RRS Discovery

Cruise D340a

Reykjavik to Dunstaffnage
via Rockall and the Wyville Thomson Ridge

10 June to 25 June 2009

T. Sherwin, D. Aldridge, J. Allen, S. Amin, K. Attard, J. Beaton, T. Brand, C. Barnard, J. Calderwood, E. Dumont, M. Hebden, V. Ivanov, A. Macey, C. Marsay, R. McLachlan, J. McRae, A. Mogg, K. Mohammed, M. Porter, J. Read, V. Rerolle, S. Richier, J. Short, S. Steigenberger, N. Wager

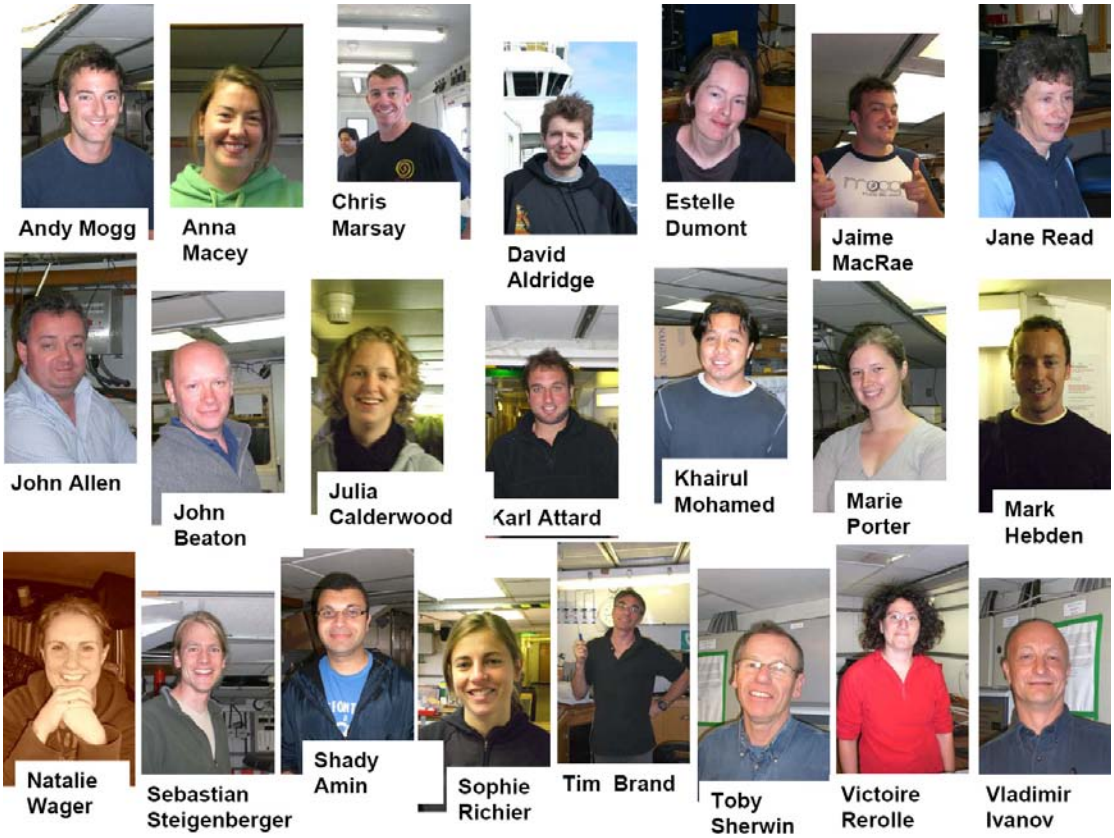
A joint SAMS / NOCS cruise led by
the Scottish Association for Marine Science

SCOTTISH ASSOCIATION for MARINE SCIENCE

Internal Report No

Dunstaffnage Marine Laboratory
Oban, Argyll, PA37 1QA, Scotland

Tel: [+44] (0)1631 559000
Fax: [+44] (0)1631 559001
www.sams.ac.uk



The scientists

The NMFSS technicians

Scientific crew

		Institution	Activity	Nominated PI
1	Toby Sherwin	SAMS	PS /PO	Toby Sherwin
2	Estelle Dumont	SAMS	Tech	Toby Sherwin
3	John Beaton	SAMS	Tech	Toby Sherwin
4	Marie Porter *	SAMS	PO	Toby Sherwin
5	Vladimir Ivanov	SAMS	PO	Toby Sherwin
6	Tim Brand	SAMS	Nutrients	Toby Sherwin
7	Karl Attard §	SAMS	Oxygen	Toby Sherwin
8	Jamie McRae §	SAMS	Chlorophyll	Toby Sherwin
9	Andy Mogg *	SAMS	DMS	Angela Hatton
10	Natalie Wager	Heriot Watt Uni	DMS	Angela Hatton
11	David Aldridge §	NOCS	Plankton Net	Duncan Purdie
12	Shady Amin *	San Diego State Uni	Boron	Frithjof Kuepper
13	Mark Hebden	BODC	Data	Mark Hebden
14	Julia Calderwood	BODC	Data	Mark Hebden
15	Jane Read	NOCS	PO	Jane Read
16	John Allen	NOCS	PO	Jane Read
17	Sebastian Steigenberger	NOCS	Fe etc	Eric Achterberg
18	Chris Marsay	NOCS	Fe etc	Eric Achterberg
19	Khairul Mohammed *	NOCS	Fe etc	Eric Achterberg
20	Victoire Rerolle §	NOCS	Carbonate system	Eric Achterberg
21	Anna Macey *	NOCS	FRRF	Eric Achterberg
22	Sophie Richier *	NOCS	Fe stress proteins	Tom Bibby

* PhD student
§ Undergraduate (or equivalent)

NMFSS technicians

Jon Short	Technical liaison officer
Rob McLauchlan	Moorings technician
Chris Barnard	IT and CTD
Richie Phipps	Hardware

Ship's crew:

Antonio Gatti	Master
Nick Jones	Chief Officer
Phil Thomas	2nd Officer
Liam MsClintock	3rd Officer
David Hartshorne	Purser / Catering Officer
Richard Coe	Chief Engineer
Stephen Bell	2nd Engineer
John Harnett	3rd Engineer
Edin Silajdzic	3rd Engineer
Robert Masters	ETO
Michael Drayton	CPO (Deck)
Martin Harrison	CPO (Scientific)
Stuart Cook	POD
Gary Crabb	SG1A
Ian Mills	SG1A
Peter Smith	SG1A
Nathan Gregory	SG1A
Duncan Lawes	MM1A
John Haughton	Head Chef
Wally Link	Chef
Jeff Orsborn	Steward

Summary

This report describes the events and activities that occurred during D340, a joint SAMS / NOCS cruise on the NERC *RRS Discovery* that took place in the summer of 2009. The principle objective of the cruise was to undertake the sampling of the Extended Ellett Line, an annual section of CTD and bio-chemical monitoring stations that runs from Iceland to Rockall and on to Ardnamurchan Point in Scotland. The Ellett line is funded by NERC under Oceans2025 (http://www.oceans2025.org/).

The principle activities were:

1. Undertake annual routine CTD + nutrients section along the Ellett line (see sketch) from Iceland to Scotland (OC2025, Theme10)
2. Recover 4 sediment trap moorings in the Iceland Basin (see box, OC2025, Theme 3)
3. Turn round ADCP mooring on the Wyville Thomson Ridge and undertake supporting CTD observations (OC2025, Theme 10)

Additional measurements were:

1. Boron in the upper water column
2. Iron and other trace metals in the surface and water column
3. Low volume atmospheric sampling for trace metals
4. DMS, DMSP lyase activity
5. FRRf, proteins, flow cytometry and chlorophyll sampling
6. Phytoplankton in coastal waters
7. Fe and Al (dissolved and particulate) in seawater and aerosols
8. Fe ligand profiles and siderophore incubations
9. Zooplankton in the surface layers

In general this was a very successful cruise, with just 1 day lost to weather and 1 day to winch problems. Fortunately none of the winch problems were of a nature that suggested that there were any lingering long term problems with the winch system. The one major disappointment was that the mooring on the Wyville Thomson Ridge failed to come up. Another ADCP mooring that was on board the ship was deployed instead.

Two undergraduate students gained seagoing experience, and three MSc and six PhD students collected data for their research projects.

The headline early result from the cruise was that whilst the temperature of the upper 800 m of the Rockall Trough was slightly cooler than in 2008 and 2007, there was no strong indication that the long term warming of these waters has come to an end.

All data from this cruise are due to be banked with BODC, either directly after the cruise, or when they are processed, as appropriate. DVDs of the data were made available to the PS and other senior scientists. A weblog of the cruise was kept and can be found at www.sams.ac.uk.

Personal acknowledgement by the PS

This has proved to be the easiest Ellett Line cruise for me to lead so far. A large part for this is down to the professionalism and co-operation that has been displayed by all the scientific and NMF technical staff. Whilst reluctant to single anyone out I must add special thanks to the help provided by Mark Hebden and Julia Calderwood of BODC who have saved us all a lot of work with the collation of all the paperwork of what is quite a complicated cruise with its wide range of scientific activities.

The success of this cruise not only depended on the skills of the master, but also on the professionalism and good humour of the whole of the ship's crew. Most scientists only spend a very small part of their time at sea so it is particularly important to have an understanding crew. The skills of the bridge officers in holding the ship on position, of the engineers in maintaining the running of the ship's systems, of the catering staff in providing excellent food, and of the ABs in operating winches and handling sensitive scientific equipment is much appreciated.

I should also acknowledge the help provided by the PML Remote Sensing Centre in providing us with updates of chlorophyll and AVHRR images of the north east Atlantic which have provided insights and stimulated discussion of the waters that we have been travelling through.

Toby Sherwin

June 2009

List of contents

1 Introduction

1.1 Chronology

Date	Julian Day		Location	Activity
10-Jun-09	161	Wednesday	Reykjavik	Under way
11-Jun-09	162	Thursday	Iceland Shelf	Extended Ellett line CTDs
12-Jun-09	163	Friday	Iceland Basin	Extended Ellett line CTDs
13-Jun-09	164	Saturday	Iceland Basin	Iceland Basin Moorings
14-Jun-09	165	Sunday	Iceland Basin	Extended Ellett line CTDs
15-Jun-09	166	Monday	Hatton Bank	Extended Ellett line CTDs
16-Jun-09	167	Tuesday	Rockall Bank	Ellett line CTDs
17-Jun-09	168	Wednesday	Rockall Trough	Ellett line CTDs
18-Jun-09	169	Thursday	Anton Dohrn	Hove to
19-Jun-09	170	Friday	Rockall Trough	Ellett line CTDs
20-Jun-09	171	Saturday		On passage
21-Jun-09	172	Sunday	WTR	WTR CTDS
22-Jun-09	173	Monday	WTR	WTR mooring and CTDs
23-Jun-09	174	Tuesday	WTR	WTR CTDs
24-Jun-09	175	Wednesday		On passage
25-Jun-09	176	Thursday	Scottish shelf	Ellett line CTDs / end

1.2 Cruise track

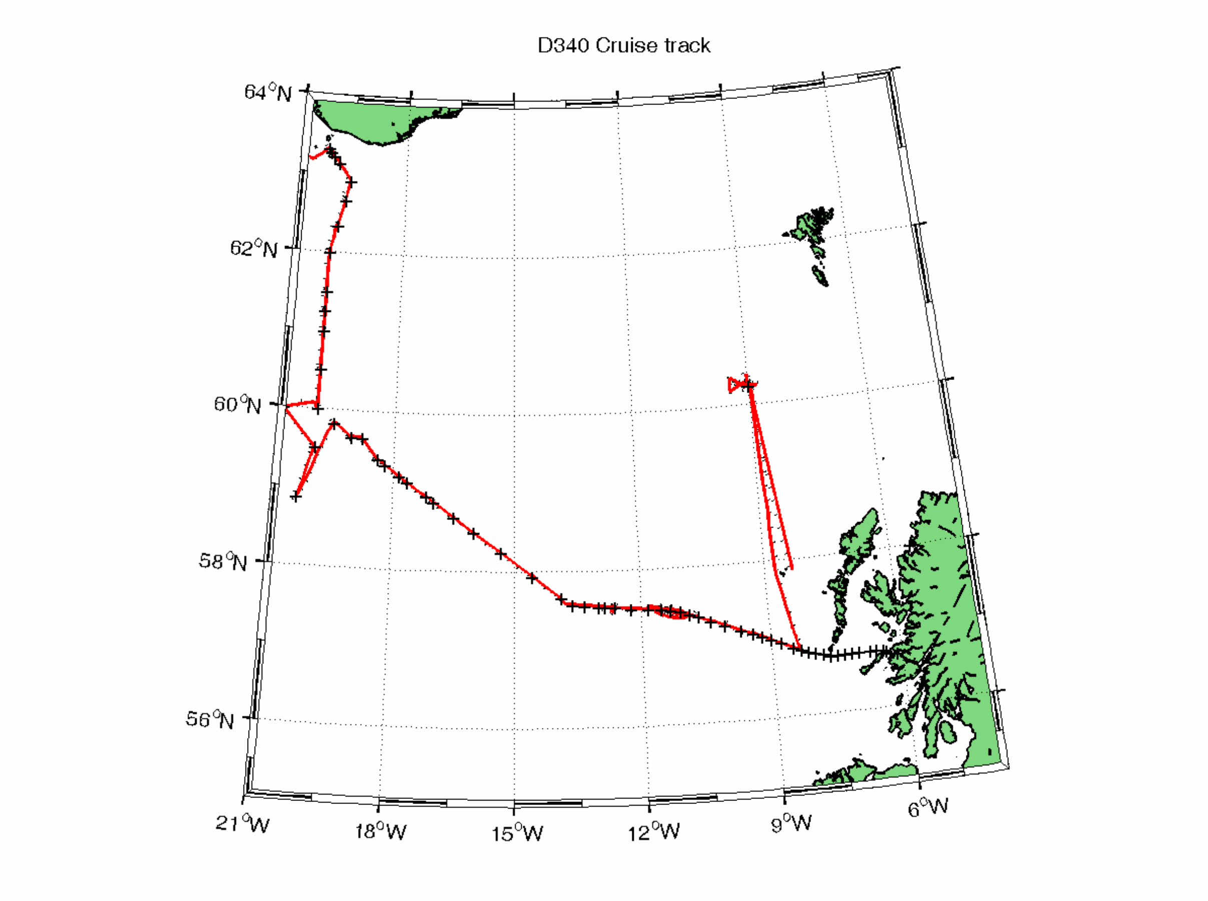


Figure 1.1. The cruise track from Iceland to Scotland. (Note: This track plot shows the cruise up to 24 June. The track for the final day in which the shelf stations were completed is unavailable.

1.3 Sea surface temperature field

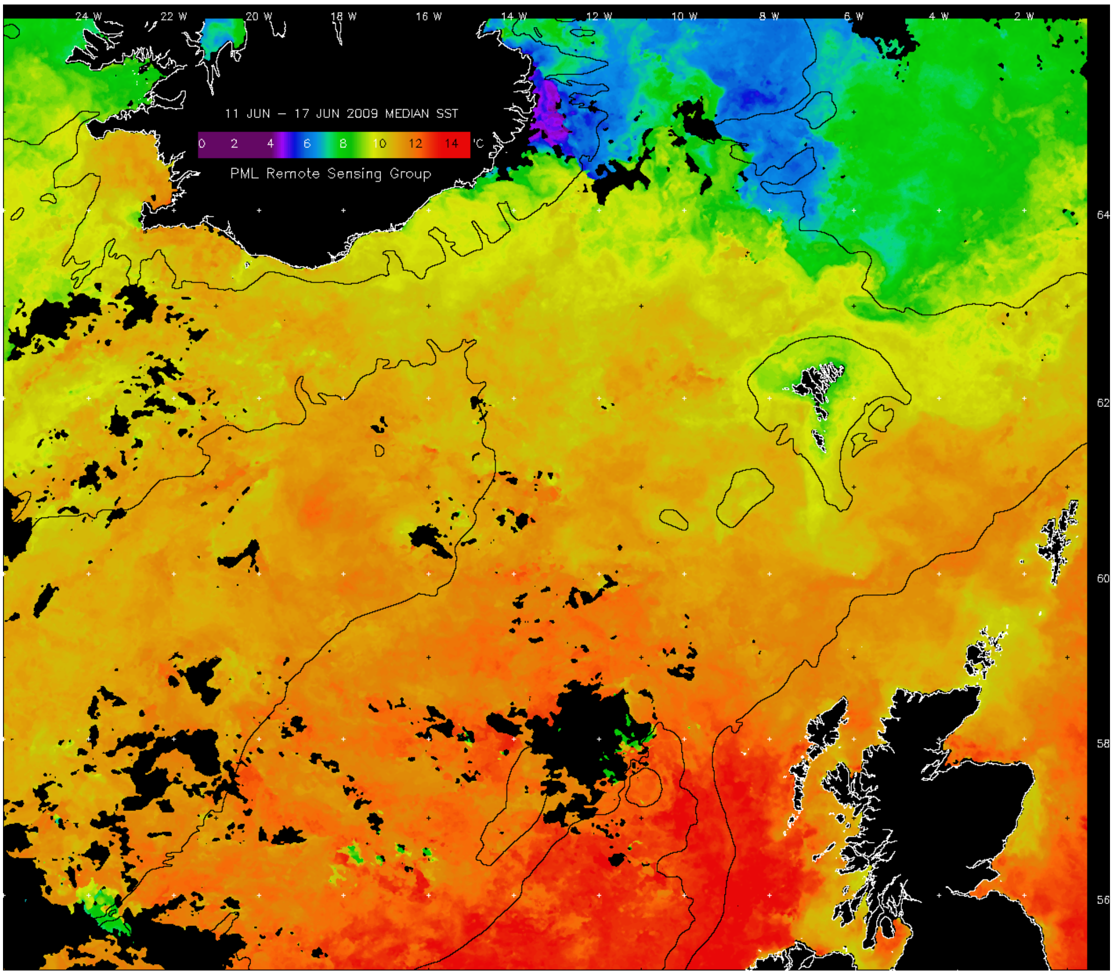
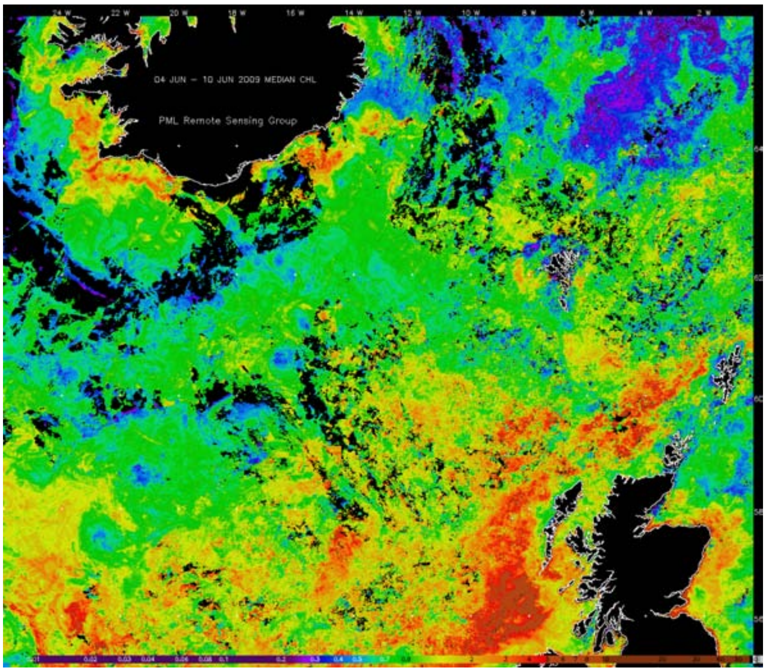
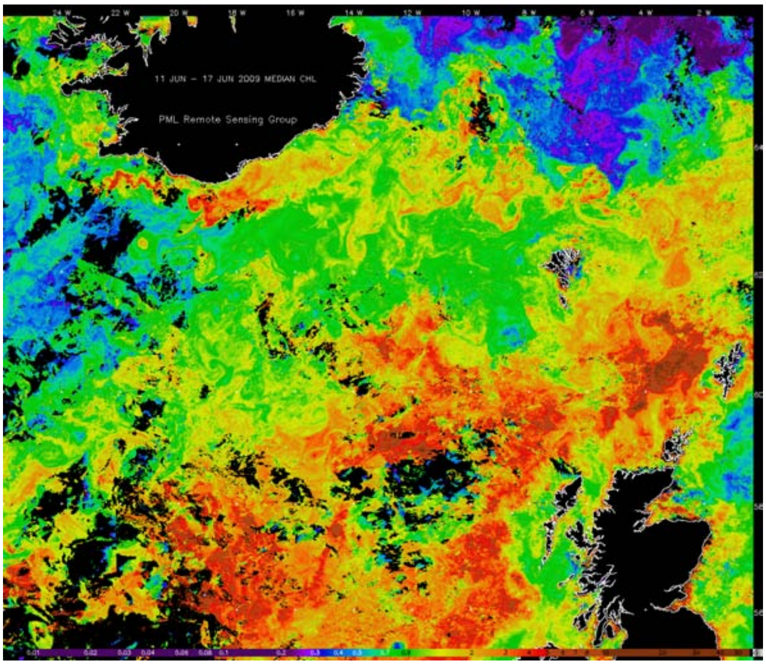


Figure 1.2. AVHRR image of the North West Atlantic showing a composite of sea surface temperature for the 7 day period to 17 June 2009. Satellite data were received and processed in near-real time by the NERC Earth Observation Data Acquisition and Analysis Service (NEODAAS) at Dundee University and Plymouth Marine Laboratory (www.neodaas.ac.uk)

1.4 Sea surface chlorophyll concentrations



a)



b)

Figure 1.3. MODIS images of the North West Atlantic showing the change during the cruise of sea surface chlorophyll *a* from composites of the 7 day periods to a) 10 and b) 17 June 2009. Courtesy of PML Remote Sensing Group

