_{bot}*", "*Assumed overshoot P_{over}*", "*Safety allowance P_{safe}*", "Specified *max. press*.", "*Estimated dive time*" and "*Specified max. time*"
7. Enter information into "*setup.txt*", in terminal window: ****
   a. **edit setup.cfg**
   b. Update "*station number*", "*max_time*" and "*max_pressure*"
   c. Press "esc" to save and exit, select "*Leave Editor*" and then "*Save Changes*"
8. Test "*setup.cfg*" file, in terminal window:
   a. **odas4ir –f setup.cfg**, check for errors, exit with "*ctrl-c*"
9. Turn off instrument and disconnect from power suppy, in terminal window:
   a. **shutdown now**
   b. Disconnect white plastic on-off switch, turn off power supply and put in dummy plug (wait 36s as weights fire)
   c. Check voltage at power supply end, should be >12.8V

On Deck:

1. Turn on and test the recovery aids
2. Remove tube from SBE conductivity sensor
3. Disconnect E/CRG cable from the instrument and install the dummy plugs at both ends, wait 36 seconds
4. Install the weights
5. Turn the instrument ON by connecting the shorting plug (check o-ring), check LED is flashing and record "*Diving start time*"
6. Deploy, record time and position and estimated surface time

* (use ping as a check; make sure mac computer is set to VMP location and Ethernet in network prefs.)

** Every 30 or so mounts (info given when log into VMP) have to run the file system check – login into VMP, cd ../../ and follow instructions in manual

*** Need to run /Desktop/JCR299/Matlab/Setup when first start up matlab to set correct paths

**** If shear probes are changed, edit the cals in setup_* file on VMP computer (VMP-5500 folder), ftp across to VMP and copy to setup.cfg ("ftp" "open 192.168.2.2" "mput filename" "cp setup_* setup.cfg")

Recovery

On Deck - ~10 minutes prior to expected surface time:

1. Send lookouts to bridge
2. When spotted: record date, time, ship position, range and bearing
3. Recover: record date, time and ship's position in the log sheet
4. Turn off recovery aids
5. Replace the tube on the SBE conductivity cell and fill with Millipore water
6. Rinse with fresh water
7. Turn instrument off, remove shorting plug and connect the E/CRG cable to the instrument
8. Check the magnesium safety pin

Laptop

1. Check and record the recovery voltage at the power supply
2. Plug the instrument in and start charging
3. Connect the Ethernet cable to the laptop, turn the instrument on by connecting plastic plug
4. FTP date and log file from the instrument to the laptop, in terminal window:
   a. "cd" to root data directory and create a new directory for the cast, "cd" to this new directory
   b. FTP to instrument:
      i. **ftp root@192.168.2.2** / password: **rglr0x**
      ii. **prompt**
      iii. **mget JR299_station#***
      iv. **get setup.cfg**
      v. **get cals.txt**
      vi. **quit**
5. Turn off the instrument by disconnecting the white plastic on-off switch on the E/CRG cable. Leave to charge for the next dive, note on the log sheet when charging started and estimated completion time. Assign someone to turn it off.
6. In Matlab perform quicklook of the data
7. Record remaining recovery details: name and size of data files and method of dive end (from station *.txt file)
8. Archive data ASAP (in Science Work Areas/VMP/VMP_5500)

JCR294 VMP 2000 LOG #

St. No.	Date (jday)		Latitude	Longitude	Time (GMT)	Water Depth	Max. Press.	File	Notes
		start							
		max							
		end							
		start							
		max							
		end							
		start							
		max							
		end							
		start							
		max							
		end							
		start							
		max							
		end							

VMP2000 computer operators guide

At the start of each deployment :

Edit current version of setup file (e.g. setup_2000_Jan_26_2014.cfg) and change prefix station number.

Start ODAS-RT application and select setup file.

Select 'Calibrate' tab and click 'Calibrate' button.

Select 'Real Time' tab and click 'connect' (check data updates and numbers are sensible)

At the start of each cast :

1. Click 'Start Recording' to start recording.
2. Tell Deck recording has started.
3. Note time (GMT), latitude, longitude, water depth, and filename in spreadsheet.
4. Monitor depth on JCR webpage (check it is updating). Tell Deck when ~ 300 m from seabed.
5. When profiler reaches maximum depth (pressure stops increasing) note pressure in spreadsheet.
6. Tell Deck the depth reached (Deck will now start winching profiler back).
7. Tell deck when profiler is near surface (~ 50 db depth).
8. When profiler is at surface stop recording.
9. **Back to step 1**

At end of deployment copy all '.p' files to legwork/VMP/VMP-2000/Data/STN4.6

4.6 References

Meredith, M. and N. Cunningham, 2011: Cruise report RRS James Cook JC054 (DIMES UK2). British Antarctic Survey Cruise Report, 206 pp.

Naveira Garabato, A. C., 2009: RRS James Cook Cruise 29, 01 Nov-22 Dec 2008. SOFine Cruise Report: Southern Ocean Finestructure. National Oceanography Centre Southampton Cruise Report No. 35, 216 pp.

Oakey, N. S., 1982: Determination of the rate of dissipation of turbulent energy from simultaneous temperature and velocity shear microstructure measurements. J. Phys. Oceanogr. 12, 256-271.

Sallée, J.-B., 2013: Cruise report RRS James Clark Ross JR281 (DIMES UK4). British Antarctic Survey Cruise Report.

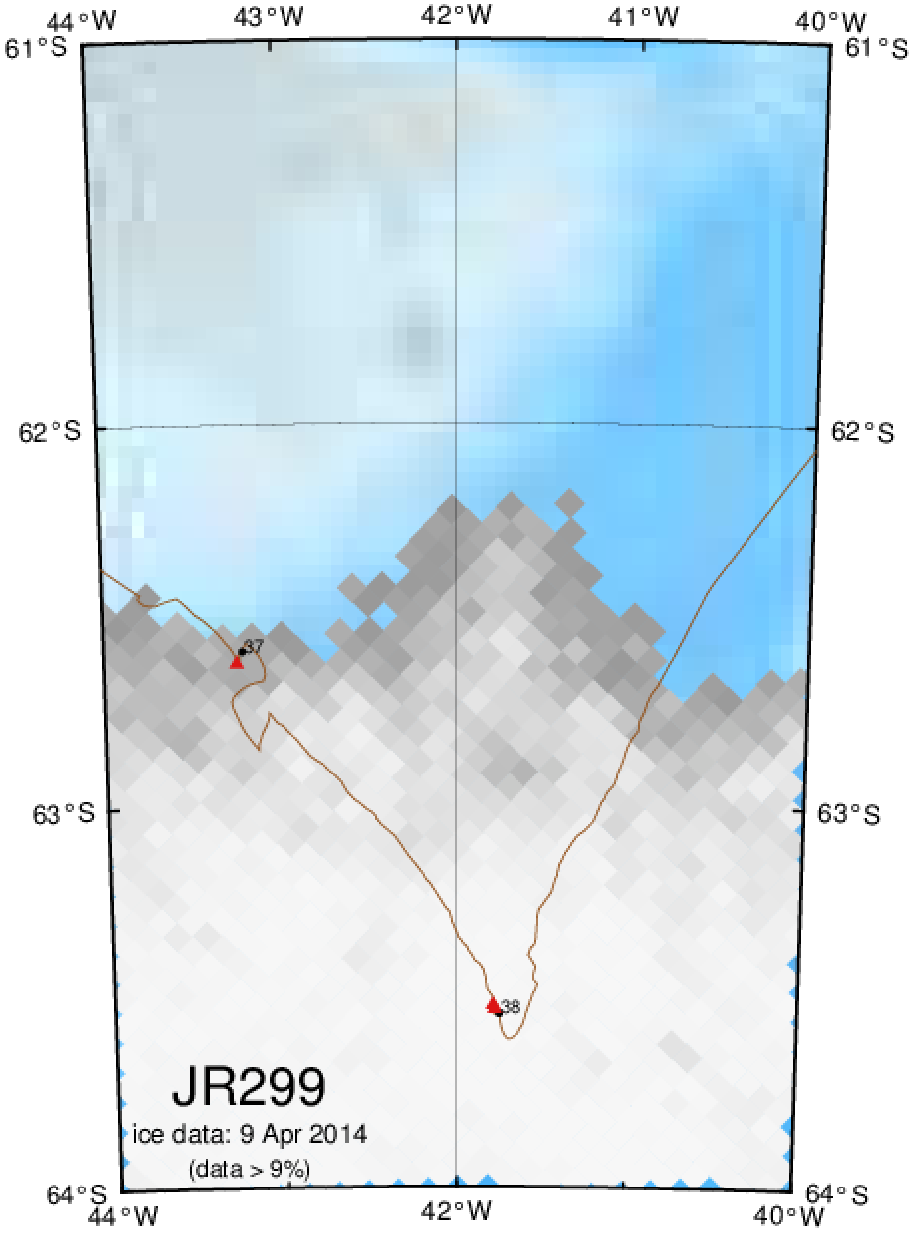
Watson, A. J., 2011: Cruise report RRS James Clark Ross JR276 (DIMES UK2.5). Cruise Report.

5 JCR299 Moorings

Philip Mele

The planned recovery and redeployment of the two Lamont-Dougherty Earth Observatory (LDEO) moorings, M2 and M3, was necessarily altered due to heavy ice conditions once again. The redeployment of M2, the northern mooring, was cancelled when it became apparent that the extremely heavy ice conditions at M3, the southern mooring, would be too heavy for a recovery and redeployment and it was decided to utilize all available equipment and time in order to deploy a second M3 alongside the original in order to maintain the time series of the more significant data set.

Figure 5.1: Location and ice conditions of M2 and M3 moorings.



Upon arrival at M2, heavy ice conditions seemed to be too heavy for recovery. Fortunately, several openings and a coverage of about 50% allowed for a successful recovery. Weather conditions were particularly harsh, -20C and 30 knot winds. All data was downloaded and extended for the entire three year deployment period. A CTD was conducted after recovery.

No replacement mooring was deployed.

AMSR2 ice data did not bode well for any operations at M3. An opening to the east looked to afford a location for deployment of a second M3 in order to maintain the far more important M3 time series. The ship progressed to the current M3 location successfully, and communicated with M3, establishing its continued operation. While ice conditions precluded retrieving M3, it was deemed possible to deploy the second M3 mooring, M3a, very near to the current M3 position. An anchor first deployment was utilized to prevent interference from the heavy ice. Deployment went well with not as harsh weather conditions, but still borderline. A CTD was conducted after deployment.

Figure 5.2: M2 mooring diagram of M2 at deployment

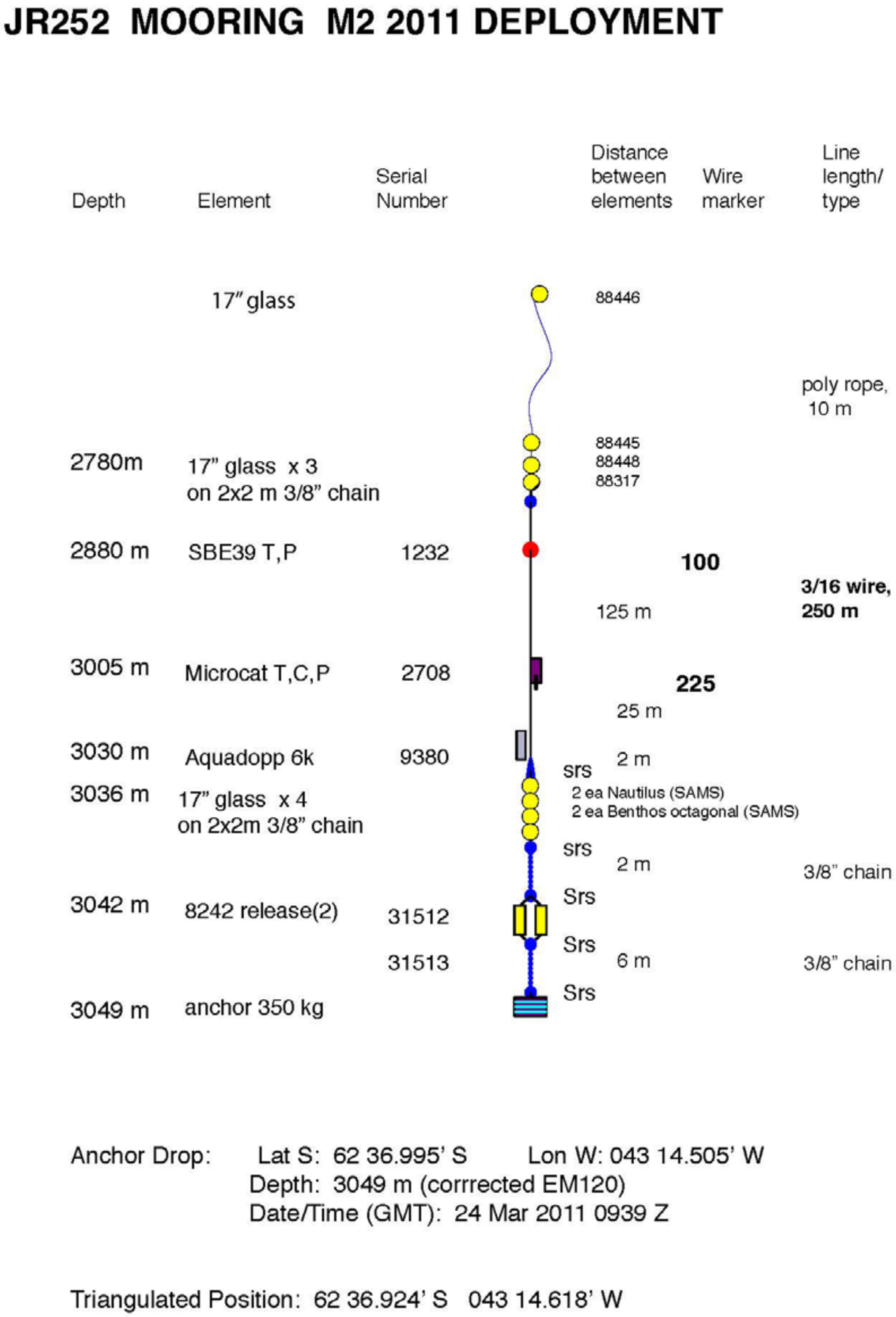
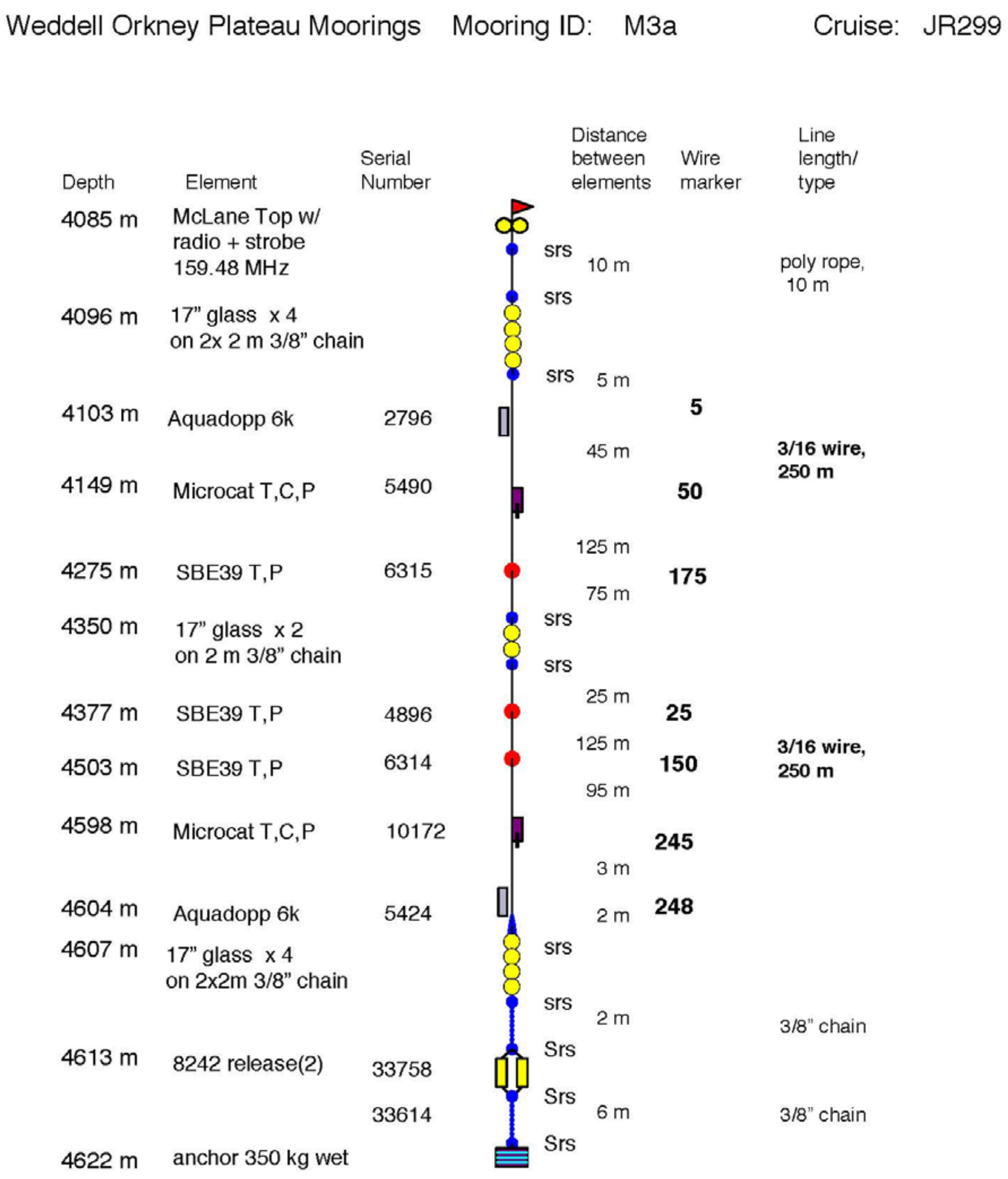


Figure 5.3: M3a mooring diagram



Deployed Position: Lat S 63° 31.998' Lon W 041° 46.656'
Depth 4622 m

Date/Time (GMT): 5 April 2014 21:12

notes: radio duty cycle: 2 s on, 4 off Anchor first deployment in 9-10 tenths ice cover

Table 5.1: Mooring location and recovery/deployment details

Station number	Time on station (UTC)	Time off Station (UTC)	Location	EA600 Depth	EM122 Depth	Bridge log event number	Notes
43	14:09:00 04/04/2014	16:25:00 04/04/2014	62° 36.996'S 43° 14.505'W	394.75	3009.84	59	LDEO Mooring M2 recovery EA600 reading - dodgy
44	17:48:00 05/04/2014	23:16:00 05/04/2014	63° 32.17'S 041° 46.04'W	0.00	3968.63	61	LDEO Mooring M3 communication with deployed mooring and new mooring deployment. EA600 reading - dodgy

The professionalism and assistance of the crew of the JCR was greatly appreciated. The assistance of Brian Guest (WHOI) and his expertise was invaluable.

6 JCR299 LADCP

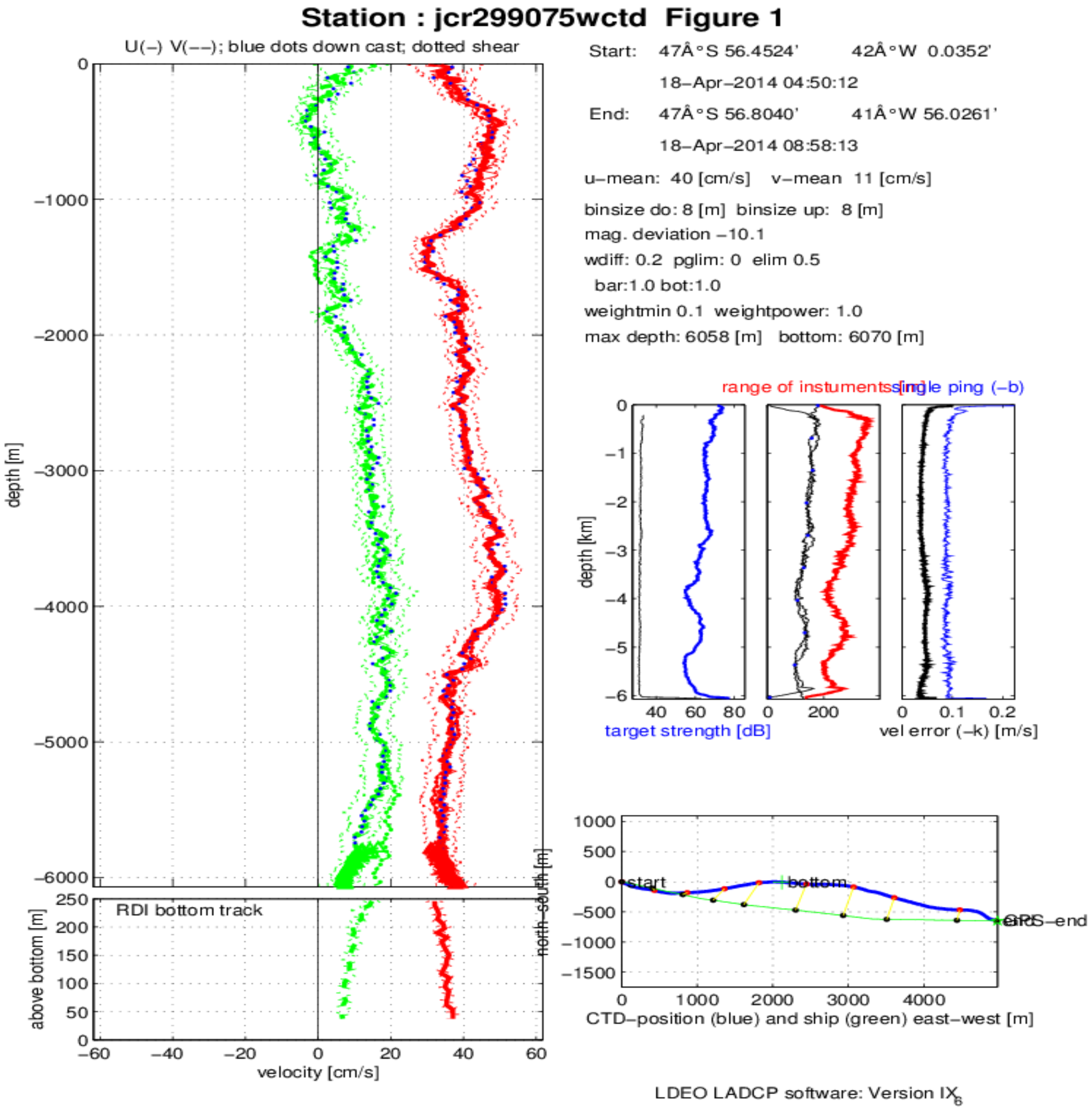
Philip Mele

LADCP data was collected on all 118 successful CTD casts of cruise JCR299/DIMES5, 1-20, 22-119. Two Teledyne RDI WorkHorse 300 kHz instruments were mounted on the CTD frame, a downlooker/master and an uplooker/slave. There is no uplooker data for stations 7-9 due to communication problems with the instrument.

Preliminary processing was completed during the cruise using the LDEO LADCP software version IX_6. Range corrections were made using sound speed profiles calculated from the CTD data for each station. Bottom tracking was successful on most casts, failing when the cast was too shallow relative to the water depth. Further processing will be performed at LDEO using higher resolution CTD data and shipboard ADCP data.

It was frequently necessary to reconnect the downlooker to initiate the unit for deployment and the uplooker for data download at the end of the cast. On station 78, the uplooker data was truncated shortly before the cast end. On station 80, and several stations shortly after, the uplooker data was in two or more files, an indication of possible octopus cable problems. The spare was already in use and it was decided to erase the memory for each unit as it had not been done up to this point. The problem did not recur and the memory was erased daily after processing.

Figure 6.1: The deepest station, 075, is shown below:



There is no data for station 21. Mechanical problems with the CTD resulted in an early termination.

The uplooker was lowered about 1" after station 44 due to scraping of the instrument on the overhead during deployment and recovery. There was no discernible effect to the data.

7 Vessel-Mounted Acoustic Doppler Current Profiler

Andrew Meijers (ship) and Brian King (remote, NOCS)

7.1 Introduction

A 75 kHz RD Instruments Ocean Surveyor (OS75, – model 71A-1029-00, SN 2088) ADCP was used during this cruise. This has also been used on JR139 (in Dec 2005, Chief Scientist Stansfield), JR161 (Oct-Dec 2006, Shreeve), JR165 (Feb 2007, Shoosmith), JR193 (Dec 2007, Quartly), JR177 (Jan 2008, Tarling), JR218 (Oct 2008, Woodward) and JR200 (Mar 2009, Korb), JR265 (Dec 2011, Yelland), JR276 (April 2011, Watson) and JR281 (March 2013, Sallee). Note that this isn't a complete list. The OS75 is capable of profiling to deeper levels in the water column than the previous 150 kHz ADCP and can also be configured to run in either narrowband or broadband modes.

7.2 Instrumentation

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

The OS75 transducer on the JCR is aligned at 60.08 degrees relative to the centre line. This differs from the recommended 45 degrees. The relatively newly fitted EM122 swath, does not appear to interfere with the VMADCP, and the instrument was used in an unsynchronised mode. The heading feed to the OS75 is the heading from the Seapath GPS unit.

7.3 Configuration

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The OS75 ran in various modes during JR299: narrowband with bottom-tracking on and narrowband in water tracking mode. On the leg up the Antarctic Peninsula the mode was varied depending on the operator, and while over Burdwood Bank it was set into bottom tracking mode with a depth that most closely matched the actual bottom depth. These choices of differing bottom depths caused problems in the CODAS processing software (see problems and troubleshooting below) and subsequently the VMADCP was only ever set into two modes: While bottom tracking the maximum water depth was set to 800m (100 bins, each 8 meters), not using the SSU. While in water track mode the depth was also 800m (100 bins, each 8 meters), again not using the SSU. Narrowband profiling was enabled with a 0 metre blanking distance and a transducer depth of 0 m. The salinity at the transducer was set to zero. Data logging was stopped and restarted approximately once a day to keep files to a manageable size for processing, but in practice the stopping and starting times varied considerably.

7.4 Outputs

The ADCP writes files to a network drive that is samba-mounted from the Unix system. The raw data (.ENR and .N1R) are also written to the local PC hard drive. For use in the matlab scripts the raw data saved to the PC would have to be run through the VMDas software again to create the .ENX files. When the Unix system is accessed (via ssh/samba) from a separate networked PC, this enables post-processing of the data without the need to move files. Output files are of the form JRNNN_XXX_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mb. ZZZ are the filename extensions, and are of the form:-
.N1R (NMEA telegram + ADCP timestamp; ASCII)
.ENR (Beam co-ordinate single-ping data; binary). These two are the raw data, saved to both disks
.VMO (VmDas configuration; ASCII)
.NMS (Navigation and attitude; binary)
.ENS (Beam co-ordinate single-ping data + NMEA data; binary)
.LOG (Log of ADCP communication and VmDas error; ASCII)
.ENX (Earth co-ordinate single-ping data; binary). This is read by matlab processing
.STA (Earth co-ordinate short-term averaged data; binary)
.LTA (Earth co-ordinate long-term averaged data; binary).
.N1R and .ENR files are saved to the secondary file path and can be reprocessed by the software to create the above files.

7.5 CODAS/Hawaii processing

The data were processed using the CODAS software. The processing route can be summarised as copying the raw files, converting them into a working format, merging navigation data, deriving velocities, quality control, and conversion of data to matlab and netcdf files.
Calibration information can be obtained after several water and bottom-track data files have been processed; calibration can be performed at any time during the cruise or left until the end. While the ship is steaming, the main signal that the ADCP instrument records is the ship speed. 12 knots (6 m/s) is 1-2 orders of magnitude greater than the water velocity. This velocity is removed using GPS derived ship velocities but there is clearly the potential for a significant error associated with this process as the output data is the small difference between two large numbers. To address this, the velocity of the bottom can be measured and compared directly to the GPS velocity of the ship. This should give the amplitude error for the ADCP and the misalignment with the ship heading. This only works in water where the bottom track ping can reach the sea bed – 800m or shallower. In deeper water the processing uses changes in the ship velocity to assess what proportion of the ship velocity is contaminating the calculated water velocity. This calculation necessarily invokes assumptions that the true water velocity is relatively constant in space (if slowing down) or time (if turning round) and is therefore considered less precise than bottom tracking.
Similarly to JR281 a large number of water track data were collected during JR299, from slowing down and speeding up from stations. Some opportunity for bottom tracking was missed early in the voyage over the Antarctic continental shelf due to operator inexperience, but later fixes were obtained over Burdwood Bank and near South Georgia and the Falkland Islands.

Note that this software sometimes outputs a decimal day, calculated from time in seconds since the start of the year. Decimal day is 0.5 for noon on the 1st January: this contrasts with a jday of 1.5 for noon on the 1st January. Below is a summary of the processing steps.

1) Created once at start of cruise
~/data/vmadcp/jr299_os75
~/data/vmadcp/jr299_os75/rawdata

2) cd ~pstar/jr299/data/vmadcp/jr299_os75
cshell script in /local/users/pstar/cruise/data/exec
vmadcp_linkscript
For dataset NNN (eg NNN = 002), this script automatically copies raw data files (ENX, N1R, etc) from /mnt/data/cruise/jcr/current/adcp into local/users/pstar/jr299/data/vmadcp/jrCCC_os75/rawdata with file names like OS75_JR299NNN_000000.ENX and redistributes raw data from rawdata to rawdataNNN; rawdataNNN is created if necessary (may need to edit vmadcp_linkscript so that it parses the file names correctly).

3) adcptree.py jrCCCNNNnbenx --datatype enx
Note "nb" for narrowband ping, and that the -- datatype has two dash characters

4) cd jrCCCNNNnbenx
copy in a q_py.cnt file. Generally, you only need to edit the dbname and datadir for each NNN.
An example q_py.cnt file is:

```
# q_py.cnt is
## comments follow hash marks; this is a comment line
--yearbase 2014
--dbname jr299001nnx
--datadir /local/users/pstar/cruise/data/vmadcp/jr299_os75/rawdata001
#--datafile_glob "*.LTA"
--datafile_glob *.ENX
--instname os75
--instclass os
--datatype enx
--auto
--rotate_angle 0.0
--pingtype nb
--ducer_depth 5
#--verbose
# end of q_py.cnt
# end of q_py.cnt
```

At the start of the cruise check yearbase, dbname, os75 or os150 and datatype enx (glob ENX). Dbname should be of form jrCCCNNNPTT where P is n for narrowband, b for broadband. The instrument should be operated in narrow unless there is a good reason to choose broad. TT is “nx” for ENX; “ns” for ENS; “nr” for ENR; “lt” for LTA; “st” for STA. Standard processing is to process ENX. As far as we can tell, dbname must not exceed 11 chars. So if we use 9 for jr299NNNn, there are only two left to identify ENX, ENS, LTA, STA

5) still in directory ~data/vmadcp/jr299_os75/jr299001nbenx
quick_adcp.py --cntfile q_py.cnt
("killed matlab engine" is the normal message received). This takes a minute or two per 24 hours
of ENX data. Note --cntfile has two dash characters

6) To see the BT (bottom track) or WT (water track) calibration, look at the ascii output of jr299001nbenx/cal/*/*out (note that a calibration is not always achieved, for example if the ship has made no manoeuvres while the ADCP is in water tracking mode, so there may be no *out file). Note also that additional calibration information may be saved after flags applied after gautoedit process.

7) To access data in Matlab
matlab &
>> m_setup
>> codaspaths

8) Can manually clean up data by applying flags to suspected bad data cycles (this can be done post-cruise, ie omitted, go straight to step 9). This step can also be a useful first look at the data. Note that the uncalibrated files may show a slight bias in u and/or v which will appear as stripes that coincide with periods of on-station and steaming. This effect will disappear when you correct for the amplitude and phase error (step 11).
>> cd data/vmadcp/jr299_os75/jr299001nbenx/edit
>> gautoedit
Clean up data. Select day and step (typically 0.1 or 0.2 days) to view, then "show now". "show now" may have to be done twice to get the surface velocity plot, as the first time may show an error. "show next" to step through the file. Note that "list to disk" must be clicked each time for the flags to be saved.
Applying edits identified in gautoedit, The gautoedit process in Matlab sets flags, but doesn’t change the data. To apply the flags and recalculate a calibration,
quick_adcp.py –-cntfile q_pyedit.cnt (note two dashes before cntfile)
where q_pyedit.cnt contains:

q_pyedit.cnt is
comments follow hash marks; this is a comment line
--yearbase 2014
--steps2rerun apply_edit:navsteps:calib:matfiles
--instname os75
--auto
end of q_pyrot.cnt

9) To get data into MSTAR:

>> cd /local/users/pstar/cruise/data/vmadcp/jr299_os75/jr299NNNnbenx
>> mcod_01
produces output file
os75_jr299NNNnnx.nc
which has a collection of vars of dimensions Nx1 1xM NxM
>> mcod_02
will calculate water speed and ship speed and get all the vars onto an NxM grid. This step makes data available for comparison with LADCP data.

10) Append individual files using
>>mcod_mapend
This script will append individual files to create a single cruise file. It does seem to depend on the files having the same bin number and bin depths which was not the case on JR299, and much fiddling needed to be done to merge the files (see Problems and Troubleshooting section). Recommend 800 m (100x8 m bins) are used throughout future voyages conducted over mostly deep water. Note that mcod_mapend can be run in any directory and will automatically find and concatenate individual files.

11) cd /local/users/pstar/cruise/data/vmadcp/jr299_os75/jr299NNNnbenx
In directory apply the final cal ONLY ONCE (adjustments are cumulative, so if this step is done twice, the cal is applied twice) when you have done the edits and after inspecting the cal out files to decide what the amplitude and phase of the calibration should be (listed earlier in this section of report):
quick_adcp.py –-cntfile q_pyrot.cnt
(note two dashes before cntfile), where q_pyrot.cnt contains (for JR299):

```
# q_pyrot.cnt is
## comments follow hash marks; this is a comment line
--yearbase 2014
--rotate_angle 1.015
--rotate_amp 0
--steps2rerun rotate:navsteps:calib
--auto
# end of q_pyrot.cnt
```

Final calibration values used were those given by the combined JR299 calibration data.

12) In each directory re-create Matlab files:
>>cd /local/users/pstar/cruise/data/vmadcp/jr299_os75/jr299NNNnbenx
>>mcod_01
>>mcod_02
Then remove and recreate the appended matlab file:
>>cd /local/users/pstar/cruise/data/vmadcp/jr299_os75
>>!/bin/rm os75_jr299nnx_01.nc
>>mcod_mapend

7.6 Problems and troubleshooting

Sequences 15 to 18 were in shallow water, and so the number of bins was reduced in data acquisition to 32 (015, 017) and 16 (016, 018). The reduction to 16 bins caused a problem in the codas software. By default, the processing employs a reference level velocity estimated from bins 3 to 20. In principle, the start and end bin of the reference level velocity can be set using the parameters rl_startbin and rl_endbin in q_py.cnt. In fact, there is a bug in the Matlab code and these settings are not passed to all the places where they are needed. When only 16 bins were available, the code crashed.
A fix was achieved by editing a Matlab program in the uh_adcp software tree. Specifically, the program
…./sw/uh_adcp/programs/matlab/rawadcp/pedit/get_pedefaults.m
was edited in line 51 from

```
editcfg.rl_bins          = [3:20];   % stay away from ringing
```
to
```
editcfg.rl_bins          = [3:16];   % stay away from ringing
```

The latter version was then used for all remaining processing. The new bin level of 16 was hardwired, just as it had been previously hardwired to 20. This was a quick and robust solution, rather than attempting a general fix with the parameter being imported correctly from q_py.cnt.

A second consequence of the reduced number of bins was that running mcod_01 produced NetCDF files with fewer rows for those file sequences 015 to 018. This was fixed by an alternative version of mcod_02.m, named
mcod_02_pad.m

Normally, mcod_02.m takes the NetCDF file from mcod_01.m and pads all variables (including time, depth) to fully-dimensioned rectangular arrays. mcod_02_pad.m further pads down to a requested number of rows, for compatibility with the rest of the cruise: 50 rows for JR299. Variables {time, lat, lon, uship, vship} are replicated into all rows. {depth} is extrapolated using the depth interval calculated from data in the input file. {uabs, vabs} are filled with NaN. Thus all files of type os75_jr299???nnx_spd.nc have the same number of rows and can be appended to create a single cruise file.

7.7 BT calibration results

The phase and amplitude results shown from the seven sequences with BT data are shown in Tables 7.1 and 7.2. Additionally, all ENX files with BT data were processed in a single batch. Links to the raw data files were created in directory rawdata_allbt, and the data were processed in directory jr299_allbt. The final row of the table includes the output from this step. We conclude that a speed calibration of 1.015 is appropriate (compared with 1.010 chosen on JR281). The angle offset is not significantly different from zero. Recall that for a speed of 10 knots (500 cm/s), then 1 cm/s of adjustment is equivalent to 1.002 factor in speed or 0.1 degrees angle. Hence 1.015 amplitude is applied, and 0.03 phase is ignored. We notice that the standard deviations are much higher for the ‘shallow’ sequences 015 to 018 than for sequences 005, 032, 033, suggesting these determinations should have less influence on our final choice. These values are taken from bottom track data, which is more reliable, although similar values were recorded in the 'water track' mode.