1.5 Meteorological measurements

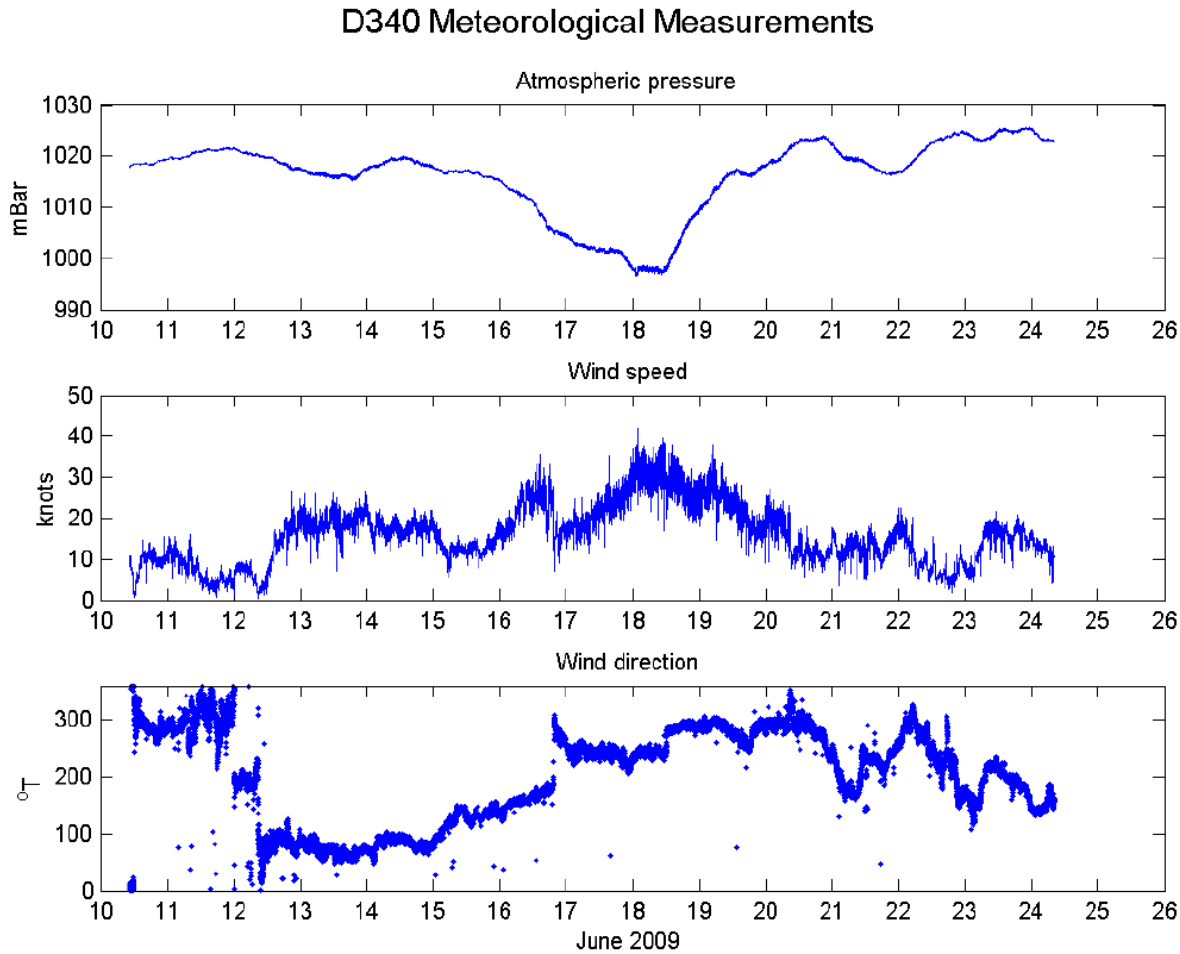


Figure 1.4 A summary of the meteorological measurements from the Surfmet logging system to 24 June 2009

1.6 Sea surface observations

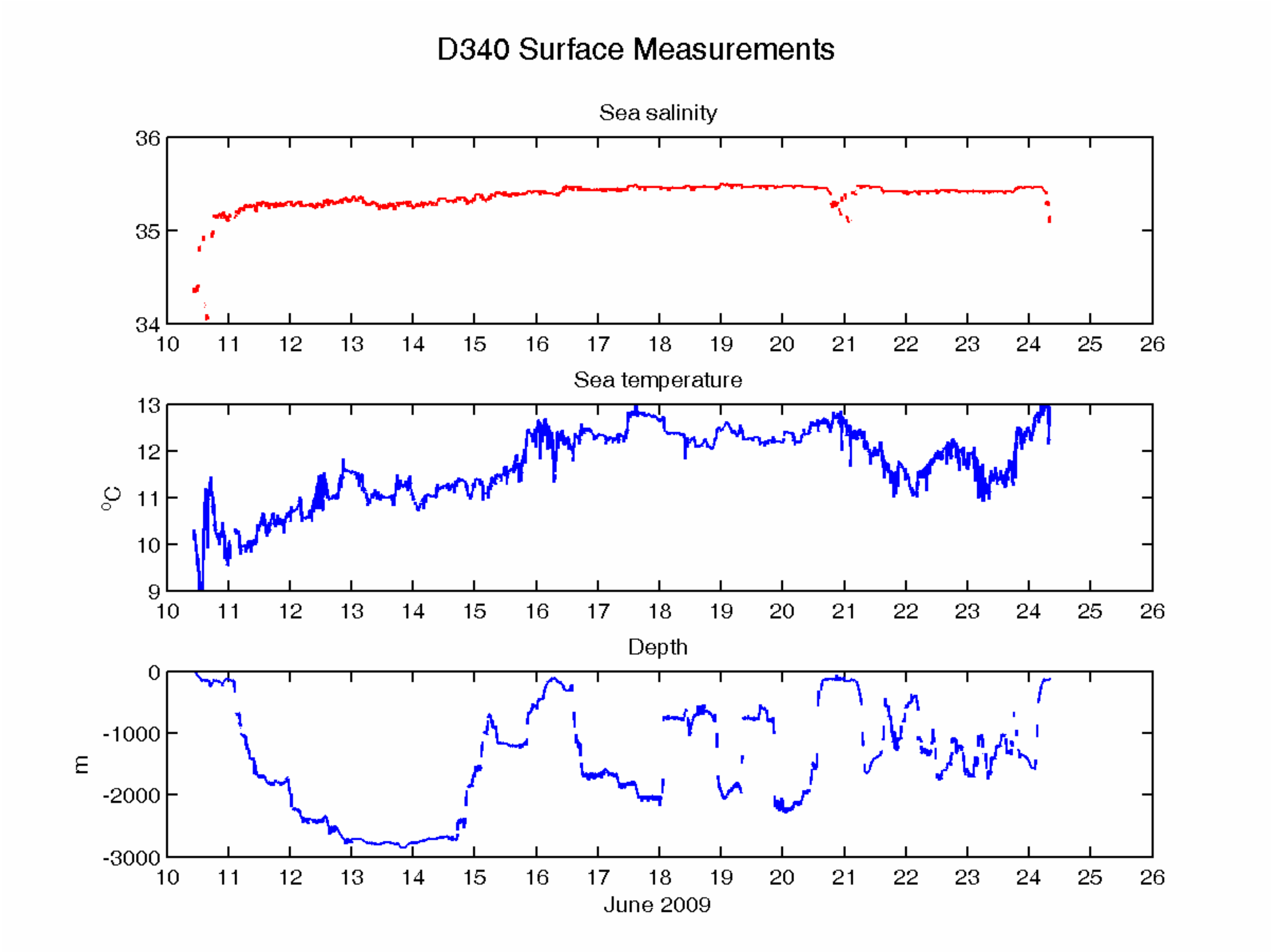


Figure 1.5. A summary of the oceanographic measurements from the Surfmet logging system to 24 June 2009. Gaps in the depth data are due to spike removal.

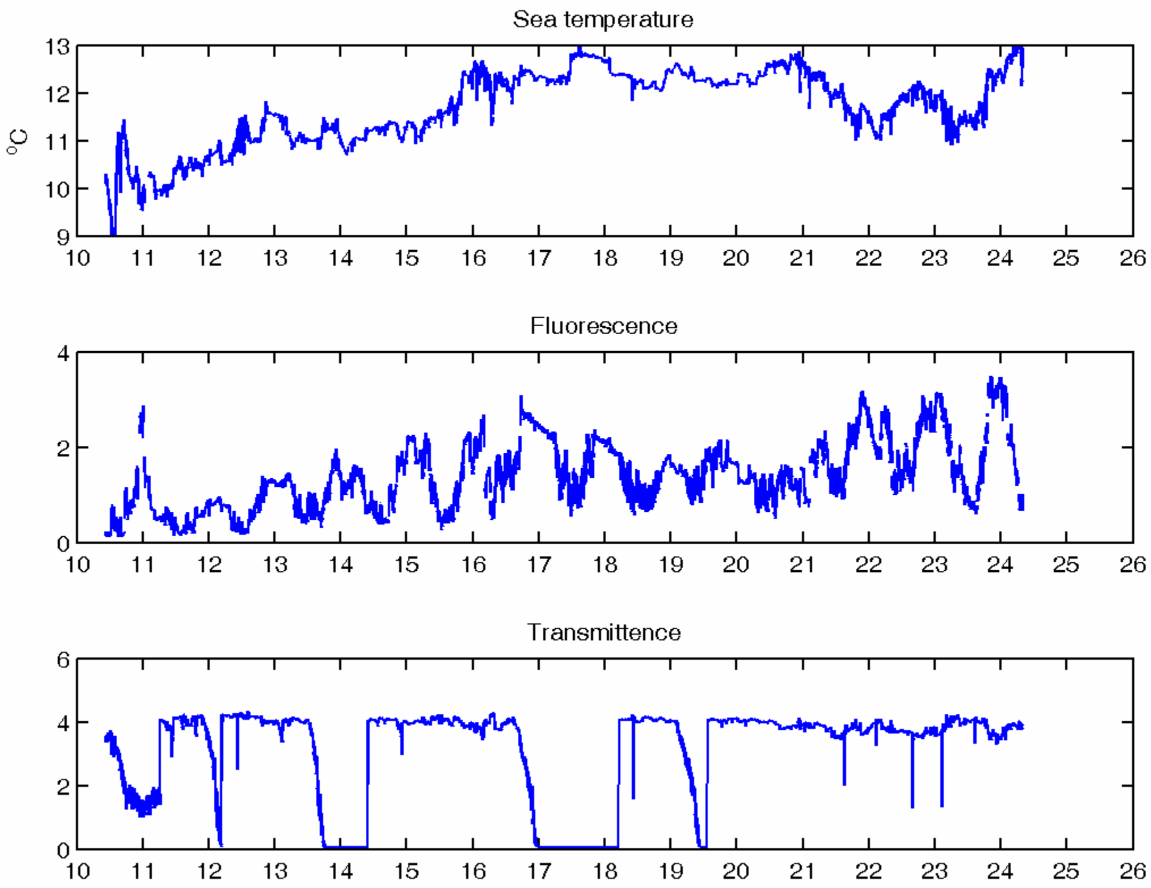


Figure 1.6. A summary of the oceanographic measurements from the Surfmet logging system to 24 June 2009. Gaps in the depth data are due to spike removal. Zero transmittance values are due to fouling.

2 Narrative

Toby Sherwin, SAMS, PSO

2.1 Wednesday 10 June (Julian day 161)

Day 1. Reykjavik; Iceland shelf; Sta IB23S. Wind light; sea state slight

Left Reykjavik at 0900 h as planned. Two surface drifters that we had been asked to deploy by the Centre de Meteorologie Marine, France, had not turned up but their omission was not enough to delay the start of the cruise. Sorted out watches, see below. A ship meeting to confirm general activities of the cruise was held at 1245 h, and a science meeting at 1300 h. A formal introduction of all staff was not done this time because Natalie Wager had offered to photograph everyone and put up some sheets with mug shots. A successful CTD test (stainless only) was held at 1500 h. The plankton net (a bongo net) was deployed but some trouble was encountered in making its tail sink. A safety muster took place at 1615 h.

Station IB23S (125 m) was occupied at 2310 h, and this time the plankton net functioned satisfactorily. There was a glorious sunset behind the little group of islands that include Surtsey and mark the start of the line.

2.2 Thursday 11 June (day 162)

Day 2. Iceland shelf edge; Stations IB22X to IB17; Wind light, sea state slight; sunny then rain at IB17

The weather forecast until next Friday appears to be very good. Station IB22X was an additional station that was added near the shelf edge to allow a titanium cast at the top of the line for the iron measurements. It is apparent that many of the chemists and biologists are keen to take samples from the Titanium frame to coincide with the iron measurements being made by Sebastian Steigenburger. No major problems.

The primary θ and S sensors on both frames are located inside the carousel, with the secondary ones on the fin. This is contrary to the stated value on the two packages and it will be necessary to flag this up when the data are archived. It also means that the oxygen sensor is inside the carousel. The streaming of navigation data to both VMADCPs is not functioning properly (there are large data dropouts) and needs to be corrected. One chlorophyll a and one salinity sample will be taken from the underway system on each watch.

There may be a problem with coming into Ullapool for the port call on 26 June if the weather is bad. We're investigating the possibility of using either Stornoway or Oban instead.

2.3 Friday 12 June (day 163)

Day 3. Iceland Basin; Stations IB16S to IB12; Wind calm at first, sunny, later freshened to NE.

Relatively uneventful day. Plankton (bongo) net lost at Sta. 14 due to unsatisfactory connector, and spare was brought into use. There is a problem with the Ashtec GPS data that are processed by VMDAS which leads to the N1R files being corrupt. This is being worked on.

An exceedingly good image of Chlorophyll a was received from PML Remote Sensing Group (modis_chlor_a_2009-06-11_1355.png in the data disk) which shows a very pronounced front NW of Hatton Bank with lower Chl a values in the Iceland Basin. We shall be crossing that front in a couple of days.

2.4 Saturday 13 June (day 164)

Day 4. Iceland Basin; Moorings STNW, STC and STS; Wind F5 ENE

The day was spent recovering NOCS sediment traps. Three of the four were recovered with remarkable ease (STC was a bit tangled) with the last being brought on board at 2030 h. The instruments looked undamaged and the sediment bottles were saved from each trap. In the morning Toby Sherwin gave a talk on 'D340 – why are we here' and Marie Porter one on 'Where the glaciers meet the sea'.

2.5 Sunday 14 June (day 165)

Day 5. Iceland Basin; Stations IB11A to IB9 and mooring STNE; Wind F4-5 E, sunny

Stations IB11A and IB4A have been added after discussions between PS and Jane Read who agreed to increase the density of stations in the western side of the Iceland Basin and on the Hatton-Rockall Plateau. Mooring STNE was successfully recovered in the afternoon (although for a while it was thought that it might not have released), making a surprisingly successful clean sweep in the Iceland Basin, given the length of time that they had been deployed.

Discovered that the first 7 LADCP deployments had been set to 45 pings per ensemble. Yet to find out if this affects processing on these stations. (Subsequently these casts had to be abandoned).

2.6 Monday 15 June (day 166)

Day 6. Hatton Bank and Hatton-Rockall Plateau; Stations IB8 to IB3; Wind F4 N, overcast

Across the Hatton Bank some stations are grouped in pairs leaving a large gap between IB4 and IB5, and consequently an additional station (IB4A) was added. It was evident in the CTD profiles that the 20 l bottles were affecting the performance of the CTD (and impinging on the DO sensor, tucked inside the carousel). Also very few people are sampling from the stainless frame, with a feeding frenzy around the titanium one instead. Therefore the 20 l bottles were replaced with 10 l ones at Sta. IB4A.

Following a series of emails with Colin Griffiths at SAMS it has been decided to alter the port call arrangements from Ullapool on the 26th to Oban on the 25th, with a transfer using *Calanus*.

2.7 Tuesday 16 June (day 167)

Day 7. Rockall Bank, Stations IB2 to E; Wind F5, freshening to F7 by 1900 h

Awoke at 0700 h to the site of Rockall in the near distance – the Iceland Basin line had been completed. Started to work across Rockall towards the Rockall Trough. Pilot whales seen at 1100 h. The LADCP data seem ok after Sta. 9. Before that the instrument had been set to save 45 s ensembles rather than every ping and test showed that this resulted in spurious observations from the Thurnhurr processing software.

This is the day problems started with the CTD winch. First the computer reported that everything was stopped when in fact it was still turning. A wire test was undertaken at 1100 h which indicated that all was ok. Conversation with the manufacturers indicated that this should not be a critical problem. Then the CTD wire came up from E with a large number of 'birdcages' (unravelling) in the outer sheave. From about 2000 h, when the CTD came out, until after about 0300 h the CTD was out of action whilst 200 m of wire was removed and the wire reterminated.

A SAPS deployment planned for Sta. E at 2200 h was abandoned because of the weather.

2.8 Wednesday 17 June (day 168)

Day 8. Western Rockall Trough, Stations E(SAPS) to I; Wind F6 WSW, sunny, whitecaps, later SW F7.

At Sta. G (1400 h) the hydrographic wire ‘birdcaged’ again. This time it was recognised that the wire had reached the end of its useful life, and that further birdcages were very likely here on in. Therefore it was decided to take it out of the system and start using the newer spare wire. The whole operation of spooling and terminating this wire took until 2220 h when Sta. H was commenced.

A problem was encountered with one of the GCS being used with Andy Mogg. He phoned SAMS and a replacement spark element is being ordered, hopefully in time for Oban.

2.9 Thursday 18 June (day 169)

Day 9. Anton Dohrn Seamount. No work. Wind SW, F8, large westerly swell.

After Sta. H, *Discovery* remained hove to all night. By morning, with no apparent break in the weather and the forecast indicating no change for 24 to 36 h and the whole of the NE Atlantic affected, it was decided to move eastwards to the shelter of Barra Head. Two main options were considered: i) sit it out at Sta. I to be ready to continue the line as soon as the weather permitted; or ii) transfer to the shelf where conditions may be easier for working the shelf stations, and/or it will be possible to shelter inside the Hebrides where *Discovery* will be best placed to make the next move depending on the conditions and the weather forecast. It seemed better to move to Barra Head.

At 1115 h received forecast that conditions would be moderating to NW F5/6 in the next 18 h. On this basis we turned back to Sta. I.

1620 h. Still WNW F7.

1930 h. Whilst still hove to Marie Porter hosted a quiz in the bar, which was well attended and well received.

Later. No change in wind conditions; watch keepers warned that it might be possible to restart at 0400 h.

2.10 Friday 19 June (day 170)

Day 10. East Rockall Trough. Stas I to L. Wind WNW F6; wind and W swell moderating during day

The anticipated lull in the wind failed to materialise at 0400 h but by 0850 we were ready to go again. Unfortunately as the CTD was being lowered into the water the cable jumped the traction winch leaving the CTD stranded overboard – a potentially disastrous situation. It was lashed to the side of the ship and by 1015 h it had been brought back on board. Finally, we got going again at 1310 h with the original cast number (35).

By the evening things were back to a steady routine and we were running for Barra Head and Sta. T.

2.11 Saturday 20 June (day 171)

Day 11. East Rockall Trough. Stas J to T followed by passage to Wyville Thomson Ridge. Wind W, continuing to moderate

Worked eastward during the day with no new incidents, and the ship relaxing back to normality. The final plan was made to be at Dunstaffnage by 1200 h BST to meet with *Calanus*. At 2100 h we finally completed Sta.T with a net, and thus set north to the Wyville Thomson Ridge. It was Estelle's birthday, and in the evening this was an opportunity for everyone to unwind.

2.12 Sunday 21 June (day 172)

Day 12. On passage to the Wyville Thomson Ridge. Stas D6 to D2. Wind and sea state moderating all day, mist in the evening.

Made good time and arrived at the southernmost Ellett Gully station (D6) at 1600 h. At 1430 the PSO gave everyone a little reminder about what was expected from them for the cruise report, and then Vladimir Ivanov gave a very interesting talk, with accompanying short movie about a cruise in October 2008 in the Arctic that he had participated in. In their case the sea was always flat, but temperatures were bitterly cold, sometimes down to -20° C. Makes our present 11° C seems positively tropical.

We worked across the gully from Sta. D6 through D5 and D4, missing out D4A for the moment because it was felt that it might be too close to the mooring. The hoped for very cold temperatures were not encountered and subsequent inspection of the LADCP data indicated that a moderate overflow with a maximum of about 1 m s^{-1} was flowing. At some stations (e.g. D4 there were dramatic changes in water depth of up to 50 m over very short periods of time). The Bridge were very good at maintaining position, in albeit benign conditions, and the NMF technicians (Jon and Chris) very co-operative in trying to get the CTD as close as possible to the sea bed.

The D line stations are very close together (often less than 1 nm apart) and it was decided to cut down on nutrient and salinity sampling to every other CTD. Before going to bed I added an extra station (DD) north of D0 on the Faroe Bank to confirm the northern end of the overflow.

2.13 Monday 22 June (day 173)

Day 13. Working the Ellett Gully and Cirolana Deep (mooring recovery and Stas D1 to CD7). Stas D3 to . Wind F3 but moderating all day. Visibility excellent.

Overnight we completed the D line to Sta. DD, and since there was still time to spare the 4-8 watch thoughtfully added another dip at station D3 on the northern side of the overflow where the isopycnals tended to be packed the tightest. After that we moved to the mooring site to start the recovery at 0600 h.

Initially things went well, with the release responding to the wake up, reporting that it had a range of 1420 m and was in the vertical position with a battery voltage of 8.6 v. It next acknowledged the release command, reported a range of 1342 m and seemed to be coming up. However, subsequent reports showed that it had had not risen any further, and it subsequently failed to acknowledge commands to release the anchor. At 0830 h after further attempts to get it to perform the release command failed, we moved on to the nearby Sta. D4.

At 0915 we went back to trying to fire the release, and although it again confirmed that it had released on a couple of occasions the rig failed to come up. At 0945 h we abandoned the mooring for 24 h and started on a LADCP/CTD survey of the Cirolana Deep. Since this survey was an intense physical investigation designed to measure vorticity in the deep, only a few nutrient measurements were made, with salinities not being measured on every cast.

There was a complete ADCP mooring on board, but enquiries with Colin Day back at base revealed that it was earmarked for another (ECOMAR) cruise and could not be used as a replacement.

At about 1500 h a very large school of pilot whales (possibly as many as 40) converged on *Discovery* and provided a great sight and photo opportunity.

2.14 Tuesday 23 June (day 174)

Day 14. Ellett Gully (mooring and CTD activity). Stas CD8 to EG5. Wind F3, overcast

We finished the Cirolana Deep survey at 0530 h and moved on to the mooring again. For a third time, from 0559 to 0635 h at position 60° 14.743’ N, 9° 00.360’ W, we attempted to get the release to fire, without response. On most occasions it took several attempts to get the release to acknowledge a command, and it now repeatedly reported that it was in the horizontal position.

At breakfast the PSO suddenly had a brainwave scheme to get agreement to use the mooring on the afterdeck, and after a number of phone calls it was agreed that an ADCP bought by SAMS and earmarked for FRS would be diverted for the ECOMAR cruise by way of a swap. The site can thus remain occupied until September / October when the mooring will be recovered by *Scotia* and placed relocated to the Faroe-Shetland Channel.

At 1000 h a school of about 20 pilot whales were seen on the port side of the ship.

Since there was still time for some extra work before turning for Oban a CTD section along the main axis of the gully (the EG section) was conducted from the Cirolana Deep to the head of the gully. At the same time John Beaton (SAMS) and Rob McLuachlan (NMF) prepared the ADCP and the mooring on the afterdeck for deployment.

A new position was prepared for this mooring, to the northeast of the failed release (at 60° 15’ 28.47” N, 8° 58’ 17.17” W in exactly 1200 m), because in the course of understanding the reasons why the release had failed it was discovered that the existing mooring was less than 800 m for an international transatlantic fibre optic cable. The proximity of this cable meant that it was not possible to grapple for the mooring, and it is conceivable that the cable had fouled the current meter rig. A more likely explanation for the problem however, is a failure of the release itself.

An RPC hosted by the captain and the PSO tool place in the evening.

2.15 Wednesday 24 June (day 175)

Day 15. On passage to and on the Ellett Line. Stas 14G to 7G . Wind SE F4. Clear skies.

Passed St Kilda at 0730 h on the way south. After breakfast the hold was opened and the boxes required for the next leg brought up onto the after deck to make space for equipment and samples acquired by those leaving at Oban (mainly Southampton scientists). At 1030 a security muster was held in which the whole crew had to search for a suspected 'terrorist' who was supposed to be on board who may have planted some bombs. Just after the bridge had announced that the exercise was over Anna Macey found a genuinely suspicious package (about 12 pouches of tobacco wrapped up in polythene) in the ceiling of the main chemistry lab to the consternation of the master and 1st mate.

1430 h Started on the shelf leg of the Ellett Line with Sta. 14G. Thus as a result of a misunderstanding on the bridge, Sta. 15G has not been conducted. This is not as serious an omission as might be thought since Sat. 15G lies close to Sta. T.

2.16 Thursday 25 June (day 176)

Day 16.Ellett Line on the Shelf. Stas 6G to 1G. Wind moderate. Sea state slight

Completed the Ellett Line (Sta. 1G) at 0607 h in good time to start the passage down the Sound of Mull, to our rendezvous with *Calanus* off Dunstaffnage at 1100 h where we handed over to mark Inall and leg B. Because of the short time between the last station and the handover, it was not possible to complete all the final processing of the CTD data from Cast 56 onwards, which was left to the next leg.

Data discs were completed by Chris Barnard and handed over. These are: D340 working area; D340 underway; D340 CTD; D340 OS75 (ADCP); D340 OS150 (ADCP). The underway data are entirely binary and end at 0758 h; the CTD disc contains the raw data for the whole cruise (up to Cast 86), the OS150 disc ends at 0429 h; and the OS75 disc ends at 0433 h.

2.17 Watch keepers

A standard watch keeping system of 4 h on, 8 h off, was maintained by the scientific staff throughout the cruise. The watch keepers are to be commended for their efforts.

8 - 12	**12 – 4**	**4 - 8**
Marie Porter*	Jane Read*	Valdimir Ivanov*
John Beaton	Estelle Dumont	John Allen
Toby Sherwin**	Mark Hebden	Julia Calderwood

* Watch leader

** as required

The NMF technicians worked a 12 h on, 12 h off, system with Jon Short working midday to midnight and Chris Barnard midnight to midday.

3 Vessel Mounted ADCP (VM-ADCP) and navigation data

John Allen, NOCS, Vladimir Ivanov, SAMS

PIS: John Allen and Toby Sherwin

3.1 Introduction

During the refit for RRS *Discovery* in March 2008, the original narrow band RDI 150 kHz Vessel-Mounted Acoustic Doppler Current Profiler (VM-ADCP) was replaced with an RDI broad band 150 kHz (Ocean Surveyor) phased array style VM-ADCP. This was in addition to the similar 75 kHz Ocean Surveyor instrument that had been in use in the forward ADCP housing since 2001.

The 150 kHz ADCP is mounted in the hull 1.75 m to port of the keel, 33 m aft of the bow at the waterline and at an approximate depth of 5 m. The 75 kHz ADCP is also mounted in the hull, but in a second water chest 4.15 m forward and 2.5 m to starboard of the 150 kHz well.

This section describes the operation and data processing paths for both ADCPs. The navigation data processing is described first since it is key to the accuracy of the ADCP current data. All integrated underway data were logged using the Ifremer TechSAS data logging system that has been gradually implemented on RRS *Discovery* for approximately 3 years. The extensive NMFSS scripts to read the netcdf format TechSAS file streams and create RVS data streams have been developed alongside the implementation of the system, and most errors and wrinkles have been worked out. However, a residual problem with the reading precision of position data (nclistit) was noticed and it is recommended that this is addressed as soon as practical - an extra 2 characters should be sufficient. The number of characters for position is constant, and currently if degrees of latitude or longitude are less than ten then the precision is 10^{-6} (i.e. ~ 10 cm resolution – and indeed this appears to be the limit of the netcdf data). However where degrees of latitude or longitude exceed 10 then the precision read reduces to 10^{-5} (i.e. only ~ 1 m resolution), and should the longitude exceed 100 degrees then the precision read would decrease to 10^{-4} (i.e ~ 10 m resolution !!).

3.2 Method

3.2.1 Navigation

The ship’s primary position instrument was the GPS Trimble 4000 system. The positional accuracy for the GPS 4000 system was determined from the data recovered whilst tied up alongside in Reykjavik (Figure 3.1). Standard deviation for positional accuracy was ~ 2.13 m in latitude and 1.53 m in longitude, but some of this maybe due to heave in the mooring lines.

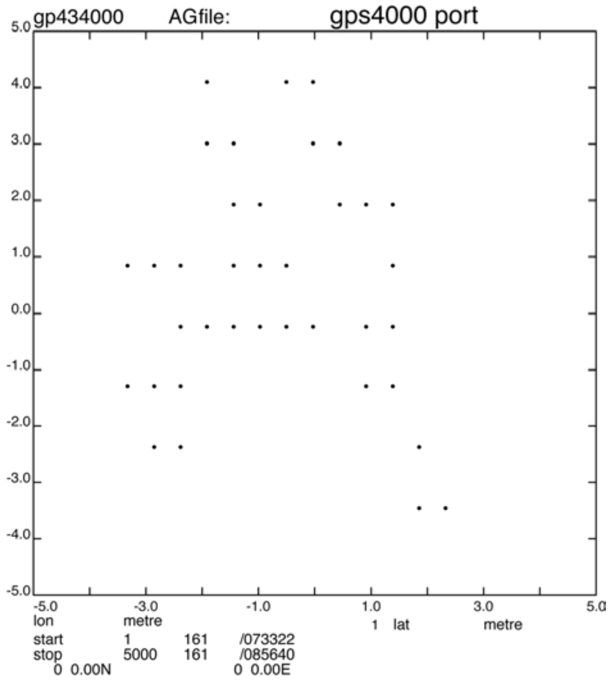


Figure 3.1. Positional accuracy in port at the beginning of the cruise for the gps4000 system

The GPS 4000 system therefore had sufficient precision to enable the calculation of ship's velocities to better than 1 cms^{-1}, and therefore below the instrumental limits (~ 1 cms^{-1}) of the RDI ADCP systems. Using the GPS 4000 system as its primary navigation source, the NMFSS Bestnav combined (10 second) clean navigation process was operational and working well on D340.

Navigation and gyro data were transferred daily from the RVS format file streams to pstar navigation files, e.g. abnv3401, gp434001 and gyr34001.

Scripts:

navexec0: transferred data from the RVS bestnav file to pstar, calculated the ships velocity, appended onto the absolute (master) navigation file and calculated the distance run from the start of the master file. Output: abnv3401

gyroexec0: transferred data from the RVS gyronmea file to Pstar, a nominal edit was made for directions between 0-360° before the file was appended to a master file.

gp4exec0: transferred data from the RVS gps_4000 file to Pstar, edited out pdop (position dilution of precision) greater than 7 and appended the new 24 hour file to a master file. The master file was averaged to create an additional 30 second file and distance run was calculated and added to both.

3.2.2 Heading

The ship’s attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. During the preceding refit, all four antennae had been removed and replaced with the single mast Christmas tree antennae system originally fitted to RRS *Charles Darwin*.

The Ashtech data were used to calibrate the gyro heading information as follows:

ashexec0: transferred data from the RVS format file gps_ash to pstar.

ashexec1: merged the ashtech data from ashexec0 with the gyro data from gyroexec0 and calculated the difference in headings (hdg and gyroHdg); ashtech-gyro (a-ghdg).

ashexec2: edited the data from ashexec1 using the following criteria:

heading	0 < hdg < 360 (degrees)
pitch	-5 < pitch < 5 (degrees)
roll	-7 < roll < 7 (degrees)
attitude flag	-0.5 < attf < 0.5
measurement RMS error	0.00001 < mrms < 0.01
baseline RMS error	0.00001 < brms < 0.1
ashtech-gyro heading	-7 < a-ghdg < 7 (degrees)

The heading difference (a-ghdg) was then filtered with a running mean based on 5 data cycles and a maximum difference between median and data of 1 degree. The data were then averaged to 2 minutes and further edited for

-2 < pitch <2

0 < mrms < 0.004

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ships velocity was calculated from position and time, and converted to speed and direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. Diagnostic plots were produced to check this. During ship manoeuvres, bad weather or around data gaps, there were spikes which were edited out manually (plxyed, Fig.3.2).

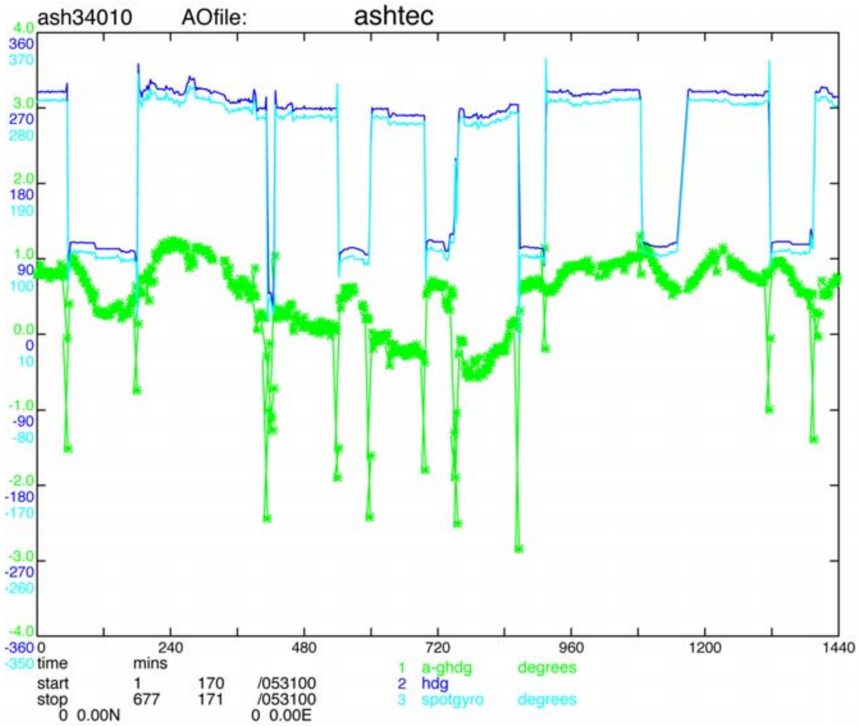


Figure 3.2. Example of the onscreen output of daily navigation hdg data generated by gyro (blue line) and ashtech (green line)

Ashtech 3D GPS coverage was generally good. Gaps over 1 minute in the data stream are listed below.

time gap : 09 163 01:16:14 to 09 163 01:17:15 (61 s)
time gap : 09 163 07:50:29 to 09 163 09:08:48 (78.3 mins)
time gap : 09 163 17:25:39 to 09 163 19:47:07 (2.4 hrs)
time gap : 09 164 01:47:50 to 09 164 01:49:21 (91 s)
time gap : 09 164 19:43:26 to 09 164 19:44:28 (62 s)
time gap : 09 165 17:09:27 to 09 165 17:14:48 (5.3 mins)
time gap : 09 167 17:05:00 to 09 167 17:06:06 (66 s)
time gap : 09 168 17:33:27 to 09 168 17:40:53 (7.4 mins)
time gap : 09 169 22:16:16 to 09 169 22:17:19 (63 s)
time gap : 09 171 00:42:29 to 09 171 00:43:36 (67 s)
time gap : 09 171 01:52:46 to 09 171 01:53:48 (62 s)
time gap : 09 171 02:01:24 to 09 171 02:02:26 (62 s)
time gap : 09 171 02:09:28 to 09 171 02:10:51 (83 s)
time gap : 09 172 15:21:12 to 09 172 15:22:16 (64 s)
time gap : 09 173 17:17:00 to 09 173 17:18:05 (65 s)

3.2.3 VM-ADCP data

This section describes the operation and data processing paths for both ADCPs, and closely follows that used on D322.

3.2.4 75 kHz and 150 kHz VM-ADCP data processing

The RDI Ocean Surveyor 150 kHz Phased Array VM-ADCP was configured to sample over 120 second intervals with 100 bins of 4m depth and a blank beyond transmit of distance of 4m. The instrument is a broad-band phased array ADCP with 153.6 kHz frequency and a 30° beam angle.

The RDI Ocean Surveyor 75 kHz Phased Array VM-ADCP was configured to sample over 120 second intervals with 100 bins of 8m depth and a blank beyond transmit of distance of 8m. The instrument is a broad band phased array ADCP with 76.8 kHz frequency and a 30° beam angle.

Both deck units had firmware upgrades to VMDAS 23.17 after the March 2008 refit. Both PCs ran RDI software VmDAS v1.46 to begin with. On JDay 165 (14th June) we reverted to VmDAS v1.42 on both PCs (files adp34005 and sur34005 onwards) in order to try to repeat the Matlab processing of VM-ADCP data carried out by Dr. M. Inall on RRS *Discovery* D312.

Gyro heading, and GPS Ashtech heading, location and time were fed as NMEA messages into the serial ports of the both PCs and VmDAS was configured to use the Gyro heading for co-ordinate transformation. VmDAS logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC clock from GPS time. This offset was applied to the data in the processing path before merging with navigation.

The 2 minute averaged data were written to the PC hard disk in files with a .STA extension, eg D340001_000000.STA, D340002_000000.STA etc. for the 150kHz data and D340_75001_000000.STA, D340_75002_000000.STA etc. for the 75 kHz data. Sequentially numbered files were created whenever data logging was stopped and re-started. The software was set to close the file once it reached 100MB in size, though on D340 files were closed and data collection restarted daily such that the files never became that large. All files were transferred to the unix directories /data32/d340ro/os150/raw and /data32/d340ro/os75/raw as appropriate. This transfer included the plethora of much larger ping by ping data files, these can be useful in the event of major failure of the ship's data handling systems as they record all the basic navigation and ships heading/attitude data supplied by NMEA message.

Both instruments were configured to run in 'Narrowband' range over resolution mode. Bottom tracking was used leaving Reykjavik, over the Icelandic shelf; file 001 for both instruments. At the time of writing it is expected that bottom tracking will also be used as we return across the UK continental shelf.

The VM-ADCP processing path followed an identical route to that developed in 2001 for the 75 kHz ADCP (RRS *Discovery* cruise 253). In the following script descriptions, "##" indicates the daily file number.

S75exec0 and S150exec0: data read into Pstar format from RDI binary file (psurvey2). Water track velocities written into "sur" (75kHz) or "adp" (150kHz) files, bottom track into "sbt" (75kHz) or "sur" (150kHz) files if in bottom track mode. Velocities were scaled to cm/s and amplitude by 0.45 to db. The time variable was corrected to GPS time by combining the PC clock time and the PC-GPS offset. An offset depth for the depth bins was provided in the user supplied information (13 m for the 75kHz and 9 m for the 150 kHz instruments), this equated to the sum of the water depth of the transducer in the ship's hull (~5 m in RRS *Discovery*) and the blank beyond transmit distance used in the instrument setup (see earlier). Output Files: 75kHz (sur340##.raw, sbt340##.raw), 150 kHz (adp340##.raw, bot340##.raw).

S75exec1 and s150exec1: data edited according to status flags (flag of 1 indicated bad data). Velocity data replaced with absent data if variable "2+bmbad" was greater than 25% (% of pings where >1 beam bad therefore no velocity computed). Time of ensemble moved to the end of the ensemble period (120 secs added with pcalib). Output files: 75kHz (sur340##, sbt340##), 150 kHz (adp340##, bot340##).

S75exec2 and s150exec2: this merged the adcp data (both files) with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: 75kHz (sur340##.true, sbt340##.true), 150 kHz (adp340##.true, bot340##.true).

S75exec3 and s150exec3: applied the misalignment angle, ø, and scaling factor, A, to both files. Variables were renamed and re-ordered to preserve the original raw data. Output Files: 75kHz (sur340##.cal, sbt340##.cal), 150 kHz (adp340##.cal, bot340##.cal).

S75exec4 and s150exec4: merged the adcp data (both files) with the bestnav (10 sec) NMFSS combined navigation imported to pstar through navexec0 (abnv3401). Ship's velocity was calculated from spot positions taken from the abnv3401 file and applied to the adcp velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv3321. Output Files: 75kHz (sur340##.abs, sbt340##.abs), 150 kHz (adp340##.abs, bot340##.abs).

3.2.5 75 kHz and 150 kHz VM-ADCP calibration

A calibration of both VM-ADCPs was achieved using bottom tracking data available from our departure from Reykjavik across the Icelandic continental shelf. No further calibration was deemed necessary from inspection of the processed data during the cruise. Using long, straight, steady speed sections of standard two minute ensemble profiles over reasonably constant bottom depth the following calibrations for mis-alignment angle, φ, and necessary amplification (tilt), A, were derived by comparing GPS derived component vectors of the vessel speed and direction with processed VM-ADCP bottom track determined component vectors of the vessel speed and direction:

	φ	**A**
150 kHz		
mean	1.531531289	1.001492999
s.d	0.126527906	0.002441841
75 kHz		
mean	0.03462772	1.001979978
s.d.	0.14342535	0.002759036

Both of these calibrations were somewhat different to those obtained on D332, but RRS *Discovery* had been in dry-dock refit over the intervening winter, and, although it was not thought that the ADCPs had been removed on this occasion, it is not unreasonable that some rotation of order 1-1.5 degrees might have occurred as a result of the general upheaval of such a procedure.

3.3 Results and Discussion

Initial data inspection included two stages. At the first stage absolute velocity vectors at selected depths, **41 m** (75 kHz), and **23 m** (150 kHz) were averaged in 4 km regular grid and plotted along the ship track. Visual comparison of these plots allowed rough assessment of the data consistency. An example of such plot is shown in Fig.3.

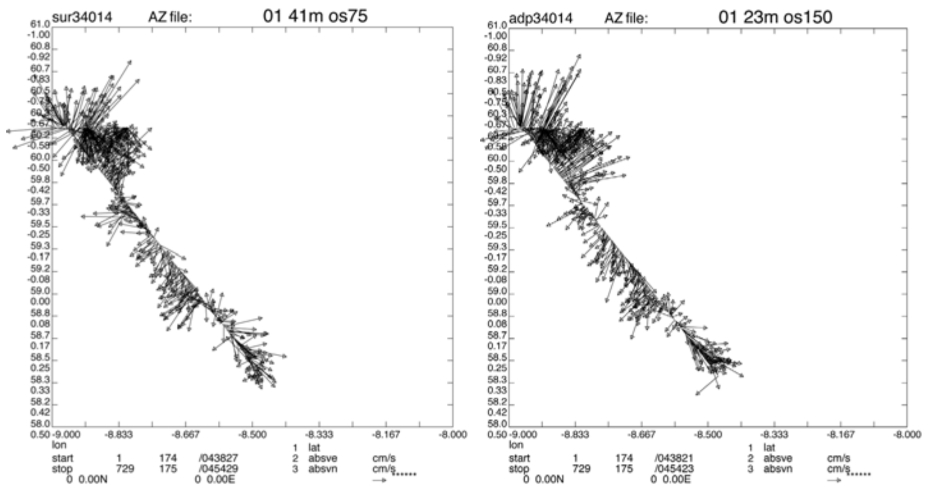


Figure 3.3. Absolute velocity vectors for 2 minutes ensemble average

At the second stage the 4km-average data were additionally processed with the purpose to obtain horizontal and vertical velocity distributions to be compared with geostrophic velocity and other relevant oceanographic parameters (temperature, salinity etc).

Normal velocity component was calculated at the straight line sections along the ship track: *A*, *B*, *C* and *D* as shown in Fig.3.3.