Table 7.1: The amplitude calibration values obtained from bottom-tracking

Amplitude from analysis of BT				
Sequence	Number of points	Median	Mean	Standard deviation
005	114	1.0192	1.0209	0.0062
015	117	1.0951	1.1634	0.1774
016	160	1.0088	1.0086	0.0080
017	232	1.0367	1.0412	0.0316
018	62	1.0215	1.0269	0.0245
032	141	1.0147	1.0170	0.0065
033	93	1.0137	1.0143	0.0039
All	886	1.0154	1.0226	0.0214

Table 7.2: The phase calibration values obtained from bottom-tracking

Phase from analysis of BT				
Sequence	Number of points	Median	Mean	Standard deviation
005	114	-0.0264	0.0060	0.2136
015	117	-0.1339	-0.5988	1.5795
016	160	-0.1067	-0.2511	0.3539
017	232	0.8606	0.9359	0.8847
018	62	0.8129	0.9927	0.8942
032	141	0.0264	0.0885	0.2345
033	93	0.0298	0.0412	0.1793
All	886	0.0282	0.2528	0.6822

8. Underway

Jesse Cussack

8.1 Oceanlogger

8.1.1 Instrumentation and data collection

Surface ocean and meteorological data were logged continuously throughout the cruise.

Ocean data were collected from the ship's uncontaminated seawater supply, whilst the meteorological data were measured by instruments on the forward mast.

Both surface ocean and meteorological data were collected at 5 second intervals.

Instruments were as follows:

Oceanlogger
SeaBird Electronics SBE45 CTD
Turner Designs 10-AU Fluorometer

Meteorological data
Photosynthetically Active Radiation (PAR) 1, Parlite Quanum Sensor, Kipp & Zonen
Photosynthetically Active Radiation (PAR) 2, Parlite Quanum Sensor, Kipp & Zonen
Transmissometer 1, Proto1 SPLite, Kipp & Zonen
Transmissometer 2, Proto1 SPLite, Kipp & Zonen
Air temperature/humidity 1, Chilled Mirror Hygrometer MBW, PM-20251/1, Temperature Sensor Pt100, PM-20252/1
Anemometer (this logs wind speed relative to the ship. At this time there is no datastream for true wind, but this can be calculated from relative wind and navigational data, if required).

8.1.2 Processing

Initial processing was carried out in Unix, which generated files that could be further processed in Matlab.

Unix

get_underway Calls the scripts *get_oceanlog*, *get_anemom* and *get_truewind*, which invoke the *listit* command to retrieve 24 hours of underway data. Output files are *oceanlog.NNN*, *anemom.NNN* and *truewind.NNN*, where NNN is the jday.

Matlab

loadunderway Calls functions *loadoceanlog* and *loadanemom* to read *oceanlog.NNN* and *anemom.NNN*. Data are stored in structure arrays and saved as *oceanlogNNN.mat* and *anemomNNN.mat*. The program then calls the function *cleanoceanlog*, which sets unrealistic values to NaNs, uses *dspike* to remove large spikes in conductivity, housing (CTD) temperature and remote (hull) temperature. Data from periods of flow >1.5 l/min or <0.4 l/min are also set to NaNs, as are data from 5 minutes after a drop in flow to allow variables to return to normal. Surface ocean data are further cleaned using an interactive editor, which allows manual removal of data considered bad. On cruise JR299 the interactive editor was modified to allow the selection data within an arbitrary polygon. Salinity is then calculated using *ds_salt* and the interactive editor is used to remove spikes and flier points. The output is *oceanlogNNNclean.mat*.

plot_oceanlog_daily Loads *oceanlogNNNclean.mat* and *seatexNNN.mat*, calculates 1 minute averages and plots maps of sea surface temperature, salinity and fluorescence. Bathymetry data from GEBCO are included in the plots. Output files are *oceanlog_navNNN.mat* and *oceanlog_navNNN_1minave.mat*.

Mstar

Code2mstarOceanlog1min299 Converts the .mat *oceanlog_navNNN_1minave.mat* to *oceanlog_navNNN_1minave.nc* mstar netCDF files. These are of the form that would be produced using the complete mstar processing (as in JR239) so can be merged as before with CTD and salinityfiles for calibration of underway SST and salinity.

Temperature Calibration

Uncalibrated CTD temperature at 7m was found for each cast and merged with oceanlogger data for calibration of the SST data. The offset (CTD minus oceanlogger) was found to be in the range (0.00, -0.16) with very slight trend to more negative offset through the cruise and a mean of offset of -0.047ºC. These values were calculated using 59 data points after the removal of one outlier.

8.1.3 Salinity samples

Throughout the cruise, water samples were collected for salinity analysis in order to calibrate the underway conductivity sensor. The water samples were collected in 200ml medicine bottles. Standard procedure was to rinse the bottle three times, before filling it to just below the neck to allow room for expansion during warming and to facilitate mixing of the bottle's contents prior to analysis. The rim and cap of each bottle was wiped dry with a tissue, then a plastic seal inserted and the screw cap replaced. Ongoing crates of salt samples were kept in the salinometer lab and allowed to equilibrate with ambient conditions for at least 24 hours prior to analysis.

The samples were analysed on one of the shipboard Guildline 8400B Autosal salinometers (s/n 68959), which had been standardised at the beginning of the cruise using Ocean Scientific International Ltd (OSIL) P155-series standard seawater. Prior to, and following, analysis of each water sample crate, a new bottle of standard seawater was analysed to ensure that the salinometer remained stable and in order to derive a calibration offset. In between batches of salinity analysis, the salinometer was flushed, and filled with milli-Q. To avoid dilution of the first standard the salinometer was first flushed several times with standard seawater left over from previous analyses before analysing the first standard of each run.

Standard procedure was to invert each sample bottle a few times in order to mix the contents but avoid the introduction of a large number of air bubbles into the sample. The salinometer cell was then flushed three times with the sample, prior to taking the first reading. The cell was then flushed and refilled for two subsequent readings.

Once analysed, the conductivity ratios were entered by hand into an Excel spreadsheet, *JR299_underway_salts.xls*, converted to salinities and transferred to the Unix system. They were then used to investigate a conductivity offset for the underway sensor.

8.1.4 Salinity calibration

The salinity offset was calculated by differencing measurements of salinity from underway samples with coincident measurements from the oceanlogger (samples minus oceanlogger). Two distinct offsets were found for the first (Julian days 70 – 82) and second legs (90 – 115) of the cruise. The mean offset during the first leg was 0.025 with a range (0.000, 0.038) and no trend. The mean offset during the second leg was 0.035 with a range (-0.025, 0.077) with a trend to more positive offset with time. The cause for this change in offset is unknown but speculated to be a result of problems with the salinometer caused by the failure of temperature control in the laboratory.

8.1.5 Problems encountered

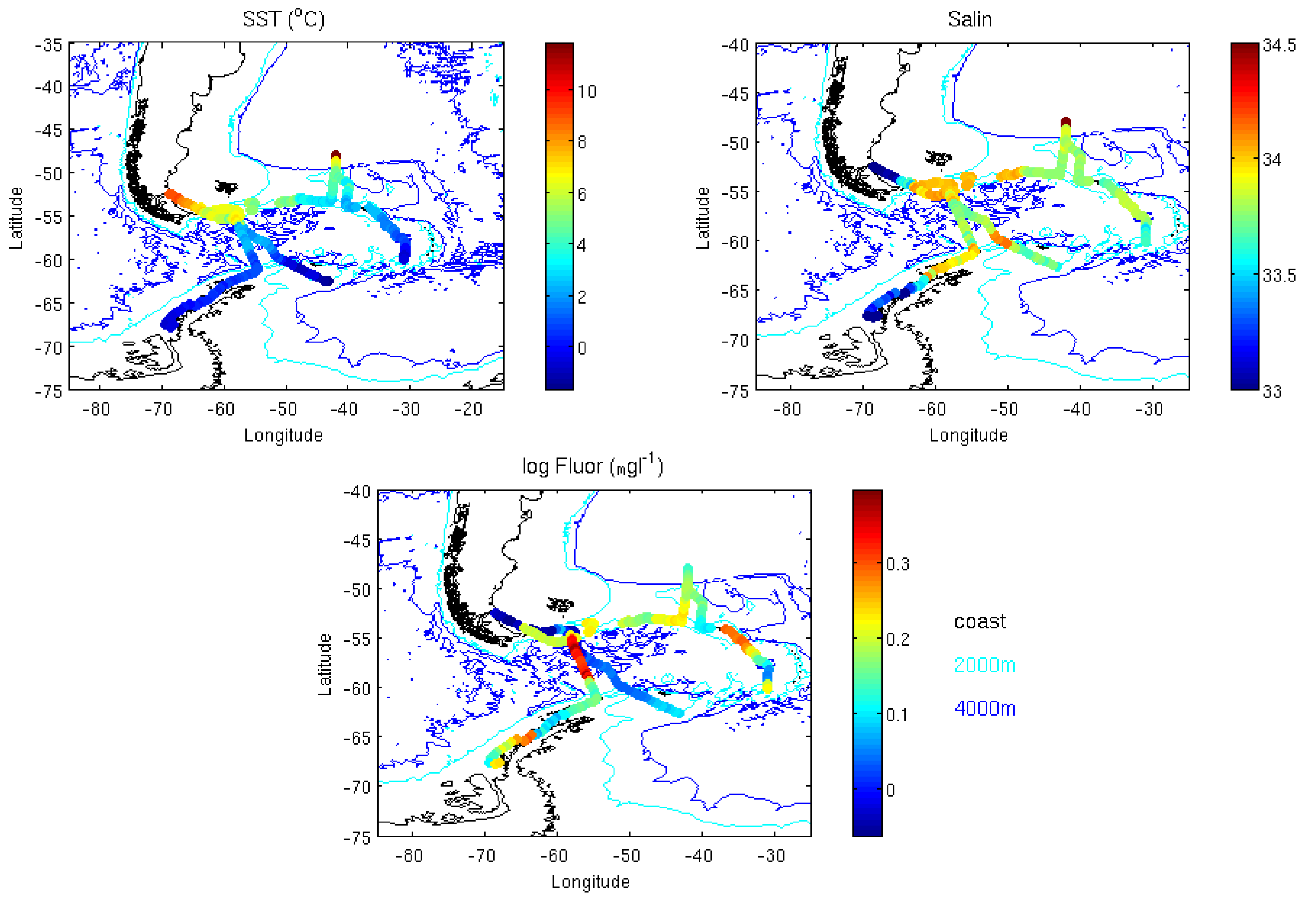
The flow to the oceanlogger was turned off on days 84 to 89 while bunkering in Punta Arenas and also on days 94 to 99 while working in sea ice. Occasional flow problems resulting in data losses, with significant losses on day 103. The flow was also switched off to avoid sediment blockages while near South Georgia on day 104.

On day 110 bubbles were discovered in the outflow tube which may have entered the system during rough weather conditions or by travelling up the outflow tube. To remove the bubbles, the flow was increased to 1.2 l/min for three minutes. The tube is now held in inverted U shape to stop further bubbles travelling up the tube.

The salinometry room temperature control failed during the second leg of the cruise, causing the air temperature in the room to oscillate between 19C and 26C over a period of days. This may have been related to engineering problems with ship heating control when entering sea ice and may have caused problems with the salinity calibration.

8.1.6 Example plot

Figure 8.1: Underway 1 shows the uncalibrated temperature, salinity and fluorescence along the cruise track



8.2 Underway Navigational Data

Jesse Cusack

8.2.1 Instrumentation and data collection

Navigational data were collected continuously throughout the cruise. Navigational data were collected every second.
Instrumentation was as follows:

Ashtec ADU2 GPS: antenna 1 used to determine the ship's position; antennae 2-4 used to determine pitch, roll and yaw.

Ashtec GLONASS GG24 (accurate to ≈15m)

Sperry Mk 37 Model D Gyrocompass

Seatex GPS (Seapath 200)

8.2.2 Processing

Navigational data were processed in Unix and Matlab using modified versions of programs developed by Mike Meredith and then read over into mstar netCDF format (still within Matlab). Data were initially read into the Unix system, then transferred to Matlab, where the bulk of the processing was carried out.

Unix

get_nav Calls the scripts *get_gyro*, *get_gpsash*, *get_gpsglos*, *get_seatex* and *get_tsshrp*, which invoke the *listit* command to retrieve 24 hours of gyrocompass, bestnav, Ashtec (ADU2), Ashtec Glonass (GG24), GPS NMEA, Seatex and tsshrp (heave, pitch and roll) data. Data are saved in subdirectories 'gyro', 'bestnav', 'gpsash', 'gpsglos', 'gpsnmea', 'seatex', and 'tsshrp' as *gyro.NNN*, *gpsash.NNN*, *gspglos.NNN*, *seatex.NNN* and *tsshrp.NNN*, where NNN is the jday.

Matlab

load_daily.m Reads in navigation files output by the Unix processing (above) by calling the following functions:

- *load_daily_gpsash*: reads in text file *gpsash.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gpsash/gpsashNNN.mat*.
- *load_daily_gpsglos*: reads in text file *gpsglos.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gpsglos/gpsglosNNN.mat*.
- *load_daily_gyro*: reads in text file *gyro.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gyro/gyroNNN.mat*.
- *load_daily_seatex*: reads in text file *seatex.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *seatex/seatexNNN.mat*.
- *load_daily_tsshrp*: reads in text file *tsshrp.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *tsshrp/tsshrpNNN.mat*.

For a quick visual check, the program then plots gpsglos and seatex data over one another (after plotting each dataset the user must hit return to continue), gyrocompass heading, and pitch and roll.

plot_seatex_all Plots entire cruise track. Loads *seatexNNN.mat* for all jdays and GEBCO bathymetry data.

code2mstar[stream]299 Reads the .mat files from *load_daily* into mstar format. This route was used as an alternative to the full mstar underway data processing (see JR239 cruise report for details of this). After this step all files are in the expected format and merge with other data such as CTD casts as expected.

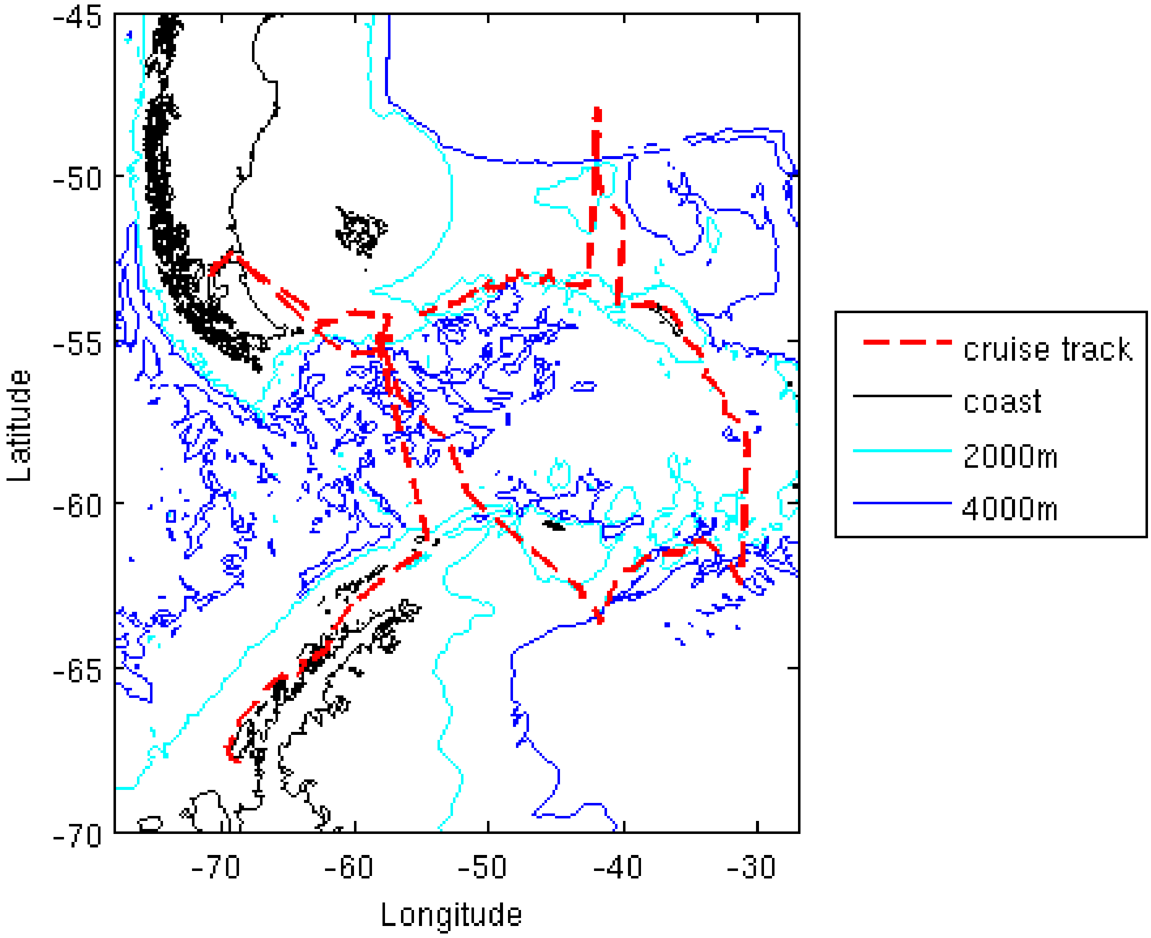
8.2.3 Problems encountered

Very few problems were encountered with the navigational data. For all navigational instruments, at various times during the cruise, the unix process compressing the raw GPS data occasionally failed. However, this did not result in the loss of any raw data and on restarting, the process resumed from where it had failed. On Julian day 107 gpsglos data was manually deleted because it was noisy and in disagreement with seatex. On days 108 and 111 parts of gpsglos data were deleted for the same reason. This did not affect the processing of any other data streams as they all make use of the more reliable seatex positions.

8.2.4 Example plot

A plot of the cruise track, extracted from the Seatex GPS is shown in Figures 8.2.

Figure 8.2: JR299 cruise track from Seatex GPS. Coastline and bathymetry data are from the GEBCO dataset.



9 Acoustic Data

Ewa Karczewska

9.1 Hydrography Echo Sounder EA600

Kongsberg Simrad EA600 is a single frequency echo sounder operating at 12kHz, with the transducers located approximately 5m below the water level.
Bathymetric data were logged approximately every 2 seconds.

Data processing for EA600 involved running the following scripts.
The scripts names were changed from sim500 to ea600 to match with the name of the instrumentation used.

get_ea600 (shell)	Uses the modified version of *listit* command from */users/dacon/projects/scs/bin/listit* to read in ea600 24 hour data into asci file and saves it as *ea600.xxx*.
Loadea600 (Matlab)	Reads in ea600*.xxx* into Matlab structure array and saves it as *ea600_xxx.mat.*
Cleanea600 (Matlab)	Loads ea600_*xxx.mat* and sets values ≤0 to NaN, then uses 1D linear interpolation to fill data gaps. The function *dspike* is used to remove spikes from the data which cleans the data further. It is then followed by linear interpolation to fill in the gaps in the data. The final step is to manually delete data anomalies using an interactive editor. The *inpolygon* function (see below) has been added to the interactive editor to make the selection of the inconsistent data points easier. Now, instead of drawing a rectangle to select the anomalies, a polygon can be drawn. The output is saved as *ea600_xxxclean.mat.*
scatter_depth (Matlab)	Loads 1 minute average latitude and longitude data from *nav/seatex/seatexxxx.mat* and *ea600_xxxclean.mat*, and then finds the nearest latitude and longitude which match both files at specified time. To make plotting easier 1 minute averages are then calculated, saved as *ea600_xxx_nav.mat*, and 1 minute average depth data is plotted. The output file is saved as *ea600_xxx_1minave.mat*

Path to ea600 code: */users/pstar/jcr/20140308/pstar/Code*
Path to ea600 data storage: */users/pstar/jcr/20140308/pstar/ea600*

9.1.1 Problems encountered

The depth readings from EA600 were consistently higher than EM122 by up to 50m.
When in ice or due to the bad weather conditions the data was particularly noisy.

cleanea600.m

```
%% Inpolygon funciton
   % Initially, the list of points is empty.
   xy = [];
   n = 0;
   % Loop, picking up the points.
   disp('Left mouse button picks points.')
   disp('Right mouse button picks last point.')
   but = 1;
   while but == 1
      [xi,yi,but] = ginput(1);
      plot(xi,yi,'ro')
      n = n+1;
      xy(n,:) = [xi yi];
      if n > 1
         plot(xy(:,1),xy(:,2),'g')
      end
   end
   % select points inside the polygon
   selected = inpolygon(x,ytemp,xy(:,1),xy(:,2));
   plot([xy(:,1);xy(1,1)], [xy(:,2); xy(1,2)],'r')
   plot(x(selected),ytemp(selected),'r.'

   %% end of inpolygon funciton
```

9.2 Opportunistic Swath Bathymetry

Ellen Bazeley-White

The multi-beam sonar on the JCR, a Kongsberg Simrad EM122, was running during most of the cruise, except during the time the ship was within the Argentinean exclusive economic zone.

No swath experts were on board and the guidance in "Using the EM122 on an Opportunistic Basis V3.1" (provided by Elanor Gowland and uploaded to the JCR wiki by Ellen Bazeley-White) was used to guide staff.

The multibeam swath on the JCR is operated through a windows based program called Seafloor Information System (SIS). The system is capable of operating several instruments simultaneously. However, on the JCR we only have one system, the EM122 and its serial number is 120, hence in SIS it appears as EM122_120.

In order to avoid interference between the EM122 and the EA600 single beam echosounder the two instruments need to be run through the SSU (Simrad Synchronisation Unit).

Ellen Bazeley-White made the digital event log JR299_EM122_Swath and liaised with the bridge to ask for opportunistic swath to be undertaken and provided the bridge with printed overview maps of the latest swath coverage (provided by Elanor Gowland) these showed the latest 2013/14 data as black lines rather than coloured bathymetric lines. Hugh Venables started the swath running on 12th March 2014; Jeremy Robst monitored the EM122 screens and changed the Sound Velocity Profiles (SVP) until 20th March 2014 when science ceased due to bad weather and the ship going alongside in Punta Arenas.

After the break in science swathing was started again by Pete Lens on 1st April 2014. Ellen provided the bridge with larger scale bathymetry print outs as we headed into less surveyed areas. From 1st April to 27th April 2014, the EM122 monitors were checked by Hugh, Pete, Ellen and Andrew Meijers (to check the sea bottom profile looked flatish) and the Force Depth was periodically adjusted.

From 1st to 10th April 2014 the SSU regularly crashed and was restarted by Pete or Hugh. There appeared to be no pattern to the crashing, it seemed to happen every few minutes for a period and then stay working for days. The reason was not determined. Swath was also turned off during this period for the moorings search or at the request of the bridge.

On 15th April 2014, Pete realised the synchronisation job to create SVPs from the CTD data was not running, on 17th April he determined this was due to an underscore having been used in the CTD file names. He manually changed the SVP and noted there wasn't too much variation. From 17th to 26th April the SVP was regularly updated using CTD data. The SVP files are located in 20140308\em122\common\svp_abscoeff and were named with the CTD number.

We stopped swathing on 27th April 2014 as the cruise drew to an end.

The files for the cruise were saved as survey jr299_a.

Table 9.1: Swath bathymetry EM122 event log

Time	Lat (seatex-gga - seatex-gga-lat)	Lon (seatex-gga - seatex-gga-lon)	Depth EA600 (ea600 - ea600-depth)	Depth EM122 (em122 - em122 -depth)	Heading (seatex-hdt - seatex-hdt-heading)	Comment	User
12/03/2014 10:25	-63.5861	-61.083	0	505.07	43.24	Swath started by HJV at 10.25. Briefly started at 10.10 but stopped to deal with ea600.	pdc
12/03/2014 13:13	-63.359	-60.6572	501.5	487.38	39.92	Named jr299_a. Bridge were informed and asked to assign as event 1.	pdc
17/03/2014 17:24	-56.495	-57.4064		3778.05	343.91	Switched to CTD SVP profile ctd_jr299_020_thinned.asvp	bridge
19/03/2014 18:46	-55.1138	-58.0055			2.83	Switched to CTD SVP ctd_jr299_032_thinned.asvp	bridge
20/03/2014 03:35	-54.8484	-58.2194	700.42		309.58	Swath switched off as had veered west of Drake Passage line in bad weather so science had to stop	pstar
01/04/2014 14:45	-54.8936	-58.0003	509.95	506.27	235.34	Swath started by Pete Lens following break in science between 20th March and 1st April 2014.	pdc

01/04/2014 23:52	-55.1211	-57.9991	2958.34	2800.84	219.93	Bridge given printed swath maps to aid planning of future waypoints to fill in gaps in data coverage.	pdc
04/04/2014 13:31	-62.5338	-43.3734	2774.02		136.99	Swath turned off following problems with the synchronisation, then turned on again.	pdc
04/04/2014 14:08	-62.6179	-43.2412			186.69	Swath turned off to aid searching for mooring.	pdc
10/04/2014 19:19	-57.97	-30.7548	3809.28		9.08	Pete Lens restarted the SSU following a crash.	pdc
11/04/2014 09:30	-57.3388	-31.8957	0	3632.48	298.06	Estimated time. SSU restarted by Hugh Venables.	pdc
14/04/2014 12:00	-53.9931	-37.1072	99.97	257.04	284.37	Estimated time. Bridge asked for swath to stop logging.	pdc
15/04/2014 00:00	-53.9144	-38.5444	198.91	160.92	262.87	Estimated time. Swath logging again, regular errors with SSU and SVP chron job not working.	pdc
17/04/2014 18:11	-48.7069	-42	5716.99	5780.21	280.9	Pete Lens identified the SVP chron job not working as CTD files are being saved with an _ (underscore) in the filename. Pete manually updated the SVP to cast 72, not too much variation.	pdc
18/04/2014 19:52	-48.9372	-42.0003	5342.21	5361.33	282.92	Pete lens changed the SVP to the cast for CTD76.	pdc
18/04/2014 23:36	-48.9372	-41.9999	5336	5359	281.74	New SVP from CTD cast 077 - Pete Lens	guest
19/04/2014 12:29	-50.373	-42.1819	1413.12	1386	187.79	New SVP from CTD cast 078 - Pete Lens	guest
20/04/2014 11:34	-53.2714	-43.7506	1413.12	1392	338.95	New SVP from CTD cast 080 - Pete Lens	guest
20/04/2014 17:06	-53.2605	-44.9289		1899	269.46	Error Message Appeared in SIS ; PU Sensor Error. Pressed OK and red flashing border went away, all green indicators and numerical display data correct. PCDL	guest
20/04/2014 22:24	-52.904	-45.506		2570.59	334.49	New SVP from CTD cast 082 - Pete Lens	guest
21/04/2014 13:18	-53.0246	-47.3756		1964	179.52	New SVP from CTD cast 086 - Pete Lens	guest
21/04/2014 18:12	-52.9191	-47.7529		2990	159.15	New SVP from CTD cast 087 - Pete Lens	guest
22/04/2014 12:51	-53.1755	-48.6867	2571.26	2601	232.18	New SVP from CTD cast 093 - Pete Lens	guest
22/04/2014 19:41	-53.3339	-49.0596		3105	239.85	New SVP from CTD cast 095 - Pete Lens	guest
23/04/2014 13:13	-53.3852	-49.8377		1017	271.4	New SVP from CTD cast 100 - Pete Lens	guest
23/04/2014 21:02	-53.3467	-50.6088	0	604.28	244.53	New SVP from CTD cast 102 - Pete Lens	guest
24/04/2014 13:13	-53.9868	-53.6165		1362	258.47	New SVP from CTD cast 106 - Pete Lens	guest
25/04/2014 21:22	-53.5586	-55.6844	3216.38	3186	330.37	New SVP from CTD cast 114 - Pete Lens	guest
26/04/2014 12:26	-53.506	-57.6567		2560	336.76	New SVP from CTD cast 118 - Pete Lens	guest
27/04/2014 07:10	-51.6772	-57.549	0		346.32	Swath off for passage into Falklands. The end. HJV	guest

10 Survey of the DIMES Tracer

Jim Ledwell

10.1 Objectives

One objective of Cruise JR299 was to sample the tracer that was deployed early in February, 2009, to the west of Drake Passage, approximately midway between the Polar Front and the Subantarctic Front. The release was in a rough 20-km 'x' pattern centered near 58 S, 107 W, on the 27.9 kg/m^3 neutral density surface (σ_θ = 27.675 kg/m^3), the depth of which was approximately 1500 meters at that location. The tracer used was CF_3SF_5, trifluoromethyl sulfur pentafluoride, and the amount released was approximately 76 kg, or 388 moles. This tracer release was part of DIMES, the Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean. The tracer has been sampled approximately yearly since 2009, with some auxiliary sampling along transects across Drake Passage during the winters of 2011 and 2013. As the name of the project implies, the aim of the tracer release is to measure mixing across (diapycnal) and along (isopycnal) surfaces of neutral density.

It was well known from previous DIMES cruises that most of the tracer by the time of Cruise JR299, taking place more than five years after the release, had already passed through the Scotia Sea and was well on its way into the South Atlantic and beyond. However, along-ACC dispersion was such that some tracer was still present in the Scotia Sea, albeit in concentrations just above the limit of detection, which is about 0.006 fM extracted from 1.5 litres of water (or 0.003 fM for "doubled" samples (see below)). This tracer was sampled during JR299 in the hopes of adding information on mixing from DIMES. The different sections occupied during the cruise had somewhat different motives or emphases.

Tracer sampling along line SR1b was intended to gather further measurement of diapycnal mixing between the entry to Drake Passage, near 67 W, and SR1b, near 57 W. The diapycnal distribution of tracer entering Drake Passage can be estimated accurately from previous sampling by assuming that the diffusivity to the west remains roughly constant with time, because DIMES has produced an accurate measurement of that diffusivity over 5 years. Between 67 W and 57 W lies a great deal of rough topography, and DIMES had already found greatly enhanced diapycnal mixing in this region, compared with that in the SE Pacific sector of the ACC. Our hope was to obtain further confirmation of this large mixing. Whether we did or not remains to be seen, as the tracer concentrations were too low to come to a quick answer. More careful analysis of those data may or may not bear more fruit. Another goal of the SR1b occupation was to determine how much tracer was south of the Polar Front, as the rate, location, and transport across the various fronts of the ACC are prime targets of DIMES. In this goal our sampling along SR1b was successful in that we can make fairly accurate estimates of the column integral of the tracer as a function of latitude. Some of the larger column integrals were in fact found south of the Polar Front. These data, combined with other data and high resolution numerical models, may help shed light on the cross-front transport.

Line A23 is well to the east of the where the ACC turns north to pass through and over the North Scotia Ridge. All of the stations occupied along A23 were therefore poleward of the

Polar Front, and most were poleward of the SACCF front, which appeared to be nestled against the SE end of S. Georgia Island during the time of the cruise. The column integrals found south of the SACCF were quite low, and uncertain due to the uncertain correction for the CF_3SF_5 that had invaded from the atmosphere (see below). Column integrals within the SACCF along A23 were higher those along SR1b (Figure 10.1).

Sampling along the transect to the north of the North Scotia Ridge was aimed at crossing the ACC where it was again headed east, having circulated through the SW area of the Argentine Basin. The aim of this sampling was to add to the data from previous cruises on the diapycnal distribution of the tracer there, and thus diapycnal mixing in the space between the North Scotia Ridge and this line. Another aim was to determine the spread of tracer-weighted salinity on neutral density surfaces, compared with sections upstream, to measure the amount of "irreversible" lateral diffusion that has occurred along the path of the tracer.

Tracer sampling along the North Scotia Ridge was aimed at obtaining a final measurement of the distribution of the tracer at the exit of the ACC from the Scotia Sea. Comparison of the distribution with that near 67 W, at the entry to the Scotia Sea, together with models of the circulation between the two locations, can give an estimate of diapycnal mixing integrated over the Scotia Sea, one of the primary goals of DIMES.

10.2 Methods

10.2.1 Sampling

Niskins were sampled by drawing water into 2-litre bottles in the following way. The sample tube was cleared of air with the water flowing. The tube was pinched tightly and the end of the tube lowered to the bottom of the 2-litre bottle. While still pinching the tube partially to limit the flow, the bottle was filled to the brim. Then the tube was no longer pinched while the bottle overflowed for a set time. Up until Station 26, this time was specified to be 40 seconds. However, it was found that, at least for a half empty Niskin, the time to flow 2 litres of water was 70 s. Hence the time was increased to one minute at Station 26, in the attempt to get at least one complete flush of the 2-litre bottle.

The samples were stored in the ship's refrigerated room, set at 4 C, while waiting for analysis. Analysis was completed with 12 hours of sampling. Bubbles did not form in the bottles during storage.

10.2.2 Gas Chromatography

As for previous cruises, a flow restrictor (10" molecular sieve column) was installed at the outlet of the carrier gas stream to increase the pressure in the lines above ambient pressure. This measure reduces the signal by about a factor of two, but reduces the noise level by quite a bit more than that. The GC parameters and columns are listed in Table 10.1.

Large Sparge Tower
The volume of the sparge tower was 1.567 litres. Tests have shown that 10 minutes of sparging at 150 ml/min are required to extract 95% of the tracer, at a sample temperature

of 2 C. Slightly higher efficiency, perhaps 96.5%, was obtained at 15 C. The temperature of the samples at the time of running them were typically 2 to 6 C, so 95% was assumed as the efficiency to correct all concentrations.

Cold Trap
The tracer and other, unwanted, gases were trapped on a Unibeads-2S trap packed in 1/8" stainless tubing. The volume of material was approximately 0.1 ml. The trap was kept at approximately -70 C during sparging and was raised to approximately 80 C during release.

Breakthrough Tests
On a recent cruise the cold trap was tested for breakthrough time by flowing standards onto the trap for longer and longer times. For times up to 24 minutes, at 150 ml/min, there did not appear to be any loss of standard, so 10 minutes were deemed safe. Also, it did appear that, within uncertainty, double samples, for which 3 litres of sparge gas were passed through the trap, were consistent with single samples from the same depth. This was decidedly not the case for CFC13, as discussed later. The breakthrough volume for CFC13 was exceeded by a great deal even with 1.5 litres of sparging.

Table 10.1: GC Parameters

Shimadzu GC-8AE	S/N C10494519797SA
ECD	10 mCi
Carrier Gas	Indura UHP N2 Tank
Sparge Gas	Indura UHP N2 Tank
Cleanup Traps	Not in use
Column inlet pressure	32.5 psig
Valve A	4" Mol Sieve
Valve H	4' Unibeads 3S & 6' Carbograph w. 1%AT1000
Main Columns in GC oven	70 C; Baked at 180C at least once a day
Precolumn in B&D oven	~58 C; Heated to ~96 C for 75 s each run
	Baked at 210 C at least once a day
Flow rate: H on front flush	23.5 ml/min;
" No columns; through ECD	30 ml/min;
H on backflush	25.6 ml/min;
A on backflush	23.1 ml/min;
Retention time CF3SF5	2:31;
Detector Temperature	330 C
Detector Current	2.0 nA
Zero	~6 turns away from the stop
Noise level	0.02 mv pk to pk (very good)
CF_3SF_5 peak height Std 5A LL (0.922 ml NTP x 106 ppt)	2.2 mv
Outlet resistor	10" Mol Sieve "DIMES 11 Feb 09"
Bubbles formed	No bubbles were seen from storage
Tower volume:	1.567 L at the top of the neck
Sparge pressure	15 psig

Tower vacuum achieved	0.4 to 0.5 psia, according to the pressure gauge.
Sample program	Trap1_1500.xls

10.3 Operating Procedures

10.3.1 Main Columns

The main columns, 4' of Unibeads 3S and 6' of Carbograph with 1% AT1000, were in a Shimadzu GC8A oven at 70C. They were baked as often as possible, usually after every second or third cast, at 180 C for as long as possible. It took at least 30 minutes to get them back to steady state at 70 C, and an hour was usually allowed for this.

10.3.2 Precolumn

A 4" long Molecular Sieve 5A column was used to remove N_2O from the chromatograms. This column was in a toaster oven, with the column wrapped in heating tape. At the start of the cruise there was a thermocouple in the air space in the oven read by the Channel-2 Temperature circuit in the system control box. The oven and heating tape were on separate Variacs (in the case of the oven, this measure was used to prevent the oven heating system from cycling on and off). The Variac for oven power is set at 18.5% while running samples. A small "personal fan" was directed at the back of the oven. There was no insulation on the top of the oven. With no power to the thermal tape this configuration keeps the temperature at the thermocouple at 52 to 58 C. These are the conditions at which a sample was injected into the GC: fan on; no insulation on oven, power to thermal tape off, and power at 18.5% to the oven heating elements.

The Molelcular Sieve column was heated and backflushed during each sample run after the tracer eluted from it, but before the N_2O eluted. With the parameters of the current cruise, backflush occurred 25 seconds after injection. Heating of the Molecular Sieve column starts a few seconds later by sending current to the thermal tape around the column. The thermal tape Variac was set at 50% and connected to the outlet at the back of the GC control box governed by the circuit for "Heater 2" (or later in the cruise run manually, when Heater 2 circuit was required for the Unibeads trap due to a failure of the Heater 1 circuit). Thus, the control program, or the operator, turned on power to the tape after backflush, and then turned it off after 75 s. The temperature at the thermocouple rose to about 96 C, then decreased to around 54 C by the time of the next injection.