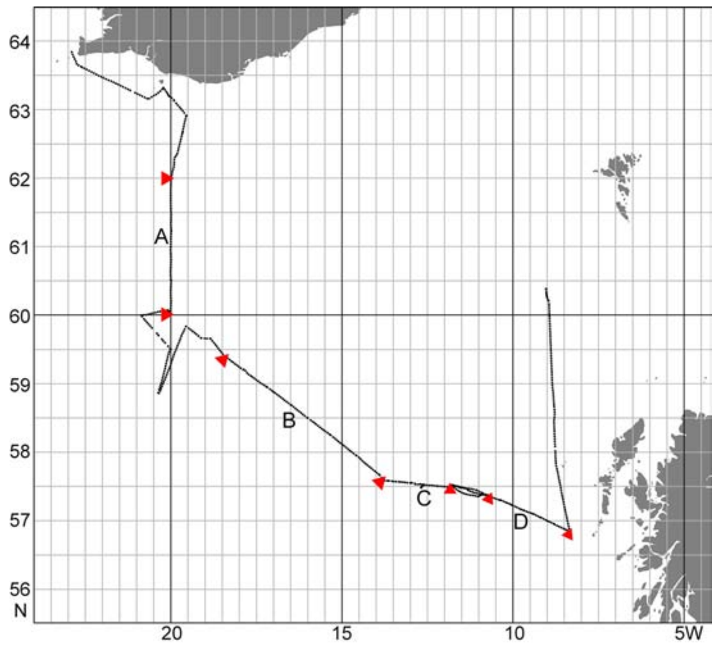


Fig. 3.3 Location of sections for normal velocity component calculation

Distribution of the normal velocity component is shown in Fig.3.4. Several relatively narrow stripes (~25-30 km in width) representing strong currents are distinguished at this plot. These narrow jets are embedded in the wider zones (~ 80-100 km) with slower currents of the same direction. The highest positive (north-eastward) velocity (~ 70 cm/s) is observed at the western side of Rockall trough. The highest negative (south-westward) velocity (~ 50 cm/s) is observed at the eastern flank of the Rockall bank. In general, barotropic component seems to dominate in the vertical current structure. However, contribution of baroclinicity might be quite substantial in the upper 200-300 m of the water column where noticeable vertical shear is present.

To characterize the spatial pattern of currents in the upper ocean, velocity components were averaged over the layer 50-150 m and resultant vectors were plotted along the ship track as shown in Figs 3.5 and 3.6.

The presence of narrow opposite directed jets, which may also be a manifestation of eddies, as, for instance, around 60ºN and 61ºN, is evident at these plots. Strong currents over the slope areas: Rockall bank, Scottish shelf break coincide in magnitude and direction at both devices and are consistent with what may be expected. Existence of the strong south-eastward currents at the southern Iceland shelf, following from the Fig. 3.5 (between 63º and 64º N), is questionable, since in the shallow water 75 kHz device is less reliable and these strong currents are not confirmed by the 150kHz ADCP (see Fig.3.6).

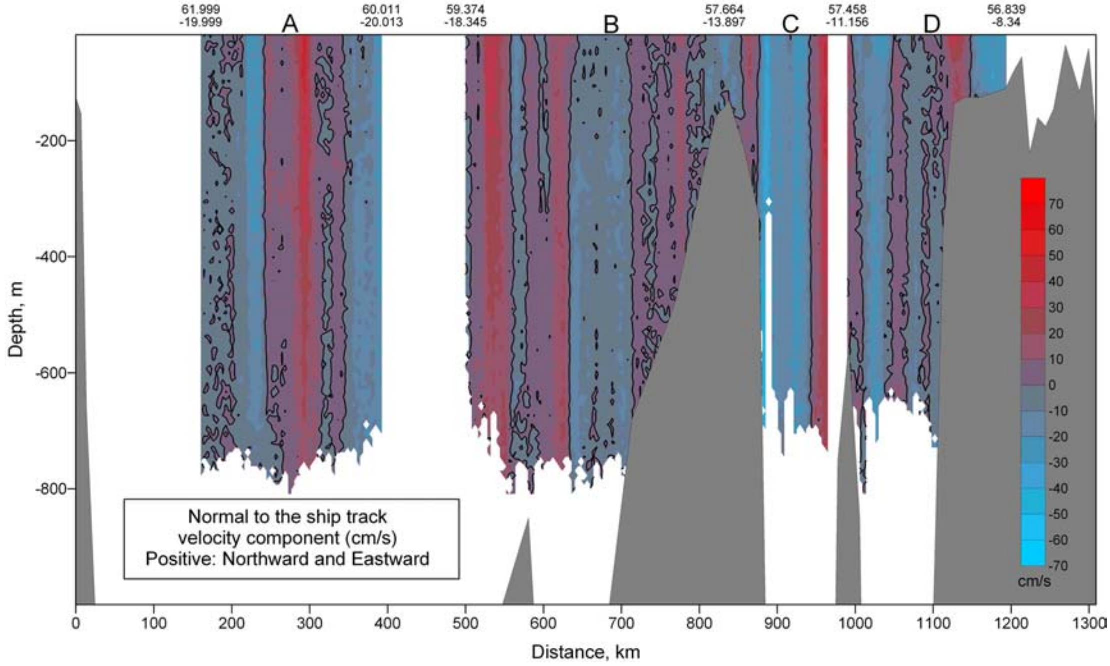


Fig.3.4. Normal to the ship track velocity component. Positive direction: inside the plot. Black lines denote zero velocity contour. ADCP-75 kHz, 4 km spatial average

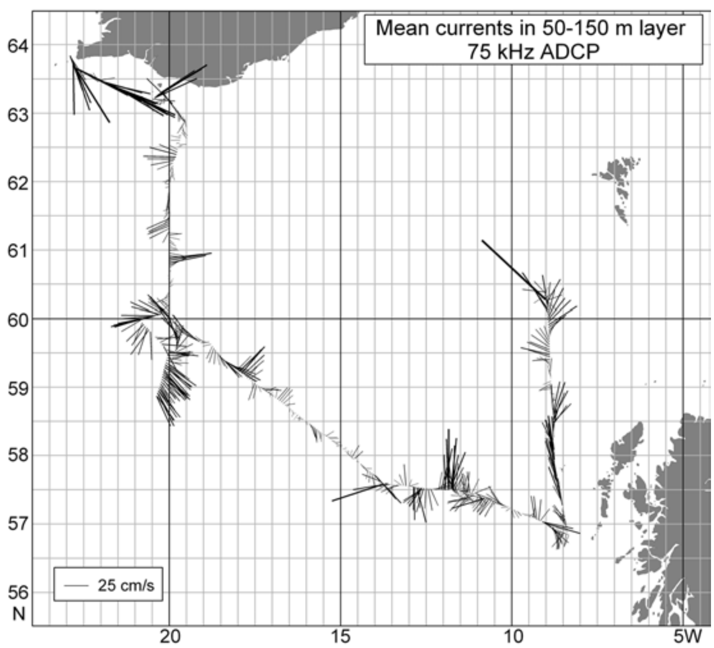


Figure 3.5. Mean currents in the upper 50-150 m layer. ADCP-75 kHz, 4 km spatial average

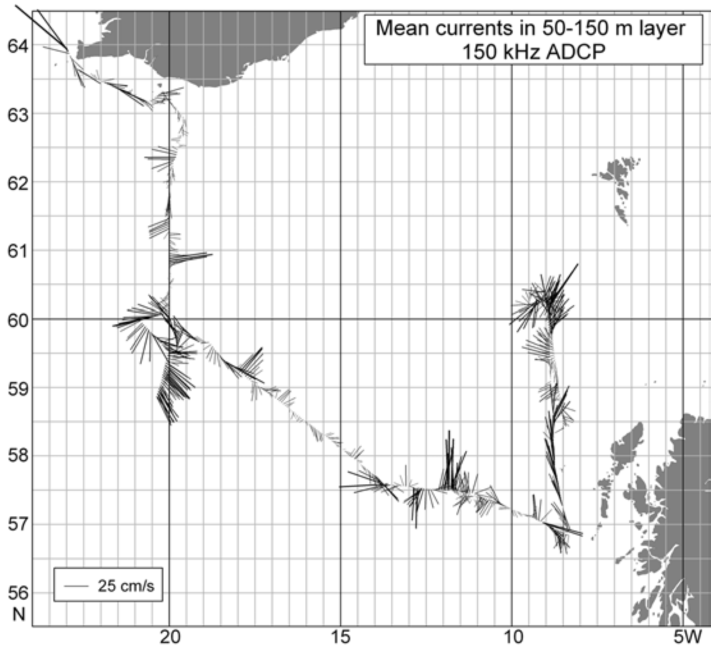


Fig. 3.6. Mean currents in the upper 50-150 m layer. ADCP-150 kHz, 4 km spatial average

3.4 Data files

The processed data can be found in the following files on the data discs. The description applies to both legs of the cruise (D340a and D340b).

3.4.1 OS75 files

sbt34001.ascii - bottom tracking file (N/A for D340a)

sur340tt.ascii - complete (no spatial interpolation) data from the OS75 (both legs)

sur340tt_4km_3006.ascii - 4 km interpolated data from the OS75 ending on 30.06 (both legs)

sur340tt4km.ascii - 4 km complete interpolated data from the OS75 (both legs)

3.4.2 OS150 files

adp340_2km_0307.ascii - 2 km complete interpolated data from the OS150 (both legs)

adp340tt.ascii - complete (no spatial interpolation) data from the OS150 (both legs)

adp340tt_0307.ascii - complete (no spatial interpolation) data from the OS150 (both legs). This is probably the same as adp340tt.ascii without the last day.

adp340tt_2km_3006.ascii - 2 km interpolated data from the OS150 ending on 30.06 (both legs)

adp340tt_4km_3006.ascii - 4 km interpolated data from the OS150 ending on 30.06 (both legs)

adp340tt4km.ascii - 4 km complete interpolated data from the OS150 (both legs)

bot34001.ascii - bottom tracking file (N/A for D340a)

Files adp340tt_0207_xt.ascii (N/A) and adp340tt_0307_xt.ascii (N/A) are not available.

4 CTD report

Toby Sherwin (PI), Estelle Dumont and Marie Porter

Fig. 4.1 The stainless steel CTD frame with its rosette of 24 20 litre Niskin bottles, and occasional onlookers.

4.1 Introduction

A total of 88 CTD casts were conducted during the cruise, with 79 using the stainless steel frame and 7 using the titanium frame. Both CTDs appeared to function satisfactorily, but since the titanium frame does not have a lowered ADCP there are some gaps in the velocity data. In addition a mistake with the settings on the LADCP meant that there are no velcotieis for the first 9 stations.

4.1.1 Objectives

CTD casts were undertaken with the objective of

1. Defining water mass characteristics between the sea surface and the sea bed from their temperature, salinity and dissolved oxygen characteristics
2. Estimating the heat content and mean salinity of the 'surface' waters along the Ellett line between Iceland and Scotland
3. Determining the full depth buoyancy frequency near the Wyville Thomson Ridge
4. Defining the depth of the near surface chlorophyll maximum from fluorescence measurements for subsequent biological sampling from water bottles

4.1.2 Methodology

Two CTD systems were used during the cruise, one housed in a standard stainless steel (SS) frame, and the other housed in a titanium (Ti) frame. Both CTDs were equipped with dual T and C sensors, SBE43 oxygen sensor, Chelsea Aqua 3 fluorometer, altimeter and Chelsea/Seatech/Wetlab CStar transmissometer. On the first Titanium cast dual Biospherical/Licor PAR/irradiance sensors were also installed.

The T and C sensors located on the vane should be used as primary sensors, however appear labelled as secondary in the dataset (t1, cond1, sal1, etc). Similarly the sensors inside the frame, which should be treated as secondary, are labelled as primary (t0, cond0, sal0, etc).

Twenty-four Niskin 20 litres bottles were fitted on the SS frame carousel until CTD020 (station IB5), then replaced by 10 litres bottles until the end of the cruise. The Ti frame carousel carried twenty-four 10 litres bottles.

The CTD was operated by trained NMFSS technicians throughout the cruise who oversaw all aspects of CTD operations from preparing the bottles to monitoring its performance during a cast to maintaining it on deck. Regular watch keepers from the scientific staff collected samples for salinity and helped with other water sampling as required.

4.2 Data processing

Estelle Dumont, SAMS

The CTD data were processed according the common standards, using Seabird Data Processing version 7.17 (part of the Seasoft-Win32 suite) and Matlab R2007a. The processing steps were:

- Step 1(SBE Data Processing, batch processing): modules Data Conversion, Wild Edit, Align CTD, Cell Thermal Mass, Filter, Derive, Translate and Bottle Sum.
- Step 2 (Matlab): despiking of the 24Hz data
- Step 3 (SBE Data Processing, batch processing): modules Ascii In, Loop Edit, Bin Average (2db-bins), Bin Average (1s-bins, for LADCP processing purposes only) and Ascii Out
- Step 4 (Matlab): plot of the data
- Step 5 (Matlab): calibration of oxygen and salinity data on both 24Hz and 2db-bin averaged datasets (post-cruise).

4.2.1 Raw data processing (SBEDataProcessing)

Data Conversion converted raw data from engineering units to binary .cnv files and produced the .btl files. Variables exported were scan number, pump status, Julian day, latitude [deg] longitude [deg], pressure [db], temperature1 [ITS-90, deg C], conductivity1 [mS/cm], temperature0 [ITS-90, deg C], conductivity0 [mS/cm], oxygen [mg/l], beam attenuation [1/m], altimeter [m], fluorescence on [ug/l], beam transmission [%] and depth [m].

Please note:

The primary TC sensors were labelled 1, secondary 0.

The depth exported here was only for indicative purposes in the bottle files. Accurate depth calculation was performed at the Derive stage, and this first depth removed in processed files.

Wild Edit detected and removed the major spikes in the data. Wild Edit's algorithm requires two passes through the data: the first pass removed data points over 2 standard deviations of a 100 scans average, while the second pass removed the data over 20 standard deviations of a 100 scans average.

AlignCTD was then run to compensate the oxygen sensor response delay, relative to pressure (+3s applied here). This ensures that calculations of dissolved oxygen concentration are made using measurements from the same parcel of water.

In **Cell Thermal Mass**, a recursive filter was ran to remove conductivity cell thermal mass effects from the measured conductivity. The constants used were the ones given by Seabird: thermal anomaly amplitude α=0.03 and thermal anomaly time constant $1/\beta$=7.

Filter applied a low-pass filter (value of 0.2) on the pressure data, which smoothed the high frequency (rapidly changing) data. To produce zero phase (no time shift), the filter was first run forward through the data and then run backward through the data. This removed any delays caused by the filter.

At the **Derive** stage, twin density sigma-theta (kg/m3), twin salinities (psu) and depth (m) were calculated.

The data was converted from binary to ASCII format by the module **Translate**. The data had been kept in binary format up to this stage to avoid any loss in precision that could occur when converting to Ascii.

Finally, the module **BottleSum** created the ASCII bottle files (.btl) for each bottle fired during a cast. These files contain mean, standard deviation, maximum and minimum values for all variables (average of 48 scans, i.e. 2s).

4.2.2 Despiking (Matlab)

The pressure, oxygen, temperature (primary and secondary) and salinity (primary and secondary) data were manually despiked (using the function Scrollingplot). Any data recorded while the pumps were not on were deleted at this stage.

Notes on the despiking:

- When a spike occurred in the pressure, temperature or salinity data, making that/those point(s) flagged as bad, the whole corresponding scan has been deleted.

- When a spike occurred in the oxygen data, making that point flagged as bad, the erroneous value was set to NaN, and other variables of the scan (i.e. temperature, salinity, etc) were kept in the dataset (if not flagged as bad themselves).

Figures 4.2 and 4.3 show an example from Sta. IB12 (Cast 13) of a CTD profile at 24 Hz before and after despiking.

4.2.3 Averaging (SBEDataProcessing)

After going through Matlab, the data files needed to be re-formatted to be recognised by SBE Data Processing. **ASCII In** added a header to the input .asc file and output a .cnv file (XXX_2.cnv).

The module **Bin Average** averaged the 24Hz data into 2db-bins, using the downcast data only. Some 1s-bin averaged were also produced (up and downcast data), used for the LADCP processing.

Ascii Out output the bin-averaged data files as ASCII (with a simplified header).

4.2.4 Plotting (Matlab)

Plots of the 24Hz raw data, 24Hz despiked data and 2db-bins despiked data were produced for the following variables: temperature, conductivity, salinity, density, oxygen, fluorescence, transmittance vs pressure; and salinity difference*, conductivity difference* and salinity difference* vs scan or time (* between primary and secondary sensors).

For the 2db-bin averaged data, the following plots were also produced: potential temperature vs pressure and salinity vs potential temperature (see Fig. 4.4).

4.2.5 Comments:

The dual temperature and conductivity measurements (on both frames) were in agreement throughout the whole cruise, except for a few casts where the secondary sensors (inside the frame) appeared to be delayed by 1 or 2s compared to the primary sensors (on the vane) in areas of sharp change in values.

There were some "noisy" sections of data, generally during the upcast, during bottle firings and in the thermocline zone.

Finally, the transmissometer on the Ti frame appeared to have a questionable calibration, and its data should be treated carefully.

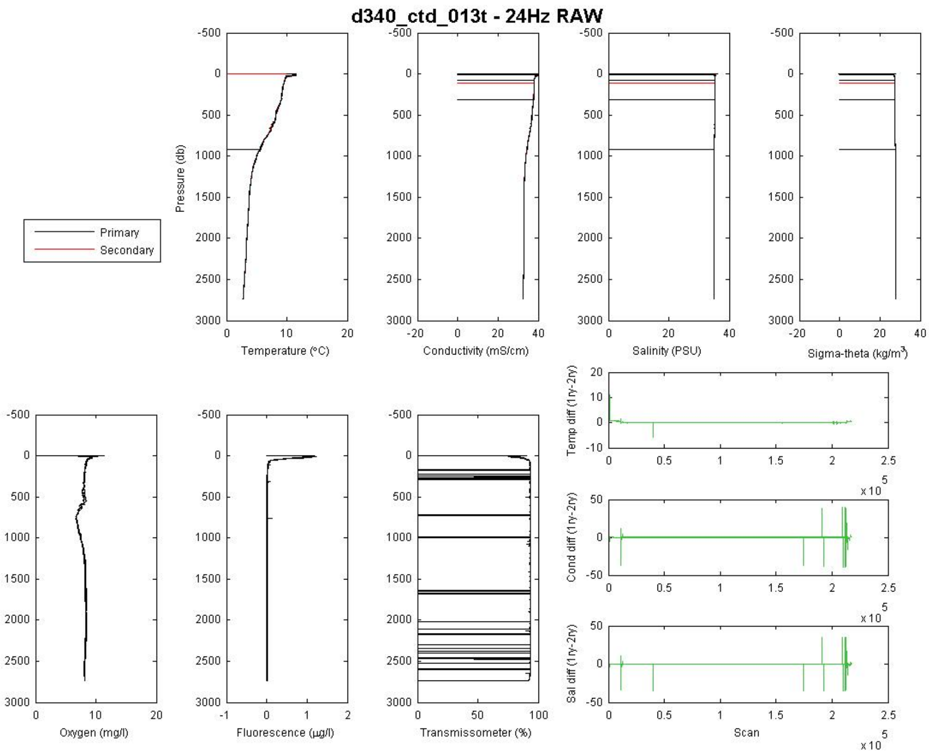


Figure 4.2. The CTD profile at Sta. IB12 before despiking.

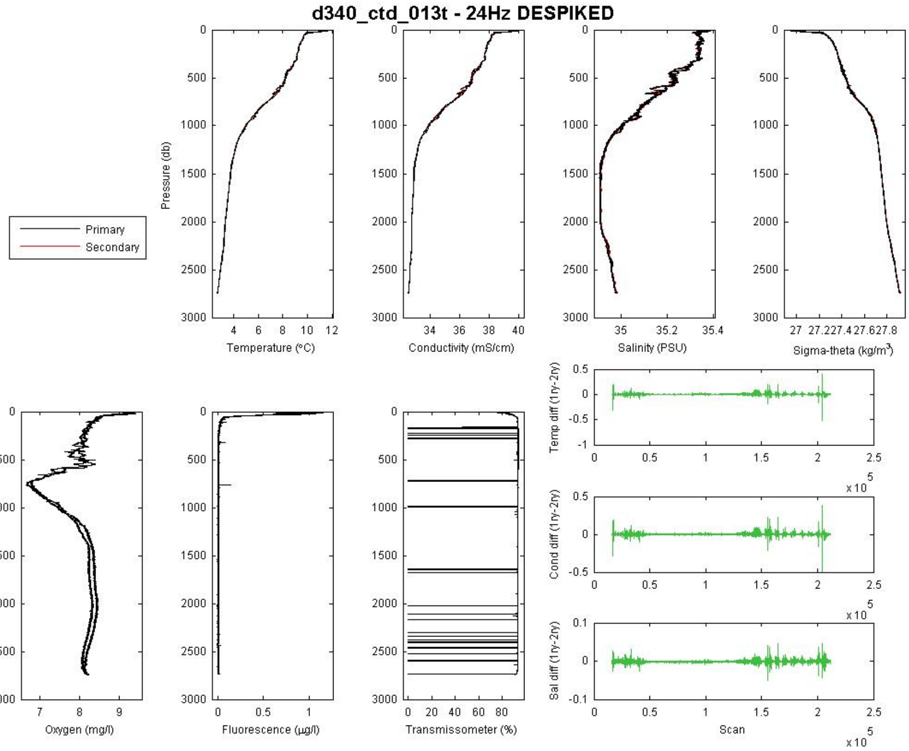


Figure 4.3. The CTD profile at Sta. IB12 after despiking.

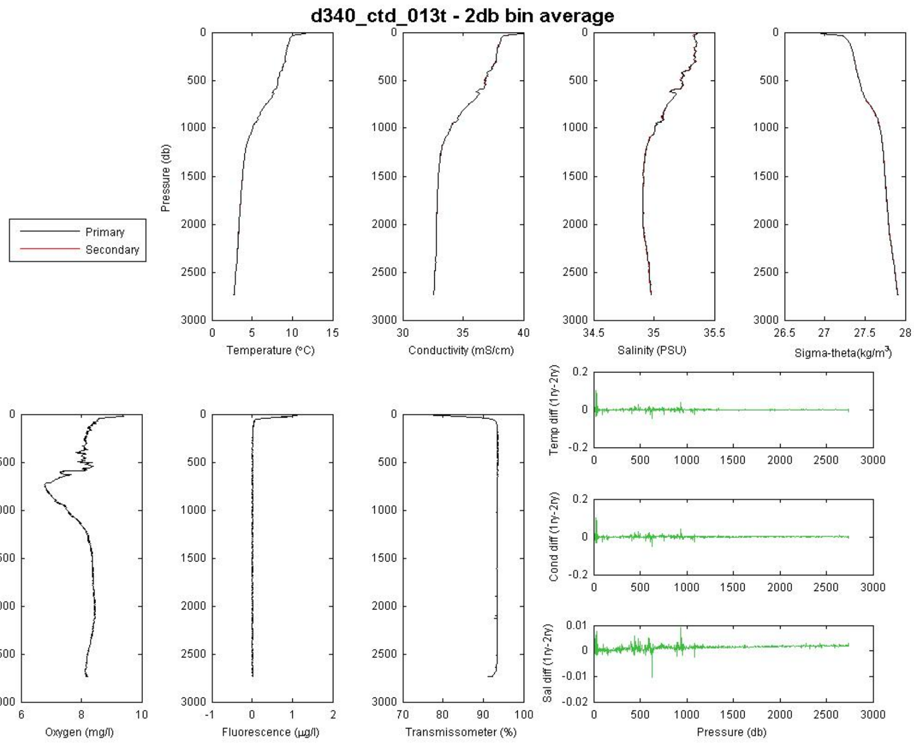


Figure 4.4. The CTD profile at Sta. IB12 bin averaged to 2 db intervals.

4.3 *CTD data summary*

(Marie Porter and Toby Sherwin)

4.3.1 Introduction

A summary of the main CTD observations has been undertaken on the cruise using the despiked uncalibrated data. Nearly all the planned CTD stations along the Extended Ellett Line were undertaken, with the exception of Sta. 15G, and three new stations were added, Sta. IB22X, a titanium frame cast on the Iceland Shelf, and Stas IB11A and IB4A in the Iceland Basin and on the Rockall Hatton Plateau.

The pre-calibrated Extended Ellett Line CTD data were smoothed over 25 m in the vertical and then imported into Surfer and gridded using the standard Krigging routine before plotting (see Table 4.1). The horizontal ranges are in ‘pseudo kilometres’ (pkm) from IB23S. The term ‘pseudo kilometre’ has been used because late on in the processing of the CTD data it was realised that an algorithm to convert latitude and longitude has been incorrectly implemented (latitudes and longitudes had been reversed). Since the plots are of uncalibrated data it was not considered necessary to correct the range for this cruise report, but it should be noted that the ranges and distances quoted in this section are incorrect and should not be compared with other section plots in the report.

Region	Stations	Range (pkm)	Depth range (m)	Horizontal grid points	Vertical gridpoints	Horizontal length (cm)	Vertical length (cm)
Iceland Basin	IB23S – IB6	0-750	0-2700	28	66	14	5.5
Hatton Bank to Rockall	IB9 - F	650-1360	0-1900	28	66	14	5.5
Rockall Trough	A-T	1150-1750	0-2300	28	66	14	5.5

Table 4.1 The plotting parameters of the contour plots

4.3.2 Water masses

The definitions of the major water masses in the Iceland Basin and Rockall Trough are given below for reference here and with the nutrient data elsewhere.

	Potential temperature θ ° C	Salinity S	Dissolved oxygen O_2 µmol kg^{-1}	Silicate Si µmol kg^{-1}	Nitrate NO_3 µmol kg^{-1}	Phosphate PO_4 µmol kg^{-1}
Labrador Sea Water, LSW	3-3.5	34.8-34.9	270 -280	11 - 12	16.1 - 17.0	~1.2
Northeast Atlantic Deep Water, NEADW	2-3	34.95-35.0	270 -280	13 - 17	15.0 - 16.0	1.1 - 1.2
Iceland-Scotland Overflow Water, ISOW	2.7 - 2.9	~ 34.92	275 -280	12 -13	15.9 - 16.0	0.9 - 1.1
Northeast Atlantic Water, NEAW	8-10	~35.3	265 -270	3 - 6	12.5 - 13.5	0.9 - 1.0

Table 4.2. The major water masses in the NE Atlantic (from Fogelqvist *et al.*, 2003, *Deep Sea Research*, **50**, 73-102). ISOW is defined for the Irminger Basin.

4.3.3 Iceland Basin (Figs 4.6)

The surface of the Iceland Basin appears to consist of NEAW, particularly in the north of the section. Below this at a depth of around 1000m relatively cool and fresh ISOW (θ ~5º C, *S* = 35.1) can be seen travelling along the deeper part of the Iceland shelf slope. LSW appears to be present at 1500 m extending from the southern edge of the Basin. A gradient can be seen in both temperature and salinity across the surface of the section with cold, fresh water θ = 8-10° C, S = 35.26 psu being seen in the north (100pkm) and warm, saline water in the south (600pkm) θ = 9-12.5° C, S = 35.3 psu. What appears to be an anticyclonic, cold core eddy is visible in the range of 250 - 300 pkm. Dissolved oxygen levels reflect this distribution in the upper and lower parts of the water column. There is however a minimum between approximately 500m and 1000m depth. This extends throughout the entire basin but is much more pronounced in the south.

4.3.4 Hatton - Rockall Plateau (Figs 4.7)

The surface waters across the Hatton Basin and Rockall are noticeably warmer θ = 10-12° C and saltier S = 35.34 – 35.38 psu than the Iceland Basin. However patterns that are seen in the surface waters further north are continued through this section; the northern surface waters of the Hatton Basin are colder and fresher than the southern. The section of low dissolved oxygen continues through the basin and is consistent at either side of both the Hatton Bank and Rockall. The low does however extend deeper in this section than in the Iceland Basin (1500m).

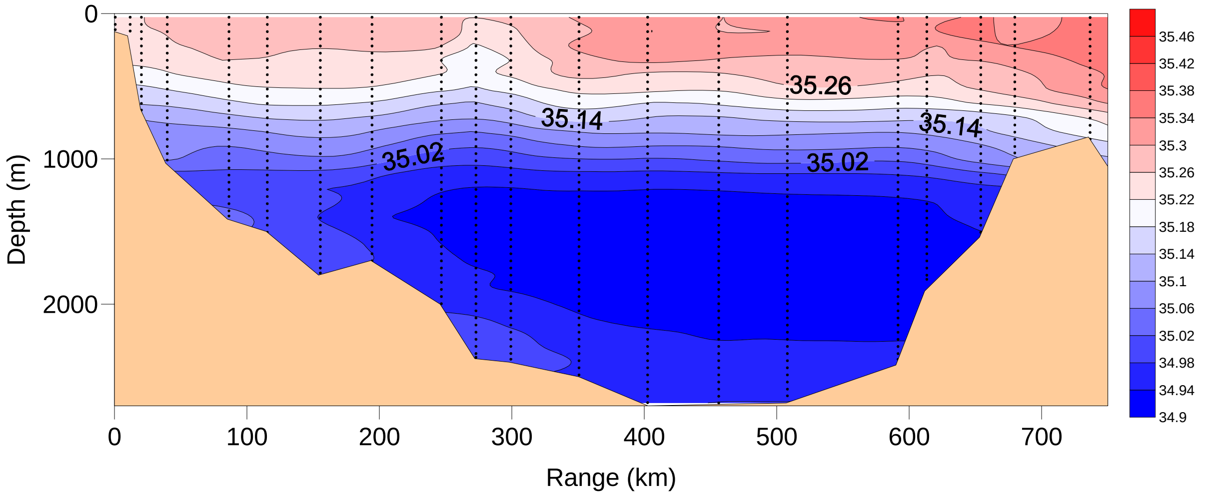
4.3.5 Rockall Trough (Figs 4.8)

The Rockall Trough appears to be consistently stratified throughout the section, with relatively uniform temperatures and salinities running west to east. The salinity minimum of between 39.1 psu at around 1750m Fig. 4.9 is indicative of LSW in the area, particularly on the eastern side of the Anthon Dorn. Higher levels of mixing also appear to be present on the western side as seen on the salinity/potential temperature profiles. Dissolved oxygen had similar profiles at either side of the Anthon Dorn, the minimum (6.7 mg l^{-1}) however was 200m lower on the western side (CTD 32) at 800m (Figs 3 and 4). Both temperature and salinity are also offset across the Anthon Dorn, for example at 1200m the temperature at CTD32 was 0.4°C warmer than the same depth on CTD39 on the eastern side (Fig. 5).

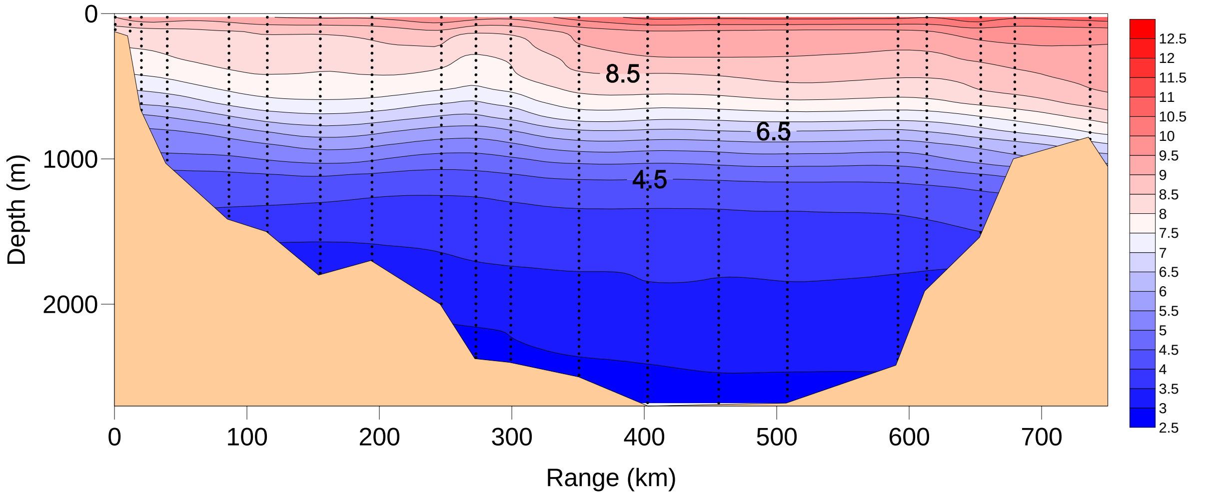
An analysis of

Fig. 4.5

Inside the winch control room with winchman Ian Mills



Temperature (°C)



Dissolved Oxygen (mg/l)

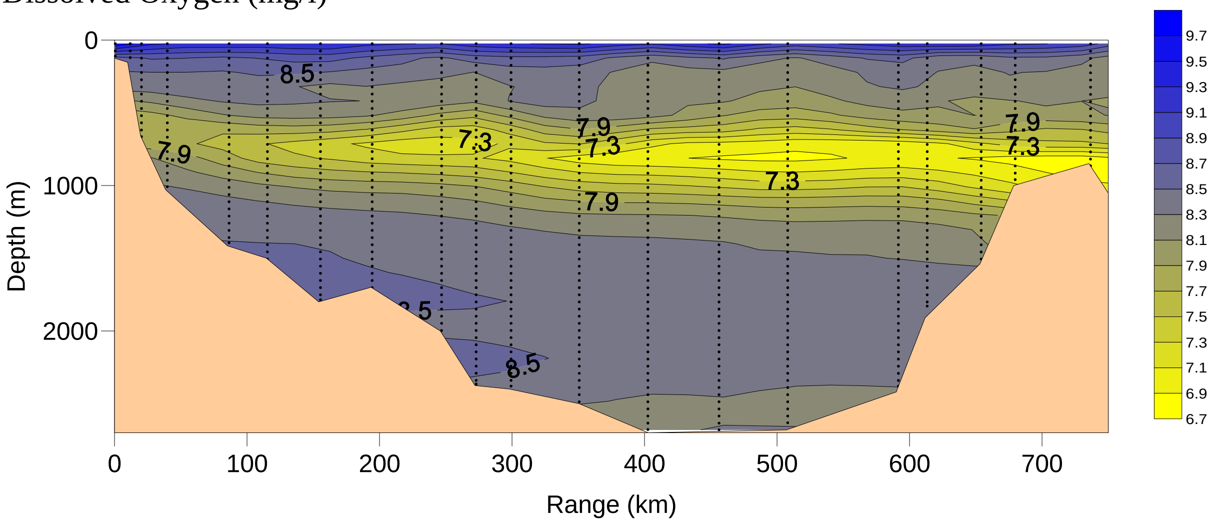


Figure 4.6. Sections across the Iceland Basin starting from the first station IB23S. Range is in pseudo kilometres. Due to the contouring method used some features may not be true and may be entirely a consequence of contouring.

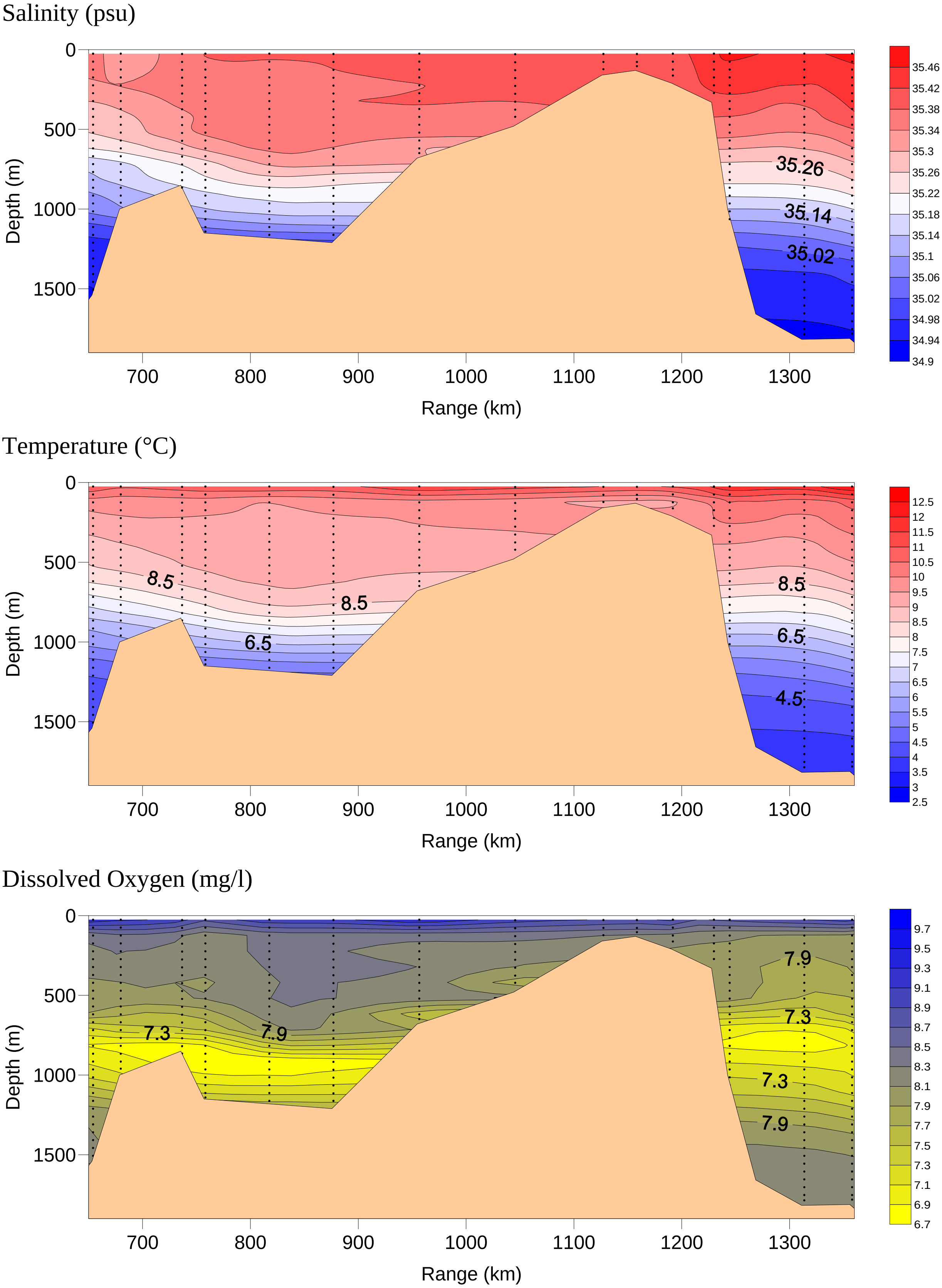


Figure 4.7. Sections across the Hatton Basin and Rockall Trough, the same cautions apply as for Fig 4.6.

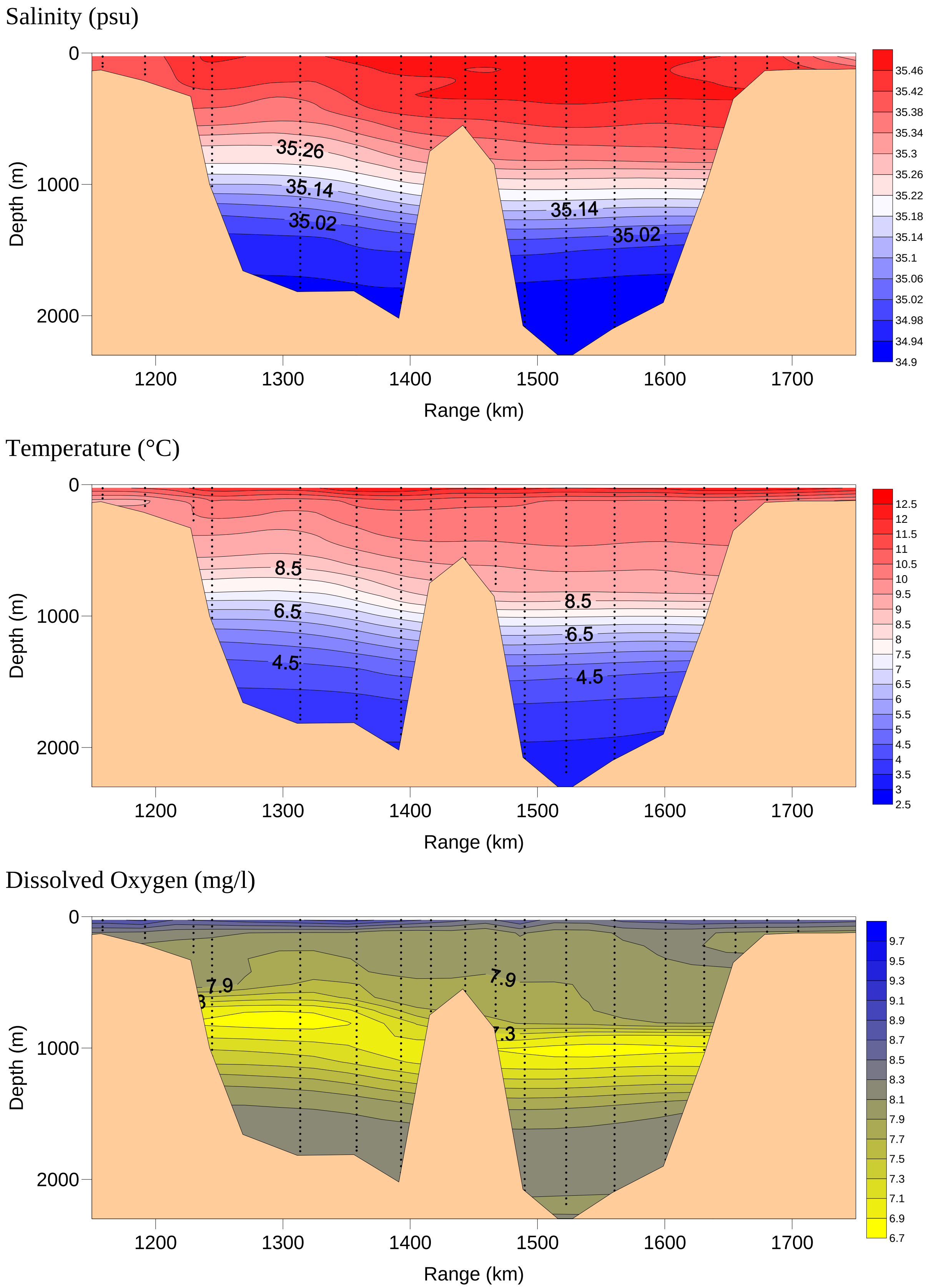


Figure 4.8. Sections across the Rockall Trough, the same cautions apply as for Fig. 4.6.

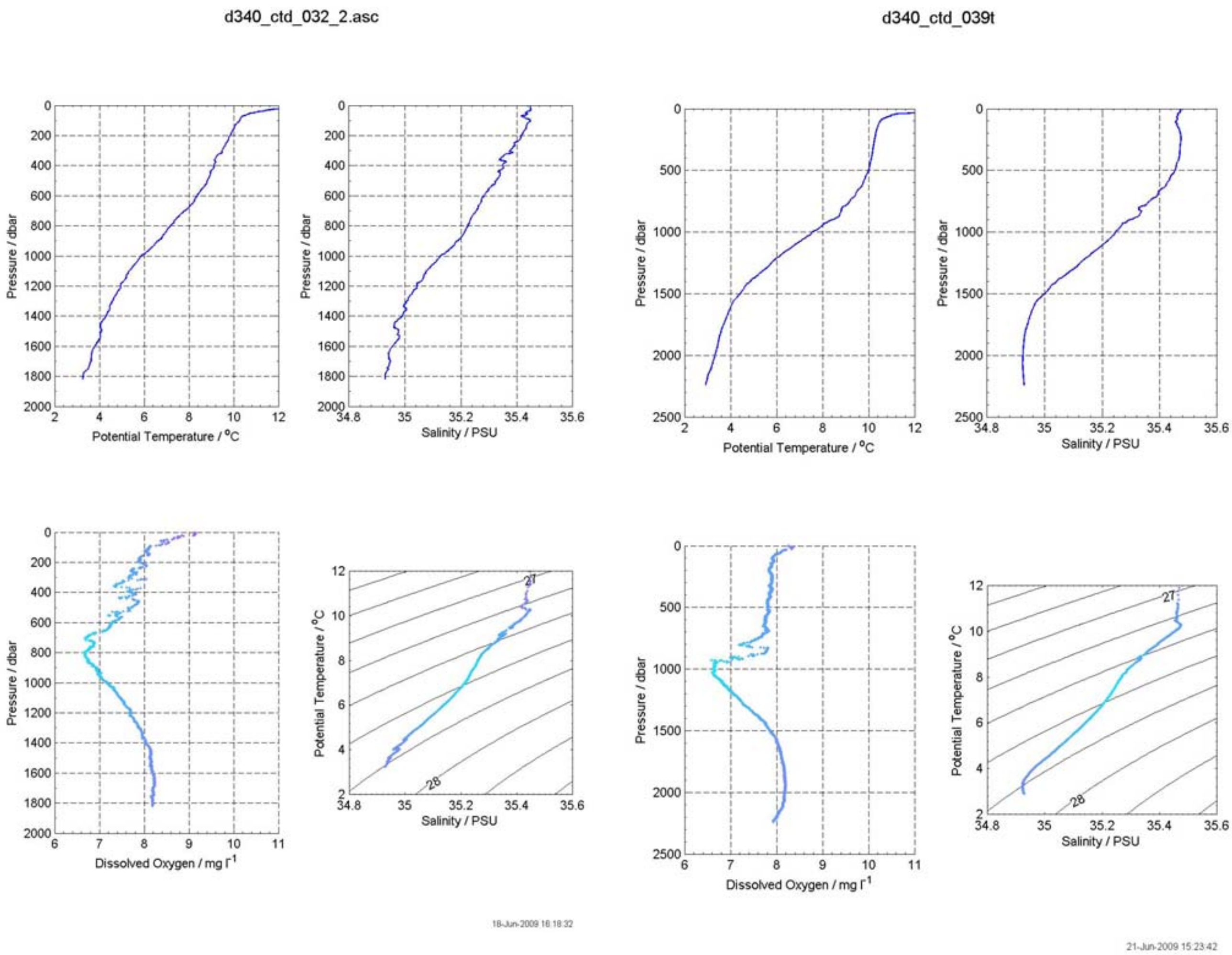


Figure 4.9. Uncalibrated profiles from CTD cast 32 (Sta. F) and CTD cast 39 (Sta. M) either side of the Anton Dohrn seamount. Note the different depth scales. The colours on the θ*S* and dissolved oxygen plots indicate the magnitude of dissolved oxygen.