When there was sufficient time, at the same time the main columns were baked, the Mol. Sieve column was also baked, in the following configuration: fan off; a layer of insulation on the top of the toaster oven; no power to the thermal tape; power to the over heating element raised by setting its Variac to 48%; (the temperature setting on the oven was always at 260 C to prevent it from turning on and off). This arrangement brought the temperature of the Molecular Sieve column to about 200 C.

10.3.3 Chromatogram Recording

Chromatograms were recorded with a netbook which received detector output in digital form via a DATAQ DI-710 A to D converter, and also on paper with a chart recorder. The digital data were acquired via software (called WINDAQ) provided by DATAQ. The finest range, of -0.01 to +0.01 volts, was used. Care was taken to keep the signals of interest within this range. The sensitivity and noise level of the DI-710 were adequate for the chromatograms. Data were saved at 10 Hz, giving a duration of 5 hours for the WINDAQ data storage program. This time was usually a bit too short to store the data from a full cast, unless storage was turned off between chromatograms. Storage was left on for the most part to avoid losing data by forgetting to turn it back on. Thus the data for full casts are typically in two files, for example STA012A.WDQ and STA012B.WDQ for station 12. For Stations 34 and 36 more than two files were required due to problems encountered during the runs. Some chromatograms were not recorded due to a malfunction of the netbook computer or due to failure to start the record function. The areas for these chromatograms were crudely estimated by comparing the very small peaks on the paper chart with other peaks that were recorded digitally.

WINDAQ provides the ability to convert the data to Excel .CSV files. When converting, only the 10 Hz voltages were saved, so just one column of numbers. The user must be aware that the data were recorded at 10 Hz. It has not been found convenient to label the chromatograms in any way in the WINDAQ files, so chromatograms were identified by their place in the sequence in the file, using numbers entered on the paper chart record and on the hand-written GC log sheet used during a run. The number of chromatograms in a file was usually less than 20, so identification is not difficult. Both WDQ and CSV files were transferred via thumb drive to a computer used to integrate the peaks and further analyze the data with programs written in Matlab. This computer was backed up daily on another computer, and the data remained on the thumb drive as well as the netbook, so that ultimately there were four copies of the data. Additionally, all tracer-related files were backed up on the L-Drive of the ship's science computer system.

The chart recorder was useful for monitoring the long term behavior of the GC, for giving an easy view of the series of chromatograms from a station while running samples, and for later identification of chromatograms in the DATAQ files, as mentioned above. The paper chart records were folded and saved in file folders, organized by Station number. If digital data were lost for some reason, then the peak areas of interest could be estimated from the paper records as described above, although with great uncertainty.

10.3.4 Peak Integration

The CFC-13 and CF_3SF_5 peak areas were integrated subjectively with the aid of a Matlab program. Because many of the CF3SF5 peaks were close to the minimum detectable level, or below, approximate start and end times, relative to the injection pulse, were determined for a chromatogram in the run showing a clear CF3SF5 peak. These times were marked on the peaks to be integrated as a guide to the user (Figure 10.1). Points on the baseline near these marks were chosen, and the area of the peak above the line segment between these two points was calculated. Care was taken in choosing end points that average properly over the local noise, and to avoid inaccurate areas that result from sudden shifts in the baseline in the vicinity of the points. A set of quality indicators was developed to record various problems encountered in the process and these were stored by number with the peak areas.

Many of the peaks were barely distinguishable from random fluctuations in the baseline. Therefore the following measures were taken to avoid bias in the integration:

1. The bottles chosen from the coolers to sample from the Niskins were chosen randomly, in no sensible order matching the Niskin numbers.

2. The samples were run in random order, selected by the GC operator in no particular order from the coolers holding them.

3. When integrating the peaks in Matlab, there was almost no awareness of where the peaks belong in the vertical profile.

10.3.5 Baseline Evolution

The baseline during analysis of the SR1b samples was sloping downward during elution of the CFC-13 and tracer peaks, while it was fairly flat for later samples (Figure 10.2 shows an example). This difference may have been due to the introduction of the clean-up traps in the carrier and sparge gas lines after SR1b or it may have been merely due to more baking of the columns and detector. In any case, sensitivity and accuracy were improved after SR1b. Also the technique of integrating the peaks was changed, in that a single linear baseline was chosen between the start of the CFC-13 peak and the end of the tracer peak, rather than a separate line for each peak. This approach assumes a flat or uniformly sloping baseline under the peaks, which seemed justified in most cases. For larger peaks there was overlap between the two peaks and the valley between them did not reach this baseline. In some cases for smaller peaks there did seem to be a departure of the baseline from straight. In particular, for some peaks there did seem to be a dip in the signal near the start of the tracer peak. The quality key assigned to each tracer peak as part of the integration procedure was used to flag such problems with the baseline.

Figure 10.1: The larger peak, on the left is CFC-13. The small peak on the slope after the CFC-13 is one of the largest tracer peaks obtained during SR1b. The sample is from 1330 m depth at Station 28. The peak area gave a concentration of 0.027 fM. One could argue that the start time for the integration should have been chosen to be earlier, but uniform start and end times were used for all the GC analysis for SR1b, to for the sake of objectivity in the process.

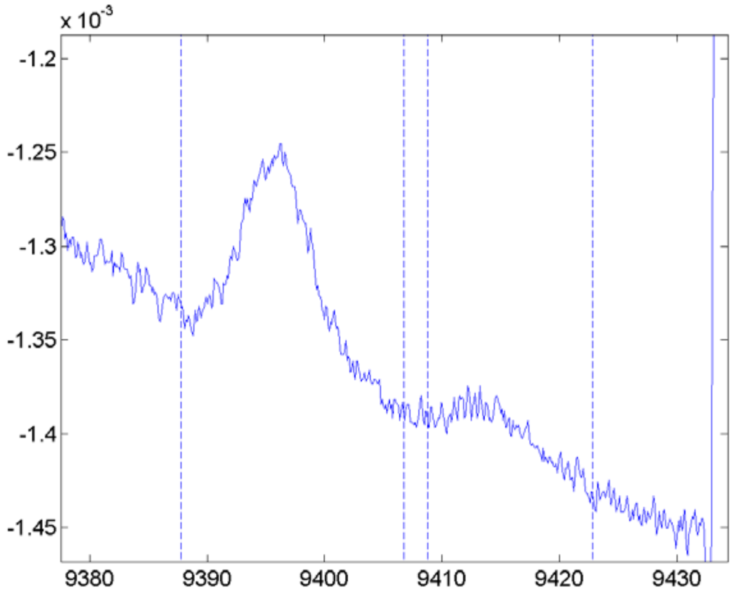
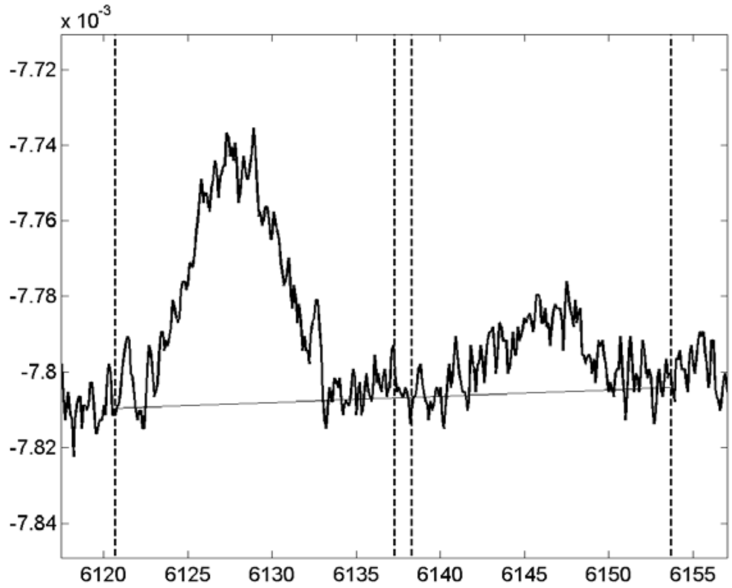


Figure 10.2: Chromatogram for the sample from Niskin 7, Station 134. The fine line shows an estimate of the baseline, above which areas for the tracer peak, on the right and the CFC-13 peak, on the left, were integrated. The tracer concentration estimated for this chromatogram was 0.020 fM, a typical value.



In spite of these measures there was a positive mean bias in the integrations, of approximately 0.0042 fM (see the very end of this section on the tracer survey, which presents the mean of all the data). This bias will be analyzed in more detail post cruise.

10.3.6 Quality and Comment Key

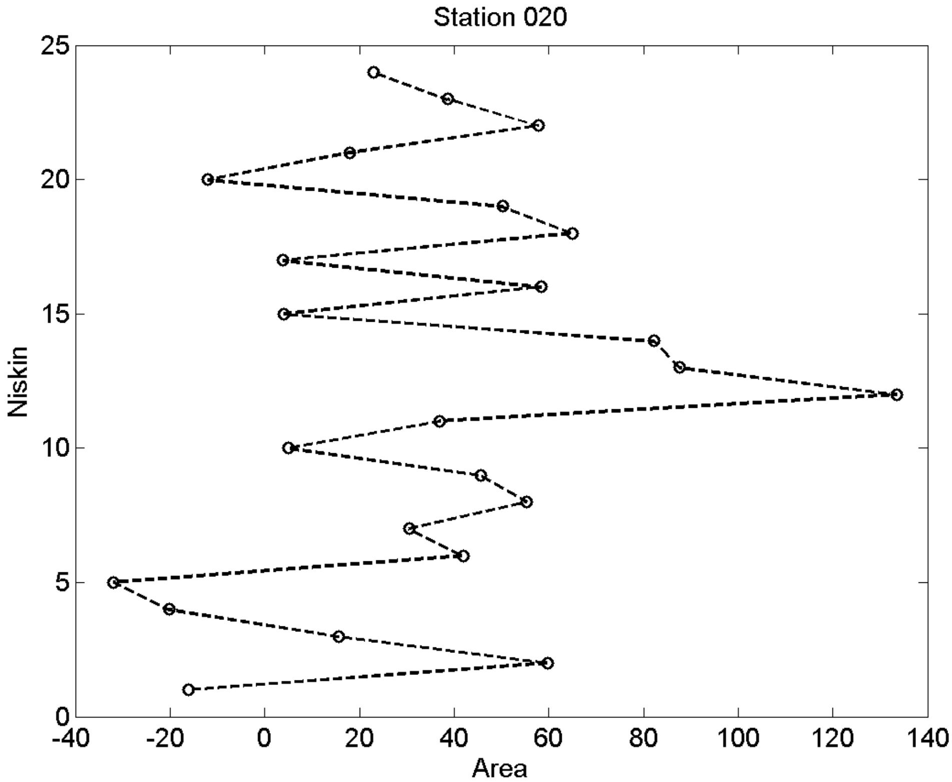
The following quality indicators were generated during integration of the various peaks and stored with the areas for the peaks. For the data set as of the end of the cruise, the uncertainty assigned to the areas does not reflect these comments, but they may be taken into account in formal uncertainties later.

0 OK
1 Looks like just noise
2 Baseline difficult to define
3 Peak heights used
4 Could be tracer, but a very small peak
5 Near-surface sample; Big CFC-13 peak with tracer on or near the tail
6 Severe Baseline slope not related to F14 – discard the area.
7 Peak seems offset in time; is it real?
8 Std 5ALL
9 Lost during the GC run, or not a sample or standard peak; ignore.
10 Near surface sample with well separated peaks
11 Std affected by too quick backflush of the Mol Sieve Column
12 Std run at different flow rate
13 Bad due to a rising baseline; discard the area.
15 First analysis of a spiked sample
16 Analysis of a resparge of a spiked sample
17 Lost some sample to vacuum; discard the area.
18 First sample of a run – area suspect due to possible air contamination
19 Trap bake off
20 Nitrogen Blank
21 Difficult dip before the tracer peak. First paid attention on STA012B peaks
22 CFC-13 and CF3SF5 tails merge significantly
23 Sample not injected: example of baseline noise
24 Convex baseline masquerading as a small peak?
25 Start time applied seems off
26 Concave baseline giving a negative area
27 Big peaks, merged, flat baseline, integrating wrt to a straight line from CFC-13 front to CF3 tail
29 N20 let through; tracer on its tail
30 Sloping baseline due to rinse anomaly; ok
31 Dip at the end of the CFC-13 peak, before the CF3SF5 peak

10.3.7 Double Samples

On inspection of the data through Station 18, it could not be said with certainty whether or not we had found any tracer from the DIMES release (see Figure 10.3). In the extreme case that none had been found then we can estimate the positive bias of the integrations at about 25 microvolt-seconds, corresponding to about 0.005 fM, and the standard deviation of replicate samples at about 30 microvolt seconds, corresponding to 0.006 fM concentration. Also, as of Station 18 we had only half a dozen or so stations left on line SR1b, and we had not yet crossed the Polar Front, so very few statistics could be obtained. The mean profile from US5 was reasonably good in spite of the low concentrations. However, that profile was the mean of 24 stations, most of which had measureable tracer. The concentrations expected in the ACC, north of the Polar Front along SR1b on the present cruise are not expected to be any greater than during US5. Hence to obtain sufficient statistics for an adequate mean, better accuracy on individual concentrations would be needed. Hence it was decided to try to sparge twice as much water for each sample, in the hope that the signal would be doubled while the noise would remain unchanged.

Figure 10.3: Example of bias and noise; Station 20 profile. The mean of areas less than 70 is 25.2, and the standard deviation of these same areas is 29.5. The three areas greater than 70 seem to indicate tracer near the target density surface, which was near Niskin 13. There is no doubt tracer in some of the other samples as well so the estimates of both the bias and the standard deviation are high. (Area units are microvolt-seconds).



The idea was to sparge two samples onto the cold trap before heating and injecting into the GC system. A test was done with samples from the underway seawater system. Six samples were drawn and analyzed in the following way. Two samples were sparged onto the trap before analysis. Then one sample, then two, and then one again. The results as recorded by the DATAQ system are in the file doubles_test.CSV. Here are the areas:

Sample Bottles	$A(CF_3SF_5)$	A(CFC-13)	2x2nd/1st CF_3SF_5	2x2nd/1st CFC-13
X5 + H05	731	24586		
X1	369	23927	1.008	1.936
C09 + J02	703	24947		
A5	319	24145	0.908	1.946

The area for the single samples should be half as great as for the doubles. The ratios of twice the area for the single samples to the areas of the double samples are listed in columns 4 and 5 of the table. These ratios are approximately unity for CF3SF5, and in fact is the case within the uncertainty of the integrations, for the ratios in the fourth column vary considerably if the integrations are repeated. For CFC-13 we see that sparging two samples gives scarcely greater area than sparging one. This means that CFC-13 was already breaking through the trap even for the first sample. Hence our CFC-13 values for the whole cruise are not quantitative; we are losing CFC-13 out the end of the trap. Nevertheless, assuming the system is linear, we will use the CFC-13 area to estimate the fraction of CF_3SF_5 that is from the atmospheric source.
The noise level was not obviously greater for the double samples than for the single, so it was decided to use double samples for the stations subsequent to Station 20. These start with Station 24, since there was no sampling at Stations 21-23.

Because of the rate at which stations were occupied and the limited number of sample bottles available, fewer than 24 levels were sampled at the DIMES tracer stations. It was decided to trip two Niskins at most of the levels sampled at the DIMES stations, to avoid effects of gas exchange in a second sample drawn from a Niskin. Later in the cruise, it was found that the second sample was of good quality as long as the level in the Niskin did not drop too far, and so in later casts 2 bottles were filled from one Niskin. To obtain better coverage with the 24 Niskins, though, only one Niskin was tripped at levels at the ends of the profile. For example at Stations 24 and 28 only Niskin 1, 2, 23, and 24 were tripped at different levels, while the other Niskins were tripped in pairs at single levels. Hence, two samples were drawn from the 4 end Niskins while only 1 sample needed to be drawn from the others.

We did return to single samples for the majority of the stations beyond Station 68, i.e., after passing by South Georgia Island. This decision was based on the higher quality integrations that were obtained with a much flatter baseline than seen during SR1b, and also higher concentrations encountered. Table 10.2 lists which method was used, by station.

Table 10.2: Summary of strategies for drawing samples from the Niskin bottles

Stations	Method	Comment
1-20	One bottle filled from each Niskin	Peaks very small
24-34	Two Niskins tripped at most depths; Bottles filled from the pair combined on the trap during analysis..	Larger peaks obtained doubled the sensitivity
35	Three Niskins tripped all at one depth near the target surface; two bottles filled from each Niskin; one pair combined; two pairs run separately, as a test.	Showed that the qualtiy of the second sample drawn was good.
36-73	Two bottles filled from each Niskin and combined in analysis.	Made more levels accessible with the 24-place rosette.
74-84	One bottle filled from each Niskin	Concentrations were generally high enough, and GC baseline quiet enough to justify this choice, which speeded sampling and analysis
86-102, 106	One bottle filled from each Niskin	
104, 108, 110	Two bottles filled from each Niskin and combined in analysis.	Low concentrations in western Shag Rocks Passage
122, 124	Two bottles filled; all samples were from above the σ_θ=27.5 surface.	Far western North Scotia Ridge
130-134	Single bottles filled and run, except for 131, for which two bottles were combined.	Falkland Trough Stations

10.3.8 Concentration Calculation and Uncertainties

Concentrations were calculated from the formula:

$$C = (A/A_{std})\ f_{std}\ (v_{loop}/V_w)(1\ \text{mole}/22.4\ \text{L atm})\ P_{lab}\ (273.15\ \text{K}/(273.15\ \text{K}+T_{loop}))$$

For example, A = 30 microvolt-s, and V_w = 1.567 L (1 sample), this formula gives approximately 0.006 fM, which is the noise level of analysis (1 standard deviation). The highest concentration expected is less than 0.03 fM. Therefore, the rms noise level is greater than 16% for all samples. This percentage error is reduced by a factor or 2 when two samples are loaded onto the cold trap, all else being equal, because V_w is doubled. In any case, the uncertainty of the peak area integration dwarfs all other sources of uncertainty for this cruise.

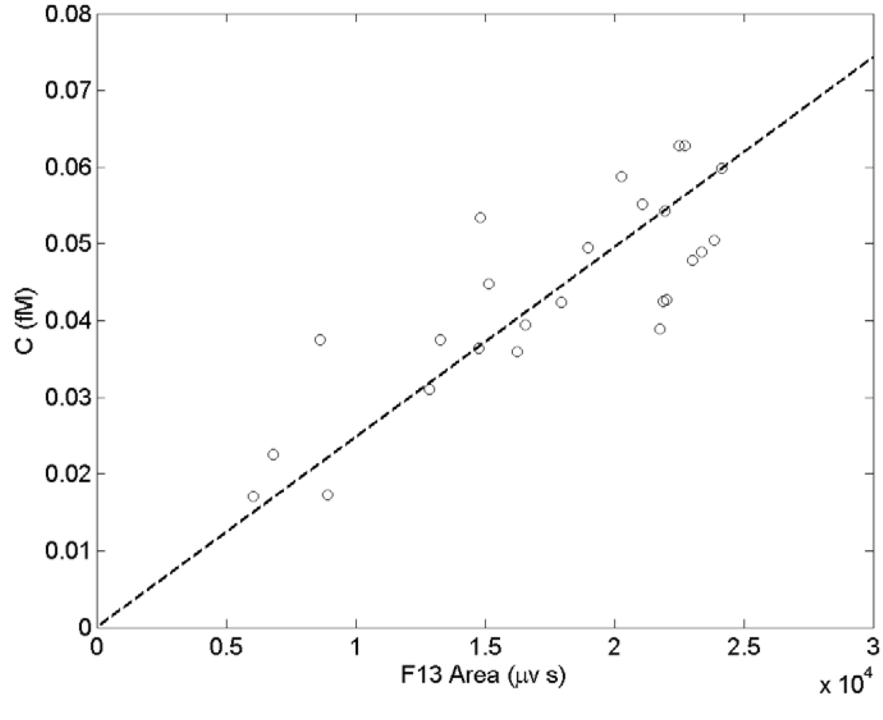
As noted above, there did appear to be a mean positive bias of order 30 microvolts because of the way the areas are integrated. This bias will dwarf all other biases, for example due to air invasion during sampling, except perhaps in a few exceptional cases when a second sample is drawn from a nearly empty Niskin.

10.3.9 Effect of tracer invading from the atmosphere

CF_3SF_5 that had invaded from the atmosphere was present in the samples, especially those south of the Polar Front, where sampling was closer to the surface and in waters more recently in contact with the atmosphere. Sampling during DIMES Cruise US5, in October/November 2013 in the Polar Front near 67 W, with the same GC system and operating parameters as used here, indicated that there is a linear relation between the tracer concentration observed well above the layer occupied by the tracer released for DIMES, and the area of the CFC-13 peak.

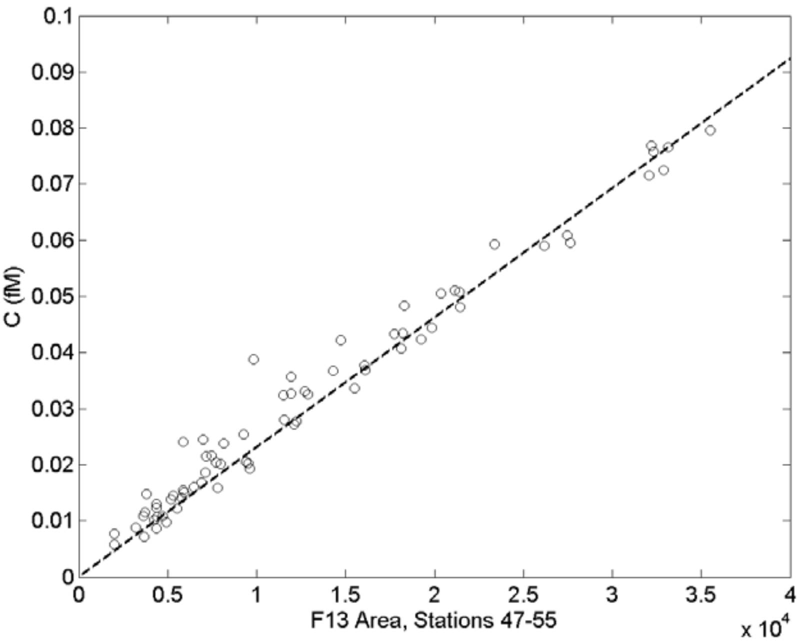
A similar relation has been found during the present cruise, although the coefficient in the relation seemed to change between the time of occupation of A23 and the work west of South Georgia Island. Figure 10.4 is a scatter plot from all the samples taken from Stations 8 through 19, along SR1b, that were at potential density less than 27.525 kg/m^3. The slope of the line, 2.48 x 10^{-6} fM (μv s)$^{-1}$, has been used for the coefficient in the estimation of atmospheric derived CF_3SF_5 as a function of CFC-13 area for all the samples along SR1b, i.e., for Stations 1 through 38.

Figure 10.4: Tracer concentration versus CFC-13 area for Stations 8 through 19, along SR1b, and for σ_θ < 27.525 kg/m^3.



The coefficient for the samples along A23 was virtually the same. Figure 10.5 shows the scatter plot for Stations 47 through 55, at which very little tracer from the DIMES release appeared to be present. The slope of the least-squares fit line, forced to go through the origin, is 2.32 x 10^{-6} fM (μv s)$^{-1}$, has been used to estimate atmospheric-derived CF_3SF_5 for the samples along A23. The samples on which this coefficient is based were doubled on the trap, with twice the volume of water sparged. The area of the CFC-13 peak, however, was not doubled, and in fact was apparently the same as if only a single sample had been sparged. As noted above, this effect implies that the trap comes to equilibrium with the CFC-13 in the sample in a time short compared with the 10-minute sparge time. The slope of the line fitting the data is different than found for US5 and for the present cruise. Whether this is due to the actual relationship between tracer and CFC-13 concentration was different in this area, or was due to the different handling of samples, or different characteristics of the GC system, is impossible to say.

Figure 10.5: Concentration of CF3SF5 versus peak area for CFC13 for samples doubled on the cold trap from Stations 47-55. The slope of the dashed line is 2.31×10^{-6} fM (μv-s)$^{-1}$.



There was a hiatus in sampling and a long bake of the columns and trap after Station 68 as we passed by S. Georgia Island. The coefficient in the relation bound between CFC-13 and the tracer concentration well above the layer of the tracer was have increased to 3.18×10^{-6} (Figures 10.6 and 10.7). Again, it is not known whether this change is due to a change to the older water masses of the Polar Front and Sub-Antarctic Front, compared with south of the Polar Front, or to a change in the GC system sensitivity to CFC-13.

Figure 10.6: Concentration of CF3SF5 versus peak area for CFC13 for samples from Stations along the North Scotia Ridge, Stations 69 through 110, but excluding 73-84. Most of the points along the line are for single samples. The slope of the dashed line is 3.18×10^{-6} fM $(\mu v\text{-}s)^{-1}$, *as for the doubled samples from Stations 122 and 124 (Figure 10.7)*.

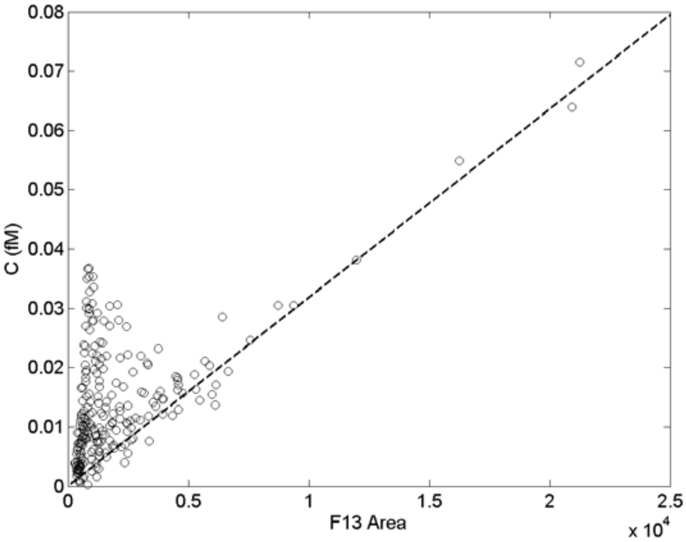


Figure 10.7: Concentration of CF3SF5 versus peak area for CFC13 for samples doubled on the cold trap from Stations 122 and 124. The slope of the dashed line is 3.18×10^{-6} fM $(\mu v\text{-}s)^{-1}$.

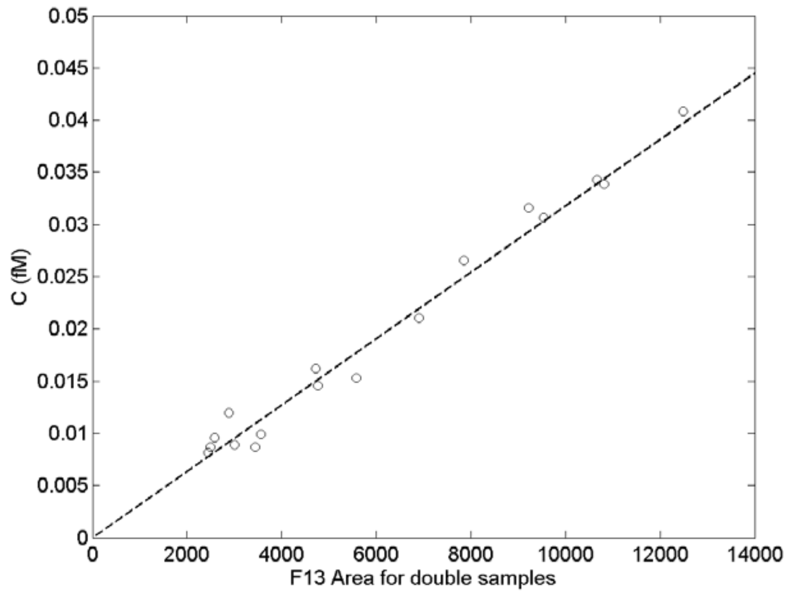


Table 10.3: Coefficients used for estimation of atmospheric derived tracer concentration

Stations	Description	Coefficient
1-38	SR1b	$2.48x10^{-6}$
47-67	A23	$2.32x10^{-6}$
69-124	North Scotia Ridge and Argentine Basin	$3.18x10^{-6}$

10.4 Results

10.4.1 Overview

A chart showing the column integral of tracer found at the stations at which relatively full tracer profiles were obtained is shown in Figure 10.8. The diameter of the red circles are proportional to the integral of tracer over the depth range which it occupied. The map shows the least tracer along SR1b, i.e., furthest upstream in the ACC and the greatest in the Argentine Basin, farthest downstream. This is to be expected, since most of the tracer has passed through the area of the survey. Modest tracer levels were found along the northern part of A23 and in the western Falkland Trough. These areas are somewhat out of the way of the main ACC path at the depth of the tracer patch – note that tracer in at the Falkland Trough stations probably came through Shag Rocks Passage, as the North Scotia Ridge appears to be too shallow in the west for it the tracer to go directly over. They may be areas that, while they take time to charge with tracer as the main patch passed by in the ACC, they are giving up their tracer more slowly as well.

Tracer concentrations well to the south of the Polar Front are mostly attributed to invasion of atmospheric CF_3SF_5, and so stations along the southern part of SR1b and of A23 are shown as black dots, meaning no or very little DIMES tracer. Nevertheless signs of DIMES tracer were detected at some of these stations.

Individual profiles with clear tracer signals were organized into sets according to geographical position and are shown in Figures 10.9 to 10.15. The first series, from northern SR1b, Stations 20 to 38 (Figure 10.9), suffer more than later profiles from uncertainty both because the concentrations were small and the analytical system was not working as well as it was for the later work. They may also suffer from inadequate coverage of the tails of the profiles. Nothing can be done about the latter problem, but the former may be alleviated by a reanalysis of the integrals.

The signal was much clearer along the northern part of the A23 transect (Figure 10.10). Concentrations were higher and difficulties with the GC system were less. Also, at the time of these stations, double samples were being sparged onto the trap, to double the signal to noise ratio. There are perhaps a few samples in this series that bear examination, however, such as the one at Station 63 near $\gamma_n = 28.05$. There does seem to be a trend of the peak toward lighted densities from south to north in the series.

Much higher concentrations were found south of Maurice Ewing Bank (Figure 10.11). These stations were starting to be closer to the Polar Front and were further downstream in the ACC than earlier stations, so higher concentrations might be expected. Even further downstream are the stations north of Maurice Ewing Bank that cross most of the ACC (Figure 10.12). The highest concentrations found during the cruise were at Stations 77, just north of the Bank, and Stations 80 and 81 on the far northern side of the ACC. The profiles from this series seem to fall into two groups. A further discussion of these stations is presented below.

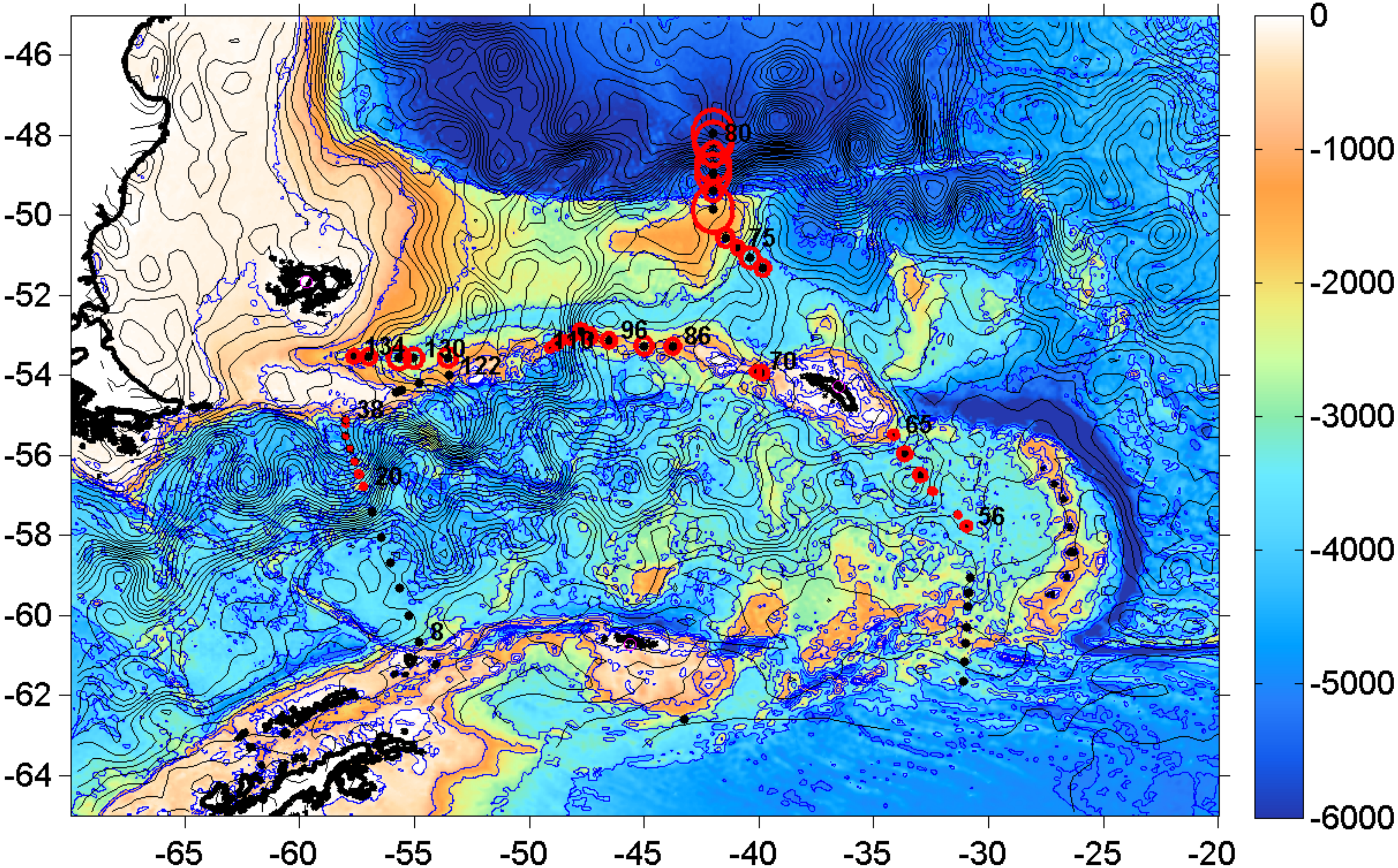
Profiles from Stations 69 and 71 on the North Scotia Ridge are reminiscent in amplitude and spread to the profiles along the northern A23 sections. This is reasonable since the SSH field (Figure 10.13) suggests that these two sets are in two limbs of the SACCF that split around either side of South Georgia Island.

The profile from the west of this series, especially 88 and 96, seem rather narrow, as do some of the profiles from Shag Rocks Passage, such as 98 and 100 (Figure 10.13). This might be expected since these stations are in the main current and have perhaps spent the least time in the Scotia Sea as opposed to the quieter Pacific, compared with other profiles from the overall survey of the present cruise.

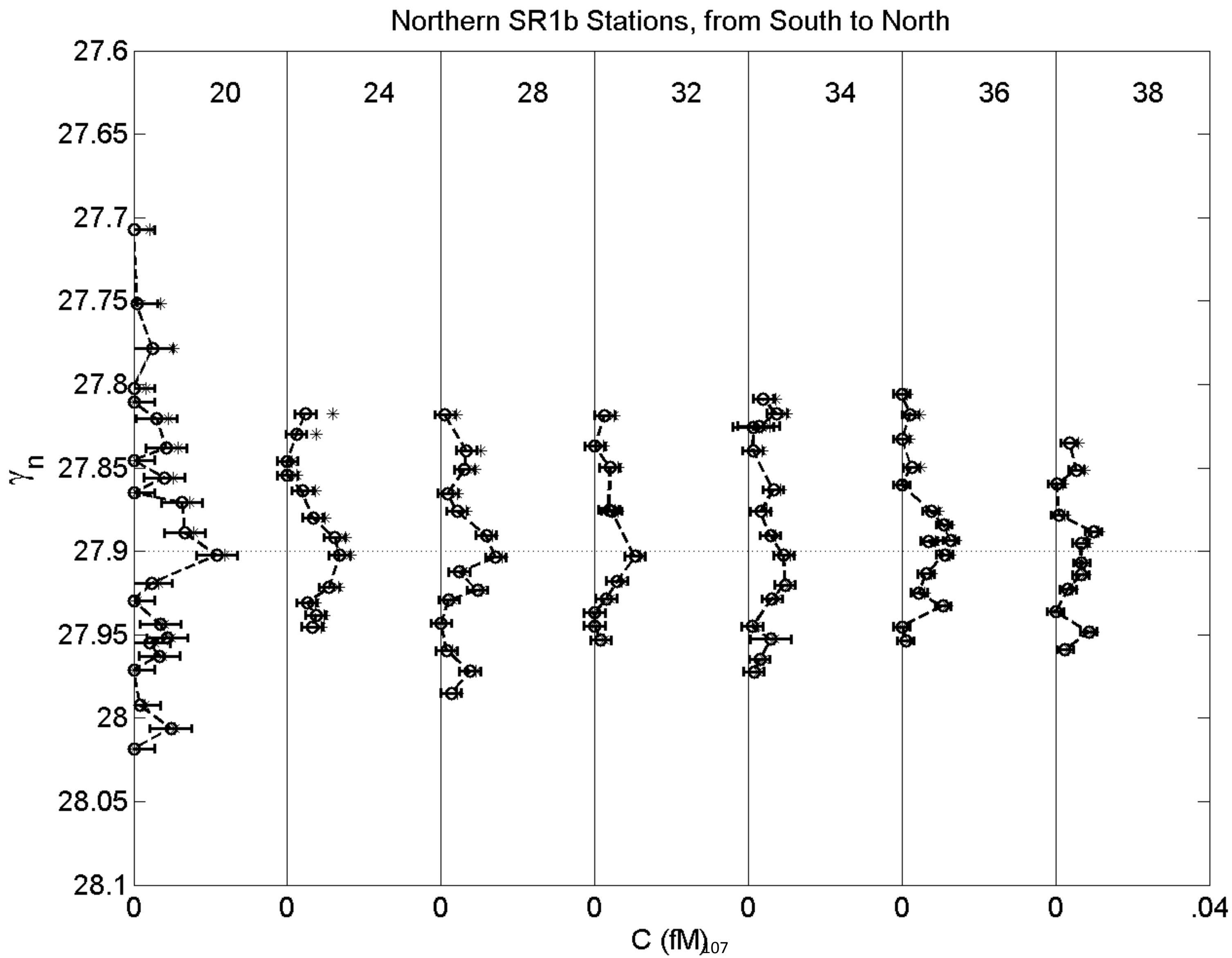
Stations to the west of Shag Rocks Passage, 122 and 124 (not shown) were too shallow to reach into very much of the tracer patch. Apparently the shoulder of Burdwood Bank is too shallow to allow flow of the ACC to pass this way at the level of the tracer, although charts show the suggestion of a deep narrow passage through the Bank that may be as deep as 2000 m – the approximate depth of the target surface in this part of the ACC.