5 Salinity calibration

Estelle Dumont (PI: Toby Sherwin)

5.1 CTD

Throughout the D340a cruise, salinity samples were taken from the CTD, according to the SAMS salinity calibration protocol (cf Annex X.X). However, fewer duplicate samples were taken than stated in the protocol. The samples were analysed onboard on a NMF Guildline Autosal by trained SAMS technicians.

It has been decided to split the data into two sets to calibrate the salinity data:

1. (corresponding to the first part of leg A) the oceanic waters samples from Iceland to the Scottish Shelf (Stas IB23S to T) and in the Wyville Thomson Ridge area.
2. (corresponding to the second part of leg A, and all of leg B) coastal data on the Scottish Shelf (Sta. 14G onward).

Calibration set	SS CTD	Ti CTD
Oceanic	228	43
Coastal (A+B)	57	0

Table 1. Total number of samples in the salinity calibrations

For both sets, calibration equations were calculated for both sensors on the SS frame, and for both sensors on the Ti frame for the oceanic set (no Ti casts in the coastal areas). The CTD data (from .btl files) were compared to the Autosal data and datapoints with a difference greater than 0.015 were removed (Figs 5.1 to 5.3). The remaining valid data were plotted, and calibration equations were obtained by a simple linear regression, see graphs and equations below.

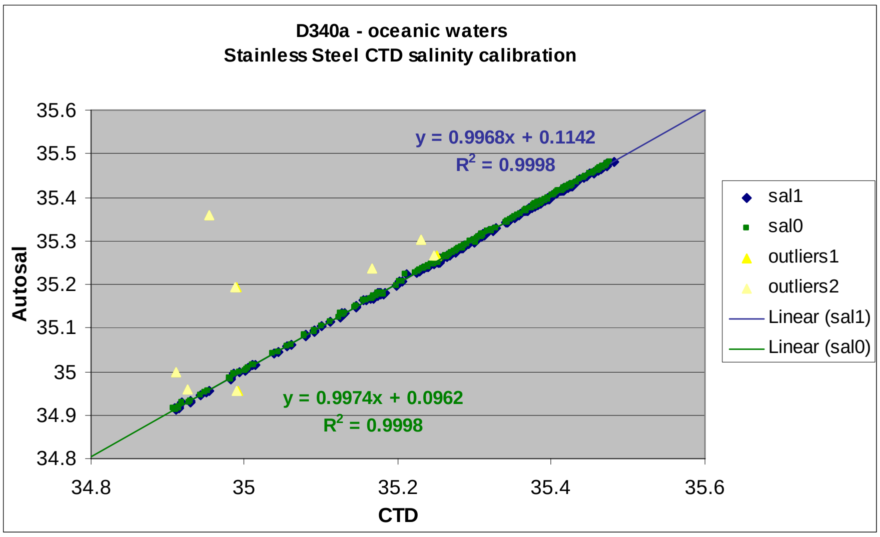


Figure 5.1 Stainless steel CTD salinity calibration in oceanic waters

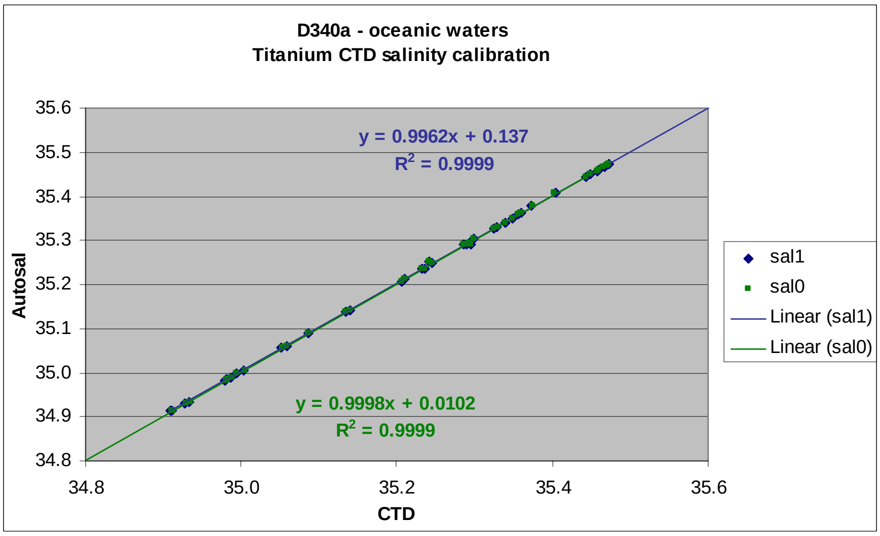


Figure 5.2 Titanium CTD salinity calibration

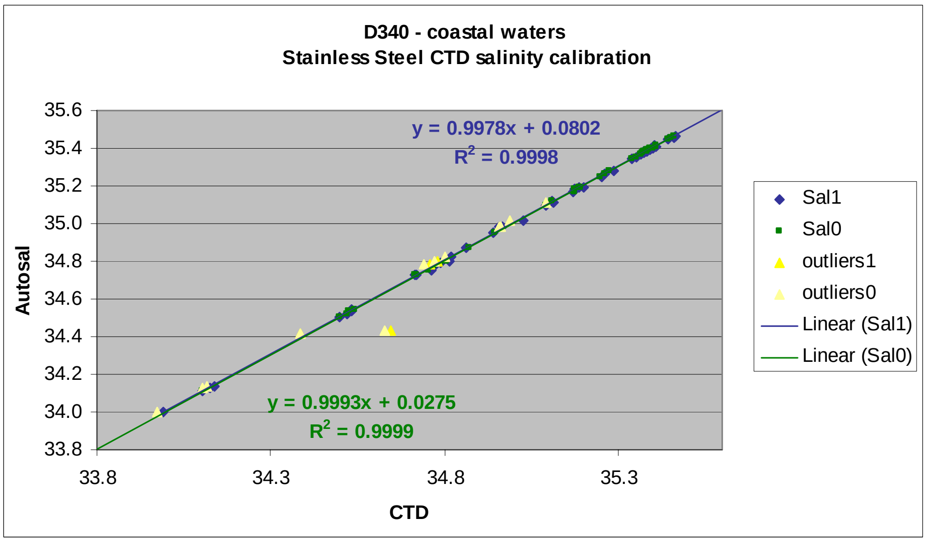


Figure 5.3 Stainless steel CTD salinity calibration in coastal waters

5.2 Underway

The underway water was sampled regularly throughout the cruise in order to calibrate the underway system salinity data. Samples were usually taken every 4 hours (except when staying on station for several hours). They were analysed onboard on the NMF Guildline Autosal. In total 115 samples were taken (including a few duplicates). For calibration, data points showing a difference greater than 0.05 between the underway sensor and the Autosal were removed. The calibration equation was obtained by a simple linear regression (c.f. graph and equation below).

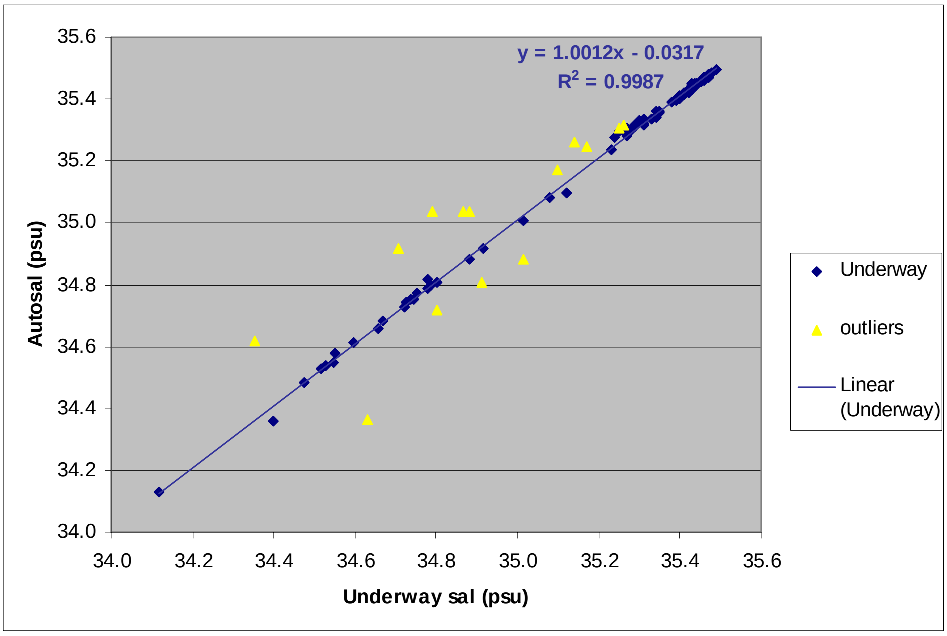


Figure 5.4. Underway salinity calibration (all waters)

5.3 Regression values

The following table summarises the definitive salinity calibrations from both legs of cruise D340 at the time of report publication. Use the SS coastal values for UK shallow waters.

System \ Variable	Salinity		Chloro	Casts number
	Salinity1	**Salinity0**		
CTD SS oceanic	y = 0.9968x + 0.1142	y = 0.9974x + 0.0962	Not done yet	≤ 73 except 2, 8, 13, 15, 21, 31, 37, 39
CTD SS coastal	y = 0.9978x + 0.0802	y = 0.9993x + 0.0275	Not done yet	≥ 73
CTD Ti	y = 0.9962x + 0.137	y = 0.9998x + 0.0102	Not done yet	2, 8, 13, 15, 21, 31, 37, 39
Underway	y = 1.0012x - 0.0317		Not done yet	/

5.4 Postscript

An alternative calibration of the oceanic salinities that follows NOCS procedures is provided below by Jane Read. Although the data will be banked with the calibrations provided in this chapter, some users may wish to apply the NOCS calibration values.

6 NOCS CTD data processing

Jane Read, NOCS (PI)

6.1 Preamble

Since D340a had both SAMS and NOCS physical oceanographers on board the cruise provided an excellent opportunity for a comparison of the ways the different laboratories conduct CTD processing calibration. Although at the time of publication no direct comparison of the resulting salinities is available, it is intended that SAMS will conduct this exercise in due course. This chapter describes the NOCS processing of the CTD data. Note however that the data banked with BODC were processed using the SAMS methodology.

6.2 Introduction

The original objective for this cruise was to test the new 'mstar' software package, however, difficulties were encountered with the setup at the beginning of the cruise and by the time they were resolved, standard processing with 'pstar' had been instigated to cope with the backlog of incoming data.

A total of 86 casts were worked during Leg 1 (Table 1), 46 casts along the Extended Ellett Line, 26 casts on the Wyville Thomson Ridge and 14 casts on the Scottish continental shelf, Line G. One station (15G) was missed in error. Of the 26 casts on the Wyville Thomson Ridge, the first 10 casts formed a north south transect across the Ellett Gully, the next 10 casts formed two intersecting sections across the Cirolana Deep and the last 5 stations were worked along the axis of the Ellett Gully.

Two CTD packages were used. Eight stations were worked with a 'clean' titanium package (casts 2, 8, 13, 15, 21, 31, 37, 39) and all remaining stations used the 'standard' stainless steel package. Both packages performed well and the processing path for both was identical. Primary temperature and conductivity sensors were fitted to the fin with secondary sensors on the main CTD sited within and at the base of the rosette.

6.3 Method

The processing path followed that of previous cruises, e.g. Poseidon 314, Discovery 306 and 321. SBE SeaSoft vn 7.18c on a PC was used for the initial stages then the data were transferred to the shipboard unix system for processing with pstar.

6.3.1 SBE SeaSoft processing

The routines DatCnv, WildEdit, alignCTD and CellTM were used in that sequence to convert the CTD data from hex to cnv format, remove spikes, align the oxygen traces and make adjustments for the thermal mass of the sensor as follows.

DatCnv was used to read in the raw data from the D340_CTD_NNN.hex file, converting engineering units using the coefficients in the D340_CTD_NNN.CON file. Scan durations was 0.026, oxygen was calculated with a window size of 2 seconds, Output consisted of an ascii D340_CTD_NNN.cnv file and the D340_CTD_NNN.ros file. The latter contained the data scan at the time each Niskin bottle was fired.

WildEdit despiked the data by scanning twice and flagging as bad all values that were outside 1 standard deviations of 10 scans on the first pass and 2 standard deviations on the second pass. Data were output to files D340_CTD_NNN_ed.cnv

AlignCTD was used to shift the oxygen sensor relative to the pressure and temperature sensors by 3 seconds to compensate for lags in the sensor response time. Manual checking on a selection of profiles suggested that no corrections were needed on the deep (>1500 m) profiles, when features on down and up casts were well-aligned on pressure. However, the misalignment in pressure on shallower casts (<1200 m) was improved by the 3 second adjustment. For consistency, and because the majority of casts were 1800 m or less, an alignment of 3 seconds was used throughout. Output was written to files D340_CTD_NNN_align.cnv

CellTM adjusts for the effect of thermal 'inertia' on the conductivity cells. It should be noted that this routine must be run only after editing or despiking of bad data values. The routine uses the temperature variable to adjust the conductivity values and if spikes exist in the former, they are amplified in the latter. The algorithm used was:

$$dt = t_i - t_{i-7}$$
$$ctm_i = -b * ctm_{i-7} + a * \partial c \partial t * dt$$
$$c_{cor,i} = c_{meas,i} + ctm_i$$
$$a = \frac{2\alpha}{7\Delta * \beta + 2}$$
$$b = 1 - {}^{2a}\!/_{\alpha}$$
$$\partial c \partial t = 0.8 * (1 + 0.006 * (t_i - 20))$$

where α, the thermal anomaly amplitude was set at 0.03 and β, the thermal anomaly time constant was set at 1/7, the SeaBird recommended values for the SBE911+ pumped system. The sample interval Δ was 1/38 seconds, dt was the temperature (t) difference taken at a lag of 7 sample intervals. $c_{cor,i}$ was the corrected conductivity at the current data cyc (i), $c_{meas,i}$ was the raw value as logged and ctm_i was the correction required at the current data cycle, $\partial c \partial t$ was a slowly varying function of the temperature deviation from 20°C.

6.4 Pstar processing

CTD data were treated in a set of 3 c-shell scripts

ctd0 read the ascii '.cnv' file into pstar binary format. Latitude and longitude, obtained from the RVS bestnav file, and water depth at the time the CTD package was at the bottom of the cast, were typed in manually and added to the header information. With a sampling interval of 0.0416667 seconds, data were written to the output file ctd340nnn.24hz .

ctd1 operated on the '.24hz' data using pmdian to remove residual spikes from all variables, then averaging the data to 1 second with pavrge. Absent data values in pressure were linearly interpolated using pintrp. Salinity and potential temperature were calculated using peos83 for both temperature and conductivity sensors, sigma0 and sigma2 (referenced to 2000 db) were calculated for the primary sensors and data were output to the file ctd340nnn.1s. A 10 second averaged file, ctd340nnn.10s, was created for merging with the ros/fir data later in the processing path.

ctd2 required manual input of the start, end and bottom data cycles of the cast. These were obtained by listing the data and scanning for appropriate data cycles that would remove the initial "soak" and time out of the water at the end. Good data, between the start and end data cycles were copied from the '.1s' file to the file ctd340nnn.ctu using pcopya. The down cast was extracted, averaged to 2db and output to the file ctd340nnn.2db .

fir0 read in the data from the '.ros' file and merged the relevant data cycles from the '.10s' file, providing a 10 second average of all CTD sensors for each Niskin bottle fired in file fir340nnn.

sam0j created a file for samples analysed from the Niskin bottles. It used pcopya to copy the 'fir' file to sam340nnn, then peditb and pintrp to create blank variables for the sample data. Variables created were botsal (salinity), botoxy (dissolved oxygen) and nutrients no2+3 (nitrate+nitrite), po4 (phosphate) and sio4 (silicate). Samples values were then added to the file manually using ppaste. Note that ammonium will also be added to the files.

6.5 Salinity / conductivity calibration

SBE application note 31 explains that offsets between the conductivity measured by the CTD sensor and conductivity obtained from samples of seawater are due to electronics drift, typically less than ±0.0001 S/m per year. Offsets greater than ±0.0002 S/m are symptomatic of sensor malfunction. Therefore correction of conductivity should assume zero offset error, unless there is strong evidence to the contrary.

Errors in salinity result from errors in the measurement of conductivity, temperature and pressure. The errors from conductivity form the greatest part of the error, and we assume that errors in temperature and pressure are corrected by laboratory calibration. Therefore we correct conductivity as follows:

$$slope = \frac{\sum_{i=1}^{n}(\alpha_i)(\beta_i)}{\sum_{i=1}^{n}(\alpha_i)(\alpha_i)} \quad \textit{(slope is typically > 1.0)}$$

where α is the CTD conductivity calculated with pre-cruise coefficients and β is the true bottle conductivity.

A total of 217 bottle samples were analysed from the stainless steel CTD package. The differences between these and the primary and secondary conductivity sensors were calculated. Where the residuals were greater than ±0.02 the sample was discounted. For the primary and secondary sensors, 12 and 17 samples were discarded respectively (residuals were more scattered for the secondary sensor).

The resulting 215 samples gave a correction for the primary sensor of:

conductivity = cond * 1.00007111

with a mean residual after correction of 0.0000 ±0.0021 (Figure 1)

The 210 samples for the secondary sensor indicated a correction of:

conductivity = cond2 * 1.00002882

giving a mean residual after correction of 0.0000 ±0.0044 (Figure 2)

From the 8 casts made with the titanium CTD package, 34 bottle samples (N) were analysed. One of these was discarded in correcting the secondary sensor.

The correction indicated for the primary sensor was:

conductivity = cond * 1.00005123   N = 34

with a mean residual after correction of 0.000 ±0.0016 (Figure 3)

and the correction for the secondary sensor was:

conductivity = cond2 * 1.00002040 N = 33

giving a mean residual after correction of 0.0000 ±0.0031 (Figure 4)

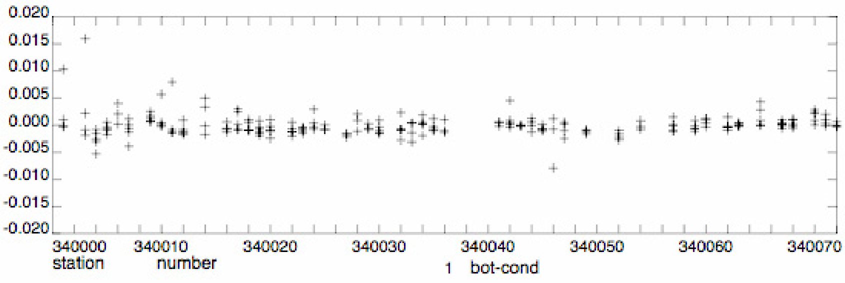


Figure 6.1. Residuals for the primary conductivity sensor on the fin of the stainless steel CTD.

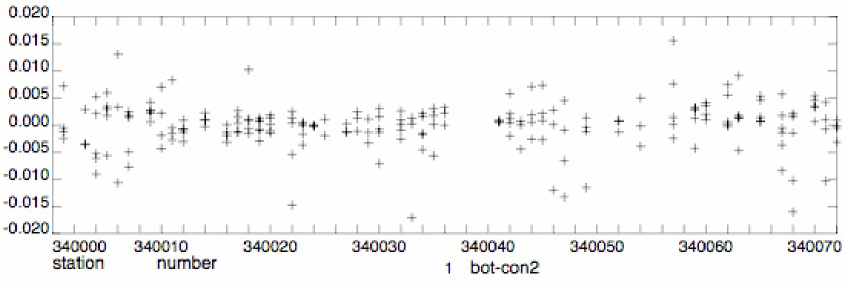


Figure 6.2. Residuals for the secondary conductivity sensor on the stainless steel CTD.

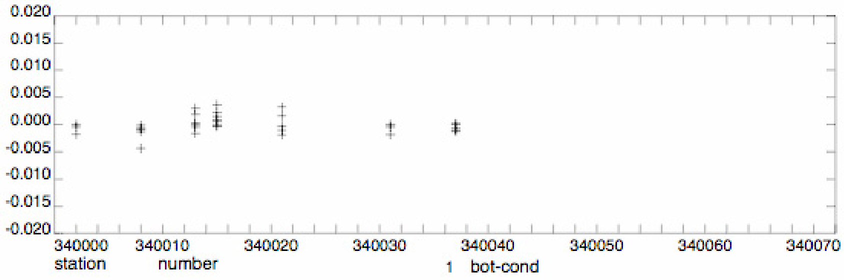


Figure 6.3. Residuals for the primary conductivity sensor on the fin of the titanium CTD.

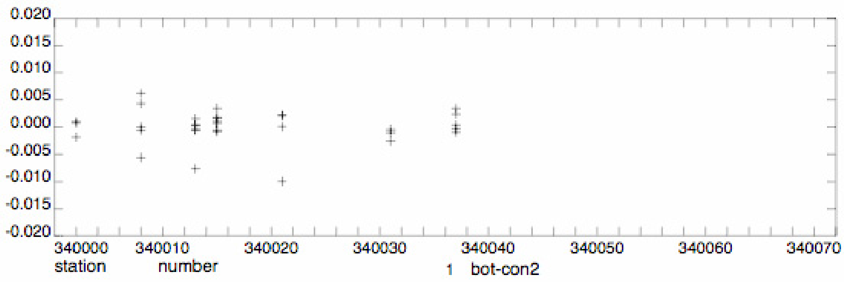


Figure 6.4. Residuals for the secondary conductivity sensor on the titanium CTD.

6.6 Results and Discussion

During the cruise and prior to the final calibrations, the cleaned up CTD down casts were gridded to 20 dbar levels by interpolation of the 2db files into sections for the extended Ellett line, across and along the Ellett Gully and across the Cirolana Deep. The results were then contoured against distance run (the extended Ellett line, Figure 5), against latitude (across the Ellett Gully, Figure 6 - left) and against longitude (along the Ellett Gully, Figure 6 - right, and across the Cirolana Deep, Figure 7). Note that distance run was calculated as the straight line distance between two points on an elliptical earth using Fischer spheroid constants. The origin of distance run was taken as the position of the first station of the section.

The contour plots were used widely during the cruise as an aid to constructing further plots, to explain the characteristics and structure of the water column and to compare with previous occupations to assess possible changes. First indications are that the Rockall Trough remains warm and salty compared to the long-term mean and that eddy activity continues to be an important feature of the Iceland Basin.

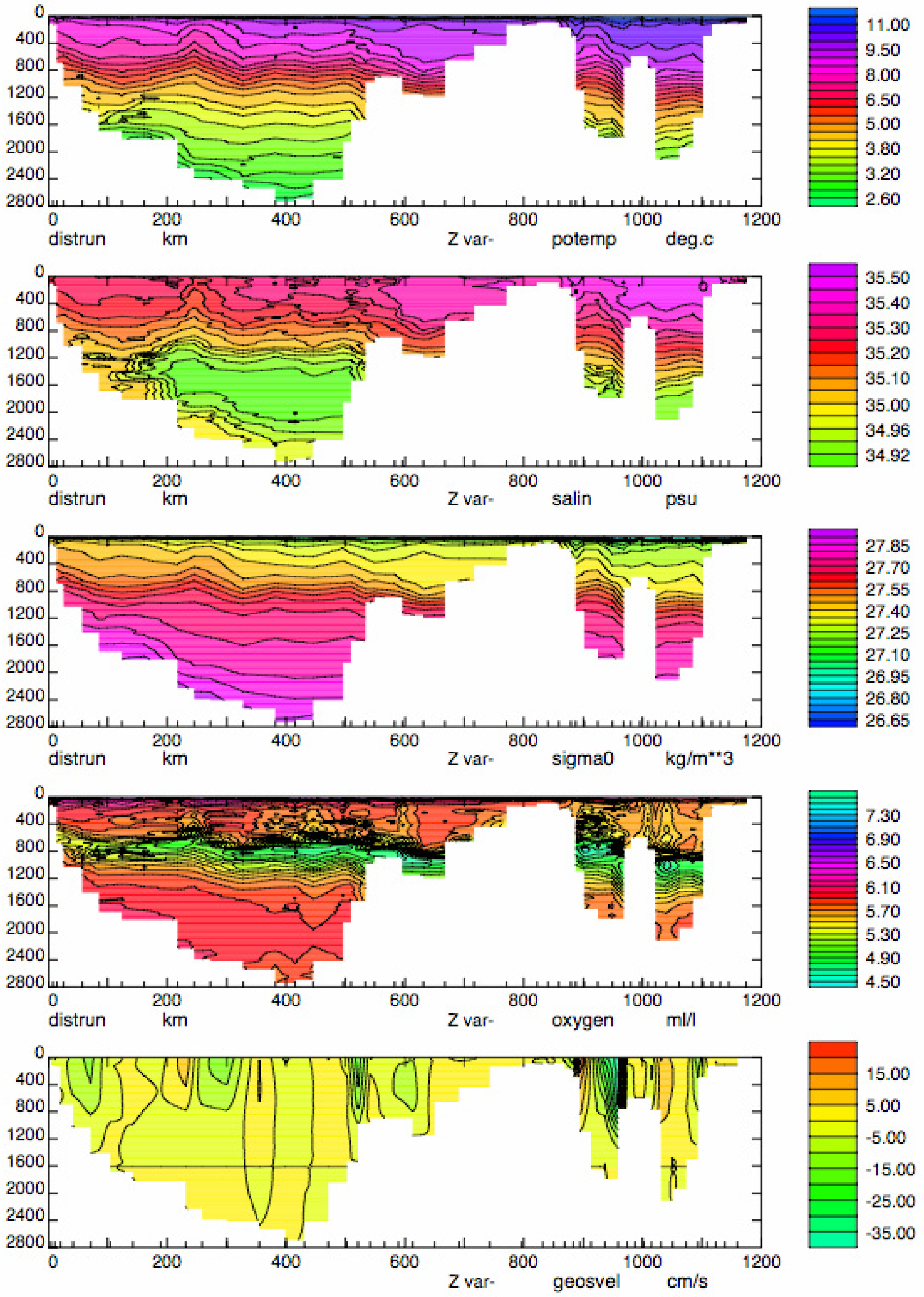


Fig.ure 6.5. Contoured sections of potential temperature, salinity, density, dissolved oxygen and geostrophic velocity along the extended Ellett line from Iceland to Scotland. Density is referenced to the surface and geostrophic velocity calculated relative to 1600 m, positive flow is out of the page.

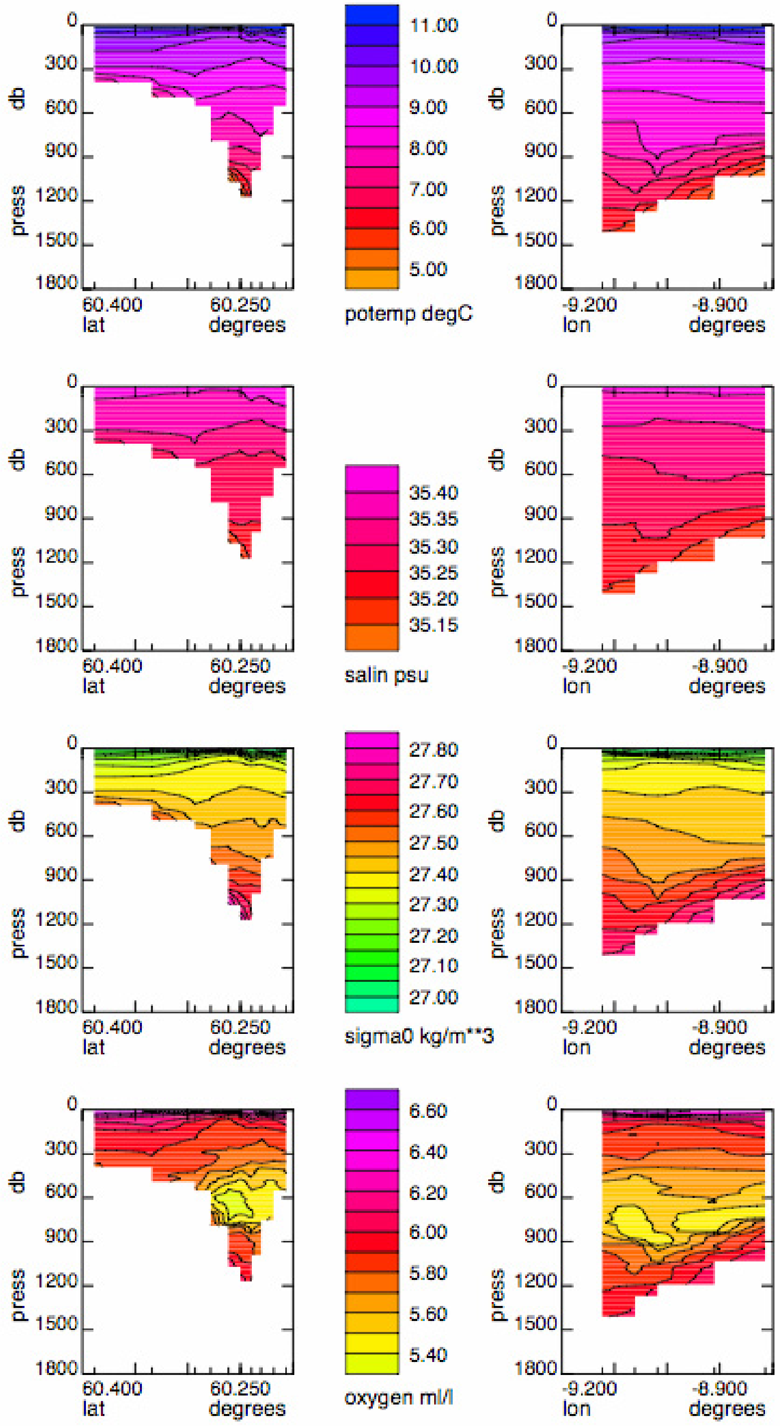


Figure 6.6. Contoured sections of potential temperature, salinity, density (referenced to the surface) and dissolved oxygen across (left) and along the axis of (right) the Ellett Gully.

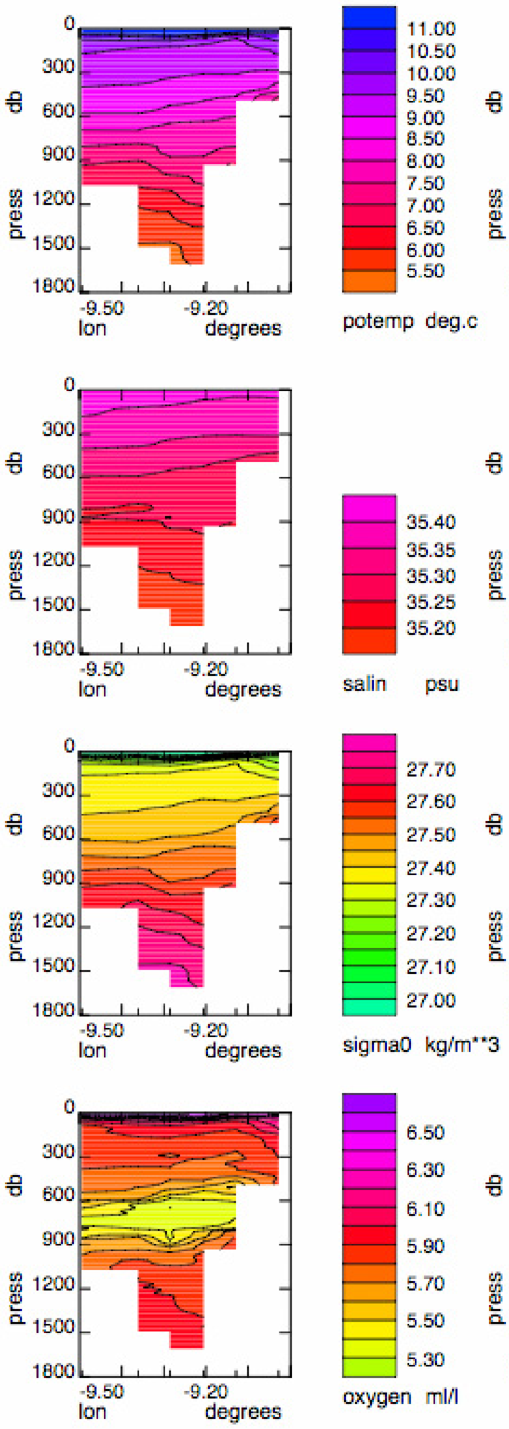


Figure 6.7. Contoured sections of potential temperature, salinity, density (referenced to the surface) and dissolved oxygen across the Cirolana Deep.

Station Name	**Number**	**jday**	**Date**	**Start time**	**Down time**	**End time**	**Latitude degrees**		**Longitude degrees**		**Depth m**	**ht off m**	
Extended Ellett Line													
IB23S	340001	161	10vi09	2320	2330	2350	63	19.34	20	13.06	124	4.8	
IB22X	340002	162	11vi09	0106	0118	0148	63	15.74	20	8.01	159	-	T
IB22S	340003	162	11vi09	0247	0319	0403	63	12.70	20	4.59	694	9	
IB21s	340004	162	11vi09	0518	0544	0626	63	8.01	19	54.89	1047	11	
IB20s	340005	162	11vi09	0818	0850	0950	62	54.80	19	33.10	1418	5	
IB19s	340006	162	11vi09	1129	1204	1322	62	39.90	19	39.83	1692	8	
IB18s	340007	162	11vi09	1556	1634	1735	62	19.94	19	50.76	1820	5	
IB17	340008	162	11vi09	1940	2023	2132	62	0.00	19	59.96	1833	-	T
IB16	340009	163	12vi09	0053	0140	0306	61	29.91	20	0.02	2232	5	
IB15	340010	163	12vi09	0500	0547	0718	61	14.96	19	59.54	2425	6	
IB14	340011	163	12vi09	0856	0944	1100	60	59.87	20	0.12	2412	5	
IB13	340012	163	12vi09	1520	1613	1731	60	30.53	19	59.85	2556	6	
IB12	340013	163	12vi09	2128	2220	2350	60	1.05	20	1.25	2744	-	T
IB11A	340014	165	14vi09	0613	0705	0830	59	50.14	19	33.63	2729	6	
IB11	340015	165	14vi09	1037	1129	1255	59	40.09	19	7.32	2695	-	T
IB10	340016	165	14vi09	1741	1828	1944	59	23.95	18	24.96	2426	3.7	
IB9	340017	165	14vi09	2112	2148	2245	59	19.79	18	13.80	1837	5	
IB8	340018	166	15vi09	0027	0102	0208	59	12.44	17	53.07	1547	4.3	
IB7	340019	166	15vi09	0326	0352	0439	59	7.09	17	40.10	997	5	
IB6	340020	166	15vi09	0642	0704	0747	58	56.98	17	11.11	892	5	
IB5	340021	166	15vi09	0945	1012	1112	58	52.97	17	0.14	1167	-	T
IB4A	340022	166	15vi09	1324	1355	1450	58	41.64	16	30.08	1196	3.8	
IB4	340023	166	15vi09	1700	1733	1815	58	30.03	15	59.99	1200	3.8	
IB3	340024	166	15vi09	2105	2124	2157	58	15.01	15	19.66	661	4.5	
IB2	340025	167	16vi09	0107	0125	0203	57	57.16	14	34.87	449	4.2	
IB1	340026	167	16vi09	0515	0523	0539	57	40.05	13	54.09	148	5	
Ellett Line													
A	340027	167	16vi09	0700	0708	0722	57	34.98	13	38.05	111	4.6	
B	340028	167	16vi09	0847	0857	0919	57	34.07	13	20.14	178	5	
C	340029	167	16vi09	1307	1322	1350	57	33.28	12	59.59	300	4	
D	340030	167	16vi09	1505	1533	1625	57	32.28	12	51.60	1104	5	
E	340031	167	16vi09	1805	1845	1945	57	31.83	12	37.83	1693	-	T
F	340032	168	17vi09	0848	0927	1034	57	30.53	12	14.36	1827	?	
G	340033	168	17vi09	1200	1246	1355	57	30.13	11	50.51	1804	4.6	
H	340034	168	17vi09	2222	2304	0011	57	28.90	11	31.78	2051	9.5	
I	340035	170	19vi09	1308	1338	1425	57	28.06	11	19.44	756	10	
J	340036	170	19vi09	1545	1610	1645	57	26.94	11	4.83	600	5	
K	340037	170	19vi09	1821	1842	1919	57	23.98	10	52.27	789	-	T
L	340038	170	19vi09	2104	2145	2258	57	21.90	10	40.17	2144	5	
M	340039	171	20vi09	0057	0147	0325	57	18.14	10	22.87	2236	-	T
N	340040	171	20vi09	0501	0553	0657	57	13.99	10	3.06	2126	-	
O	340041	171	20vi09	0829	0912	1021	57	9.15	9	41.84	1939	5	
P	340042	171	20vi09	1136	1209	1310	57	6.19	9	25.76	1554	3.5	
Q	340043	171	20vi09	1420	1432	1456	57	3.12	9	12.84	295	3.5	
R	340044	171	20vi09	1600	1610	1630	56	59.86	8	59.82	130	-	
S	340045	171	20vi09	1750	1759	1812	56	56.69	8	47.00	125	-	
T	340046	171	20vi09	2012	2021	2034	56	50.18	8	20.09	120	-	

Wyville Thomson Ridge

D6	340047	172	21vi09	1605	1624	1650	60	12.41	8	57.44	568	2
D5A	340048	172	21vi09	1722	1740	0000	60	13.12	8	58.45	723	1.5
D5	340049	172	21vi09	1819	1843	1925	60	13.82	8	59.38	992	-
D4	340050	172	21vi09	1955	2024	2049	60	15.00	9	0.34	1247	15
D3	340051	172	21vi09	2110	2136	2157	60	15.68	9	0.53	1087	-
D2	340052	172	21vi09	2220	2242	2325	60	16.70	9	0.76	814	0.9
D1	340053	173	22vi09	0000	0024	0039	60	17.60	9	1.06	556	1.7
D0	340054	173	22vi09	0118	0141	0000	60	20.02	9	1.68	501	1.2
DD	340055	173	22vi09	0303	0322	0000	60	23.30	9	2.22	399	1.4
D3	340056	173	22vi09	0447	0513	0536	60	15.73	9	0.56	1095	1.2
D4A	340057	173	22vi09	0732	0802	0859	60	14.39	8	59.85	1275	1.8
CD1	340058	173	22vi09	1031	1054	1115	60	17.50	9	7.77	947	-
CD2	340059	173	22vi09	1150	1230	1335	60	16.08	9	12.40	1718	5
CD3	340060	173	22vi09	1417	1452	0000	60	14.84	9	17.15	1605	5
CD4	340061	173	22vi09	1620	1653	0000	60	13.62	9	21.67	1488	4.4
CD5	340062	173	22vi09	1807	1833	1915	60	11.54	9	29.62	1081	6
CD6	340063	173	22vi09	2030	2056	2155	60	21.27	9	26.56	1246	2
CD7	340064	173	22vi09	2238	2312	2345	60	19.08	9	21.16	1593	2
CD8	340065	174	23vi09	0027	0104	0000	60	17.40	9	16.86	1680	2
CD9	340066	174	23vi09	0243	0322	0349	60	15.00	9	9.64	0	3.5
CD10	340067	174	23vi09	0428	0456	0530	60	13.45	9	4.43	1066	-
EG1	340068	174	23vi09	0724	0807	0856	60	15.52	9	7.37	1631	45-65
EG2	340069	174	23vi09	0930	1014	1043	60	14.81	9	3.69	1407	16
EG4	340070	174	23vi09	1124	1159	1233	60	14.53	8	54.66	1208	25
EG5	340071	174	23vi09	1320	1343	1415	60	14.55	8	48.82	1031	10
EG3	340072	174	23vi09	1539	1610	1655	60	14.77	9	1.10	1300	5

Line G

14G	340073	175	24vi09	1427	1434	1459	56	48.50	8	9.93	129	2.5
13G	340074	175	24vi09	1550	1555	1601	56	47.06	7	59.96	120	3.4
12G	340075	175	24vi09	1653	1658	1704	56	45.55	7	49.88	45	3.5
11G	340076	175	24vi09	1755	1800	1810	56	43.89	7	39.68	65.5	2
10G	340077	175	24vi09	1857	1908	1935	56	44.07	7	30.26	226	0.9
9G	340078	175	24vi09	2029	2035	2056	56	43.95	7	19.71	153	5
8G	340079	175	24vi09	2138	2144	2152	56	43.94	7	10.04	171	2.9
7G	340080	175	24vi09	2245	2252	2315	56	43.96	7	0.15	136	4
6G	340081	176	25vi09	0030	0335	0044	56	44.08	6	45.18	36	4
5G	340082	176	25vi09	0133	0138	0144	56	44.04	6	35.99	68.5	1.7
4G	340083	176	25vi09	0233	0244	0301	56	44.06	6	27.04	111	2
3G	340084	176	25vi09	0339	0346	0350	56	42.65	6	21.98	72	1.2
2G	340085	176	25vi09	0431	0437	0444	56	41.15	6	17.09	35	3.8
1G	340086	176	25vi09	0532	0546	0605	56	40.02	6	8.04	163	10

Table 6.1. CTD Station List.

7 Dissolved oxygen probe calibration

Karl Attard, SAMS

(PIs: Tim Brand and Toby Sherwin)

Figure 7.1 Oxygen sampling

7.1 Introduction

Dissolved oxygen measurements were required to calibrate the oxygen sensors on the stainless steel and the titanium CTD frame. To do this, Niskin bottles from various depths were sampled regularly throughout the sampling period. The depths were chosen based on observed minima and maxima from the downcast profile. The dissolved oxygen concentrations were determined in triplicate measurements using a Winkler titration technique and used as reference values for the calibration.

7.2 Method

7.2.1 Sample collection

Samples were collected immediately following the recovery of the CTD. A 20cm-long silicon tube was attached at one end to the Niskin bottle nozzle and the valve was opened to allow a gentle, non-turbulent flow of water. The water was allowed to flow through the silicon tube until all the air present within the tube was displaced. The tube was then lowered to the bottom of a volume-calibrated glass bottle and the water was left to overflow until the bottle had been flushed by approximately 3 times the volume of water required to fill it. Following this, the sample was fixed by adding 1 ml of manganese chloride (600g/l solution) followed by 1ml of alkaline iodide (320g/l sodium hydroxide solution mixed with 600g/l sodium iodide solution). Both solutions were added using automatic dispensers with the tip of the dispenser being inserted to just below the water level to prevent air bubbles being introduced into the sample. The lid was first placed on the bottle diagonally to ensure no bubbles were trapped then slowly turned vertically. The sample was then gently shaken until an even distribution of manganese (II) and (III) hydroxide precipitates could be seen throughout the sample. The samples were then stored in the dark at room temperature. After 1 hour the samples were shaken gently and then stored for a minimum of 4 hours before further analysis.