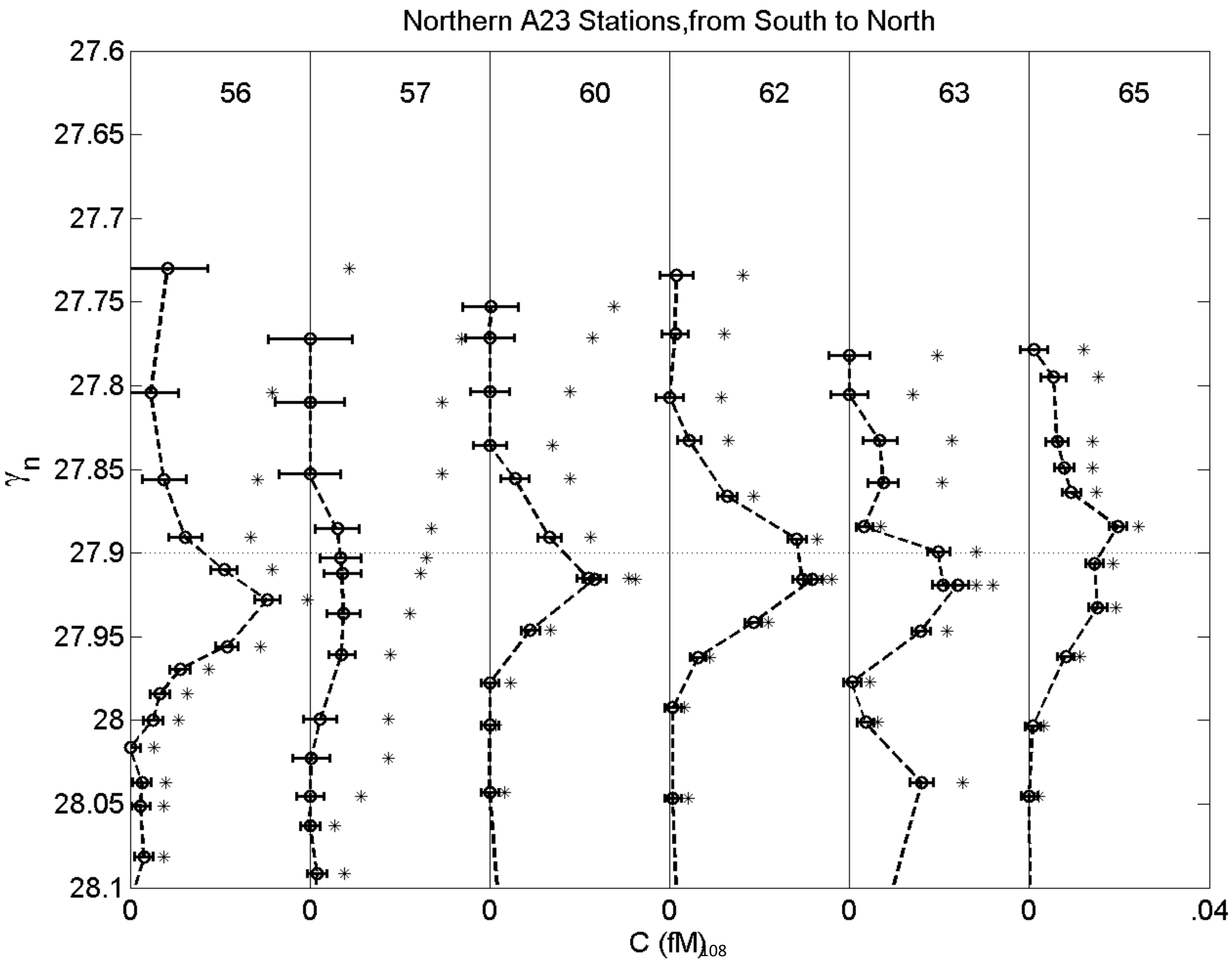
Finally, the profiles from the series of stations in the Falkland Trough show moderately high concentrations and rather broad wings that merit some further examination (Figure 10.14). It may be that the positive bias in the integration was worsening as the integrator became more fatigued! Or it may be that there is indeed a diffuse field of tracer in what may be a *col de sac*, due to a long residence time.

Figure 10.8: Tracer map. The stations at which full tracer profiles were obtained are shown as black dots. The diameters of the red circles around them are proportional to the column integral of tracer, the maximum value being approximately 35 pmol/m^2. The color indicates bathymetry, with blue contours drawn at 200, 1000, 2000, 3000, 4000 and 5000 m. The fine black lines show the sea surface height from AVISO estimated for 13 April 2014, with a contour interval of 5 cm. The numbers on the stations were selected for reference to the series of profiles plotted in Figures 10.9 to 10.14.

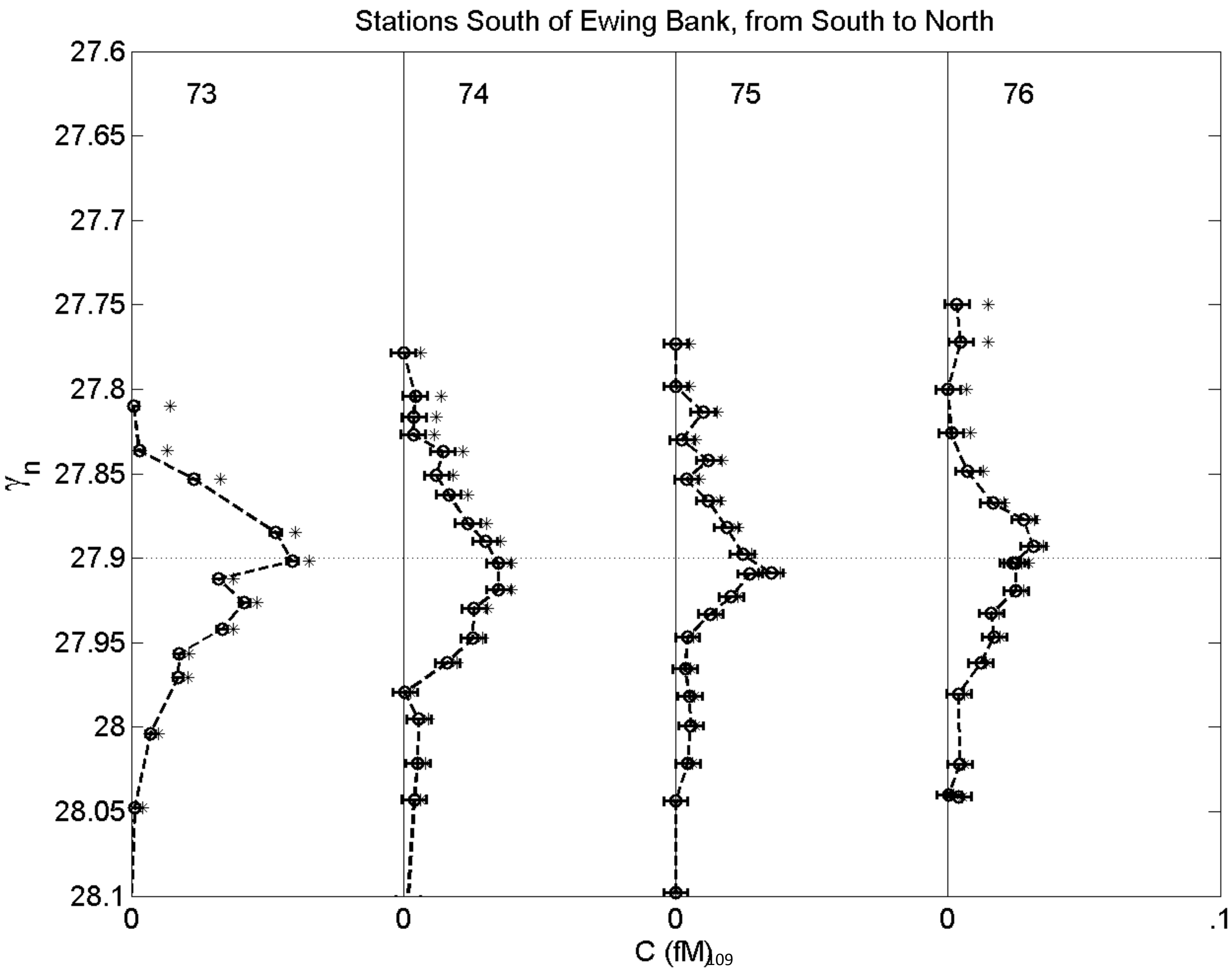

80
75
96
86
134
130
122
70
38
65
20
56
8
-46
-48
-50
-52
-54
-56
-58
-60
-62
-64
-65
-60
-55
-50
-45
-40
-35
-30
-25
-20
0
-1000
-2000
-3000
-4000
-5000
-6000

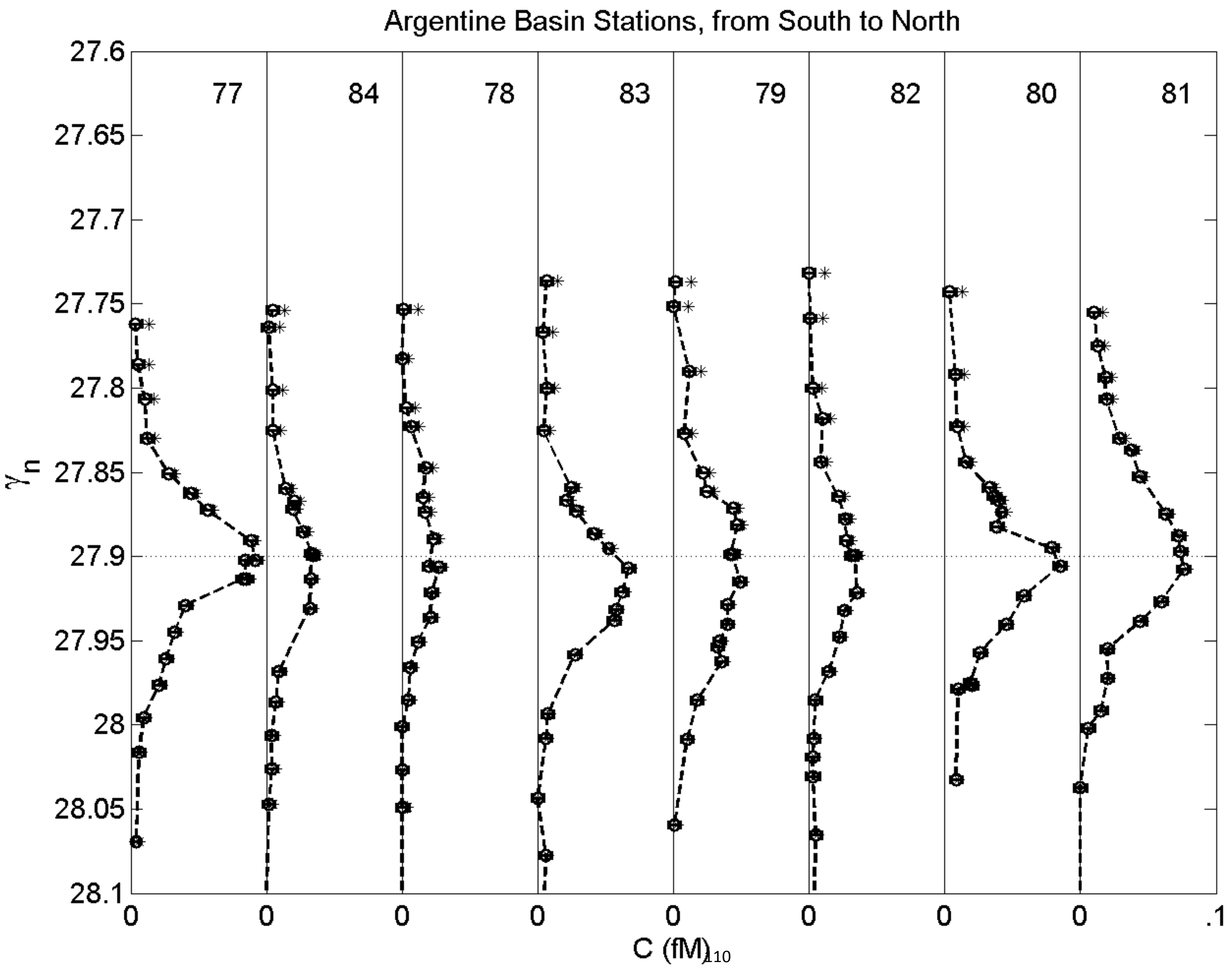
Figures 10.9-10.15: Series of profiles of tracer as a function of neutral density for selected geographical locations, indicated in the title over each figure. Each panel in the series is labelled by station number. The stations can be located from the map in Figure 10.8. The density range is the same in all figures, from 27.6 to 28.1. The concentration range is from 0 to 0.04 fM in all of the series except those south of Ewing Bank and in the Argentine Basin for which the range is 0 to 0.1 fM. Asterisks are drawn for the raw concentrations, while circles with error bars are drawn for the concentrations corrected by subtracting the estimated contribution from atmospheric CF3SF5 to the sample, based on the response of the GC system to the CFC-13 in the sample. Error bars represent a very preliminary estimate. Negative concentrations were set to zero.

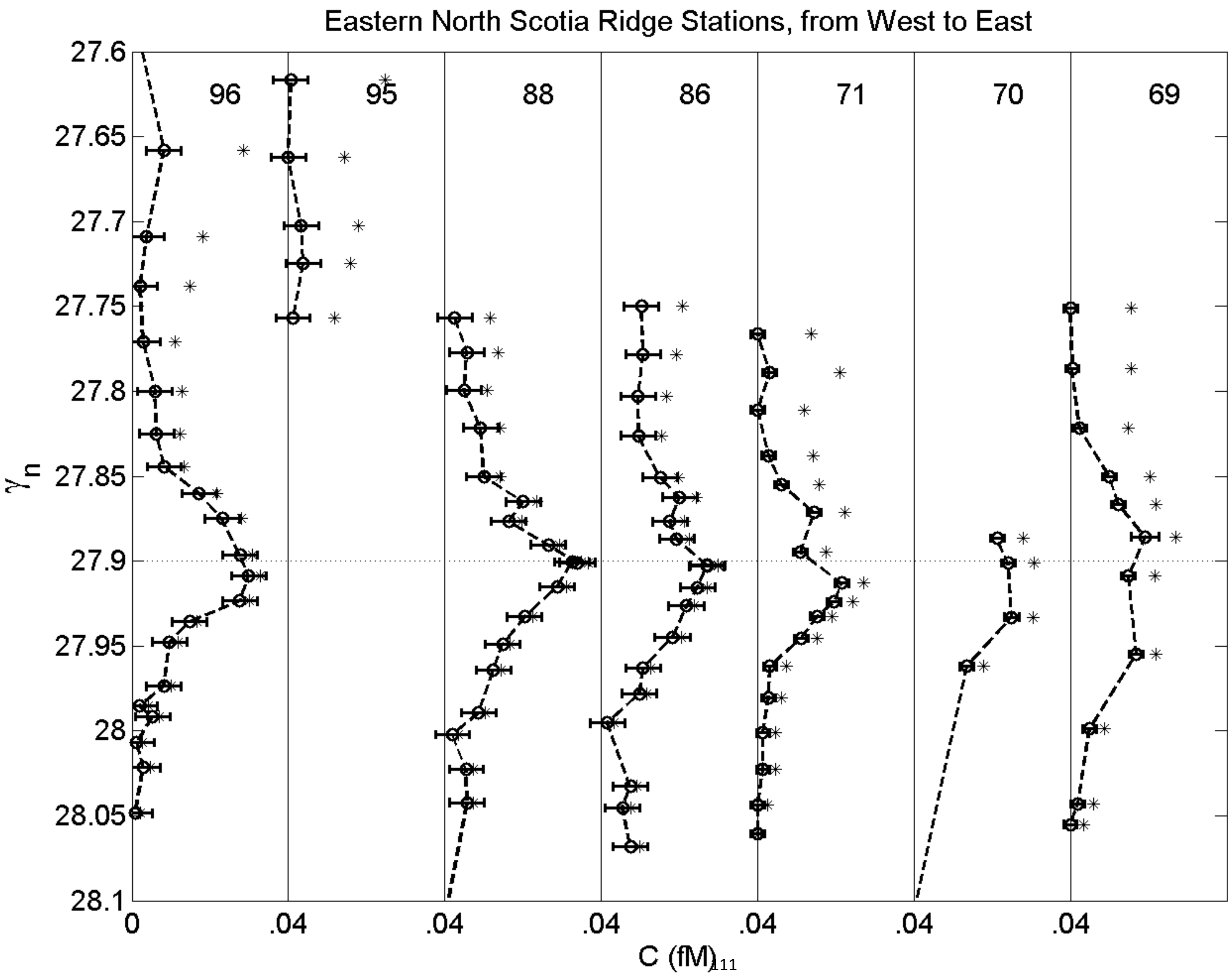

Northern SR1b Stations, from South to North
20
24
28
32
34
36
38
γn
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
0
0
0
0
0
0
0
.04
C (fM)



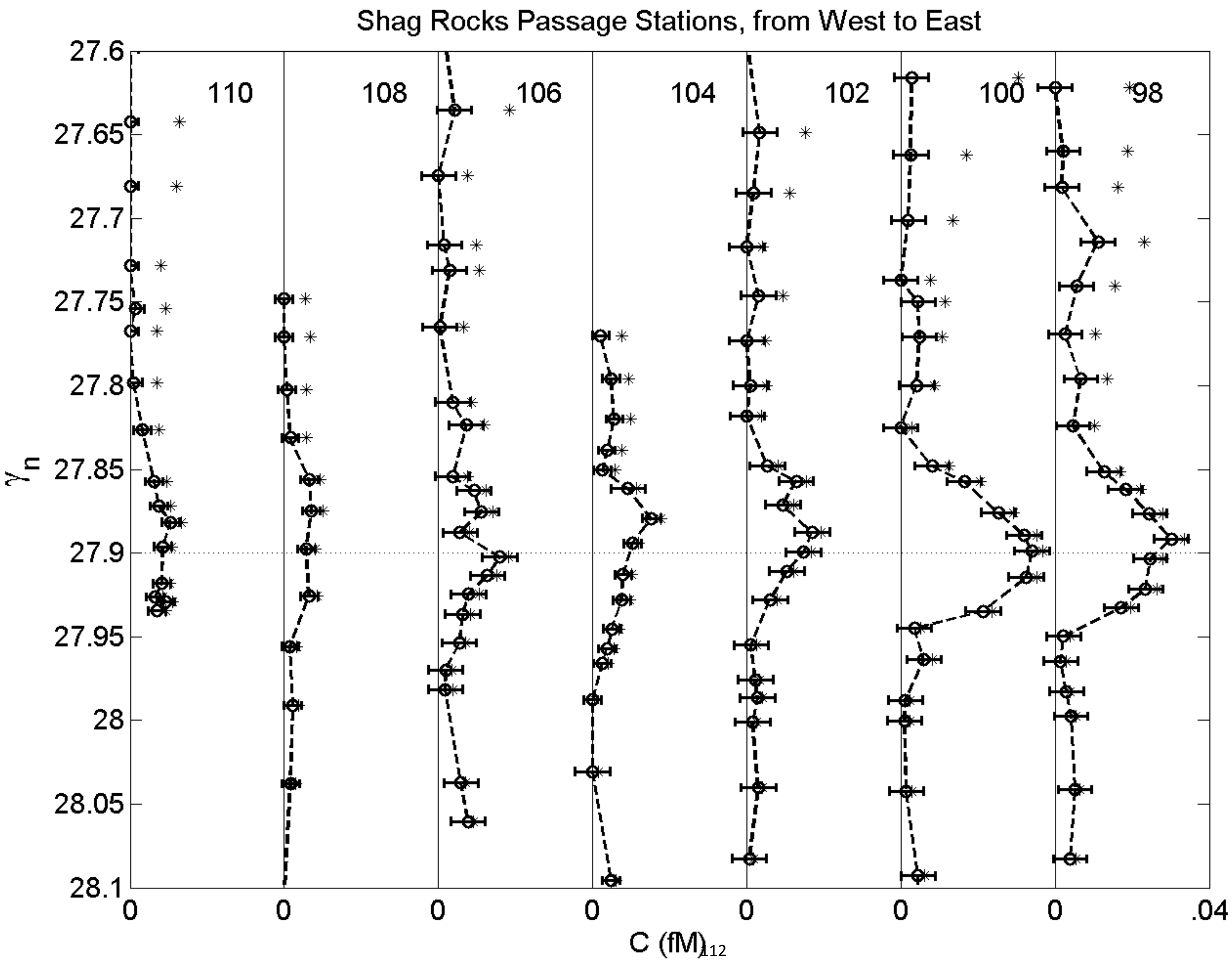
Northern A23 Stations,from South to North
56
57
60
62
63
65
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
γn
0
0
0
0
0
0
.04
C (fM)

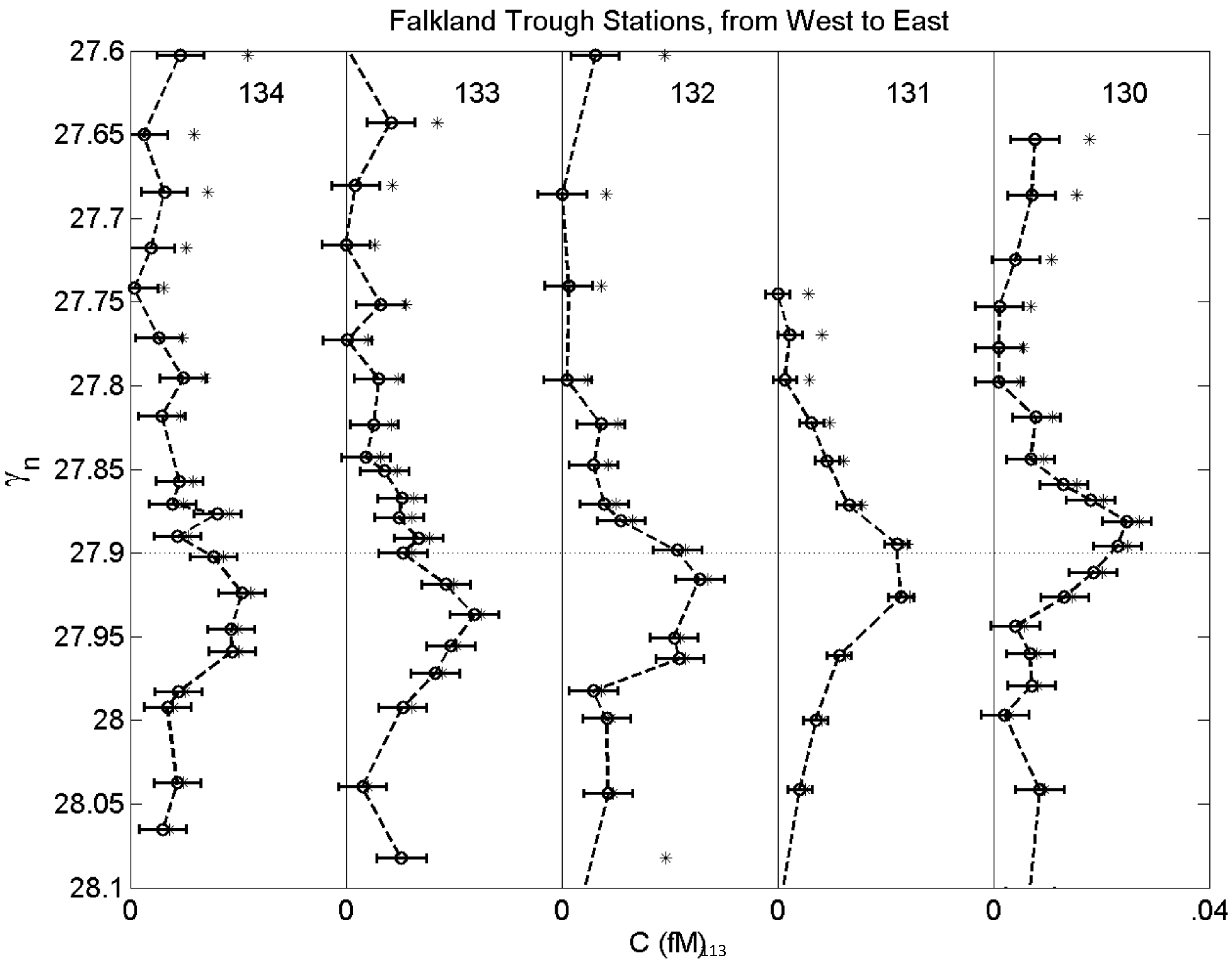

Stations South of Ewing Bank, from South to North
73
74
75
76
γn
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
0
0
0
0
.1
C (fM)


Argentine Basin Stations, from South to North
77
84
78
83
79
82
80
81
γ_n
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
0
.1
C (fM)



Eastern North Scotia Ridge Stations, from West to East
96
95
88
86
71
70
69
γ_n
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
0
.04
.04
.04
.04
.04
.04
C (fM)


Shag Rocks Passage Stations, from West to East
110
108
106
104
102
100
98
γn
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
0
0
0
0
0
0
0
.04
C (fM)



Falkland Trough Stations, from West to East
134
133
132
131
130
27.6
27.65
27.7
27.75
27.8
27.85
27.9
27.95
28
28.05
28.1
γ_n
0
0
0
0
0
.04
C (fM)

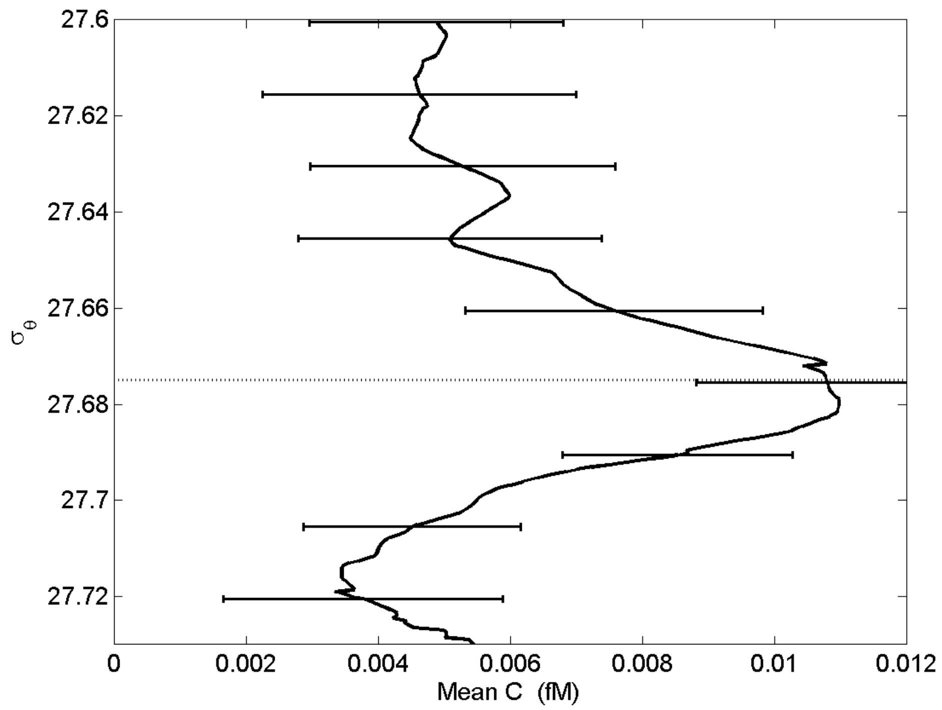
10.4.2 Leg 1 SR1b Results – Further Discussion

The tracer was sampled at several stations along SR1b. At some stations a full profile was obtained at depths clustered around the target density surface, defined as the isopycnal surface at which the potential density (reference to 0 pressure) was σ_θ = 27.675 kg/m^3, while at other stations three samples were obtained from near the target density surface (Table 10.4). Concentrations were near or below the minimum detectable level of less than approximately 0.006 fM for the 1.57-litre samples that were sparged (degassed) through Station 20. Starting with Station 24, samples from two Niskins sampled at the same depth, or two samples from the same Niskin, were combined for analysis in most cases to give a sparged volume of 3.14 L to double the signal with no increase in the noise. The mean of all full profiles along SR1b as a function of density is shown in Figure 10.16.

Table 10.4: Summary of tracer sampling along SR1b

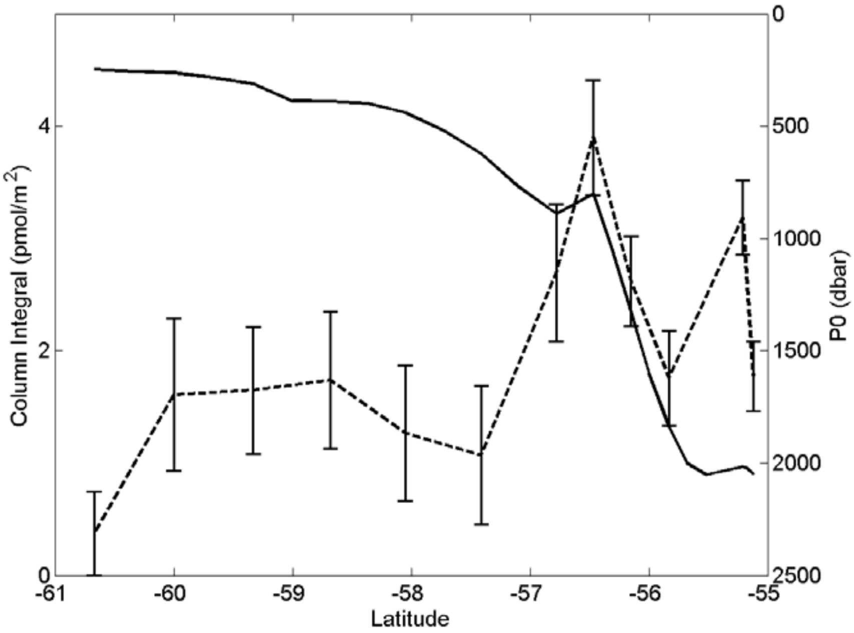
Station	
1	Bransfield Strait, full profile
8, 10, 12, 14, 18, 29	Full profiles, 24 Niskins centered on target surface
11, 13, 15, 17, 19	3 Niskins at target, and 50 m above and below the target
24, 28, 32, 34, 36, 38	Full profiles, but with 2 Niskins tripped at most levels
26, 30, 33, 35, 37	3 Niskins at target, or at target and 50 m above and below

Figure 10.16: The mean of all concentration profiles from Stations 8 to 38, along SR1b, based on first-pass integration of the raw data and correction for atmospheric-derived tracer. The profiles were averaged as a function of potential density after interpolating them onto a potential density grid.



Also, a crude estimate of the column integral of tracer, with rough correction for atmospheric invasion, shows that tracer levels are higher within the PF and SAF, and relatively low, but not zero in the region to the south (Figure 10.17).

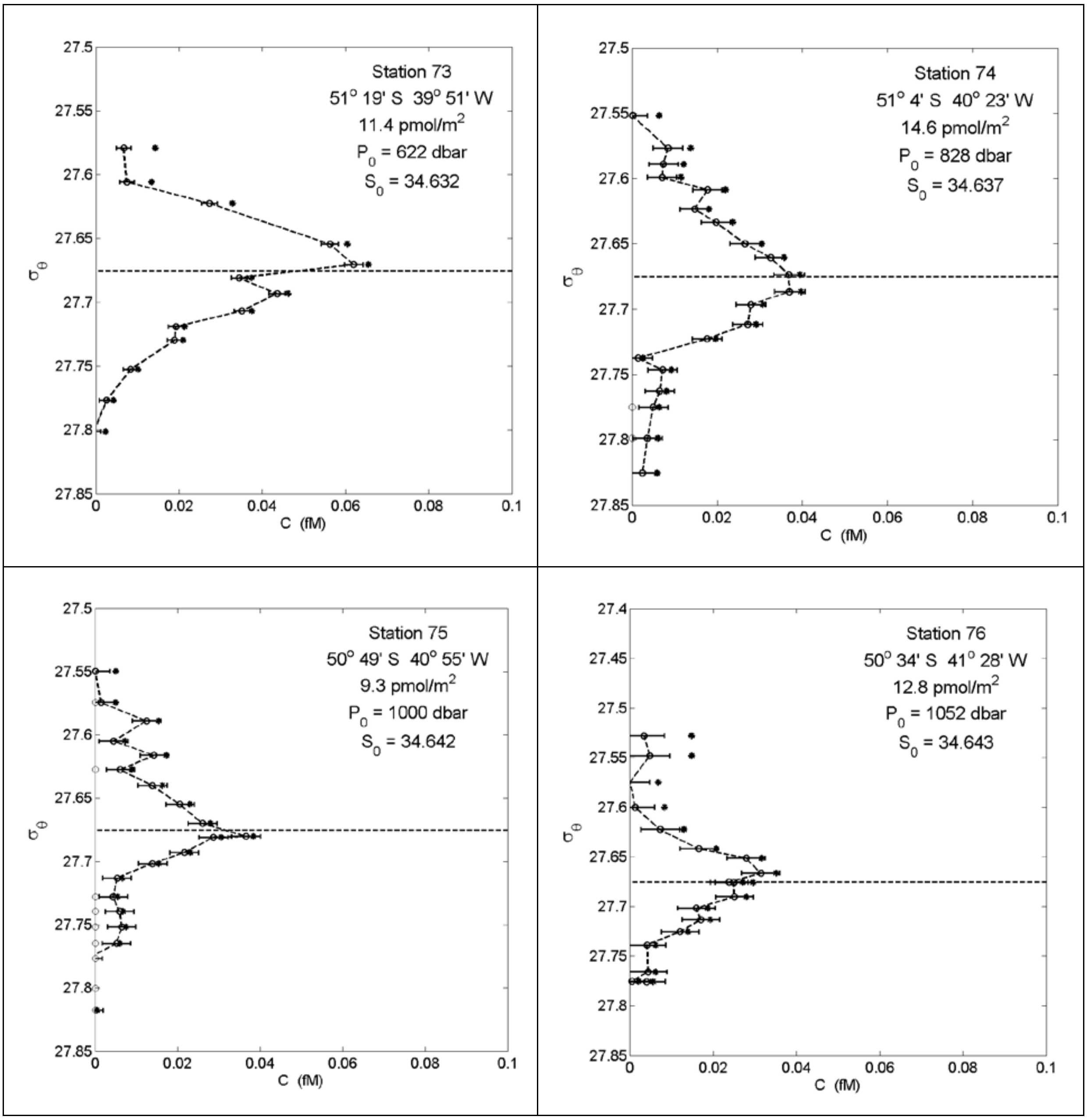
Figure 10.17. Column integral of tracer as a function of latitude along SR1b (dotted line). The depth of the 27.675 surface is shown as the solid line. The Polar Front and Subanrarctic Fronts are merged and are north of 56.5 S.



10.4.3 Argentine Basin Stations – Further Discussion

Four stations, 73 to 76, were occupied for tracer along a line running northwest from the North Scotia Ridge to the edge of the Maurice Ewing Bank (Figure 10.18). The legend in each panel of the figures gives the station number, position, salinity S_0 at the σ_θ =27.675 kg/m^3 for that station, and the column integral of tracer in the density range from σ_θ =27.575 to 27.775 kg/m^3, including contributions from noise and the bias. Units used for column integral are pmol/m^2 = picomoles/m^2.= 10^{-12} moles/m^2.

Figure 10.18: Tracer profiles from the line running NW to Maurice Ewing Bank. The legend gives the station number, position, column integral, and pressure P_0 and salinity S_0 at the σ_θ =27.675 kg/m^3. The column integral is for the density range from σ_θ =27.575 to 27.775 kg/m^3, including contributions from noise and the bias. Units for the column integral are pmol/m^2 = picomoles/m^2= 10^{-12} moles/m^2.



Stations on the line northward from Maurice Ewing Bank (Figures 10.19 and 10.20), crossing the Polar Front and the Sub Antarctic Front on their path eastward, seemed to be of two types. Five of the profiles were fairly symmetric in density space, with peak concentration near 27.675 and, except for Station 77, more modest column integrals. The three profiles farthest towards the Atlantic subtropical side of the ACC, as indicated by the salinity S_0 at the 27.675 surface, were asymmetric with peak concentration near 27.700 rather than 27.675, and with a broader distribution in density above that level than below it. These three stations also yielded relatively high column integrals.

Figure 10.19: Tracer profiles from Stations 77-80, occupied along 42 W, north of Maurice Ewing Bank. (See the next figure for four more profiles).

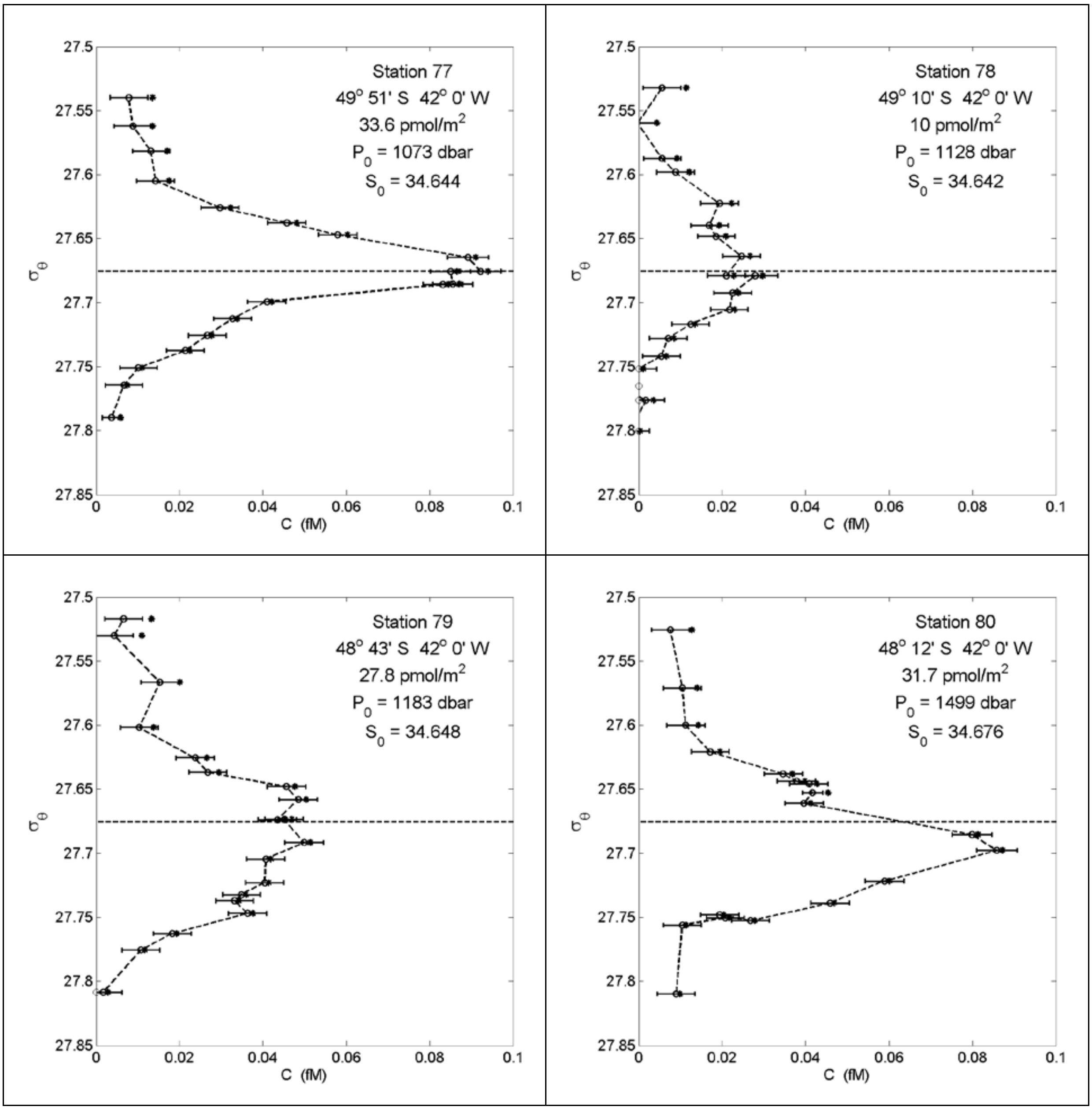
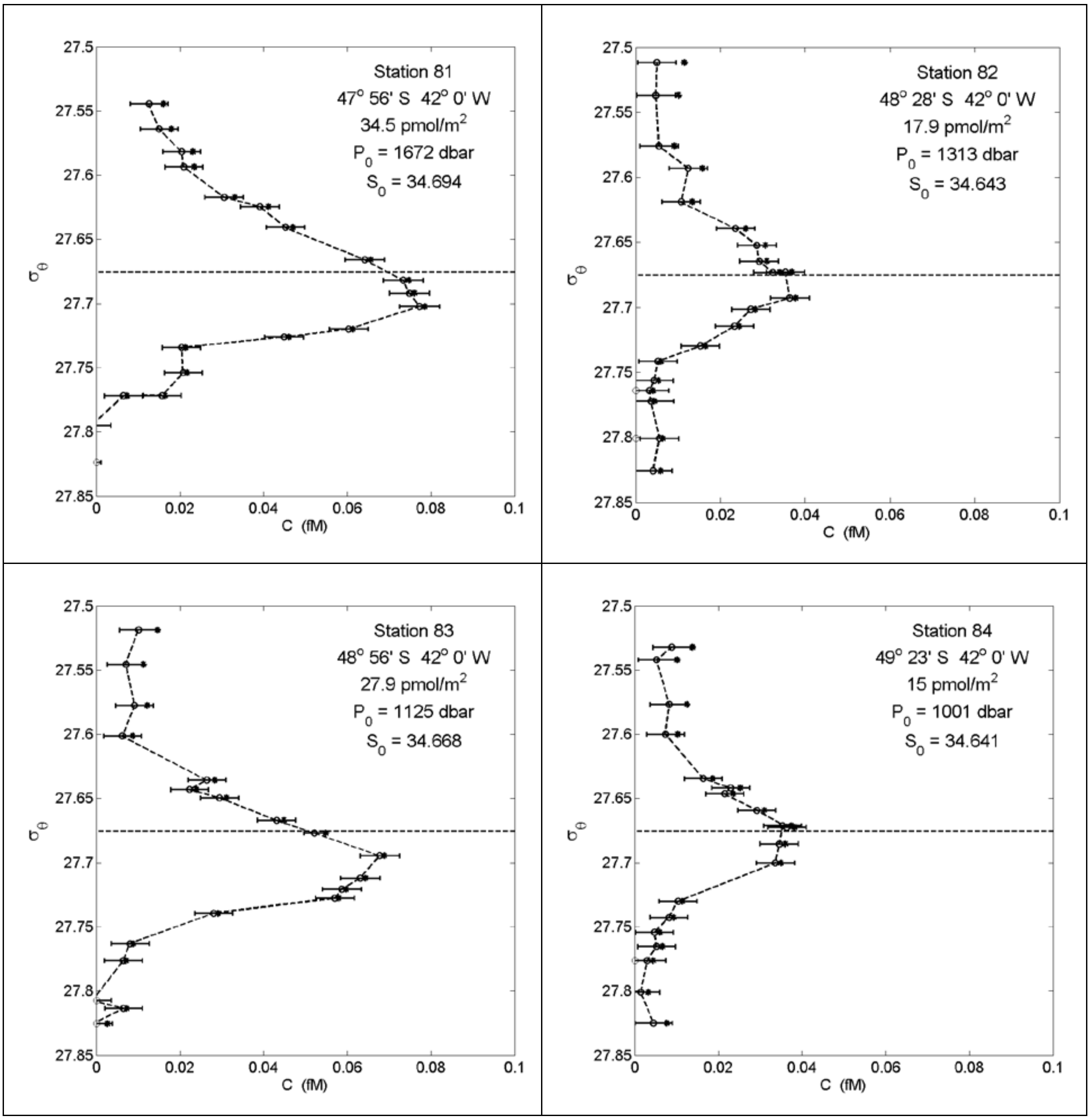


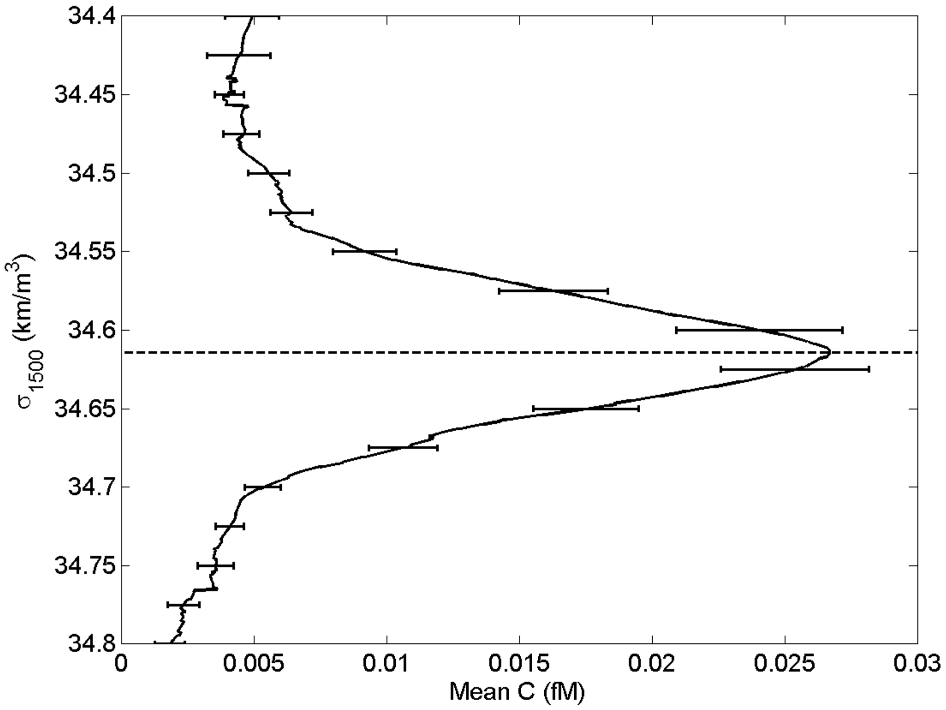
Figure 10.20: Tracer profiles from Stations 77-80, occupied along 42 W, north of Maurice Ewing Bank. (See the previous figure for four more profiles).



10.4.4 Cruise Mean Profile

Despite the inhomogeneity of the system, one cannot resist calculating the mean tracer profile for the whole cruise (Figure 10.21). To do this, the individual profiles were all interpolated to a standard density grid, using potential density referenced to 1500 dbar, which here is called σ_{1500}. Then the concentrations were averaged at each level. Profiles are allowed to drop out of the average at density levels they did not cover, resulting in discontinuities in the mean profile.

Figure 10.21: Mean of all profiles with significant tracer concentrations as a function of potential density, referenced to 1500 dbar. The error bars are the standard error calculated from the variance of the concentrations that enter at each level. The dashed line is the target density of the original tracer release in early February 2009.



This mean profile shows promise, but also illustrates work that remains with the data. The promise lies in the observation that the peak is directly at the target density, suggesting that shear in the mean ACC current has not left behind in the region of the survey tracer that is preferentially deep. In fact it seems a bit surprising that the peak is not a bit below the target isopycnal from the effect of mean shear. Promise also lies in the fairly Gaussian shape of the mean curve, if the wings are ignored. The high wings illustrate the presence of a positive bias, mentioned earlier, in the integration of the tracer peaks, of about 0.004 fM in the mean. Furthermore, there appears to be a trend in this bias, with it being stronger above the target surface than below it. This trend may be due to a trend in an error in the correction for atmospheric CF_3SF_5, or it may be due to an increase of the bias with concentration, since the concentrations are much greater in the upper tail than in the lower tail before correction for the atmospheric contribution. Further analysis must wait.

As a final note, the reader should realize that these data are preliminary and will be examined and possibly improved in accuracy and freed of some error with time. Potential users should consult with Jim Ledwell, at WHOI, jledwell@whoi.edu.

11 Halocarbons; Chlorofluorocarbons (CFCs), carbon tetrachloride (CCl4) and sulphur hexafluoride (SF6)

Siobhán Moran, Mike Boniface

A total of 1036 seawater samples were collected from 52 stations for future analysis to measure concentrations of halocarbons, namely CFC-12 (dichlorodifluoromethane, CF_2Cl_2), CFC-11 (trichlorofluoromethane, $CFCl_3$), CFC-113 (trichlorotrifluoroethane, $C_2F_3Cl_3$), CCL4 (carbon tetrachloride) and SF_6 (Sulfur hexafluoride). The analysis will be carried out at the University of Exeter under the direction of Dr. Marie-José Messias.

11.1 Motivation

Halocarbons are inert gases of anthropogenic origin which make excellent oceanic transient tracers as the atmospheric concentrations over time are known. The data will be used to study oceanic circulation, ventilation, and mixing processes as well as to investigate anthropogenic carbon storage in the Southern Ocean.

11.2 Sample collection technique

Halocarbon samples were collected approximately every second CTD cast, alternating with DIMES tracer casts. Sample depths were chosen to resolve the water column, with high resolution sampling for bottom waters in the north section of A23 and along the North Scotia Ridge. On average two duplicate samples were taken from every cast.

Water samples were collected from 10 litre bottles attached to the CTD sampling rosette. As per WOCE protocol they were the first samples drawn. The Niskin nitrile 'O' rings had been previously washed in isopropanol and baked in a vacuum oven for 24 hours to remove susceptible contamination before installation in individual Niskin bottles. Sample procedure followed USGS Reston Chlorofluorocarbon Laboratory CFC bottle sampling protocol. Water was collected in 500 ml *glass bottles*, with aluminium foil lined caps. The sample bottles were filled from the bottom using a copper tube connected to the Niskin spigot using a short length of Tygon tubing. The bottles were overflowed into a 3 litre glass beaker until 1 litre had flushed through the bottle from the bottom and the bottle was completely submerged. Bottles were capped underwater without allowing the water in the bottle to come into contact with the air. The capped bottles were then taped securely with three rounds of electrical tape to secure the cap to the bottle. Bottles were then stored upside down in a cool room kept at a constant temperature of 4 °C (±2 °C).

Several problems were encountered with the above technique. In the first week three beakers were broken as they are fragile and awkward to manipulate round the CTD while the ship is in motion. Rope was affixed to the outside of the beaker to improve grip and ease of manipulation, however breakages continued throughout the cruise. Revaluation of the sampling technique is strongly advised for future cruises.

On station 113 the penultimate beaker was broken and a replacement beaker was improvised and tested on station 119. The beaker replacement consists of a 2 litre acrylic plastic jug with suitable dimensions which allow the sample bottle to be completely submerged and yet minimise water usage and avoid gas exchange problems for future samples. A perforated polypropylene plastic collar, ballasted by two steel weights is fitted over the shoulder of the bottle to prevent the bottle cap from becoming trapped in the narrow space between bottle and jug. The method was tested by taking a series of samples from 967 m (the oxygen minimum) on station 119. The first niskin fired at this depth a duplicate sample was taken using the new method. The next two niskins were sampled first with the new method, then duplicates were taken using the glass beaker. Two more niskins were sampled, this time the first sample was drawn using the glass beaker, and the duplicates drawn using the new method. As the test results could not be analysed whilst at sea the new method was used only to provide extra resolution on full profiles from stations 123 and 125.

The PSO personally tests the new method (left) and tightening the cap while the sample is submerged (right).

11.3 Data

In total 52 of the 119 CTD casts were sampled for halocarbons, with 1036 samples collected for post cruise measurement. 10.7% of the samples collected were duplicates.

Full depth profiles were collected from Station 2 in Bransfield Strait and from Station 44 at the LDEO M3 mooring site.

Along SR1b full depth profiles were sampled from 17 of the 36 CTD stations. Halocarbon samples were collected at around half the standard SR1b resolution for the first half of the section, however the increased number of stations over the fronts meant that halocarbons were sampled for at standard SR1b resolution (CFC stations 26 to 41). 10 additional samples from the bottom 1730 m of station 6 were collected to obtain estimates of the origin and mixing history of the bottom intensified, cold and fresh current seen in the CTD profiles and the VMP data in stations 5 and 6.

Full depth profiles were collected from 12 of the 22 stations along A23. The cruise track was slightly altered to optimise stations in the regionally deepest bathymetric features. This was with the hope of observing and constraining mixing rates of trapped Weddell Sea Deep Water periodically flushed through the region, as outlined in the introduction. Therefore in the north of the section the vertical resolution was increased in the bottom 1000 m to prioritise sampling from these deep bathymetric features, whist still resolving the water column.

Full depth profiles were sampled from 20 of the 39 stations along the North Scotia Ridge. These profiles aimed to resolve the water column with increasing resolution with depth.

Table 11.1: List of stations where samples were collected for future analysis of halocarbon concentrations. For full station information please refer to Table A.1

	Date	**Station number (CTD cast)**	**Total number of samples**	**Number of duplicates**	**wire out (m)**	**Comments**
Test Station	12/03/2014	2	24	0	1422	Bransfield Strait – test station, training ongoing. Beaker difficult to manipulate while sampling – attached rope round beaker for grip. Still concerns about possible breakages
SR1b	13/03/2014	3	10	2	358	
	13/03/2014	5	18	2	1029	Strong westward bottom currents – stronger version of feature also seen in station 6
	13/03/2014	6	10	2	1780	Not originally meant to sample here, however the T&S plot showed an interesting deep layer so CFCs were taken between 500m and the bottom. VMP also showed strong near bottom currents.
	14/03/2014	7	20	2	2585	Beaker broke as sample was finished, bottom cracked on contact with the deck
	14/03/2014	9	24	3	3419	
	14/03/2014	11	23	2	3661	
	15/03/2014	13	23	2	3760	Beaker broken during sampling, slipped during overflowing and smashed on metal section of deck
	15/03/2014	15	24	2	3875	Beaker broken during sampling, entire bottom cracked off, no obvious knock
	16/03/2014	17	24	2	3441	
	17/03/2014	19	23	2	4209	
	17/03/2014	26 (23)	22	2	3265	
	18/03/2014	30 (25)	22	2	4270	
	18/03/2014	33 (27)	23	2	4387	
	19/03/2014	35 (29)	24	3	4241	
	19/03/2014	37 (31)	24	3	3094	

	01/04/2014	39 (33)	9	1	494	One beaker found broken after rough seas
	01/04/2014	40 (34)	15	1	1525	
	01/04/2014	41 (35)	19	3	2327	
LEDO M3 mooring site	06/04/2014	44 (38)	26	2	4549	
A23	08/04/2014	45 (39)	26	2	4719	
	08/04/2014	46 (40)	26	2	4841	
	09/04/2014	48 (42)	22	2	3412	
	09/04/2014	51 (45)	23	2	3779	
	10/04/2014	52 (46)	23	2	3396	
	10/04/2014	54 (48)	24	4	3506	
	10/04/2014	55 (49)	23	2	3989	
	11/04/2014	58 (52)	24	3	3588	
	11/04/2014	59 (53)	24	3	4003	
	12/04/2014	61 (55)	23	2	4022	
	13/04/2014	64 (58)	23	2	3711	
	13/04/2014	66 (60)	14	2	1500	
North Scotia Ridge	14/04/2014	68 (62)	10	2	463	
	15/04/2014	70 (64)	14	2	2082	
	15/04/2014	72 (66)	10	2	483	
	20/04/2014	85 (79)	10	2	479	
	20/04/2014	87(81)	14	2	1043	
	21/04/2014	95 (83)	14	2	1508	
	21/04/2014	97 (85)	12	2	1226	
	21/04/2014	99 (87)	26	2	2481	
	21/04/2014	101 (89)	26	2	3051	Beaker broken - down to two
	22/04/2014	103 (91)	26	2	2594	
	22/04/2014	105 (93)	24	2	2438	
	22/04/2014	107 (95)	26	2	3107	
	23/04/2014	109 (97)	24	2	2592	
	23/04/2014	111 (99)	20	2	1474	
	23/04/2014	113 (101)	11	2	950	Beaker broken - only one left
	24/04/2014	119 (103)	10	5	967	Tests of jug to be used as beaker replacement
	24/04/2014	121 (105)	10	2	501	
	24/04/2014	123 (107)	16	2	1498	
	24/04/2014	125 (109)	25	2	1919	
	25/04/2014	128 (112)	26	2	1019	
		Total	**1036**	**111**		

12 Carbonate parameters

Ollie Legge

12.1 Objectives

- To take deep section measurements of dissolved inorganic carbon (DIC) and total alkalinity (TA) along the SR1b section across Drake Passage.
- To take deep section measurements of DIC and TA along the A23 section in the northern Weddell Sea and eastern Scotia Sea.
- To take deep section measurements of DIC and TA across Shag Rocks passage on the North Scotia Ridge in order to investigate the transport of natural and anthropogenic carbon by the Antarctic circumpolar current.

12.2 Sampling

Carbon samples were drawn into 250mL borosilicate glass bottles from the 10L Niskin bottles of the CTD rosette using tygon tubing. Bottles were rinsed twice before filling and were overflowed for 20 seconds, allowing the bottle volume to be flushed twice. Samples were stored in coolboxes prior to fixing and were fixed as soon as possible, usually within two hours of sampling. On fixing, a 2.5mL headspace was created to allow for expansion due to warming and 50µL of saturated mercuric chloride was added to each 250mL bottle (Dickson *et al*., 2007). Bottles were then sealed using stoppers greased with Apiezon grease, secured with elastic bands and stored in the dark.

Twelve to sixteen depths were sampled from deep stations with fewer samples being taken on shallower casts. Approximately every fourth depth sampled for carbon was sampled in duplicate in order to quantify uncertainty associated with sampling, storage and analysis and to provide a running check on instrument performance when analysing samples.

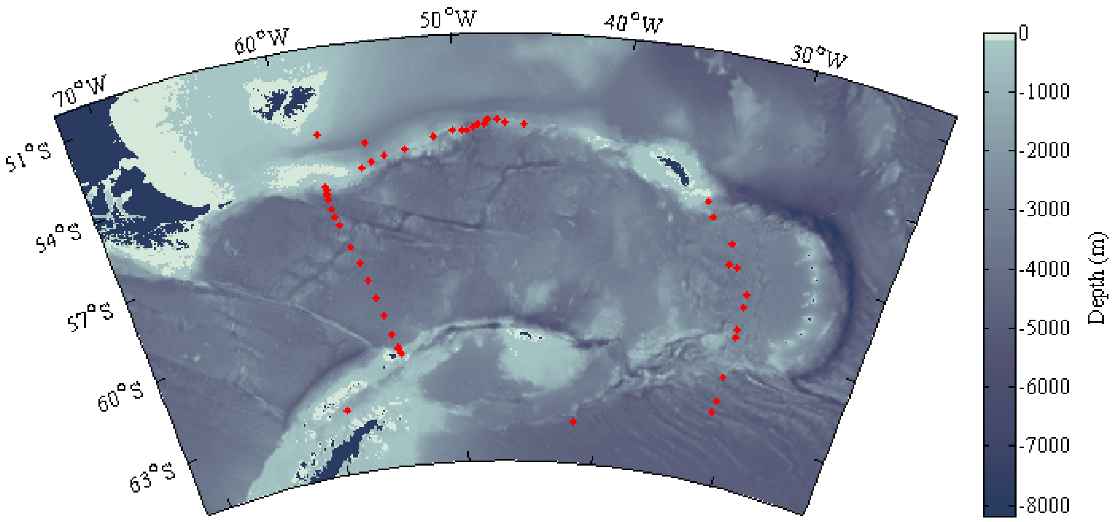
Total number of stations sampled for carbon: 48
Total number of Niskins sampled for carbon: 651
Total number of carbon samples taken: 804

Table 12.1: Summary of stations sampled for carbon and nutrients

Station no.	CTD no.	Lat (deg N)	Lon (deg E)	Date	No. Niskins sampled
2	2	-62.7652	-59.1095	20140312	16
3	3	-61.0488	-54.5888	20140313	8
5	5	-60.8497	-54.7130	20140313	13
7	7	-60.8005	-54.7383	20140314	16
9	9	-60.3327	-55.0317	20140314	16
11	11	-59.6671	-55.4450	20140315	16
13	13	-59.0002	-55.8558	20140315	16
15	15	-58.3667	-56.2502	20140316	16
17	17	-57.7337	-56.6402	20140316	16
19	19	-57.1002	-57.0357	20140317	16
26	23	-56.3081	-57.5243	20140317	16

30	25	-55.9938	-57.7187	20140318	15
33	27	-55.6768	-57.9125	20140318	16
35	29	-55.3683	-57.9993	20140319	16
37	31	-55.1716	-57.9971	20140319	16
39	33	-54.8935	-58.0002	20140401	8
40	34	-55.0102	-58.0031	20140401	11
41	35	-55.1250	-57.9992	20140401	16
44	38	-63.5463	-41.7513	20140406	16
45	39	-62.4886	-31.2541	20140408	16
46	40	-62.0636	-31.1830	20140408	16
48	42	-61.1702	-31.0486	20140409	15
51	45	-59.7658	-30.9058	20140409	16
52	46	-59.4358	-30.8570	20140410	16
54	48	-58.6352	-30.8237	20140410	14
55	49	-58.2120	-30.8178	20140410	12
58	52	-57.3397	-31.8902	20140411	13
59	53	-57.2768	-32.3731	20140411	13
61	55	-56.5766	-32.5073	20140412	12
64	58	-55.7397	-33.9505	20140413	13
66	60	-55.2600	-34.4435	20140413	12
95	83	-53.1752	-45.9145	20140421	13
97	85	-53.1070	-47.0553	20140421	12
99	87	-52.9925	-47.5021	20140421	16
101	89	-53.0103	-48.0590	20140421	14
103	91	-53.1448	-48.2792	20140422	13
105	93	-53.1445	-48.5985	20140422	12
107	95	-53.2993	-48.9252	20140422	14
109	97	-53.3790	-49.2692	20140423	14
111	99	-53.3867	-49.5308	20140423	12
113	101	-53.3784	-50.0947	20140423	8
119	103	-53.5519	-51.2991	20140424	8
121	105	-53.9140	-53.0077	20140424	5
123	107	-54.0702	-54.2450	20140424	8
125	109	-54.2298	-55.0952	20140424	12
128	112	-54.3938	-55.6753	20140425	6
132	116	-53.5460	-55.3003	20140426	24
135	119	-53.0149	-58.0383	20140426	13

Figure 12.1: Location of stations sampled for carbon and nutrients



12.3 Analysis

Carbon samples will be analysed for DIC and TA at the Centre for Ocean and Atmospheric Sciences (COAS) at the University of East Anglia using VINDTAs (Mintrop, 2004). DIC will be measured using coulometry following Johnson *et al*. (1993). Alkalinity will be measured using potentiometric titration of 100mL of sample with hydrochloric acid from a Metrohm titrino. Certified reference material (CRM) from Scripps Institute of Oceanography will be used to calibrate both DIC and TA measurements.

12.4 Data

Once analysed and quality controlled the data will be submitted to the British Oceanographic Data Centre (BODC) and to the publically available CO_2 database at the Carbon Dioxide Information Analysis Centre (CDIAC).

12.5 References

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Editors) (2007). Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp.

Johnson, K.M, Wills, D.B., Butler, W.K., Johnson, C.S. (1993). The performance of an automated continuous gas extractor and coulometric detector. Marine Chemistry, 44, 167-188.

Mintrop, L. (2004). VINDTA, Versatile Instrument for the Determination of Titration Alkalinity. Manual for versions 3S and 3C. Version 2.0. MARine Analytics and Data (MARIANDA), Kiel, Germany, 45pp

13 Dissolved inorganic nutrients

Ollie Legge

13.1 Objectives and rationale

- To collect inorganic nutrient samples from the same Niskins as carbon samples to allow the accurate calculation of total alkalinity, which is affected by silicate and phosphate.
- Silicate concentrations will also be useful when analysing barium data as there is a global correlation between their oceanic concentrations and any discrepancies between their profiles may shed light on processes affecting Barium.
- Nutrient concentrations will also aid water mass identification. For example, Southeast Pacific Deep Water can be distinguished from other forms of Lower Circumpolar Deep Water by its high silicate concentration.

13.2 Sampling

Nutrient samples were taken from the same Niskin bottles as carbon samples and occasional duplicates were taken in order to quantify uncertainty associated with sampling and storage. Samples were drawn into 60mL polyethylene pots, which were rinsed twice before filling. Care was taken not to touch spigots and the inside of lids and pots to avoid contamination. Samples for nitrate and phosphate were taken separately from those for silicate. Nitrate/phosphate sample pots were stored in the dark at approximately -20°C and silicate sample pots were stored in the dark at approximately 4°C due to concerns about incomplete silicate recovery from frozen samples (Karel Bakker, Pers. Comm.)

Nutrient samples were also taken from four depths at station 83 in the Argentine Basin in order to investigate an apparent potential density inversion which may be explained by silicate concentrations.

13.3 Analysis

Samples taken for silicate, nitrate and phosphate will be analysed at the Centre for Ocean and Atmospheric Sciences at the University of East Anglia using a San++ Continuous Flow Analyzer (Skalar, Delft, The Netherlands). This instrument has multiple channels so phosphate, silicate and either nitrite or nitrite with nitrate may be measured simultaneously. The principals of these analyses are outlined below.

Nitrate

To determine the nitrate concentration the samples are analysed twice, initially to measure the nitrite concentration and a second time to measure nitrate plus nitrite; the nitrate concentration is determined by the difference between the two. Nitrite reacts with sulphanilamide and N-1-naphthylethylene diamine dihydrochloride (NEDD) to produce a purple coloured azo dye. The intensity of this colouration is determined via colourmetric absorption at 540nm. For the second analysis the sample is passed through a copper/cadmium column which reduces any nitrate to nitrite. This method is similar to the methods of Armstrong et al. (1967) and Grassoff (1983).

Silicate
The sample is acidified with sulphuric acid and mixed with an ammonium heptamolybdate solution. Ascorbic acid is used as a reductant to produce a blue dye. The intensity of the colour is proportional to the concentration of silicate and is measured as absorption at 810nm. Oxalic acid is added to reduce interference from phosphate. This method is based on that of Brewer and Riley (1966).

Phosphate
Phosphate is measured by introducing the sample to an acidified medium containing ammonium heptamolybdate and potassium antimony (III) oxide tartrate forming an antimony-phospho-molybdate complex. Ascorbic acid is used to reduce this to a blue coloured complex, measured at 880nm. The principals of this method were developed by Murphy and Riley (1962).

Standards and CRMs
For each of these nutrients calibrations will be produced using lab made solutions of known concentrations. To ensure the robustness of these calibrations certified reference materials sourced from RTC (Laramie, WY, USA), Environment Canada and the European Commission Joint Research Centre will be employed.

13.4 References

Armstrong, F.A.J., Stearns, C.R. and Strickland, J.D.H., (1967). The measurement of upwelling and subsequent biological process by means of the Technicon Autoanalyzer® and associated equipment. Deep Sea Research 14(3): 381-389.

Brewer, P.G. and Riley, J.P., (1966). The automatic determination of silicate-silicon in natural waters with special reference to sea water. Analytica Chimica Acta, 35: 514-519.

Grassoff, K., (1983). Determination of nitrate. In: K. Grasshoff, M. Ehrhardt and K. Kremling (Editors), Methods of Seawater Analysis. Weinheim : Verlag Chemie

Murphy, J. and Riley, J.P., (1962). A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta, 27: 31-36.

14 Dissolved oxygen

Ollie Legge

14.1 Objectives and rationale

- To collect and analyse a sufficient number of discrete oxygen samples to calibrate the SBE43 oxygen sensor on the CTD.
- Oxygen values from the CTD, along with carbon measurements, can be used to calculate anthropogenic carbon concentrations using back calculation techniques.
- Oxygen concentrations will also aid water mass identification.

14.2 Sampling

Oxygen samples were drawn from Niskin bottles into 125mL borosilicate glass flasks of calibrated volume using tygon tubing. Oxygen was the first parameter to be sampled from Niskins to avoid diffusion of oxygen into/out of the Niskin headspace altering results. The flask was inverted and rinsed with the tubing pushed to the base of the flask as the flask was rotated. To fill, the tubing was pinched to minimise flow and the flask was returned swiftly to upright and filled slowly. Once full and bubble free, the flask was overflowed for 30 seconds to allow the flask volume to be flushed roughly three times. During overflowing the temperature of water in the flask was taken using a digital temperature probe. Flow was minimised when removing tubing in order to avoid turbulence. Immediately after filling, 1mL of a mixture of 8M sodium hydroxide and 4M sodium iodide (NaOH/NaI) followed by 1mL of 3M manganese chloride ($MnCl_2$) were dispensed to the bottom of the filled flask using 1mL dispensers. The flask was then sealed with the corresponding ground glass stopper and shaken vigorously for 1 minute. The neck of the flask was filled with MilliQ. After sampling, all flasks were shaken again for 1 minute and the neck was refilled with MilliQ. Samples were stored in the dark before analysis and the MilliQ around the neck was kept topped up.

Six stations were sampled for oxygen. Bottle depths were chosen to give a range of oxygen values from a range of pressures. Most Niskins were sampled either in duplicate or triplicate in order to check analytical precision.

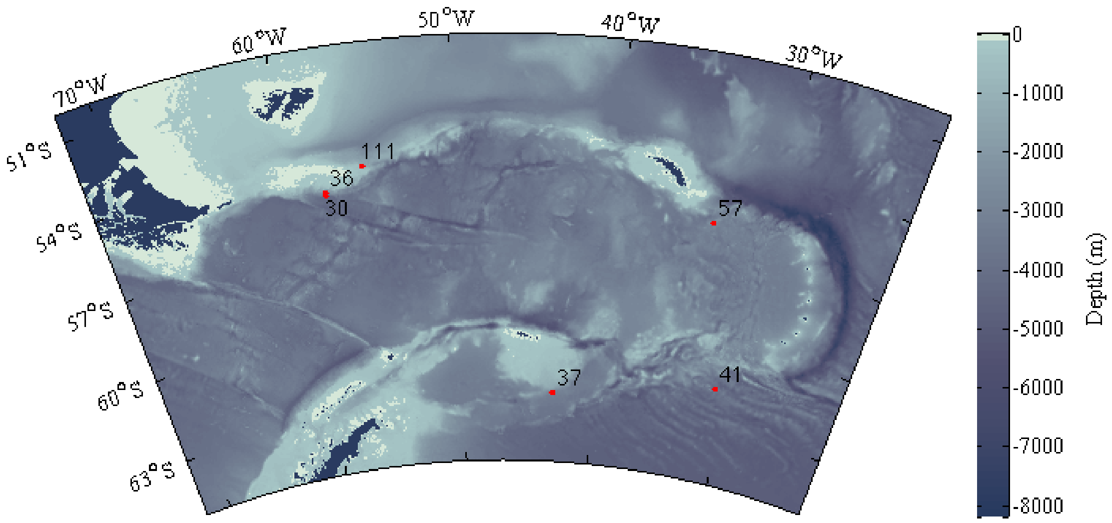
Total number of stations sampled for oxygen: 6
Total number of Niskins sampled for oxygen: 78
Total number of oxygen samples analysed: 154

Table 14.1: Summary of stations sampled for oxygen

Station no.	CTD no.	Lat (deg N)	Lon (deg E)	Date	No. Niskins sampled	No. samples
36	30	-55.2142	-57.9997	20140319	8	24
42	36	-55.1212	-57.9990	20140402	20	30
43	37	-62.5939	-43.2174	20140404	12	24

47	41	-61.6620	-31.1088	20140408	12	24
63	57	-55.9582	-33.6595	20140413	10	20
127	111	-54.3625	-55.5537	20140425	16	32

Figure 14.1: Location and CTD number of stations sampled for oxygen



14.3 Analysis

Samples were stored for at least 12 hours prior to analysis. The stopper was removed and 1mL of 5M sulphuric acid (H_2SO_4) and a magnetic stirrer bar were added to the sample. The sample was then mixed briefly to allow the majority of the precipitate to dissolve. Titration with 0.2M sodium thiosulphate ($Na_2S_2O_3$) was performed using a custom built photometric detector to determine the endpoint. Room temperature at the time of each titration was recorded using a digital temperature probe. Before analysing each batch of samples, blanks and sodium thiosulphate standards were run.

For standards, a flask was filled with MilliQ and a magnetic stirrer bar was added. 1mL of 'standard' 23.36mM potassium iodate (KIO_3) solution was added using a Metrohm Dosimat. 1mL of sulphuric acid, 1mL of NaOH/NaI and 1mL of $MnCl_2$ were added (in that order) using 1mL dispensers and the flask was topped up to the neck with MilliQ. This solution was then titrated with $Na_2S_2O_3$ using a Metrohm Dosimat and the volume of titrant corresponding to the equivalence point was recorded. Room temperature at KIO_3 addition and at $Na_2S_2O_3$ titration was recorded using a digital temperature probe. In sample oxygen concentration calculations a mean of the standardisations is used for $Na_2S_2O_3$ concentration.

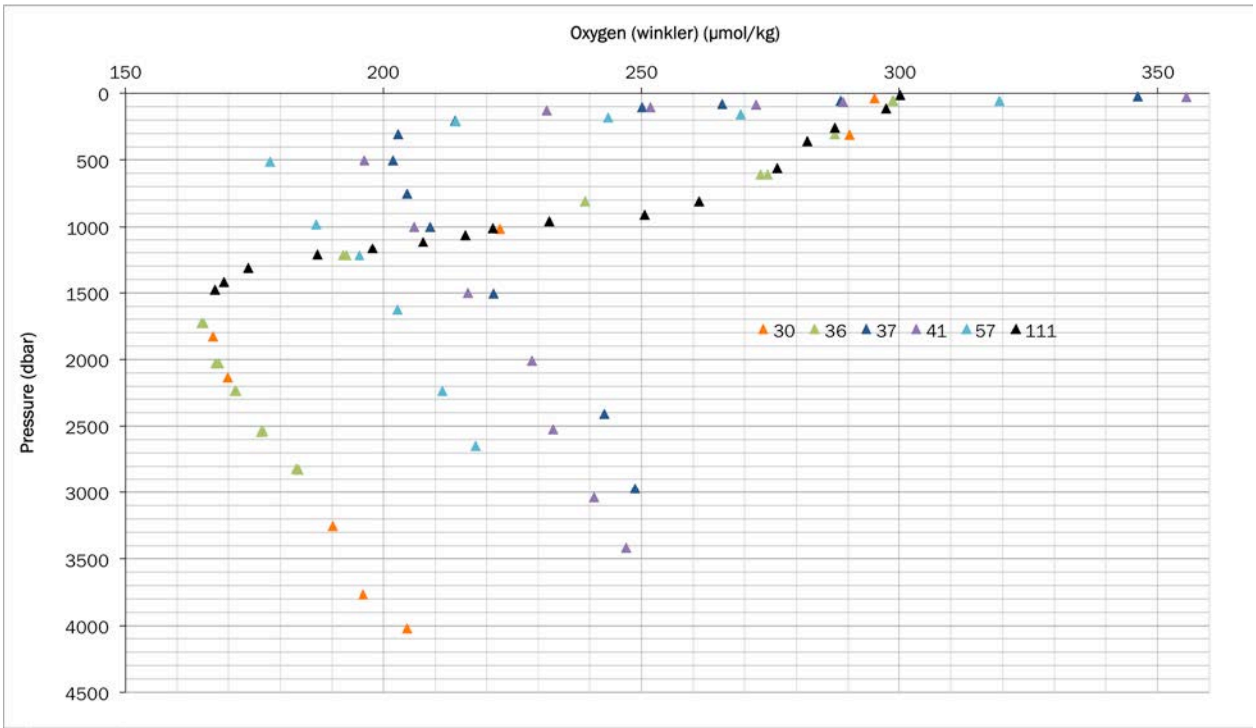
For blanks, a flask was filled with MilliQ and 0.1 mL of KIO_3 was added using a pipette. A magnetic stirrer bar was inserted and 1mL of sulphuric acid, 1mL of NaOH/NaI and 1mL of $MnCl_2$ were added (in that order) using 1mL dispensers. This solution was then titrated with $Na_2S_2O_3$ and the volume of titrant corresponding to the equivalence point was recorded.

After this initial titration a further 0.1mL of KIO_3 was added using a pipette and the $Na_2S_2O_3$ titration was repeated. Room temperature was recorded at each titration using a digital temperature probe. The difference between the two titrant volumes was taken as the blank volume. In sample oxygen concentration calculations a mean of all blank values is used.

14.4 Results

Oxygen profiles from the six stations sampled for oxygen are shown below. Duplicate and triplicate Winkler analyses usually agreed to within 1µM/Kg and the dataset as a whole has a RMSE of 0.39.

Figure 14.2: Oxygen profiles from the six stations sampled. Most points are means of duplicates.
Colour corresponds to CTD number.



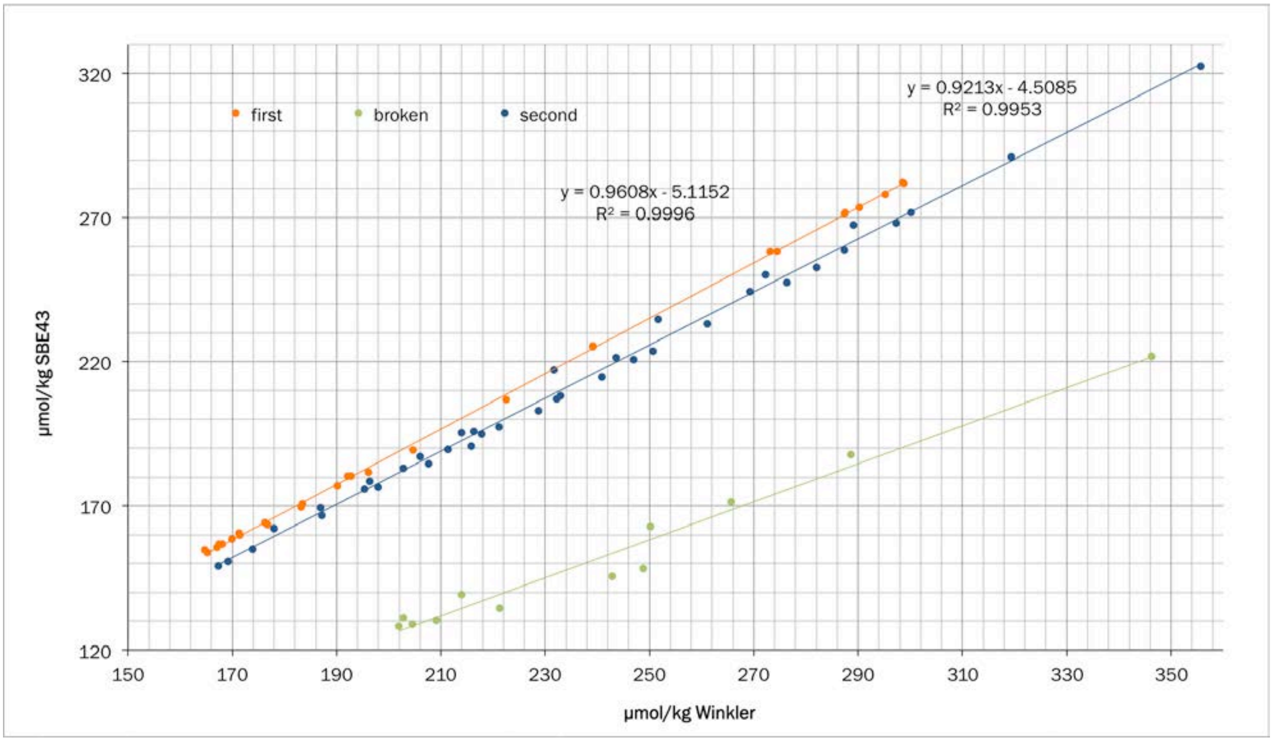
Data from Winkler analyses were plotted against data from the CTD SBE43 oxygen sensor. The calibration from CTD 37 was alarmingly different from that of stations 30 and 36 (see figure below). The period between CTDs 36 and 37 was the transit south, across the Scotia Sea to the northern Weddell Sea and we believe the SBE43 sensor to have frozen while on deck. Similar oxygen sensor failure has been observed previously which was also attributed to freezing (Hugh Venables, Pers. Comm.). Following CTD 37 the original SBE43 (serial number 2290) was replaced with a new sensor (serial number 0676). The broken sensor will be returned to Seabird for repair. The oxygen calibration is therefore split into two periods: one for the first sensor and one for the second. As the figure below shows, the two sensor calibrations are similar. Calibration coefficients shown in the calibration plot below are preliminary and subject to change following final quality control.

RECOMMENDATION: DO NOT ALLOW OXYGEN SENSORS TO FREEZE

The results from the first calibration period agree well with the calibration from the previous cruise (JR294) which used the same Winkler titration instrument, the same batches of reagents and the same SBE43 oxygen sensor. Results from the first calibration period can therefore be combined with data from JR294 to give more data for a calibration. The close agreement between JR299 and JR294 calibrations suggests that the sensor was stable throughout the first leg of JR299, across the Drake Passage.

The second calibration period covers the stations along the A23 section, stations in the Argentine Basin and stations along the North Scotia Ridge. As the figure below shows, the data from the second calibration period are slightly noisier around the linear fit than those from the first calibration period. However, this may not be indicative of sensor stability or precision but may instead reflect the fact that CTDs 30 and 36 were geographically and oceanographically very similar whereas CTDs 41, 57 and 111 were more diverse. Factors such as a pressure effect may therefore have affected results differently at different stations.

Figure 14.3: Calibration of the CTD oxygen sensors. Orange represents data from the first calibration period (CTDs 30 and 36), green represents data collected after sensor failure (CTD 37) and blue represents data from the second calibration period (CTDs 41, 57 and 111). Coefficients are preliminary.



15 Dissolved barium concentrations

Kim Pyle

Throughout JR299 water samples were collected and stored for future dissolved barium (Ba_d) concentration analysis. A total of 609 samples were collected across sections SR1b, and A23, along the North Scotia ridge, and from the LEDO M3 Mooring site in the Weddell Sea. These samples will be stored onboard the JCR until its return to the UK; they will then be analysed for dissolved barium concentrations at Bristol/Cardiff Universities using isotope dilution mass spectrometry (ID-ICP-MS).

15.1 Rationale

There are many proposed uses of dissolved and particulate barium as proxies for past and present oceanic conditions such as export production, alkalinity, and meltwater input. Understanding of the oceanic barium cycle is not yet comprehensive, particularly in the Southern Ocean. The analysis of these samples will feed into a wider investigation to establish the spatial and temporal distribution of dissolved barium in the Southern Ocean, and the responses of this dissolved pool to factors such as biological activity, sea ice formation, sediment fluxes and meltwater input. To this end, depth profiles were collected across the SR1b and A23 sections of the Drake Passage, across the North Scotia Ridge, and in the Weddell Sea. Samples for dissolved barium analysis were collected in tandem with silicate and nitrate samples that will be analysed by Oliver Legge at UEA, in order to investigate links between barium cycling and biological production and export. At several stations, including shallow stations on the continental shelf, samples were preferentially collected from the base of the water column in order to investigate potential fluxes of dissolved barium from sediment, and their interaction with deep waters.

15.2 Collection, Treatment, and Storage of Samples

Samples for Ba_d analysis were collected primarily from "CFC" designated stations, and were drawn from the 20L Niskin bottles attached to the CTD rosette only once samples sensitive to gas exchange (CFCs, carbon, or DIMES tracer) had already been taken. As Ba_d is present in seawater in only trace amounts, with a small dynamic range of approximately 70-100nM, care was taken with the sampling technique to reduce potential contamination between samples.

The water samples for Ba_d were drawn from the Niskin bottles using specified Tygon tubing into trace-metal clean 60mL or 125mL HDPE bottles. These HDPE bottles were cleaned at Cardiff University using 2N nitric acid and 18MΩ deionised water. The Tygon tubes were reserved for Ba_d sampling, and in between CTD stations were rinsed three times with, and stored in, deionised water. Samplers were required to wear clean nitrile gloves when handling Ba_d bottles and Ba_d sampling equipment, and followed a sampling protocol summarised as follows:

- Attach Tygon tubing to Niskin spigot, and rinse water through tube for several seconds.
- Rinse HDPE bottle three times by filling with approximately 10mL, capping, shaking, and emptying over the tube and spigot.

- Fill to the neck of the bottle and screw cap on tightly. Throughout process, avoid touching the ends of the Tygon tubing, the neck of the bottle, or the thread of the screw caps, to avoid potential contamination from the outer surface of the gloves.

Once samples had been collected they were individually acidified with Optima for Ultra traces analysis 32-35% hydrochloric acid (HCl) by either Kimberley Pyle or Oliver Legge (60µL of HCl added to 60mL samples; 125µL added to 125mL samples) in order to prevent biological alteration of the sample during storage. If necessary, the necks of bottles were dried using Kimtech wipes to prevent salt crystal formation at the bottle rim. Bottles were then capped, sealed with Parafilm, and stored in the cool room at a constant temperature of 2-4°C to prevent evaporation.
This process was conducted in a fume hood in the Radiation Lab, which was cleaned thoroughly at the start of the cruise and kept as a 'barium clean' area as much as possible. In order to reduce air contamination, the length of time that samples were left uncapped was minimised, and 8 'blanks' of deionised water treated as samples were prepared throughout the cruise to quantify the level of air contamination.

In order to determine the level of uncertainty introduced by the sampling method, 16 duplicate samples were collected from various CTD casts throughout the cruise, whereby two samples were collected from the same Niskin. Five 'Niskin duplicates' were also collected, which entailed two samples being drawn from two different Niskins that were fired at the same depth. Comparison of the dissolved barium concentrations in each of these duplicates will allow a quantitative analysis of the uncertainty introduced by use of this CTD rosette and sampling method.

15.3 SR1b Section

15 samples were collected from Station 2 in Bransfield Strait, and 272 samples from 19 CTD casts along the SR1b section (Stations 3-41) crossing Drake Passage from the West Antarctic Peninsula to Punta Arenas, southern Chile.

Table 15.1: Barium sampling - SR1b Section

Event Number	Station	CTD	Date	Barium bottles used	No. of Ba samples
2	2	2	12/03/2014	1-15	15
6	3	3	13/03/2014	16-24; 28; 32	11
9	5	5	13/03/2014	25-27; 29-31; 33-39	13
11	6	6	13/03/2014	40-46; 48, 49; 53	10
13	7	7	14/03/2014	50-52; 54-64; 67-69	17
17	9	9	14/03/2014	65, 66; 85-98	16
20	11	11	14/03/2014	71; 100-114	16
23	13	13	15/03/2014	70; 72-84; 99; 119	16
27	15	15	15/03/2014	115-118; 120-129; 140, 141; 143; 145	18
30	17	17	16/03/2014	130-132; 134; 142; 144; 146-155	16
33	19	19	17/03/2014	133; 135-139; 156-159; 161-167	17
40	26	23	17/03/2014	168-171; 174; 176-187	17
42	30	25	18/03/2014	172, 173; 175; 190; 192-194; 196, 197; 199-204	15
44	33	27	18/03/2014	189; 195; 205-208; 209-220	18
48	35	29	19/03/2014	188; 191; 198; 221-231; 234; 236	16
52	37	31	19/03/2014	232, 233; 235; 253-261; 263, 264; 267	15
55	39	33	01/04/2014	237-242; 244-247; 262; 265, 266; 268	14
56	40	34	01/04/2014	243; 248-252; 269; 271; 273-275	11
57	41	35	01/04/2014	270; 272; 276-289	16

18 samples were collected from a CTD cast at Station 44 at the LDEO M3 mooring site in the Weddell Sea, and 167 samples from 13 CTD casts along the A23 section (Stations 45-67).

Table 15.2: Barium sampling – Mooring site and A23 section

Event Number	Station	CTD	Date	Barium bottles used	No. of Ba samples
63	44	38	06/04/2014	290-304; 308; 311, 312	18
64	45	39	08/04/2014	305-307; 309, 310; 313-322; 324	16
65	46	40	08/04/2014	323; 325-338; 340	16
67	48	42	09/04/2014	339; 341-353	14
70	51	45	09/04/2014	354-367	14
71	52	46	09/04/2014	368-374; 376-383; 386	16
73	54	48	10/04/2014	387-400	14
74	55	49	10/04/2014	384, 385; 401-410	12
78	59	53	11/04/2014	411-422	12
80	61	55	12/04/2014	423-432; 434; 436, 437	13
83	64	58	13/04/2014	433; 435; 438-445; 447, 448	12
85	66	60	13/04/2014	446; 449-456	10
86	67	61	14/04/2014	457; 459, 460-468	12

143 samples were collected from CTD casts along the North Scotia Ridge (NSR) section (Stations 68-128).

Table 15.3: Barium sampling - North Scotia Ridge Section

Event Number	Station	CTD	Date	Barium bottles used	No. of Ba samples
87	68	62	15/04/2014	469, 470; 489; 491-494	7
104	85	79	20/04/2014	473; 475; 478, 479; 486-488; 490	8
106	87	81	20/04/2014	472; 474; 476, 477; 480-485	10
118	95	83	21/04/2014	495-498; 500-507	12
120	97	85	21/04/2014	499; 508-515; 552	10
124	100	88	21/04/2014	2x 500mL bottles (labelled 16 and 17)	0
126	101	89	21/04/2014	553-564	12
129	103	91	22/04/2014	528-539	12
132	105	93	22/04/2014	516-527	12
136	107	95	22/04/2014	578-590	13
142	111	99	23/04/2014	540-551	12
144	113	101	23/04/2014	565-571; 573	8
156	123	107	24/04/2014	572; 575-577; 591-594	9
158	125	109	24/04/2014	595-605; 610	12
161	128	112	25/04/2014	606-609; 611; 616	6

16 δ18 Oxygen

Andrew Meijers

δ18O samples were collected on behalf of Jenny Roberts, a PhD student at the University of Cambridge/BAS. She sent 80 sample vials along, with the intention of a full water column inventory at or near her ample site of interest; the sediment core GC528 (53° 00.78' S, 58° 02.43' W) on the northern side of the Falkland Trough at 600m water depth.

16.1 Sample sites

With only 24 possible water bottle depths and only so many useful duplicates that could be made, the decision was made to also sample the SubAntarctic front water that flushes the sample site on the western end of the North Scotia Ridge. Additionally, δ18O samples were opportunistically made by Mike Meredith using these vials on the second test CTD in Bransfield Strait. Table 16.1 indicates the sites and samples taken.

Table 16.1: δ18O sampling – whole cruise

Event Number	Station	CTD	Date	Vials used	No. of δ18O samples
4	2	2	12/03/2014	1 through 24	24
165	132	116	26/04/2014	1-15,1-50,1-8,1-16,1-11,1-5,1-1,1-7,1-6,1-13,1-41,1-42,1-10,1-3,1-41,1-12,1-1,1-9,1-2,1-44,1-46,1-49,1-47,0-25,1-45,0-27,0-29,1-48,0-28,0-30,0-26,1-14,1-43	32
168	135	119	26/04/2014	1-21,1-22,1-26,1-31,1-19,1-23,1-33,1-32,1-17,1-18,1-20,1-24,1-36,1-37,1-25,1-29,1-27,1-28,1-30,1-35,1-39,1-40,1-38,1-34	24

16.2 Collection, Treatment, and Storage of Samples

As water isotopes are not particularly sensitive to atmospheric contamination, they were sampled last after more sensitive samples were taken. Tygon tubing from the nutrient/barium sampling was attached to the niskin tap. Upon opening the tap, the tube was squeezed to control the flow. Water was allowed to drain through the tube to flush it from the previous sample. The flow rate was controlled by closing the tap such that no bubbles were coming out of the tap and the water was coming out of the end of the tube just faster than dripping. The tygon tube was also squeezed along its length to remove any air bubbles. The vial was then filled by pouring the water from the tube down the edge of the vial to minimize bubbles forming. The vial was filled and emptied 2-3 times to rinse it thoroughly. Finally the vial was filled until totally full, ensuring no air bubbles, capped and sealed with parafilm. Samples were stored in the 4 degree freezer immediately after sampling, and remained there for the voyage back to the UK.

17 Surface Drifters

Andrew Meijers (ship) Jean-Baptiste Sallee (remote, L'OCEAN) and Emily Shuckburgh (remote, BAS)

17.1 Introduction and aims

Sixteen surface drifters of two types were deployed in two targeted locations along the North Scotia Ridge using satellite altimetry information and a novel deployment configuration based on ideas from dynamical systems research. The main goal of these deployments was to examine lateral mixing driven by submesoscale (<10km) processes. These processes cannot presently be observed using satellite altimetry as is the case for mesoscale features (although their likely presence can be inferred remotely) and drifter deployment is one of the few available methods of observing them.

The new deployment configuration, which was tested as part of the AARDVARK project in December 2010 and April 2011, was designed to provide a more robust quantification of mixing than is otherwise possible from the examination of Lagrangian particles. Near-real time satellite altimetry was used to chose the release location based on the identification of target structures. The target structures are unstable manifolds of hyperbolic points (also called Lagrangian coherent structures). The altimetry data was then used to calculate geostrophic surface velocity fields, from which backward-time finite-size Lyapunov exponents (FSLEs) were calculated to identify the unstable manifolds in near real time. Fixed-velocity forward-time integrations were also performed to give an indication of the location of the stable manifolds and hence the hyperbolic points.

The manifolds provide a dispersion and a mixing mechanism by folding the fronts of advected tracers in thin filaments, enhancing small-scale diffusion. By studying relative dispersion of floats from the submesoscale up to the mesoscale (typically reached a few weeks after deployment), precise measurements of manifold properties can be obtained and these can be used to provide a quantitative validation of the corresponding measurements of the altimetry-based calculation. Near real-time satellite altimetry maps were examined at L'OCEAN in Paris by Dr. Jean-Baptiste Sallee every day prior to release and the FSLE were calculated for the North Scotia Ridge region. These maps were examined to identify suitable target structures close to the ship track. Surface drifters were then deployed on lines at a low angle to the predicted unstable manifolds, intersecting the predicted hyperbolic point, with a spacing between drifters/floats of 10 km. Two such structures were targeted, one with 10 drifters and a second with 6 drifters.

17.2 Surface drifter specifications

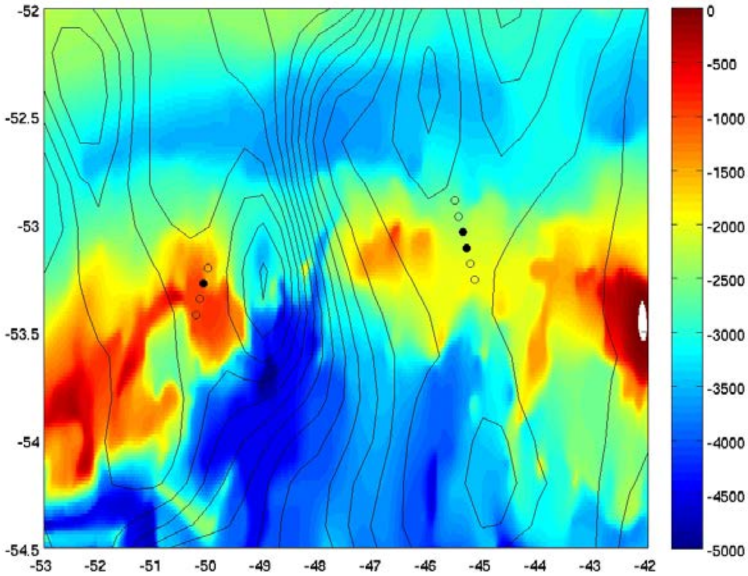
Drifting buoys provide sea surface temperature data and position (hence surface velocity) measurements for climate prediction models, as well as being useful tools for regional process experiments. Two types of drifters were used in this experiment. Six drifters were purchased from Data Buoy Instrumentation by BAS explicitly to examine submesoscale features on this voyage. These instruments house alkaline D-cell batteries, a transmitter, a thermistor, a GPS unit and a tether strain sensor to verify the presence of the drogue. The drogue sits approximately 15 m beneath the float on the surface to ensure the instrument is propelled by the ocean current rather than the wind. The drogue is of a 'holey sock' design with rigid rings and spokes supporting the drogue’s cylindrical shape. Each drogue section contains two opposing holes, which are rotated 90 degrees from one section to the next. These holes disrupt the formation of organized lee vortices. The batteries of a deployed DBI drifter transmitting GPS coordinates and sea surface temperature (SST) at 15 minute intervals via a 9602 SBD irridium modem are expected to last between 9-12 months. Such a high temporal resolution was specifically chosen in order to measure the small spatial scale variability associated with submesoscale (<10 km) feautres. This data is transmitted directly back to the PI's email accounts.

Ten other drifters were obtained serendipitously from the Global Drifter Program (GDP) shortly before the cruise departed. The GDP is a branch of the National Oceanic and Atmospheric Administration (NOAA). The NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) coordinates deployment and processes/archives the data. These drifters were supplied by the University of California (San Diego) so that a new type of firmware designed to prolong drifter life in cold waters could be tested. As their precise deployment location was not critical to their primary aim (maximising lifespan) we combined these floats with the high resolution drifters in the arrays designed to test submesoscale mixing. The GDP floats were functionally similar to the high resolution floats, although instead of iridium they make use of a Kenwood PMT A3 transmitter using the Argos constellation and hence their reporting period is limited to the presence of Argos satellites overhead. At the latitude of release this will be approximately every 2-3 hours. The batteries of a deployed drifter are expected to last approximately two years before ceasing transmission, but this is somewhat unknown and this deployment is largely aimed at addressing this question. In addition to position the drifters collect SST. Each drifter transmitter is assigned a Platform Terminal Transmitter (PTT) code, often referred to as the drifter ID for the Argos tracking satellite system. The data from these instruments will be made available through the WDP NOAA data portal in a delayed mode.

17.3 Deployment

Based on near real time altimetric information provided by J-B Sallee an unstable manifold with a hyperbolic point located at around 53S, 45W was targeted on the 20th of April 2014. A total of 10 floats (4 high resolution, 6 low) were deployed by dropping them from the aft deck while the ship steaming at a steady 3-5 kts. Deployments were made at six separate stations (Table 17.1, Figure 17.1) separated by 10 km each along a line heading NWW.

Figure 17.1: Drifter deployment locations over North Scotia Ridge bathymetry (m). Open circles show single drifter locations, while filled show triples. Contours indicate SSH as of 21-April-2014.



The remaining six floats (2 high resolution and 4 low) were deployed on a second unstable manifold on the 23rd of April with a hyperbolic point located at approximately 53S, 50W (Table 17.1, Figure 17.1). These were done over four stations on a line heading NE, again separated by approximately 10 km each.

Table 17.1: JR299 surface drifter deployment details.

Type: hires/lowres drifter	Serial Number	Name	Date	Year Day	Time (GMT)	Lat	Lon	Station	User initial
lowres	116335	Carly	20/04/2014	110	19:45	-53 15.542	-45 09.228	89	TM/AM
lowres	116334	Paul	20/04/2014	110	20:19	-53 11.067	-45 13.575	90	EK/AM
hires	159720	Alison	20/04/2014	110	20:52	-53 06.42	-45 18.18	91	AM
lowres	116332	Pingu	20/04/2014	110	20:52	-53 06.42	-45 18.18	91	KP/PM
lowres	116331	Little Dragon	20/04/2014	110	20:52	-53 06.42	-45 18.18	91	XY/TM
hires	157720	Piggy	20/04/2014	110	21:26	-53 02.11	-45 22.57	92	XY/HR
hires	157690	Siobhan	20/04/2014	110	21:26	-53 02.11	-45 22.57	92	EBW/TM
hires	157700	James St Teahouse	20/04/2014	110	21:26	-53 02.11	-45 22.57	92	PM
lowres	109558	Brian	20/04/2014	110	21:58	-52 57.76	-45 26.86	93	TM/PM
lowres	116333	Heather	20/04/2014	110	22:30	-52 53.31	-45 31.29	94	HR/TM
lowres	109554	Olibob	23/04/2014	113	16:07	-53 25.16	-50 12.88	114	TM/AM
lowres	109562	Meg	23/04/2014	113	16:40	-53 20.88	-50 09.29	115	EK/TM
hires	156740	Roen	23/04/2014	113	17:20	-53 16.40	-50 04.77	116	BG
hires	159680	Genevieve	23/04/2014	113	17:20	-53 16.40	-50 04.77	116	AM
lowres	109559	VandA	23/04/2014	113	17:20	-53 16.40	-50 04.77	116	KP/TM
lowres	109560	Little Ed	23/04/2014	113	17:57	-53 12.02	-50 01.48	117	MB/OL

Initial transmission data showed that all floats were successfully deployed and reporting their positions. Low resolution drifter position may be publically viewed at: http://gdp.ucsd.edu/projects_portal/dimes_uk5/
Data may be accessed via the world drifter programme website: http://www.aoml.noaa.gov/phod/dac/index.php

17.4 Further analysis

Further analysis will be undertaken upon return to land to calculate the FSLEs from the initial drifter/float trajectories, to compare the trajectories and FSLEs to the altimetry-based prediction, and to combine drifter/float and altimetry-based predictions to obtain a quantification of local eddy diffusivity and estimate the submesoscale contribution.

18 ARGO Float Deployments

Thomas Millgate

18.1 Introduction

Eight U.K. Met Office ARGO floats were deployed during JR299 (Table 18.1). The floats were pre-programmed and in pressure activation mode, meaning they simply needed deploying. Although initially earmarked for deployment in Drake Passage, after consultation with Brian King (NOC) and Jon Turton (Met Office) they were deployed in a straight line across the deep section (2500m or more) of Shag Rocks Passage between the Falkland Islands and South Georgia.

This location was chosen as once the floats have cleared the passage they should hopefully disperse to the north and south of the Polar and Southern Atlantic Fronts, ensuring a nice spread as they move into the South Atlantic. This deployment location fulfilled two roles, firstly to provide information on ACC streamlines, and secondly to replace ARGO floats into an under populated region. All floats were deployed successfully and their deployment reported to Brian King and Jon Turton.

Table 18.1: ARGO Float Deployments

ARGO number	Float Serial Number	Date	Jday	Time Deployed (UTC)	Station Number	Lat S	Lon W
ARG01	6599	21/04/2014	111	16:25	99	-52 59.55	-47 30.13
ARG02	6598	21/04/2014	111	20:00	100	-52 55.58	-47 44.81
ARG03	6597	22/04/2014	112	03:00	102	-53 05.83	-48 11.71
ARG04	6596	22/04/2014	112	04:00	103	-53 06.844	-48 16.850
ARG05	4997	22/04/2014	112	12:20	105	-53 07.51	-48 35.05
ARG06	6241	22/04/2014	112	15:30	106	-53 12.249	-48 45.917
ARG07	6600	22/04/2014	112	19:00	107	-53 17.45	-48 54.70
ARG08	6601	23/04/2014	113	05:30	109	-53 22.61	-49 16.36

Deployment Procedure:

Pre-deployment

- Remove float from crate at the station before deployment.
- Stand in a bucket of seawater to enable the chamber at the base of the float to flood, meaning the float will begin to sink at the location of deployment rather than drift on the surface whilst the chamber flooded.
- Leave the plastic bag over the sensor and the 3 labelled plugs attached to ensure the sensors remain clean.

Deployment

- Record the float serial number on the logsheet.
- Remove the plastic bad and 3 plugs from the sensors.

- Do not drop the instrument, use ropes to gently lower it into the water.
- Once lowered in the water release and ensure no rope is left attached to the float.
- Record the time, lat & long of deployment as well as water depth on the logsheet.

19 Data Management Report for JR299

Ellen Bazeley-White

19.1 Cruise numbering and relationship to previous cruises

During cruise planning by the National Marine Facility JR299 was considered to consist of three cruises, the PSO wished the cruise to solely be known as JR299 and for data to be organised in one leg. The leg start date was assigned the date that the scientific staff arrived on the ship, 8th March 2014, 20140308.

Table 19.1: Relationship of JR299 work with previous cruises

Project/Area (Cruise number used in planning)	**Transect**	**Previous Cruises**
Drake Passage Repeat Hydrography (JR293)	SR1b	17 cruises during the last 20 seasons. A good summary is given in the cruise report for JR265_254d
Northern Weddell Sea to South Georgia (JR272c)	A23	JR010 (1995) JR040 ALBATROSS (1999) USA CLIVAR (2005) JR239 ANDREX (2010) JR272A (2012) USA CLIVAR (2013) JR281 (2013)
North Scotia Ridge (JR273b)	NSR	JR080 ShagEx (2003) JR272A (2012) – not a full transect JR281 (2013)
Argentine Basin		JR281 (2013)
DIMES		UK1 JR208 (2009) UK2 JC054 (2010) UK2.5 JR276 (2011) UK3 JC069 (2012) UK4 JR281 (2013)
LDEO Moorings		ES031 (2007) ES033 (2009) JR252 (2011) JR281 (2013)

19.2 Pre-cruise preparation

In preparation for JR299 the following activities were undertaken

- Read the SME reports submitted to NMF and produced an Outline Data Management Plan
- Met with PSO to discuss role onboard – asked to participate in watches, monitor swath and assist with cruise report compilation

- Researched BAS physical oceanography cruises and obtained and read relevant past cruise reports , also contacted PSOs of cruises lacking cruise reports
- Populated the PDC Cruise Metadata Database with metadata about previous cruises
- Produced a list from the BAS planning system 'SOUTH' of the cruise participants and crew onboard
- Copied relevant resources to hard drives to take for use on board the ship

19.3 Start of cruise activities

- Attended cruise planning meeting and emphasised the use of the JCR digital event logs
- Set up key folders in the cruise 'work' folder (L drive)
- Aided with the design of a CTD sampling spreadsheet
- Asked Mark Preston to produce an AME report for his time onboard (this covers the previous cruise JR294 and JR299)
- Informed Jeremy Robst that although this cruise was assigned three cruise numbers, the PSO wishes it to be known as JR299 and that it will cover the period from Rothera on 8th March 2014 (20140308) to Stanley, so no changes to event logs, work folder or data folder in Punta Arenas
- Swath was started by Hugh Venables on 12th March 2014, I informed bridge that it was to have event number 1, so that the event log would indicate that this type of data was collected
- Following a discussion with the PSO, the digital event logs were set up, Jeremy Robst was asked to start the automated web archiving (as detailed in the cruise report for JR280 section 12.7.2 Archive Script) and archives have been saved periodically in cruise/20140308/data/web
- Attended training in CTD sampling methods
- Gave a presentation on Information Management after the PSO science presentation, unfortunately some staff were sampling at the time and also some ships staff left after the science presentation
- Set up a 'blue' ring binder to save hard copy logsheets and an area in the work folder for scanned sheets and metadata entered from logsheets into spreadsheets
- Made a photo sheet of the Scientific Cruise Party and displayed around the ship

19.4 During the cruise

- Checked the bridge log and asked for corrections or edits when required
- Populated event logs (see Table 19.2)
- Entered the CTD sampling information into excel spreadsheets or checked those entered by Tom Millgate (thanks Tom)
- Scanned CTD, LADCP, CTD Sampling and Watchkeeper logs and filed paper sheets
- Aided with CTD sampling for 31 CTDs and sample copping (recording of bottle metadata) for 4 CTDs
- Monitored the data streams and logging, logged errors in event logs and notified Pete, Seth or Craig (Deck Engineer) as required
- From early April onwards ensured that Seth was aware of any CTD equipment issues being recorded on the CTD sampling sheets and encouraged samplers to contact him themselves

- Maintained and periodically displayed my own summary logs (compiled in word docs) on the UIC whiteboard for the stations and events
- Promoted the use of the JCR digital event logs, website, my summaries and CTD sampling data being entered at cruise planning meetings and by the display of posters next to the UIC white board
- Checked with Hugh Venables what information he would need for a CTD table for the cruise report and saved digital logs to excel in prep for rearranging as required
- Liaised with Pete Lens and Hugh Venables to try and keep the SSU going and keep the EM122 using a suitable SVP
- Asked scientists about their data management
- Edited the photo sheet of the ship's crew following a minor cruise change in Punta Arenas
- Wrote a blog piece for the "A drop in the Southern Ocean" blog (about my role on board and history of BAS) and obtained permission from the BAS Archives Manager for Katy to use a film clip online [http://www.adropinthesouthernocean.blogspot.co.uk/2014/04/data-data-everywhere.html]
- Provided some entertainment activities – origami polar animals, a cruise quiz, jumping...

19.5 Event Logs and Data Sheet Summary

Table 19.2: Digital Event Logs

Log	Contains	Maintained by	Notes
Bridge Sciencelog JR299	Detailed event information	Bridge	Ellen checked and had corrections implemented as required
JR299_Station_depths	Lat, Lon, EA and EM depth at arrival times on station	EBW	
JR299_CTD2_log	Information about CTD at Time onboard	EBW	Accidentally called 2 columns 'Lat', the data stream detail shows which is actually 'Lon'.
JR299_CTD_log	Information about CTD at Time in	EBW	
JR299_General Info	Any logging failures or correction to bridge log	EBW	
JR299_ADCP_log		N/A	No Records
JR299_Tethered_VMP_log		N/A	No Records – see Cruise report tables
JR299_VMP_log		N/A	No Records – see Cruise report tables
JR299_ARGO_log		N/A	No Records – see paper logs, spreadsheets and cruise report table
JR299_EM122_Swath	EM122 operation	EBW & PL	Log also added to by JR and HV

Table 19.3: Paper Logs

Log	Contains	Maintained by	Notes
Watchkeeper	Observations from data displays every 4 hours	Watchleaders	Scanned
CTD	Deployment info for CTD	Watchleaders	Scanned and data entered into digital logs
CTD sampling log	Bottle sampling information	Sample Cops	Scanned and data entered into spreadsheets
LADCP	Deployment and Recovery	Watchleaders	Scanned
Salinometer	Salinometer values	Hugh Venables	Data entered into spreadsheets
ARGO Floats and Drifter	Deployment information	Tom Millgate	
Oxygen sampling	Oxygen analysis information	Ollie Legge	Scanned, Paper logs are filed with the CTD sampling logs

Paper logs were scanned and saved in the work area at:
L:\Event Logs and Sample Sheets\Scans of sampling sheets

Data entered into spreadsheets were saved at:
L:\Event Logs and Sample Sheets\Data entered from log sheets

Digital Logs were saved in excel spreadsheets (from csv export which doesn't always format well and from copying and pasting from the browser window) at the end of the cruise and saved.
In addition the JCR daily position reports on the BAS internal website (http://basweb.nerc-bas.ac.uk/operations/ships/reports/), that provide a daily report from the master were also saved:
L:\Event Logs and Sample Sheets

19.6 JR299 Data and Metadata

The ship remained on GMT-3 throughout the cruise. During the cruise the USA moved to Daylight Saving Time and the UK to British Summer Time, all times relating to data collection were recorded in UTC (=GMT).

All data and records in the data area (K drive) and work area (L drive) have be saved on the UNIX servers at BAS Cambridge in /data/cruise/jcr/20140308

NERC funded data and collected data is covered by the NERC Data Policy:
http://www.nerc.ac.uk/research/sites/data/policy/

Information from the Cruise Summary Report form will be used to populate the British Oceanographic Data Centre's cruise inventory:
https://www.bodc.ac.uk/data/information_and_inventories/cruise_inventory/

The following tables provide an overview of the key datasets produced and locations of data.

Ship based data collected via the shipboard computer system (e.g. met equipment, depths, lat/lon, underway data, pitch/roll) are recorded at various intervals and are saved at:
K:\scs

CTD

Paper log	Paper	Blue Folder (taken to BAS by Ellen)
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\CTD Sampling Sheets
Digital Log	JR299_CTD_log & JR299_CTD2_log – contains a summary from the paper logs	
Data - raw	K:\ctd	
Processing notes	Preliminary onboard processing (see chapter 2): K:\pstar	
Data - profiles	L:\CTD	
Calibration	Salinity samples from CTD niskins. L:\Science Work Areas\salts	
Long-term data management and data centre	Data/metadata managed by BAS Polar Oceans group/Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC	

LADCP

Paper log	Paper	Blue Folder (taken to BAS by Ellen)
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\LADCP (copies have also been saved in work\Science Work Areas\LADCP\LogSheets)
Data	L:\Science Work Areas\LADCP (NB the area K:\ladcp is empty)	
Processing notes	Preliminary onboard processing (see chapter 6): Further processing will be undertaken at LDEO.	
Long-term data management and data centre	Data/metadata managed by BAS Polar Oceans group/LDEO/Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC & LDEO	

VMP & TVMP - Vertical Microstructure Profiler & Tethered Vertical Microstructure Profiler
Brief Description:
Microstructure shear, temperature and conductivity variability (turbulence), finestructure temperature, and salinity
Cruise participants working with the equipment/data:
Katy Sheen, Alex Forryan, Paul Provost and John Wynar

Paper log	Paper	Diving and recovery logs - Katy took to NOC	Katy
	Scans	L:\Science Work Areas\VMP\VMP_5500\LogSheets & L:\Science Work Areas\VMP\VMP_2000\LogSheets	Katy
Paper notes	Paper	Katy took to NOC	Katy
	Scans	L:\Science Work Areas\VMP\Admin	Katy
Digital log	JR299_VMP_log & JR299_Tethered_VMP_log		not used
Records	L:\Science Work Areas\VMP\Admin		
Data – raw	L:\Science Work Areas\VMP\VMP_5500\Data & L:\Science Work Areas\VMP\VMP_2000\Data		Katy
Processing notes	Data processing was done during the cruise - data will be re-processed in a similar manner but with higher quality control back in the UK		Katy
Long-term data management and data centre	The data will be saved at NOCS and on completion sent to the BODC (this will be done by Katy Sheen or Alex Forryan and overseen by Alberto Naveira Garabato).		Katy & Alex

Moorings

Paper Logs	Paper	??
	Scans	??
Digital Log	No	
Data - raw	??	
Processing notes	??	
Long-term Data Management and Data Centre	LDEO	
Ownership	LDEO	

ADCP

Paper Log	Paper	None
	Scans	N/A
Data - raw	K:adcp	
Processing notes	Onboard processing (see chapter 7): L:\Science Work Areas\VMADCP	
Long-term Data Management and Data Centre	Data/metadata managed by BAS Polar Oceans group /Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC	

Underway and Navigational data

Paper Log	Paper	None
	Scans	N/A
Data - raw	K:scs	
Processing notes	Onboard processing (see chapter 8): K:pstar	
Long-term Data Management and Data Centre	Data/metadata managed by BAS Polar Oceans group /Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC	

EA600

Paper Log	Paper	None
	Scans	N/A
Data - raw	K:scs (NB K:ea600 is empty)	
Processing notes	Onboard processing (see chapter 9): K:pstar/ea600	
Long-term Data Management and Data Centre	Data/metadata managed by BAS Polar Oceans group /Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC	

EM122

Paper Log	Paper	None
	Scans	N/A
Digital log	JR299_EM122_Swath	
Data - raw	K:em122 (jr299_a)	
Processing notes	None onboard	
Long-term Data Management and Data Centre	Data/metadata managed by BAS Polar Oceans group /Polar Data Centre/British Oceanographic Data Centre	
Ownership	NERC	

CTD Water Sampling

Paper Log	Paper	Blue Folder (taken to BAS by Ellen)
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\CTD Sheets
	Data transcribed	L:\Event Logs and Sample Sheets\Data entered from log sheets\CTD Sampling
What is being sampled?	CFCs, DIMES Tracer, Oxygen, Carbon, Barium, Nitrate, Silicate, Salts	

DIMES Tracer

GC (Gas chromatogram) Analysis

Gas analysis produces digital data and a paper graph

Paper Logs	Paper	Paper chart & GC log sheet (see 10.3.3)
	Scans	No
Data (raw & processed)	On netbook (.wdq raw files) and converted to .csv Preliminary analysis done onboard (chapter 10) Backed up at L: DIMES_Tracer	
Long-term data management and data centre	Contact Jim Ledwell - jledwell@whoi.edu Dimes Data Policy - http://dimes.ucsd.edu/data_policy Following NSF and NERC guidelines, all DIMES data will ultimately be reported to the US National Ocean Data Center, National Geophysical Data Center, and/or the British Oceanographic Data Centre	
Ownership	Dimes Data Policy - http://dimes.ucsd.edu/data_policy	

Halocarbons

Paper log	Paper	On CTD sampling log sheet
	Scans	N/A
Digital log	see Table 11.1 Subset of information from the CTD sampling logs - L:\Science Work Areas\CFCs\ CFC_station_sheets.pdf	
Data - raw	Samples stored at 4C for transit back to UK	
Data - Analysis	Analysis will be carried out at the University of Exeter under the direction of Dr. Marie-José Messias. As of 29th Oct. 2014, there is some doubt about the viability of samples following a fridge failure at UoE. Hopefully most samples will be salvaged, but their status is unknown at present.	
Long-term data management and data centre	University of Exeter	
Ownership	NERC/University of Exeter	

Carbonates

Paper log	Paper	On CTD sampling log sheet
	Scans	N/A
Digital log	None – see Table 12.1	
Data - raw	Samples	
Data - Analysis	Samples will be analysed for DIC and TA at the Centre for Ocean and Atmospheric Sciences (COAS) at the University of East Anglia	
Long-term data management	Once analysed and quality controlled the data will be submitted to the British Oceanographic Data Centre (BODC) and to the publically available	

and data centre	CO_2 database at the Carbon Dioxide Information Analysis Centre (CDIAC)
Ownership	NERC/ University of East Anglia

Nutrients

Paper log	Paper	On CTD sampling log sheet
	Scans	N/A
Digital log	None	
Data - raw	Samples	
Data - Analysis	Samples will be analysed for silicate, nitrate and phosphate at the Centre for Ocean and Atmospheric Sciences (COAS) at the University of East Anglia	
Long-term data management and data centre	NERC/ University of East Anglia	
Ownership	NERC/ University of East Anglia	

Oxygen

Paper log	Paper	On CTD sampling log sheet and log managed by Ollie Legge
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\Oxygen_sampling_sheets
Digital log	None – see Table 14.1	
Data - raw	Samples	
Data - Analysis	Done onboard	
Long-term data management and data centre	NERC/ University of East Anglia	
Ownership	NERC/ University of East Anglia	

Barium

Paper log	Paper	On CTD sampling log sheet
	Scans	N/A
Digital log	None	
Data - raw	Samples L:\Science Work Areas\Barium	
Data - Analysis	Samples will be analysed for dissolved barium concentrations at Bristol/Cardiff Universities	
Long-term data management and data centre		
Ownership	NERC/Bristol University/Cardiff University	

Drifters – high res (Data Buoy) & low res (Global Drifter Programme)

Paper log of deployment info	Paper	Blue Folder (taken to BAS by Ellen)
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\Drifters and Floats
	Data transcribed	L:\Event Logs and Sample Sheets\Data entered from log sheets\Drifters and Floats
Digital log	None	
Data - raw	Emailed to principle investigator or transmitted to the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML)	
Data - Analysis	AARDVARK project team after cruise & NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML)	
Long-term data management and data centre	Low res: http://gdp.ucsd.edu/projects_portal/dimes_uk5/ & WDP NOAA data portal: http://www.aoml.noaa.gov/phod/dac/index.php	
Ownership	NERC/ NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML)	

Argo Floats

Paper log of deployment info	Paper	Blue Folder (taken to BAS by Ellen)
	Scans	L:\Event Logs and Sample Sheets\Scans of sampling sheets\Drifters and Floats
	Data transcribed	L:\Event Logs and Sample Sheets\Data entered from log sheets\Drifters and Floats
Digital log	Not used	
Data - raw		
Data - Analysis		
Long-term data management and data centre	http://research.metoffice.gov.uk/research/ocean/argo/ http://www.argo.ucsd.edu/	
Ownership		

19.7 Towards the end of the cruise and back in Cambridge

- Produced summary counts of sampling in prep for Cruise Summary Report (CSR) Form
- Drafted the CSR for the PSO to check over, checked his additions and emailed to BODC
- Wrote sections for the cruise report and compiled and checked the various drafts
- Tidied work folder
- Copied work folder for own back-up
- Packed the paper logs to transport to Cambridge and accessioned to the PDC

19.8 Other activities to support onboard science

- Asked Jeremy Robst to edit the JCR digital event logs to indicate the data stream in the online view and in the csv export – completed
- Informed Jeremy Robst and Hugh Venables that the underway sea thermometer had recently been replaced and an additional one added. The additional stream has been added to the end of the oceanlogger file and Jeremy updated the tpl file and has named the new stream sstemp2, the original stream has not been renamed and is still sstemp (so any running scripts with continue to work)
- Discussed with Jeremy Robst, Mark Preston, Pete Lens and Seth Thomas the difficulty in determining which instruments have been used over time, how best to list these will be followed up in Cambridge
- Liaised with Hugh Venables about which cruises he has cleaned navigational data for and forwarded information to the Cruise Metadata Project team in Cambridge
- Asked permission of the BAS Archives Manager to put copies of archive material and information products on the ship's media drive – granted
- Tidied unix area /users/eab (Ellen Bazeley-White]
- Copied unix area /users/njcu (Nathan Cunningham – previous data manager) to a portable hard drive to take back to Cambridge, once copied to a server in Cambridge recommend the area be deleted from the ship (NB some of the JCR wiki content may be using html and pfds in the unix area)
- Audited the book collection on board in all public areas (didn't get time to do the master's cabin) comparing with a list supplied by the BAS Library Manager and adding non-listed items as appropriate
- Displayed a poster encouraging staff to contact the BAS Library Manager with ideas for books that should be on the JCR
- Created an area called BAS Information Services on the P drive area and populated it with presentations, archive leaflets and films, the cruise database and digital cruise reports and the library book list. Printed out the posters from the BASIS open session in April to make a pack for those on staff to read and emailed everyone on board to tell them about BASIS and the new P drive area
- Started a draft for new PSO standing orders and data management guidance in prep for a re-edit over the summer and following the appointment of a new ships operation manager
- Pete Lens copied the JCR wiki to a hard drive for me to take back to Cambridge
- Pete Lens gave me 2 ring binders, one of cruise reports by ICT staff and another of end of cruise check sheets – these may be useful for the PDC Cruise Metadata Project, so were packed to take back to Cambridge

19.9 Other activities

Not much time was available for other activities, but

- Learnt some very basic UNIX DPS to summarise and export data
- Sent comments to Helen Peat on the poster she designed for the BASIS (BAS Information Services) afternoon in BAS Cambridge
- Responded to an enquiry from BODC about JR cruises
- Enquiry work – JCR deck log observations for sunrise/sunsets during JR291

19.10 Observations, Issues & Recommendations

- The regular cruise planning meetings at the start of the cruise were useful, especially for distributing information, once people went on to shifts it was harder to inform – hence use of posters on the UIC whiteboard, but not sure people were regularly checking them
- I created a digital log for the swath and Hugh and Jeremy/Pete were aware of this and used it, but it wasn't used regularly to update to the level of detail asked for in the opportunistic swath guide, I could have emphasised this better
- The SSU periodically crashed, Pete Lens led on the investigating and restarting
- The SVP for the EM122 was not updating as described in the guidance, the chron job was not working as the CTD files had been named with an '_' in the name. Pete Lens identified the error and for the last part of the cruise we could then manually update the SVP from recent CTD casts.
- The scanner would periodically freeze, but could be cured by turning it off and turning it on again (that old IT trick!) or rebooting the PC, finally the scanned image became unusable and I used the photocopier in the combined office on the Bridge deck, which could batch scan. It would be good to have a better scanner and more sophisticated scanning package available in the data prep room.
- The 'library' collection has presumably not been reviewed by the BAS library for a while, books are old, outdated and little used – recommend the BAS Library Manager visit the ship, update the collection (hopefully following suggestions from staff) and enthuse staff to use it (or at least know about it)

20 ICT Cruise Report for JR299

Pete Lens

20.1 Cruise Summary

Cruise : JR299, DIMES, moorings, CTD, Tracer, A23, SR1
PSO : Andrew Meijers
ICT : Jeremy Robst (first leg), Pete lens (Second leg from 25th March 2014)
AME : Mark Preston (First Leg), Seth Thomas (second leg)
Captain : Jerry Burgan
Sailed from Rothera to Stanley, via Punta Arenas
Logging start - 8th March 2014 @ 15:00

20.2 Cruise Log

jpro 15:00, 8 March 2014 (UTC)
ACQ Started

jpro 19:28, 8 March 2014 (UTC)
Reenabled jcrdata transfer from bslceng

jpro 14:04, 10 March 2014 (UTC)
Modified scs oceanlogger.xml to reflect extra sea surface temperature sensor -> oceanlogger-sstemp2

Pcdl 11:04, 6 April 2014 (UTC)
SSU crashes every few minutes (system and screen freeze) solved by a reboot of EM122 PC and below decks equipment
New Sophos (S3a) server introduced and all machines moved to it, PC inventory taken as part of process.
Three times a day crash of the raw2compress processes - solved by running raw2compress.pl ./raw2compress.xml as scs on jrlb.

Pcdl 17:43, 7 April 2014 (UTC)
WSUS Server built. Needs first sync with large bandwidth - waiting on packeteer change.

Pcdl 11:58, 9 April 2014 (UTC)
AMOS moved to Windows 7. Replication, backup, robocopy and databases all running correctly.
Solved Veeam replication issues; hostname must be in capitals in the credentials store.

Pcdl 19:13, 10 April 2014 (UTC)

SSU crashed several times so rebooting all EM122 hardware, this time the SSU crashed immediately after the reboot. No pattern to the crashing, seems to happen every few minutes for a period and then stay working for days.

Pcdl 14:54, 15 April 2014 (UTC)
Stock check complete including printers and UPS batteries.
SSU has been up for several days without issue.

Pcdl 20:17, 16 April 2014 (UTC)
All E1000E Virtual network cards replaced with E1000 for the new SABRIS configuration, Veeam replication increased from ~60MB/s to ~150MB/s
WSUS successfully synched with Cambridge and PC's moved into correct groups.

Pcdl 13:06, 18 April 2014 (UTC)
JPRO fixed Bridge Log remotely; typo in html template
Moved JCR-BRIDGE-L1 to exclude group for WSUS as it stopped functioning. Will be replaced this refit.

Pcdl 21:29, 18 April 2014 (UTC)
JRW-SCSDISP-V1 displays failing for users. CPU at 100%. Added 2nd CPU and increased resources. No effect although no longer 100% CPU. Removed Sophos. Now working. Will be replacing this server with Win7 on new Dell servers soon.

Pcdl 16:59, 19 April 2014 (UTC)
SABRIS Print Server built
All Windows Servers checked for settings; VNC, RDP, NTP, WSUS

Pcdl 15:47, 22 April 2014 (UTC)
Replaced JRW-SCSDISP-V1 with JRW-LVDISP-V1 providing underway graphical displays to users on the main LAN via a web browser. The new server is Windows 7 Enterprise 64bit with 2 CPU's and 2GB RAM. The CPU usage is high but the server is better able to cope than the last VM. Find them under http://wiki.jcr.nerc-bas.ac.uk/LabVIEW_Displays

Pcdl 16:37, 26 April 2014 (UTC)
SSU has not crashed for 16 days. Still unknown what the cause of earlier instability was. Complete spare unit in the cage if required.

20.3 End of cruise backups

From the Bridge EA600 PC, copy the data to the legwork area
Save the EM122 PU Parameters and User Settings
Make two backups; 1 from unix and 1 from Windows

Plug a clean disk into the Dell server jr-esx0
Use VMware vSphere Client to Add new USB device to JRLC
Login to jrlc as root

Type the following to find out which device to use

```
ls -al /dev/disk/by-label
```

assume the drive is /dev/sdb1

```
mkfs.ext4 -L cruisedata /dev/sdb1
mkdir /mnt/cruisejr299
mount /dev/sdb1 /mnt/cruisejr299
```

now backup the data

```
mkdir /mnt/cruisejr299/20140308
/usr/bin/rsync -vlrhAt /data/cruise/jcr/current/ /mnt/cruisejr299/20140308
```

cleanup

```
unmount /mnt/cruisejr299
rmdir /mnt/cruisejr299
```

Use VMware vSphere client to Remove the USB device
Disconnect the HDD from the ESX Server

20.4 Recommendations

Replace PC's for; ELEC, ECR-D2, DPREP-D5
Replace Bridge laptop
Replace A3 scanner with one that has Windows 7 drivers.
Replace batteries in both Smart-UPS 5000 units for ESX and SCS racks

21 Antarctic Marine Engineering (AME) Report

Two members of staff from the BAS AME group supported JR299, each wrote a report, these have been included as sections 21.2 for the fest few weeks of the cruise (NB this includes information about equipment and activities before the start of JR299) and 21.3 for the last part of the cruise.

Calibration certificates have not been included in the report but can be obtained by containing the BAS Antarctic Marine Engineering group (http://www.antarctica.ac.uk/engineering).

21.1 AME form intro and end of cruise procedure

Engineering Technical Section
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

FAO:
The BAS AME (electronics) marine scientific instrumentation support engineers

Cruise Report Instructions

Neil French (nefren) is the first point of contact for marine scientific instrumentation – any questions email (nfren@nerc.ac.uk) or phone him (01223 221398); try Rob White (robite 01223 221294) or secondly Steve Bremner (sfbr, 01223 221416) when Neil not available.

Before you leave HQ for cruise support obtain an up to date image of the JCR directories from the M: drive. The database for locating incidentals and spares is now maintained on the JCR by AME and a copy for reference should be sent back to the UK each year. Please contact nefren if you are unfamiliar with this database. A list of spares/stock required should be included at the end of this report. However critical items must be ordered immediately.

A brief cruise report checklist is required for every cruise AME are responsible for supporting. Include pertinent notes on fault history and diagnosis at the end of the report even if you have already discussed via email. This information will be added to the instrumentation database maintained in the UK .

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

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

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

Please leave a copy of the cruise report on the ship in the electronics workshop for the next support engineer and email a copy to nefren, robite & sfbr.

End of Cruise Procedure

At the end of the cruise, please ensure that:

- the XBT is left in a suitable state (store in cage if not to be used for a while – do not leave on deck or in UIC as it will get kicked around). Remove all deck cables at end of cruise prior to refit.
- the salinity sample bottles have been washed out and left with deionised water in – please check this otherwise the bottles will build up crud and have to be replaced.
- the CTD is left in a suitable state (washed (including all peripherals), triton + deionised water washed through TC duct, empty syringes put on T duct inlets to keep dust out and stored appropriately). Be careful about freezing before next use – this will damage the C sensors (run through with used standard seawater to reduce the chance of freezing before the next use). Remove all the connector locking sleeves and wash with fresh water. Blank off all unconnected connectors. See the CTD wisdom file for more information. If the CTD is not going to be used for a few weeks, at the end of your cruise please clean all connectors and attach dummy plugs or fit the connectors back after cleaning if they are not corroded.
- the CTD winch slip rings are cleaned if the CTD has been used – this prevents failure through accumulated dirt.
- the SVP is left in a suitable state (washed and stowed). Do not leave this on deck without a cover for any length of time as it rusts. Stow inside at end of cruise.
- all manuals have been returned to the designated drawers and cupboards.
- you clean all the fans listed below every cruise or every month, whichever is the longer.

21.2 AME report JR299 to 21st March 2014

Cruise: JR294 & JR299 Start date:21/01/2014 Finish date:21/03/2014
Name of AME engineer: Mark Preston
Name of principle scientist (PSO): K Heywood (294) A Meijers (299)

LAB Instruments

Instrument	**S/N Used**	**Comments**
AutoSal	68959	
Scintillation counter		
Magnetometer STCM1		
XBT		

ACOUSTIC

Instrument	**S/N Used**	**Comments**
ADCP	Y	
Hydrophone		
EM122	Y	
TOPAS	Y	
EK60	Y	
SSU	Y	
USBL	Y	Tracking VMP – no problems
10kHz IOS pinger		
Benthos 12kHz pinger S/N 1316 + bracket		
Benthos 12kHz pinger S/N 1317 + bracket		
MORS 10kHz transponder		
Benthos UDB9000		
Hull Transducer	Y	

OCEANLOGGER

Instrument	**S/N Used**	**Comments**
UIC		
Ocean Logger PC	**Y**	
Ocean Logger Interface	**Y**	
Barometer1	#V145002	
Barometer2	#V145003	

Foremast Sensors		
Air humidity & temp1	#60599569	
Air humidity & temp2	#60599557	
TIR1 sensor (pyranometer)	#112993	
TIR2 sensor (pyranometer)	#112992	
PAR1 sensor	#110127	
PAR2 sensor	#110126	
Prep Lab		
Thermosalinograph SBE45	#4524698-0018	
Transmissometer C-STAR	CST-396DR	
Fluorometer	Y	
Flow meter	#11950	
Transducer Space		
SBE38 Seawater Temp	#0501	Fitted 20/12/2013 see notes
SBE38 Seawater Temp	#0599	Fitted 20/12/2013 see notes

CTD (all kept in cage/ sci hold when not in use)

Instrument	**S/N Used**	**Comments**
CTD PC	Y	CTD PC1
Deck unit 1 SBE11plus	#-0458	
Underwater unit SBE9plus	#-0707	
Temp1 sensor SBE3plus	#03P4472	
Temp1 sensor SBE3plus	#03P4302	See notes at the end of this report
Temp2 sensor SBE3plus	#03P2366	
Cond1 sensor SBE 4C	#04C2222	
Cond1 sensor SBE 4C	#04C2875	See notes at the end of this report
Cond2 sensor SBE 4C	#04C2289	
Pump1 SBE5T	#4488	
Pump 2 SBE5T	#3415	
Standards Thermometer SBE35	#3527735-0024	
Transmissometer C-Star	CST-846DR	
Fluorometer Aquatraka Mk3	#088-216	

Oxygen sensor SBE43	#2290	
PAR sensor	#7235	
Altimeter PA200	#163162	
CTD swivel+ linkage	#196111	
Carousel + 24 Bottle Pylon	#0636	
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc		

LADCP

Instrument	S/N Used	Comments
300KHz WH Monitor	15060	
300KHz WH Monitor		
Battery Pack	Y	
Charger	Y	
Cables	Y	
AME Laptop (BBTalk)	Y	

MISC

Instrument	S/N Used	Comments
NMEA Server	Y	Crashes with VISA error
LabView Server	Y	See notes at end of report
DWNM PC (acoustic st'n)		

AME UNSUPPORTED INSTRUMENTS BUT LOGGED

Instrument	Working ?	Comments
EA600	Y	
Anemometer	Y	Froze on occasions
Gyro	Y	
DopplerLog	Y	
EMLog	Y	
Seapath 320+	Y	

Please clean the intake fans on the following machines:

Instrument	Cleaned?
Oceanlogger	N

EM122, TOPAS, NEPTUNE UPSs	N
Seatex Seapath	N
EM120 Tween Deck	N
TOPAS Tween Deck	N

Additional notes and recommendations for change / future work

LADCP

There is provision for running two LADCP on the frame simultaneously hence the provision of two cables between the water-bottle annexe and the chemi-lab. I was notified in the previous cruise report that one of the cables was faulty, so at the start of JR 294 the other cable was used. This cable also then became faulty meaning that both cables were then removed and replaced with new. No further problems were encountered during JR294. At the start of JR 299 I was informed that a second upwards pointing LADCP was required. Serial number 14443 was retrieved from the cage and bolted in place within the designated frame. The second 'leg' of the star cable was connected to the LADCP but connection to it from the PC was not possible. Fault finding then began concluding that one leg of the star cable was 'dead'. A spare cable was then retrieved from the cage and installed. This, to a great, extent cured the problems as both LADCPs could be communicated with – however things were never 100%. The 'slave LADCP' would occasionally lock up during the pre deployment tests necessitating unplugging of the LADCP briefly to power it down, and then commonly it would be OK again. For a while it was suspected that the old Dell AME laptop was causing problems, or that the USB to serial converter was the problem. To rule this out the second Toshiba AME laptop was used so that both LADCPs were running on 'real' com ports on separate machines. This didn't solve the problem – however both machines were run like that for the whole of JR 299.

It was noted, pretty much immediately that LADCP serial number 14443 was reporting pre deployment test failures. It was then replaced with Serial number #14897 which was used for the rest of the cruise.

CTD system

The CTD system was set up and operational when I joined the ship. Calibration parameters had already been entered, basically the system was ready to go. In the hand-over notes the previous engineer noted that there termination insulation resistance was substantially low but this was not causing a problem. During the first 'test CTD' the resistance dropped further necessitating a re-terminate of the conducting cable. This was done and load tested before the CTD transects began.

A further re-termination of the cable was needed between CTD 48 and CTD 49 as the cable was showing signs of degradation. The outer layer of the conduction cable was starting to 'open up'. This revealed a lot of rust debris inside the cable which further caused concern. It was decided to remove this damaged cable and 900m was flaked on deck and cut from the drum. Again the wire was re-terminated and load tested before CTD operations resumed

At the end of JR294 the scientists had processed sufficient data to show that the primary conductivity sensor (04C2222) was offset from the secondary and the Autosal salinities by +0.015 PSU. To correct this the primary T&C pair (04C2222 and 03P4472) were swapped for 04C2875 and 03P4302 and a test cast conducted. The results of this were that the conductivity was now in excellent agreement with the secondary but the temperature was approx 6 degrees out. Obviously it was immediately suspected that there had been an error in entering the calibration co-efficients. There were checked, re entered, exported as XML, rechecked but the 6 degrees maintained.

Eventually it was concluded that the sensor must be faulty and the original primary temp 03P4472 was re-installed. No further problems were encountered with the CTD setup for the rest of the cruise with the exception on the PC UPS. During the first part on JR294 the UPS would intermittently show a battery error and start bleeping. At the first available opportunity the unit was powered off and tested. It proved to be able to hold a load for a number of minutes so it was thought that it possibly just needed a reset after recharging. All was well for the remainder of JR294 and the first half of JR299 when the same thing happened. The UPS was then removed from the system and turned off. I suspect that it needs new batteries – but none were available on board so it should be done at refit.

The two 'acoustic cabinets' in the UIC have a total of 12 cooling fans fitted in the top. It was noted during JR294 that some of the fans had failed and others were in the process of failing. The agent in Punta was contacted and he went looking for replacements. None could be found locally however. The agent then agreed to purchase 20 of the correct fans (12 running and 8 spares) in Santiago, ship them to Punta then get them on a Dash flight to Rothera where they could have been fitted during the first part of JR299. For reasons unknown the fans were purchased, shipped to Punta but were never put on a flight to Rothera. The fans should be delivered to JCR on arrival in Punta. If I have a chance then I'll fit them otherwise Seth can do them.

Labview Nav/med display

This is a great addition to the display systems on board – there is however a slight display glitch that might need looking at. The problem relates to the display of lat and lon and was therefore difficult to witness. What apparently happens is that:

74 59.99

+0.01

74 00.00

+0.01

75 00.01

There seems to be some sort of error in the manipulation of the whole degrees.

NMEA splitter computer

The NMEA splitter computer sometime displays VISA error. The causes the system to stop outputting GPS to the USBL

Support Engineer: Mark Preston Date: 21st March 2014

21.3 AME report JR299 to from 23rd March to 28th April 2014

Cruise: JR299 Start date: 23 Mar 2014 Finish date: 28 Apr 2014
Name of AME engineer: Seth Thomas
Name of principle scientist (PSO): Andrew Meijers

LAB Instruments

Instrument	S/N Used	Comments
AutoSal		
Scintillation counter	N	
Magnetometer STCM1	N	
XBT	N	

ACOUSTIC

Instrument	S/N Used	Comments
ADCP	Y	
PES	N	
EM122	Y	
TOPAS	N	
EK60	N	
SSU	Y	
USBL	N	
10kHz IOS pinger	N	
Benthos 12kHz pinger S/N 1316 + bracket	N	
Benthos 12kHz pinger S/N 1317 + bracket	N	
MORS 10kHz transponder	N	

OCEANLOGGER

Instrument	S/N Used	Comments
Barometer1(UIC)	145002	
Barometer1(UIC)	145003	
Foremast Sensors		
Air humidity & temp1	60599569	
Air humidity & temp2	60599557	
TIR1 sensor (pyranometer)	112993	
TIR2 sensor	112992	Not working

(pyranometer)		
PAR1 sensor	110127	
PAR2 sensor	110126	
prep lab		
Thermosalinograph SBE45	0018	
Transmissometer	396	
Fluorometer	1100243	
Flow meter	811950	
Uncontaminated seawater temp		
Transducer Space		
SBE38 Seawater Temp	0501	
SBE38 Seawater Temp	0599	

CTD (all kept in cage/ sci hold when not in use)

Instrument	**S/N Used**	**Comments**
Deck unit 1 SBE11plus	0458	
Underwater unit SBE9plus	0707	
Pylon	0636	
Temp1 sensor SBE3plus	4472	
Temp2 sensor SBE3plus	2366	
Cond1 sensor SBE 4C	2875	
Cond2 sensor SBE 4C	2289	
Pump1 SBE5T	4488	
Pump2 SBE5T	3415	
Standards Thermometer SBE35	3527735-0024	
Transmissometer C-Star	846	
Oxygen sensor SBE43	2290	Dicey values after a freezing incident (removed)
Oxygen sensor SBE43	0676	Replacement for 2290
PAR sensor	7235	
Altimeter PA200	244740	
LADCP (master)	15060	
LADCP (slave)	14897	Occasional file fragmentation – see notes
CTD swivel linkage	Both used	

Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc		Many O-rings changed throughout cruise due to leaky sample bottles. It is presumed this is due to the very cold temperature at the start of the cruise.

AME UNSUPPORTED INSTRUMENTS BUT LOGGED

Instrument	**Working?**	**Comments**
EA600	Y	
Anemometer	Y	
Gyro	Y	
DopplerLog	Y	
EMLog	Y	

Please clean the intake fans on the following machines:

Instrument	**Cleaned?**
Oceanlogger	N
EM120, TOPAS, NEPTUNE UPSs	N
Seatex Seapath	N
EM120 Tween Deck	N
TOPAS Tween Deck	N

Additional notes and recommendations for change / future work

Everything went well aside from one incident where the air temperature dropped by 20 celsius overnight. This froze the water in the TC ducts and caused the dissolved oxygen sensor (#2290) to give erroneous readings (according to the scientist doing oxygen titrations). This was swapped for #0676, and it was noted that now the values closely matched those of the titrations.

Apparently, there was a change in offsets for the salinity measurements (based on temperature and conductivity sensors) that occurred at the same time as this, though it was only pointed out to myself today (26/04/14) with only one more CTD station to run.

It is advised that both sets on temperature and conductivity sensors be changed before the start of the Arctic cruise (I will do this as I am also doing the Arctic cruise)

On three occasions the LADCP slave unit provided fragmented files.

The 1st time it was noted that the unit had not been erased during the duration of the cruise but before I had looked at available space, the data was erased as I'd mentioned it as a possibility.

It has been noticed that the file is never fragmented if the memory in the unit is erased prior to cast, so that it what has been done throughout the latter part of the cruise. It has also been suggested that this may be due to power dropouts mid cast which may indicate a cable fault. I am sceptic of this as the cable is brand new, and I would assume that the instrument would simply stop logging if it lost power, until such time as the 'start-up script' is applied.

The spare cable winch for the CTD has had slip rings and dry-end terminations fitted, and is now ready for immediate use if the main CTD cable deteriorates further.

Support Engineer: Seth Thomas Date: 27/04/2014

APPENDIX

Table A.1: Station summary for JR299

Throughout the cruise the PSO produced station plans, these were saved in the 20140308\work\Cruise Information - science and data\Station_plans folder and the filename indicates the date of the plan. This summary table below was compiled by Ellen Bazeley-White to record information about the actual stations visited and to summarise the events. See 20140308\work\Cruise Report\Event Tables for a more detailed version of this table.

Station No.	On transect	Arrival time on station	Departure time from station	Planned station location from PSO plan	Lat (rounded from bridge log)	Lon (rounded from bridge log)	Start lat (from bridge log)	Start lon (from bridge log)	Depth of seabed (m) from PSO plan	Depth (m) from EA600 at arrival time	Depth (m) from EM122 at arrival time	Event Numbers	CTD	VMP	TVMP	Drifter/ Float	CTD Sample Type – taken from PSO plan – see next column for what was actually sampled	What was actually sampled	Notes
1		16:57:00 12/03/2014	19:02:00 12/03/2014		-62.77	-59.11	-62.76528	-59.11189		1477.63	1438.34	2 & 3	CTD001	VMP001	-	-		DIMES/Salts	Near Deception Island – Test 1
2		19:43:00 12/03/2014	22:17:00 12/03/2014		-62.77	-59.11	-62.76519	-59.10951		1477.15	1441.44	4 & 5	CTD002	VMP002	-	-		CFC/O18//Carbon/Barium/Nitrate/Silicate/Salts	Near Deception Island – Test 2 Same geographical location as Station 1
3	SR1_pt1	15:13:00 13/03/2014	16:03:00 13/03/2014	61 2.930'S 54 35.300'W	-61.05	-54.59	-61.04798	-54.58909	351	0.00	366.14	6	CTD003	-	-	-	CFC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	EA600 reading - dodgy
4	SR1_pt1	16:46:00 13/03/2014	18:26:00 13/03/2014	60 58.890'S 54 37.800'W	-60.98	-54.62	-60.98280	-54.62848	590	599.04	578.57	7 & 8	CTD004	VMP004	-	-	Salts only	Salts	
5	SR1_pt1	19:23:00 13/03/2014	21:00:00 13/03/2014	60 51.040'S 54 42.810'W	-60.85	-54.71	-60.84979	-54.71303	987	1059.84	1043.68	9 & 10	CTD005	VMP005	-	-	CFC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
6	SR1_pt1	21:16:00 13/03/2014	00:12:00 14/03/2014	60 49.990'S 54 43.320'W	-60.83	-54.72	-60.83320	-54.72169	1712	1671.17	1767.36	11 & 12	CTD006	VMP006	-	-	CFC	CFC/Barium/Salts	
7	SR1_pt1	00:36:00 14/03/2014	02:58:00 14/03/2014	60 47.940'S 54 44.570'W	-60.80	-54.74	-60.80049	-54.73827	2595	2543.62	2597.67	13	CTD007	-	-	-	CFC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
8	SR1_pt1	04:02:00 14/03/2014	07:57:00 14/03/2014	60 40.010'S 54 49.490'W	-60.67	-54.82	-60.66705	-54.82441	3083	3139.58	3095.31	14 & 15	CTD008	VMP008	-	-	DIMES	DIMES/Salts	
9	SR1_pt1	10:10:00 14/03/2014	13:48:00 14/03/2014	60 19.970'S 55 1.910'W	-60.33	-55.03	-60.33237	-55.03185	3400	3483.65	3393.13	16 & 17	CTD009	VMP009	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
10	SR1_pt1	15:57:00 14/03/2014	18:58:00 14/03/2014	59 59.980'S 55 14.290'W	-60.00	-55.24	-59.99683	-55.23885	3713	3566.59	3495.47	18	CTD010	-	-	-	DIMES	DIMES/Salts	
11	SR1_pt1	21:13:00 14/03/2014	01:36:00 15/03/2014	59 40.020'S 55 26.640'W	-59.67	-55.45	-59.66725	-55.44601	3788	3723.26	3671.17	19 & 20	CTD011	VMP011	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
12	SR1_pt1	03:48:00 15/03/2014	07:55:00 15/03/2014	59 20.010'S 55 39.040'W	-59.33	-55.64	-59.33189	-55.64429	3723	3800.06	3755.08	21 & 22	CTD012	VMP012	-	-	DIMES	DIMES/Salts	
13	SR1_pt1	10:12:00 15/03/2014	13:03:00 15/03/2014	59 0.020'S 55 51.360'W	-59.00	-55.86	-59.00019	-55.85591	3803	3815.42	3767.65	23	CTD013	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
14	SR1_pt1	15:15:00 15/03/2014	19:26:00 15/03/2014	58 41.070'S 56 3.270'W	-58.68	-56.06	-58.68268	-56.05688	3770	3793.92	3746.50	24 & 25	CTD014	VMP014	-	-	DIMES	DIMES/Salts	
15	SR1_pt1	21:40:00 15/03/2014	02:08:00 16/03/2014	58 22.000'S 56 15.020'W	-58.37	-56.25	-58.36675	-56.25015	3830	3929.09	8076.39	26 & 27	CTD015	VMP015	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	EM122 reading - dodgy
16	SR1_pt1	04:22:00 16/03/2014	08:04:00 16/03/2014	58 3.010'S 56 26.780'W	-58.05	-56.45	-58.04877	-56.44759	4130	0.00	3962.25	28	CTD016	-	-	-	DIMES	DIMES/Salts	EA600 reading - dodgy
17	SR1_pt1	10:16:00 16/03/2014	14:05:00 16/03/2014	57 44.010'S 56 38.410'W	-57.73	-56.64	-57.73385	-56.64114	3462	3505.15	3491.74	29 & 30	CTD017	VMP017	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
18	SR1_pt1	16:08:00 16/03/2014	19:39:00 16/03/2014	57 24.940'S 56 50.340'W	-57.41	-56.84	-57.41381	-56.84017	3326	3462.14	3433.45	31 & 32	CTD018	VMP018	-	-	DIMES	DIMES/Salts	
19	SR1_pt1	21:43:00 16/03/2014	00:50:00 17/03/2014	57 6.030'S 57 2.170'W	-57.10	-57.04	-57.10025	-57.03566	3980	2337.79	2305.38	33	CTD019	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
20	SR1_pt1	02:59:00 17/03/2014	06:49:00 17/03/2014	56 46.990'S 57 13.850'W	-56.78	-57.23	-56.78394	-57.23027	2450	3078.14	3156.32	34 & 35	CTD020	VMP020	-	-	DIMES	DIMES/Salts	
21	SR1_pt1 Hires	07:25:00 17/03/2014	09:09:00 17/03/2014	56 42.255'S 57 16.755'W	-56.70	-57.28	-56.70421	-57.27886	3074	3677.18	3735.60	36	-	-	TVMP021	-	N/A		
22	SR1_pt1	09:45:00	16:36:00	56 37.520'S	-56.62	-57.33	-56.62456	-57.32773	3733	4202.50	4167.30	37, 38 &	CTD021	VMP022	-	-	~~CFC~~	DIMES/Salts	From station 22 onwards CTDs will be

	Hires	17/03/2014	17/03/2014	57 19.660'W								CTD test	& un-named test						named consecutively and will cease matching the station number Problem with CTD and additional CTD test run
23		17:00:00 17/03/2014		56 32.785'S 57 22.565'W					3864				-	-	~~TVMP023~~	-	N/A	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Station 23 cancelled – problems with TVMP
24	SR1_pt1 Hires	17:39:00 17/03/2014	20:25:00 17/03/2014	56 28.050'S 57 25.470'W	-56.47	-57.42	-56.46582	-57.42366	3788	3738.62	7179.77	39	CTD022	~~VMP024~~	-	-	DIMES	DIMES/Salts	Problems with VMP EM122 reading - dodgy
25		20:59:00 17/03/2014		56 23.280'S 57 28.473'W					3475				-	-	~~TVMP025~~	-	N/A	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Cancelled – problems with TVMP
26	SR1_pt1 Hires	21:36:00 17/03/2014	00:08:00 18/03/2014	56 18.510'S 57 31.475'W	-56.31	-57.52	-56.30815	-57.52427	3342	3259.39	3216.08	40	CTD023	~~VMP026~~	-	-	CFC	DIMES/Salts	Problems with VMP
27		01:18:00 18/03/2014		56 13.740'S 57 34.478'W					2932				-	-	~~TVMP027~~	-	N/A	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Cancelled – problems with TVMP
28	SR1_pt1 Hires	01:20:00 18/03/2014	04:15:00 18/03/2014	56 8.970'S 57 37.480'W	-56.15	-57.62	-56.15164	-57.61918	3340	3369.98	3336.05	41	CTD024	~~VMP028~~	-	-	DIMES	DIMES/Salts	Problems with VMP
29		05:00:00 18/03/2014		56 4.225'S 57 40.418'W					3936				-	-	~~TVMP029~~	-	N/A	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Cancelled
30	SR1_pt1 Hires	05:30:00 18/03/2014	08:52:00 18/03/2014	55 59.480'S 57 43.357'W	-56.00	-57.72	-55.99392	-57.71659	3927	0.00	9207.66	42	CTD025	~~VMP030~~	-	-	CFC	DIMES/O2/Salts	Dodgy depths – CTD sheet recorded EA depth as 3960 Bridge log noted - V/l moving astern with the current at 1.7kts
31		09:33:00 18/03/2014		55 54.735'S 57 46.295'W					4177				-	-	~~TVMP030~~	-	N/A	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Cancelled
32	SR1_pt1 Hires	10:06:00 18/03/2014	13:38:00 18/03/2014	55 49.990'S 57 49.234'W	-55.83	-57.82	-55.83359	-57.82047	4943	4749.31	4728.23	43	CTD026	-	-	-	DIMES	DIMES/Salts	Bridge log noted - Vessel running with the current at 1.3kts
33	SR1_pt1 Hires	14:46:00 18/03/2014	19:10:00 18/03/2014	55 40.570'S 57 55.072'W	-55.68	-57.91	-55.67727	-57.91354	4417	4552.70	4537.19	44 & 45	CTD027	-	TVMP033	-	CFC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
34	SR1_pt1 Hires	20:23:00 18/03/2014	00:34:00 19/03/2014	55 31.150'S 58 0.000'W	-55.52	-58.00	-55.51865	-57.99964	4333	4239.36	4204.25	46 & 47	CTD028	-	TVMP034	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Bridge log noted - V/L tracking 272 x 0.2 kts
35	SR1_pt1 Hires	01:37:00 19/03/2014	06:15:00 19/03/2014	55 22.000'S 58 0.000'W	-55.37	-58.00	-55.36825	-57.99931	4158	4270.08	4239.55	48 & 49	CTD029	-	TVMP035	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
36	SR1_pt1 Hires	07:24:00 19/03/2014	11:42:00 19/03/2014	55 12.850'S 58 0.000'W	-55.21	-58.00	-55.21425	-57.99956	3703	3846.14	3897.02	50 & 51	CTD030	-	TVMP036	-	DIMES/ Oxygen	O2/Salts	
37	SR1_pt1 Hires	12:08:00 19/03/2014	15:50:00 19/03/2014	55 10.240'S 58 0.000'W	-55.17	-58.00	-55.17175	-57.99711	3080	0.00	3108.99	52 & 53	CTD031	-	TVMP037	-	CFC	DIMES/O2/	EA600 reading – dodgy Bridge log noted - v/l tracking 335 x 0.1 kts
38	SR1_pt1 Hires	16:18:00 19/03/2014	18:36:00 19/03/2014	55 7.240'S 58 0.000'W	-55.12	-58.00	-55.12113	-57.99943	2735	2764.80	2786.76	54	CTD032	-	-	-	DIMES	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
39	SR1_pt1 – Hires - gap	14:28:00 01/04/2014	15:43:00 01/04/2014	54 53.700'S 58 0.000'W	-54.89	-58.00	-54.89356	-58.00021	503	509.95	506.27	55	CTD033	-	-	-	CFC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
40	SR1_pt1 – Hires - gap	16:37:00 01/04/2014	18:07:00 01/04/2014	55 0.000'S 58 0.000'W	-55.00	-58.00	-55.00081	-58.00276	1338	0.00	1544.62	56	CTD034	-	-	-	DIMES	CFC/Carbon/Barium/Nitrate/Silicate/Salts	EA600 reading - dodgy
41	SR1_pt1 – Hires - gap	18:41:00 01/04/2014	21:09:00 01/04/2014	55 4.500'S 58 0.000'W	-55.07	-58.00	-55.07377	-57.99645	2123	0.00	2329.58	57	CTD035	-	-	-	CFC	DIMES/O2/Salts	EA600 reading - dodgy
42	SR1_pt1 – Hires - gap	21:34:00 01/04/2014	00:18:00 02/04/2014	55 7.254'S 58 0.000'W	-55.12	-58.00	-55.12110	-57.99908	2737	2958.34	2799.47	58	CTD036	-	-	-	Oxygen	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
43a	N/A	14:09:00 04/04/2014	16:25:00 04/04/2014	62 36.996'S 43 14.505'W	-62.61	-43.24	-62.61782	-43.24113	2976	394.75	3009.84	59	-	-	-	-	-	DIMES/Salts	LDEO Mooring M2 recovery EA600 reading - dodgy
43b	N/A	16:56:00 04/04/2014	19:20:00 04/04/2014	62 36.996'S 43 14.505'W	-62.60	-43.22	-62.59273	-43.21691	2976	394.75	3009.84	60	CTD037	-	-	-	DIMES/ Oxygen	DIMES/Salts	At Mooring M2 recovery site EA600 reading - dodgy
44a	N/A	17:48:00 05/04/2014	23:16:00 05/04/2014	63 31.350'S 41 46.197'W	-63.52	-41.77	-63.52259	-41.76834	4748	0.00	3968.63	61 & 62	-	-	-	-	-	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	LDEO Mooring M3 communication with deployed mooring and new mooring deployment. Bridge log noted – Mooring slipped.

																			Position at stern 63 32.17'S 041 46.04'W EA600 reading - dodgy
44b	N/A	23:28:00 05/04/2014	03:12:00 06/04/2014	63 31.350'S 41 46.197'W	-63.55	-41.75	-63.54504	-41.75186	4748	4697.09	4609.68	63	CTD038	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
45	A23	02:05:00 08/04/2014	Not noted in bridge log	62 29.472'S 31 15.684'W	-62.49	-31.25	-62.48870	-31.25397	4800	4804.61	4786.32	64	CTD039	-	-	-	CFC	DIMES/Salts	[had been station 49 on previous plan]
46	A23	12:26:00 08/04/2014	15:57:00 08/04/2014	62 4.524'S 31 11.010'W	-62.06	-31.18	-62.06377	-31.18285	4699	4890.62	4889.17	65	CTD040	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
47	A23	19:10:00 08/04/2014	21:55:00 08/04/2014	61 39.672'S 31 6.660'W	-61.66	-31.11	-61.66550	-31.11455	2849	3397.63	3399.12	66	CTD041	-	-	-	DIMES/ Oxygen	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
48	A23	01:05:00 09/04/2014	03:50:00 09/04/2014	61 10.254'S 31 2.760'W	-61.17	-31.05	-61.17158	-31.04969	3223	0.00	3484.68	67	CTD042	-	-	-	CFC	DIMES/Salts	EA600 reading - dodgy
49	A23	08:16:00 09/04/2014	10:00:00 09/04/2014	60 41.964'S 31 0.594'W	-60.70	31.00	-60.69952	-31.00334	1377	1708.03	1660.35	68	CTD043	-	-	-	DIMES	DIMES/Salts	
50	A23	12:29:00 09/04/2014	14:58:00 09/04/2014	60 18.912'S 30 57.510'W	-60.31	-30.96	-60.31636	-30.95951	2634	2749.44	2804.39	69	CTD044	-	-	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
51	A23	18:27:00 09/04/2014	21:11:00 09/04/2014	59 45.972'S 30 54.324'W	-59.77	-30.91	-59.76578	-30.90613	3363	3843.07	3825.02	70	CTD045	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
52	A23	23:23:00 09/04/2014	01:58:00 10/04/2014	59 26.136'S 30 51.612'W	-59.44	-30.86	-59.43574	-30.85694	2929	3480.58	3440.61	71	CTD046	-	-	-	CFC	DIMES/Salts	
53	A23	04:27:00 10/04/2014	07:01:00 10/04/2014	59 3.024'S 30 49.818'W	-59.05	-30.81	-59.05162	-30.81750	2639	3102.72	3145.37	72	CTD047	-	-	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
54	A23	09:41:00 10/04/2014	12:21:00 10/04/2014	58 38.112'S 30 49.470'W	-58.63	-30.82	-58.63523	-30.82372	3401	3551.23	3661.76	73	CTD048	-	-	-	CFC	DIMES/Salts	
55	A23	14:55:00 10/04/2014	18:01:00 10/04/2014	58 12.780'S 30 49.314'W	-58.21	-30.82	-58.21256	-30.81812	3550	3778.56	4034.30	74	CTD049	-	-	-	CFC	DIMES/O2/Salts	Depth discrepancy
56	A23	20:38:00 10/04/2014	23:22:00 10/04/2014	57 46.140'S 30 58.116'W	-57.77	-30.97	-57.77002	-30.96844	3327	3449.86	5172.61	75	CTD050	-	-	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Depth discrepancy
57	A23	01:32:00 11/04/2014	04:26:00 11/04/2014	57 29.310'S 31 19.770'W	-57.49	-31.33	-57.48853	-31.32851	3683	2795.52	3736.07	76	CTD051	-	-	-	DIMES	DIMES/Salts	Depth discrepancy
58	A23	06:35:00 11/04/2014	09:26:00 11/04/2014	57 20.400'S 31 53.400'W	-57.34	-31.89	-57.33983	-31.89028	3914	2300.93	3635.47	77	CTD052	-	-	-	CFC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	Depth discrepancy Bridge log didn't record lat and lon initially.
59	A23	11:32:00 11/04/2014	14:31:00 11/04/2014	57 12.474'S 32 21.126'W	-57.27	-32.37	-57.27784	-32.37329	4069	4058.11	4036.48	78	CTD053	-	-	-	CFC	Barium/Salts	
60	A23	16:57:00 11/04/2014	19:25:00 11/04/2014	56 53.400'S 32 25.800'W	-56.89	32.43	-56.89060	-32.43026	3150	0.00	3118.23	79	CTD054	-	-	-	DIMES	CFC/Barium/Salts	EA600 reading - dodgy
61	A23	21:43:00 11/04/2014	00:40:00 12/04/2014	56 34.602'S 32 30.750'W	-56.58	-32.51	-56.57666	-32.50744	3627	4067.33	4052.09	80	CTD055	-	-	-	CFC	DIMES/Salts	
62	A23	07:34:00 12/04/2014	10:40:00 12/04/2014	56 29.700'S 32 58.368'W	-56.49	-32.97	-56.49425	-32.97251	3605	3861.50	3838.23	81	CTD056	-	-	-	DIMES	CFC/DIMES/Salts	Behind schedule due to bad weather
	A23			56 10.350'S 33 17.898'W					3347					-	-	-	CFC	DIMES/Salts	Station that had initially been assigned 63 for CFCs cancelled due to bad weather
63	A23	08:54:00 13/04/2014	11:40:00 13/04/2014	55 57.600'S 33 39.600'W	-55.96	-33.65	-55.95818	-33.65947	2898	2869.25	2846.92	82	CTD057	-	-	-	DIMES/ Oxygen	CFC/Salts	New station 63
64	A23	13:25:00 13/04/2014	16:19:00 13/04/2014	55 44.400'S 33 57.000'W	-55.74	-33.95	-55.73972	-33.95052	3195	3763.20	3739.58	83	CTD058	-	-	-	CFC	DIMES/Salts	
65	A23	17:50:00 13/04/2014	19:54:00 13/04/2014	55 29.082'S 34 7.998'W	-55.48	-34.13	-55.48400	-34.13060	2302	2485.25	2480.35	84	CTD059	-	-	-	DIMES	DIMES/Salts	
66	A23	21:34:00 13/04/2014	22:48:00 13/04/2014	55 15.570'S 34 26.622'W	-55.26	-34.44	-55.26008	-34.44355	1261	1532.93	1499.68	85	CTD060	-	-	-	CFC	DIMES/Salts	
67	A23	23:15:00 13/04/2014	00:40:00 14/04/2014	55 12.912'S 34 30.480'W	-55.22	-34.51	-55.21511	-34.50685	260	0.00	535.64	86	CTD061	-	-	-	Barium	DIMES/Salts	EA600 reading - dodgy
68	North Scotia Ridge	04:24:00 15/04/2014	05:26:00 15/04/2014	53 57.256'S 39 38.702'W	-53.95	-39.64	-53.95401	-39.64168	364	476.93	469.03	87	CTD062	-	-	-	CFC	DIMES/Salts	
69	North Scotia Ridge	06:34:00 15/04/2014	07:59:00 15/04/2014	53 55.637'S 39 53.596'W	-53.93	-39.89	-53.92654	-39.89134	1126	3766.27	3743.08	88	CTD063	-	-	-	DIMES	DIMES/Salts	
70	North	08:46:00	10:44:00	53 54.779'S	-53.91	-40.05	-53.91287	-40.04667	1711	2129.28	2100.07	89	CTD064	-	-	-	CFC	DIMES/Salts	

	Scotia Ridge	15/04/2014	15/04/2014	40 2.807'W															
71	North Scotia Ridge	11:20:00 15/04/2014	12:51:00 15/04/2014	53 53.952'S 40 9.386'W	-53.90	-40.16	-53.89903	-40.15572	1326	93.31	1265.77	90	CTD065	-	-	-	DIMES	DIMES/Salts	EA600 reading - dodgy
72	North Scotia Ridge	13:50:00 15/04/2014	14:38:00 15/04/2014	53 52.218'S 40 22.911'W	-53.87	-40.38	-53.87079	-40.38204	619	1259.06	494.42	91	CTD066	-	-	-	CFC	DIMES/Salts	Depth discrepancy
73	Arg Basin	05:54:00 16/04/2014	08:50:00 16/04/2014	51 18.601'S 39 50.989'W	-51.31	-39.85	-51.31226	-39.85040	3817	3806.21	3789.71	92	CTD067	-	-	-	DIMES	DIMES/Salts	
74	Arg Basin	11:30:00 16/04/2014	14:11:00 16/04/2014	51 3.602'S 40 23.248'W	-51.06	-40.39	-51.05936	-40.38796	3746	3766.27	3743.08	93	CTD068	-	-	-	DIMES	DIMES/Nitrate/Silicate /Salts	Bridge log noted - v/l tracking 010 x 0.2 kts
75	Arg Basin	16:47:00 16/04/2014	18:48:00 16/04/2014	50 48.600'S 40 55.497'W	-50.81	-40.92	-50.81003	-40.92416	2335	2337.79	2305.38	94	CTD069	-	-	-	DIMES	DIMES/Salts	
76	Arg Basin	21:31:00 16/04/2014	22:59:00 16/04/2014	50 33.591'S 41 27.739'W	-50.56	-41.46	-50.55958	-41.46173	1802	2079.74	1855.24	95	CTD070	-	-	-	DIMES	CFC/Barium/Nitrate/Si licate/Salts	
77	Arg Basin	03:58:00 17/04/2014	05:46:00 17/04/2014	49 51.087'S 42 0.000'W	-49.85	-42.00	-49.85215	-41.99984	1775	1821.70	1790.09	96	CTD071	-	-	-	DIMES	DIMES/Salts	
	Arg Basin			49 23.633'S 42 0.000'W					5360			-	-	-	-	-	DIMES	CFC/Barium/Nitrate/Si licate/Salts	Original station 78 skipped due to bad weather
78	Arg Basin	10:24:00 17/04/2014	13:50:00 17/04/2014	49 9.931'S 42 0.000'W	-49.16	-42.00	-49.16360	-41.99812	4858	4924.42	4977.24	97	CTD072	-	-	-	DIMES	DIMES/Salts	Was station 79 on station plan of 16th April
79	Falk. Basin	16:35:00 17/04/2014	20:22:00 17/04/2014	48 42.417'S 42 0.000'W	-48.71	-42.00	-48.70705	-41.99842	4784	5716.99	5770.02	98	CTD073	-	-	-	DIMES	CFC/DIMES/Carbon/B arium/Nitrate/Silicate /Salts	From station plan 17/04/2014 1900
80	Falk. Basin	21:50:00 17/04/2014	02:57:00 18/04/2014	48 12.571'S 42 0.000'W	-48.20	-42.00	-48.41304	-41.99850	5846	5735.42	5766.36	99	CTD074	-	-	-	DIMES	DIMES/Salts	Most of station in slightly different point to start position. Bridge log noted - Vessel moving astern at 2.0kts for surface current.
81	Falk. Basin	04:38:00 18/04/2014	09:07:00 18/04/2014	47 56.537'S 42 0.000'W	-47.94	-42.00	-47.94086	-42.00160	6223	6039.55	6081.72	100	CTD075	-	-	-	DIMES	CFC/Carbon/Barium/N itrate/Silicate/Salts	
82	Falk. Basin	12:08:00 18/04/2014	16:21:00 18/04/2014	48 28.605'S 42 0.000'W	-48.47	-42.00	-48.47651	-41.99819	5591	5726.21	5744.64	101	CTD076	-	-	-	DIMES	DIMES/Salts	Bridge log noted - v/l tracking 080 x 0.5kts
83	Falk. Basin	19:19:00 18/04/2014	23:38:00 18/04/2014	48 56.230'S 42 0.000'W	-48.94	-42.00	-48.93719	-42.00054	5235	5336.06	5354.34	102	CTD077	-	-	-	DIMES	CFC/Carbon/Nitrate/Si licate/Salts	
84	Falk. Basin	02:28:00 19/04/2014	06:26:00 19/04/2014	49 23.633'S 42 0.000'W	-49.39	-42.00	-49.39469	-42.00023	5360	5234.69	5255.38	103	CTD078	-	-	-	DIMES	DIMES/Salts	
85	North Scotia Ridge	05:34:00 20/04/2014	06:26:00 20/04/2014	53 21.439'S 42 46.282'W	-53.36	-42.77	-53.35961	-42.77130	498	552.96	493.81	104	CTD079	-	-	-	CFC/Bar/N	CFC/Carbon/Barium/N itrate/Silicate/Salts	
86	North Scotia Ridge	09:59:00 20/04/2014	11:34:00 20/04/2014	53 16.288'S 43 45.029'W	-53.27	-43.75	-53.27147	-43.75172	1717	1413.12	1375.31	105	CTD080	-	-	-	DIMES	DIMES/Salts	
87	North Scotia Ridge	14:11:00 20/04/2014	15:18:00 20/04/2014	53 15.997'S 44 26.722'W	-53.27	-44.44	-53.26664	-44.44402	1098	1044.48	1059.17	106	CTD081	-	-	-	CFC/Bar/N	CFC/Carbon/Barium/N itrate/Silicate/Salts	
88	North Scotia Ridge	17:24:00 20/04/2014	19:04:00 20/04/2014	53 15.507'S 44 59.487'W	-53.26	-45.00	-53.25804	-44.99175	1951	1895.42	1868.80	107	CTD082	-	-	-	DIMES	DIMES/Salts	
89	Drift. Arr. 1	19:45:00 20/04/2014		53 15.538'S 45 9.146'W	N/A	N/A	-53.25902	-45.15368	1833	1784.83	1748.91	108	-	-	-	Drifter1 x lowres	-	CFC/Carbon/Barium/N itrate/Silicate/Salts	
90	Drift. Arr. 2	20:19:00 20/04/2014		53 11.104'S 45 13.537'W	N/A	N/A	-53.18513	-45.22568	2186	0.00	2172.01	109	-	-	-	Drifter1 x lowres	-	DIMES/Salts	EA600 reading - dodgy
91	Drift. Arr. 3	20:52:00 20/04/2014		53 6.669'S 45 17.927'W	N/A	N/A	-53.11125	-45.29874	2316	2313.22	2253.76	110, 111 & 112	-	-	-	Drifter 2 x lowres & 1 x high res	-	CFC/Carbon/Barium/N itrate/Silicate/Salts	
92	Drift. Arr. 4	21:26:00 20/04/2014		53 2.259'S 45 22.317'W	N/A	N/A	-53.03734	-45.37228	2365	2460.67	2420.26	113, 114 & 115	-	-	-	Drifter 3 x high res	-	DIMES/Salts	
93	Drift. Arr. 5	21:58:00 20/04/2014		52 57.873'S 45 26.707'W	N/A	N/A	-52.96462	-45.44507	2516	2491.39	2449.78	116	-	-	-	Drifter1 x lowres	-	CFC/Carbon/Nitrate/Si licate/Salts	
94	Drift. Arr. 6	22:30:00 20/04/2014		52 53.487'S 45 31.097'W	N/A	N/A	-52.89154	-45.51824	2701	2574.34	2530.62	117	-	-	-	Drifter1 x lowres	-	DIMES/Salts	
95	North Scotia Ridge	00:52:00 21/04/2014	02:26:00 21/04/2014	53 10.502'S 45 54.842'W	-53.18	-45.91	-53.17519	-45.91444	1789	1554.43	1513.90	118	CTD083	-	-	-	CFC/Bar/N	CFC/Carbon/Barium/N itrate/Silicate/Salts	

96	North Scotia Ridge	05:10:00 21/04/2014	06:46:00 21/04/2014	53 7.499'S 46 31.520'W	-53.12	-46.53	-53.12471	-46.52669	1378	1422.34	1388.41	119	CTD084	-	-	-	DIMES	Salts	
97	North Scotia Ridge	08:53:00 21/04/2014	10:12:00 21/04/2014	53 6.436'S 47 3.248'W	-53.11	-47.06	-53.10701	-47.05559	1274	1262.59	1230.06	120	CTD085	-	-	-	CFC/Bar/N/ DIC	CFC/Carbon/Barium/N itrate/Silicate/Salts	
98	North Scotia Ridge	11:34:00 21/04/2014	13:20:00 21/04/2014	53 1.496'S 47 22.532'W	-53.02	-47.38	-53.02417	-47.37544	1975	0.00	1957.37	121	CTD086	-	-	-	DIMES	Salts	EA600 reading - dodgy
99	North Scotia Ridge	13:58:00 21/04/2014	16:32:00 21/04/2014	52 59.551'S 47 30.121'W	-52.99	-47.50	-52.99198	-47.50283	2536	2515.97	2482.15	122 & 123	CTD087	-	-	ARGO 1	CFC/Bar/N/ DIC	CFC/Carbon/Nitrate/Si licate/Salts	
100	North Scotia Ridge	17:39:00 21/04/2014	19:57:00 21/04/2014	52 55.669'S 47 44.909'W	-52.9	-47.75	-52.92621	-47.74762	2968	3022.85	2980.73	124 & 125	CTD088	-	-	ARGO 2	DIMES	Salts	
101	North Scotia Ridge	21:28:00 21/04/2014	23:44:00 21/04/2014	53 2.485'S 48 2.664'W	-53.0	-48.0	-53.04130	-48.04490	3001	3105.79	3046.39	126	CTD089	-	-	-	CFC/Bar/N/ DIC	CFC/Carbon/Nitrate/Si licate/Salts	Bridge log noted - Vessel tracking 350° at 1kt for current.
102	North Scotia Ridge	00:45:00 22/04/2014	03:06:00 22/04/2014	53 7.361'S 48 11.413'W	-53.1	-48.2	-53.12117	-48.19108	2209	2574.34	2557.05	127 & 128	CTD090	-	-	ARGO 3	DIMES	DIMES/Salts	Bridge log noted - tracking 355 x 0.7 kts
103	North Scotia Ridge	03:43:00 22/04/2014	06:08:00 22/04/2014	53 8.834'S 48 16.858'W	-53.1	-48.3	-53.14572	-48.27920	1955	2571.26	2580.55	129 & 130	CTD091	-	-	ARGO 4	CFC/Bar/N/ DIC	CFC/Carbon/Barium/N itrate/Silicate/Salts	Bridge log noted - tracking 355 x 1.0kts
104	North Scotia Ridge	07:19:00 22/04/2014	09:28:00 22/04/2014	53 8.912'S 48 30.142'W	-53.1	-48.50	-53.14778	-48.50043	2893	2823.17	2783.05	131	CTD092	-	-	-	DIMES	DIMES/Salts	Bridge log noted - Vessel tracking 009° at 1.0 kt for current.
105	North Scotia Ridge	10:02:00 22/04/2014	12:14:00 22/04/2014	53 8.669'S 48 35.938'W	-53.1	-48.6	-53.14454	-48.59800	2596	2386.94	2329.70	132 & 133	CTD093	-	-	ARGO 5	CFC/Bar/N/ DIC	CFC/Carbon/Barium/N itrate/Silicate/Salts	Bridge log noted - Vessel tracking 008° at 1.0kts.
106	North Scotia Ridge	13:19:00 22/04/2014	15:30:00 22/04/2014	53 12.985'S 48 47.083'W	-53.2	-48.8	-53.21564	-48.78424	2794	2731.01	2836.13	134 & 135	CTD094	-	-	ARGO 6	DIMES	Salts	Bridge log noted - V/l tracking 050 x 0.5 kts
107	North Scotia Ridge	16:32:00 22/04/2014	18:57:00 22/04/2014	53 18.017'S 48 55.741'W	-53.3	-48.9	-53.29919	-48.92516	2949	3102.72	3125.40	136 & 137	CTD095	-	-	ARGO 7	CFC/Bar/N/ DIC	O2/Salts	Moved during station. Following 107, a break to allow sampling processing to catch up
108	North Scotia Ridge	19:55:00 22/04/2014	02:19:00 23/04/2014	53 20.906'S 49 6.101'W	-53.3	-49.10	-53.34792	-49.10066	2751	2967.55	2945.97	138	CTD096	-	-	-	DIMES	CFC/Carbon/Barium/N itrate/Silicate/Salts	From plan "UK5_v23-Apr-2014" Arrived on station and waited 4 hours before started CTD
109	North Scotia Ridge	03:09:00 23/04/2014	05:26:00 23/04/2014	53 22.805'S 49 15.996'W	-53.4	-49.27	-53.37919	-49.26870	2712	2651.14	2608.53	139 & 140	CTD097	-	-	ARGO 8	CFC/N/DIC	Salts	
110	North Scotia Ridge	06:17:00 23/04/2014	08:17:00 23/04/2014	53 22.841'S 49 27.360'W	-53.38	-49.46	-53.37908	-49.45587	2131	1935.36	1902.95	141	CTD098	-	-	-	DIMES	DIMES/Salts	
111	North Scotia Ridge	08:43:00 23/04/2014	10:31:00 23/04/2014	53 23.208'S 49 31.820'W	-53.39	-49.53	-53.38683	-49.53158	1516	1508.35	1487.00	142	CTD099	-	-	-	CFC/Bar/N/ DIC	DIMES/Salts	
112	North Scotia Ridge	11:00:00 23/04/2014	12:16:00 23/04/2014	53 23.465'S 49 37.367'W	-53.39	-49.62	-53.39102	-49.62286	1010	1032.19	1000.65	143	CTD100	-	-	-	Salts only	DIMES/O18/Carbon/B arium/Nitrate/Silicate /Salts	
113	North Scotia Ridge	14:12:00 23/04/2014	15:16:00 23/04/2014	53 22.703'S 50 5.647'W	-53.38	-50.09	-53.37836	-50.09487	587	983.04	958.94	144	CTD101	-	-	-	CFC/Bar/N/ DIC	DIMES/Salts	
114	Drift. Arr. 2	16:08:00 23/04/2014		53 25.305'S 50 13.028'W	N/A	N/A	-53.42095	-50.21683	867	0.00	1226.69	145	-	-	-	Drifter1xl ow res		DIMES/Salts	EA600 reading - dodgy
115	Drift. Arr. 2	16:41:00 23/04/2014		53 20.910'S 50 9.102'W	N/A	N/A	-53.34797	-50.15059	822	0.00	1717.95	146	-	-	-	Drifter1xl ow res		O18/Carbon/Nitrate/S ilicate/	EA600 reading - dodgy
116	Drift. Arr. 2	17:21:00 23/04/2014		53 16.521'S 50 5.057'W	N/A	N/A	-53.27489	-50.08354	1952	0.00	932.93	147, 148 & 149	-	-	-	Drifter 2xhi,1xlo w		**What was actually sampled**	EA600 reading - dodgy
117	Drift. Arr. 2	17:59:00 23/04/2014		53 12.141'S 50 0.892'W	N/A	N/A	-53.20238	-50.01525	1328	1007.62	930.07	150	-	-	-	Drifter1xl ow res		DIMES/Salts	
118	North Scotia Ridge	20:11:00 23/04/2014	20:50:00 23/04/2014	53 20.029'S 50 35.068'W	-53.33	-50.58	-53.33379	-50.58448	489	546.82	495.60	151	CTD102	-	-	-	Salts only	CFC/O18//Carbon/Bar ium/Nitrate/Silicate/S alts	
119	North Scotia Ridge	23:50:00 23/04/2014	00:58:00 24/04/2014	53 33.140'S 51 17.987'W	-53.55	-51.30	-53.55186	-51.29909	951	0.00	975.25	152	CTD103	-	-	-	CFC/N/DIC	CFC/Carbon/Barium/N itrate/Silicate/Salts	EA600 reading - dodgy

120	North Scotia Ridge	04:42:00 24/04/2014	05:42:00 24/04/2014	53 48.484'S 52 12.386'W	-53.81	-52.21	-53.80916	-52.20633	235	844.80	826.31	153	CTD104	-	-	-	Salts only	Salts	
121	North Scotia Ridge	08:46:00 24/04/2014	09:38:00 24/04/2014	53 54.808'S 53 0.340'W	-53.9	-53.01	-53.91396	-53.00765	548	562.18	513.94	154	CTD105	-	-	-	CFC/N/DIC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	Vessel tracking 250° at 0.3kts for current
122	North Scotia Ridge	11:35:00 24/04/2014	12:44:00 24/04/2014	53 58.060'S 53 30.692'W	-54.00	-53.51	-53.96856	-53.51335	1341	1016.83	1002.19	155	CTD106	-	-	-	DIMES	CFC/Barium/Salts	
123	North Scotia Ridge	15:35:00 24/04/2014	17:01:00 24/04/2014	54 4.220'S 54 14.599'W	-54.07	-54.25	-54.07023	-54.24484	1175	1532.93	1504.17	156	CTD107	-	-	-	CFC/Bar/N/DIC	CFC/Carbon/Barium/Nitrate/Silicate/Salts	
124	North Scotia Ridge	19:25:00 24/04/2014	20:34:00 24/04/2014	54 11.077'S 54 50.239'W	-54.18	-54.8	-54.18425	-54.83684	1782	1492.99	1463.06	157	CTD108	-	-	-	DIMES	DIMES/Salts	
125	North Scotia Ridge	21:44:00 24/04/2014	23:25:00 24/04/2014	54 13.789'S 55 5.732'W	-54.23	-55.10	-54.22973	-55.09518	1716	1935.36	1906.59	158	CTD109	-	-	-	CFC/Bar/N/DIC	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
126	North Scotia Ridge	00:30:00 25/04/2014	01:55:00 25/04/2014	54 17.744'S 55 19.481'W	-54.30	-55.32	-54.29613	-55.32260	1758	1723.39	1692.01	159	CTD110	-	-	-	Salts only	DIMES/Salts	New schedule dated 14/04/2014
127	North Scotia Ridge	03:00:00 25/04/2014	04:30:00 25/04/2014	54 21.700'S 55 33.231'W	-54.36	-55.55	-54.36243	-55.55371	1562	1502.21	1473.60	160	CTD111	-	-	-	Oxygen	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
128	North Scotia Ridge	05:13:00 25/04/2014	06:56:00 25/04/2014	54 23.653'S 55 40.552'W	-54.39	-55.68	-54.39179	-55.67159	861	1078.27	1049.92	161	CTD112	-	-	-	CFC/Bar/N/DIC	DIMES/Salts	
129	Falk. Trough	07:37:00 25/04/2014	08:25:00 25/04/2014	54 25.497'S 55 49.105'W	-54.43	-55.82	-54.42505	-55.81929	568	599.04	543.56	162	CTD113	-	-	-	Salts only	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
130	Falk. Trough	14:27:00 25/04/2014	16:58:00 25/04/2014	53 34.272'S 55 1.806'W	-53.57	-55.03	-53.57157	-55.03054	2954	3302.40	3271.26	163	CTD114	-	-	-	DIMES	DIMES/Salts	
131	Falk. Trough	19:30:00 25/04/2014	21:40:00 25/04/2014	53 33.516'S 55 41.052'W	-53.56	-55.68	-53.55867	-55.68441	3241	3409.92	3183.35	164	CTD115	-	-	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
132	Falk. Trough	00:07:00 26/04/2014	02:31:00 26/04/2014	53 32.760'S 56 20.292'W	-53.55	-53.55	-53.54597	-56.33903	3025	3216.38	2986.83	165	CTD116	-	-	-	DIMES/d18O/DIC/N/Bar	DIMES/Salts	Barium added
133	Falk. Trough	05:00:00 26/04/2014	07:27:00 26/04/2014	53 32.010'S 56 59.538'W	-53.53	-56.99	-53.53373	-56.99148	2806	2853.89	2798.09	166	CTD117	-	-	-	DIMES	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	
134	Falk. Trough	09:56:00 26/04/2014	12:16:00 26/04/2014	53 31.254'S 57 38.778'W	-53.52	-57.65	-53.52071	-57.64533	2439	2608.13	2570.50	167	CTD118	-	-	-	DIMES	DIMES/Salts	
135	GC528	16:23:00 26/04/2014	17:21:00 26/04/2014	53 0.780'S 58 2.430'W	-53.01	-58.04	-53.01494	-58.03831	609	675.84	596.68	168	CTD119	-	-	-	d18O/DIC/N	CFC/DIMES/Carbon/Barium/Nitrate/Silicate/Salts	