7.2.2 Sample analysis

1ml 5M sulphuric acid was pipetted into the sample. A small magnetic stirrer was placed into the solution and the sample was stirred on the Radiometer auto titrator (ABU91) until the precipitate was dissolved and the sample turned a clear yellow solution following the liberation of iodine by the unstable manganese (III). Titration was performed using pre-standardised sodium thiosulphate (0.23M). The end-point was determined spectrophotometrically and the titre value recorded. This value was then used to calculate the concentration of dissolved oxygen within the sample (μM).

7.2.3 Data analysis and CTD calibration

Calculations of the average and standard deviation were based on triplicate measurements. The corresponding values from the oxygen sensors were taken from the processed bottle files from the CTD up cast. For this the sensor data was first transformed from mg/l to μM. The oxygen concentrations (μM) were then plotted (Winkler Analysis (x-axis) vs Oxygen sensor (y-axis)) and a regression analysis was performed. After a good linear relationship was achieved, the intercept and gradient of the slope were used to calibrate the CTD oxygen sensor using (7.1)

$$\text{Corrected } O_2 \text{ value} = (\text{CTD}-c)/m \qquad (7.1)$$

where CTD = value as determined by the CTD oxygen sensor; c = intercept of calibration curve and m = gradient of calibration curve.

7.3 Results

7.3.1 Regression analysis

Figs. 7.1 and 7.2 show the regression relationship between the data for the O_2 concentrations as obtained by the CTD-mounted oxygen sensor and Winkler titration for the steel CTD and titanium CTD respectively. These show a good linear relationship (steel CTD R^2 = 0.9767; titanium CTD R^2 = 0.9854). Table 7.1 summarizes the input data required for the calibration of both CTD sensors.

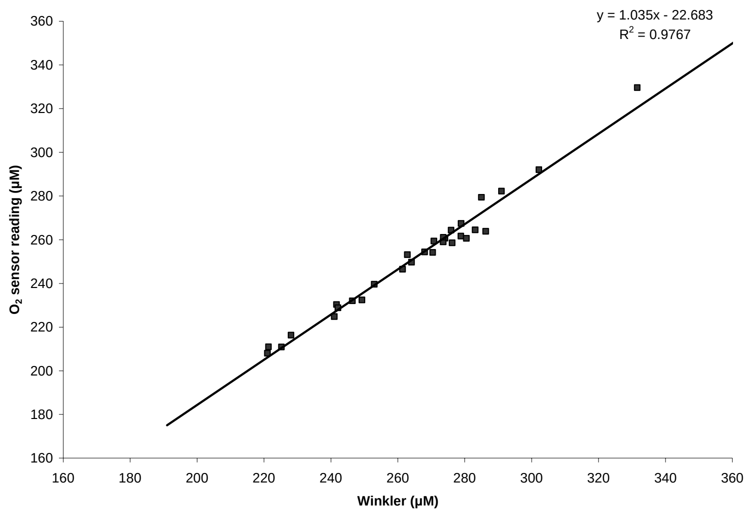


Figure 7.1. Regression between the data for the O_2 concentrations as obtained by the CTD-mounted oxygen sensor and Winkler titration for the steel CTD

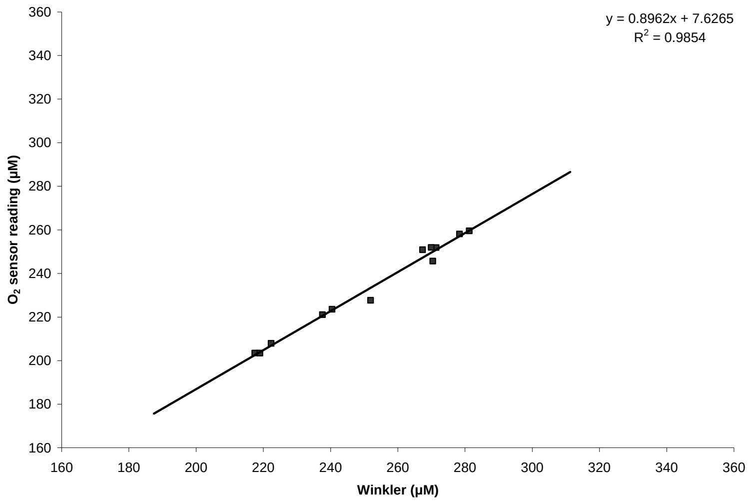


Figure 7.2. Regression between the data for the O_2 concentrations as obtained by the CTD-mounted oxygen sensor and Winkler titration for the titanium CTD

7.4 Station data

Dissolved oxygen samples were taken at the following stations and depths:

Stainless Steel CTD

Date	Station	Sample depth (m)
10/06/2009	IB23S	10, 120
11/06/2009	IB20S	50, 300, 700
11/06/2009	IB19S	5, 100, 500, 700
12/06/2009	IB14	300, 650, 1500
12/06/2009	IB13	600, 820, 1000, 2000
14/06/2009	IB11A	500, 750, 1000, 2000, 2697
15/06/2009	IB4A	500, 750, 950, 1184
16/06/2009	C	5, 150
16/06/2009	E	300, 800, 1000
17/06/2009	F	1000, 1500
19/06/2009	L	1000, 1500, 2095

Titanium CTD

Date	Station	Sample depth (m)
12/06/2009	IB17	400, 800
14/06/2009	IB11	300, 780, 2000
15/06/2009	IB5	300, 850, 1141
19/06/2009	K	50, 300, 765
20/06/2009	M	1000, 1300, 1500, 2000

7.5 Regression values

CTD sensor	R^2	Gradient (m)	Intercept (c)
Steel frame	0.9767	1.0350	-22.6830
Titanium frame	0.9854	0.8962	+7.6265

Table 7.1. A summary of the regression analysis data required for the calibration of the steel CTD and titanium CTD oxygen sensor

8 Lowered ADCP (LADCP) Processing

Toby Sherwin (PI)

8.1 Introduction

Lowered Acoustic Doppler Current Profiler (LADCP) data were obtained from every CTD cast for which the stainless steel frame was used – there was no LADCP on the titanium frame. A single downward looking 300 kHz RDI 'Workhorse' LADCP was deployed on the frame (rather than the more common 2 ADCPs) because there have been some recent problems with the integrity of the transducer heads under repeated deep cycling of new ADCPs and it was not considered prudent to risk two at once.

All profiles were processed by the end of the cruise using 'Visbeck' routines recently adapted and improved (A.M. Thurnherr, 2008, 'How to process LADCP data with the LDEO software') and identified as LDEO version IX.5. They were combined with CTD data to provide accurate information on the vertical velocity of the frame through the water, and with the ship's navigation data to calculate its exact position in the water using the ship as a reference.

8.2 Processing

LADCP data are available from all non-titanium CTD casts after cast 7. Before the pings were averaged over ensembles of 45 (leading to 1 minute sample averages) and the LDEO software was unable to compute realistic velocity profiles. There are thus no LADCP data across the Iceland Shelf edge north of Sta. IB16.

From IB16 onwards the single down looking ADCP appears to have given realistic looking current profiles provided sufficient smoothing was applied. The eastward (u) and westward (v) velocities casts were smoothed using block averaging over 5×10 m bins and combined into ascii xyz files using prepare_velocities_D340,m. In the case of the Extended Ellett Line from the Iceland Basin to the Scottish Shelf a single file of xyz values were created with range values counted along the axes with Stas IB23 and T having ranges of) and 1755 km respectively. Figures 8.1 to 8.4 were then drawn using Surfer by gridding with a Krigging technique that had 12 levels in the vertical and the default horizontal value to allow 'realistic' plots of the data. The range on the x-axis in these figures is the same as that on the plots of the state parameters from the CTD (Figs 4.6 to 4.8). The density of profiles from the LADCP are a little less than those of the CTD because of the lack of LADCP on the titanium frame.

8.3 Results from the Ellett Line

Iceland Basin (Fig. 8.1)

Currents in the southern part of the Iceland Basin were generally less than 0.2 m s^{-1}. Along the west side of the Hatton Bank (700 km) there appears to be a north-east flowing current throughout the depth with speeds of about 0.1 – 0.15 m s^{-1}. Elsewhere there are indications of features with spatial scales of order 100 to 200 km.

Rockall Plateau (Fig. 8.2)

Within the central plateau a south-westward current of order 0.1 m s^{-1} was observed in the central part of the water column, with a north-westward current flowing along the western flank of the Rockall Bank. Stronger currents (possibly tidal) were encountered in the shallow water over the bank, whilst on its eastern side there wsa a pronounced southerly flow of up to

0.4 m s^{-1}. The width of this current in the plot is undoubtedly exaggerated by the lack of LADCP observations to the east of the bank.

Rockall Trough (Fig. 8.3)

The relative narrowness of the trough and the consequent proximity of boundaries tends to constrain the currents to flow north-south and it in this direction that the most orderly patterns are seen. The shelf edge current on its eastern side in the upper 500 m of the water column at 1650 km is well defined with speed of up to 0.2 m s^{-1}. Further west there appears to be a strong anti-cyclonic cell around the Anton Dorhn Seamount (1450 km) with speeds of up to 0.2 m s^{-1} at about 800 m, the depth of the top of the seamount.

8.4 Wyville Thomson Ridge and Ellett Gully

The opportunity was taken during the mooring activity on the Wyville Thomson Ridge to undertake a number of CTD surveys with the express objective of determining the velocity structure along various sections. The old Section D was surveyed with additional stations included to increase the resolution in the deeper parts of the gully and to extend the survey onto the Faroe Bank. A new survey was undertaken of the Cirolana Deep to see whether there was evidence of eddy formation. And at the end a survey was conducted up the Ellett Gully from the Cirolana Deep to determine the up-talweg velocity profile. Unfortunately during this time the current was not particularly strong and the temperatures not particularly cold. A vertical profile of the currents in the centre of the gully is included (Fig.x.4).

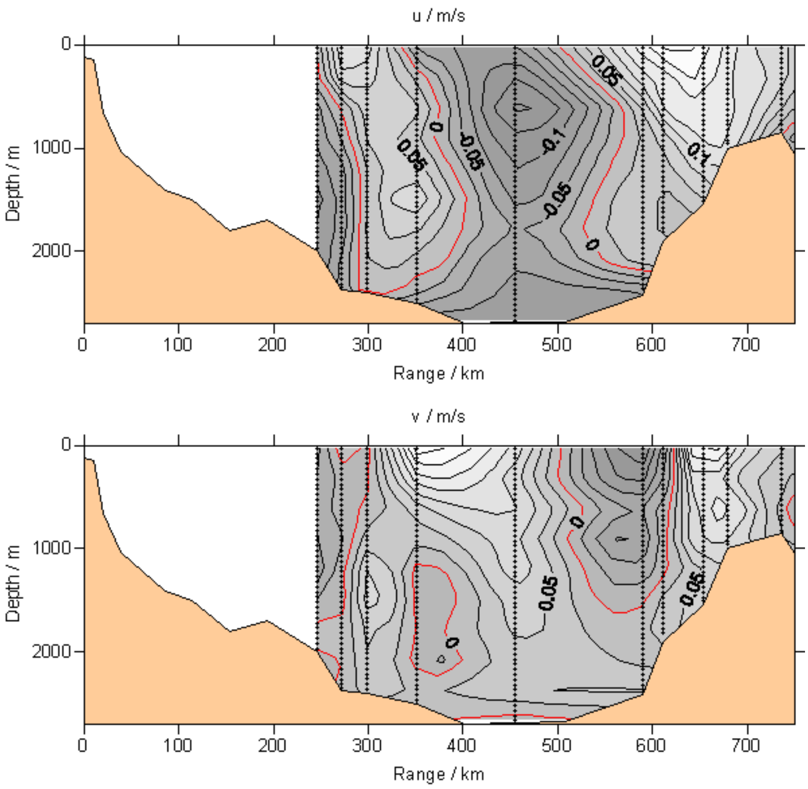


Figure 8.1. Velocities in the Iceland Basin from Iceland (lhs) to the Hatton Bank (rhs) in. m s^{-1}. East-west (*u*, +ve northwards) and north-south (*v*, +ve eastwards) currents in measured by the LADCP. X-axis units are in pseudo-kilometers (see Chapter 4 for explanation).

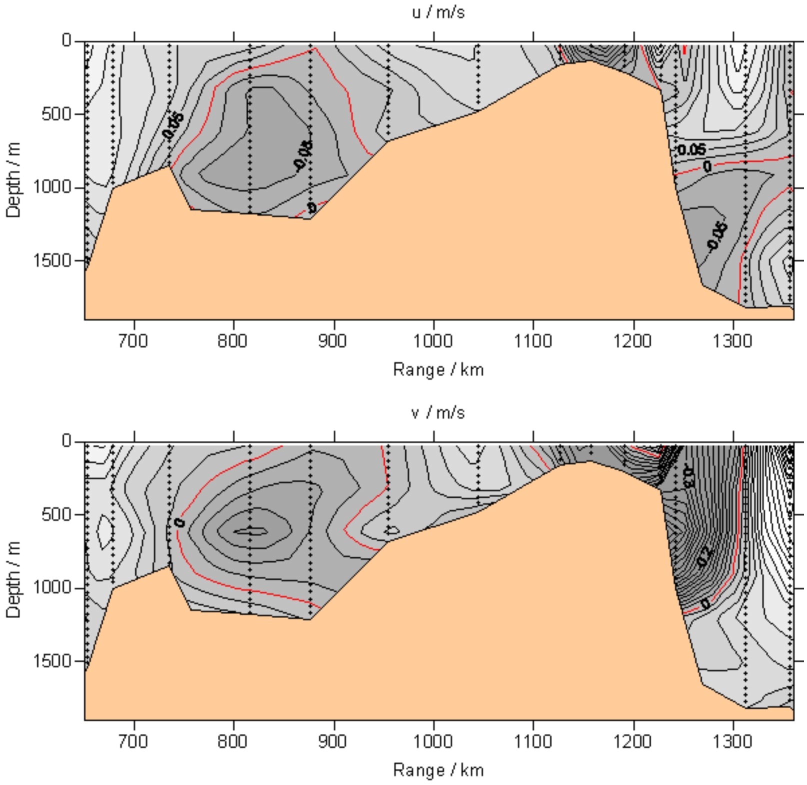


Figure 8.2. As for Fig. 8.1, but over the Rockall – Hatton Plateau.

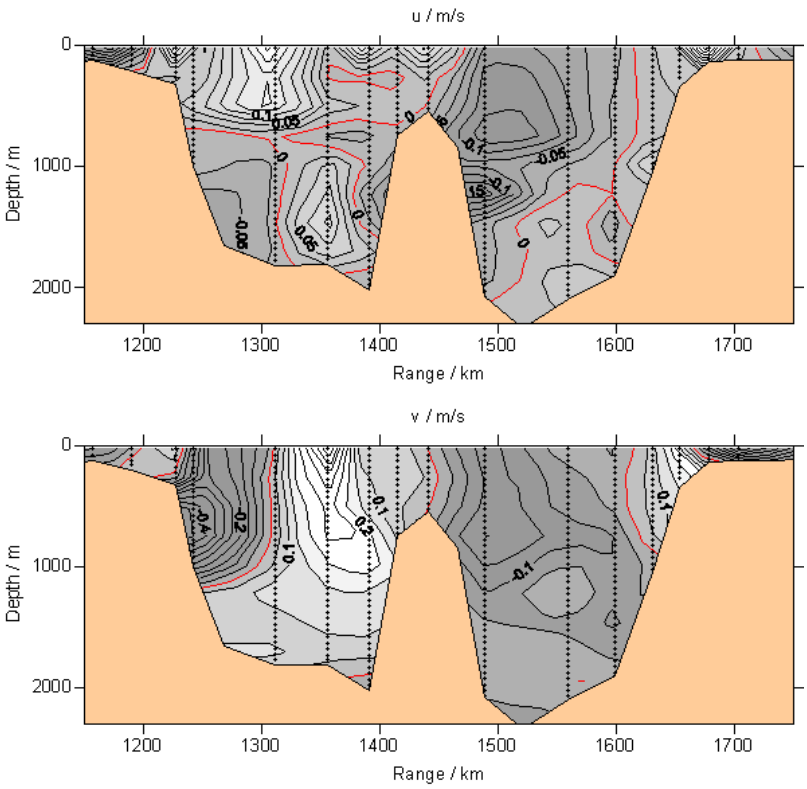


Figure 8.3. As for Fig. 8.1, but for the Rockall Trough from Rockall (lhs) via the Anton Dohrn Seamount (centre) to the Scotland Shelf (rhs).

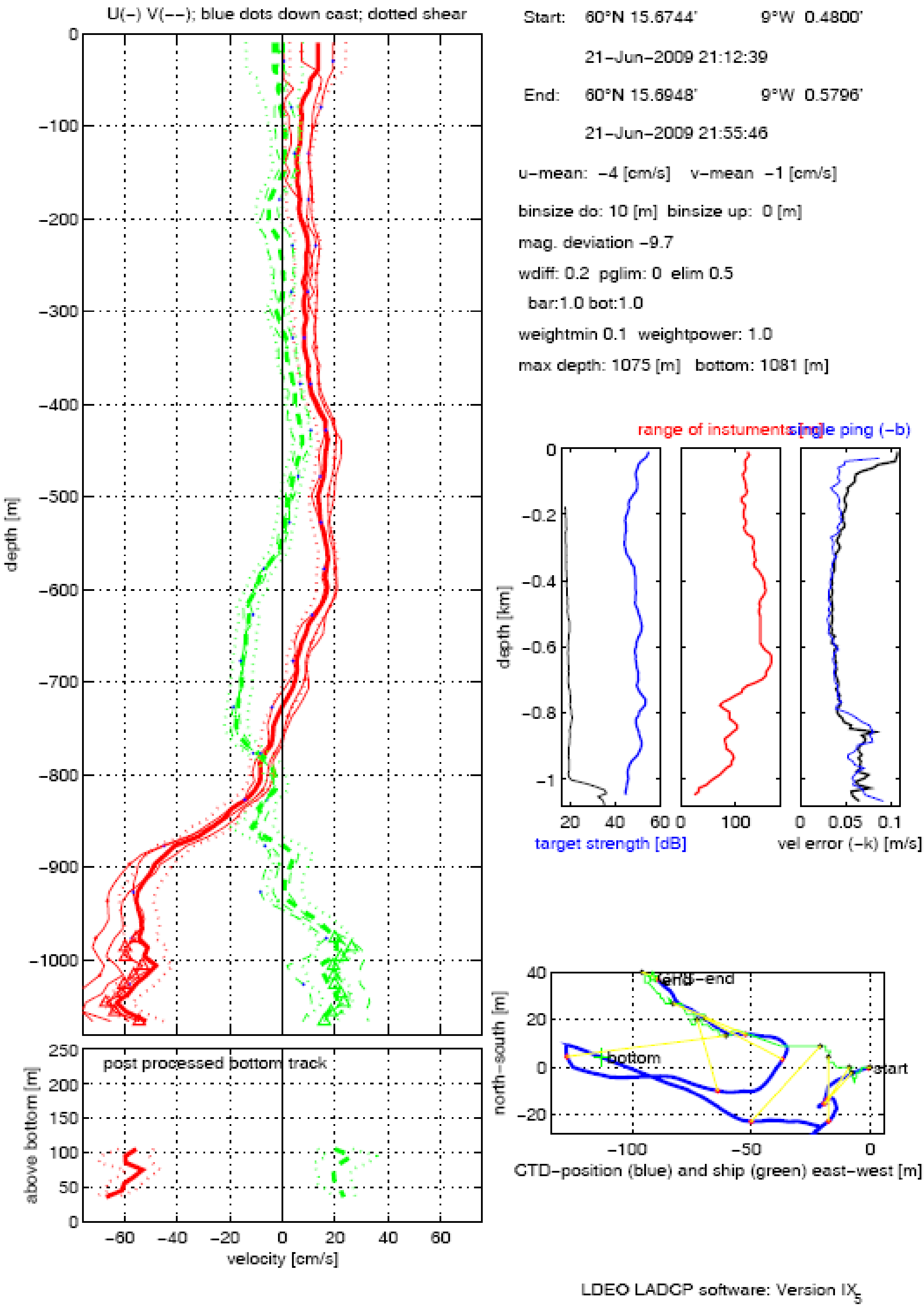


Figure 8. 4. Velocity profile near the ADCP mooring in the Ellett Gully as computed by the LADCP. Output from the LDEO software, version IX.5.

9 Dissolved Inorganic Nutrients

Tim Brand

PI: Toby Sherwin

9.1 Introduction

The basic water column dissolved nutrients, ammonia, phosphate, silicate (reactive silica) and nitrate (+ nitrite) were analyzed from CTD casts along the extended Ellett line (incl. Iceland basin) and around Wyville Thomson Ridge. Depths for the samples were chosen to correspond with observed changes in water mass (salinity, temperature and oxygen) and algal biomass based on CTD fluorescence. Samples were taken from the conventional steel framed CTD and the Ti frame used for trace iron studies (Steigenberger, this report). A full list of nutrient samples taken and analyzed on board is shown in Table 1.

9.2 Method

Samples were collected in 250mls acid cleaned polythene bottles directly from the CTD spigots without the use of a tube. Samples were always analyzed within 24 hours of collection and stored in a fridge prior to analysis. Measurement was conducted using a Lachat *QuikChem 8500* flow injection autoanalyser using the manufacturers recommended methods: Ammonia, 31-107-06-1-B; Orthophosphate, 31-115-01-1-G; Silicate, 31-114-27-1-A and Nitrate/Nitrite, 31-107-04-1-A.

Samples were measured in triplicate to identify instrument precision. Standards were prepared in deionised water and the samples were run in a carrier stream of dionised water. Salt correction of the result was performed by running a small number of Low Nutrient Sea Water samples (OSIL, http://www.osil.co.uk, Batch LNS 17, Salinity 35) during each sample batch run and the mean result was subtracted from sample results.

A standard reference solution prepared from nutrient standard solutions supplied by OSIL containing 1 µM NH_4, 1 µM PO_4, 10 µM SiO_2 and 10 µM NO_3 was run at the start and end of each sample batch. As well as providing an independent check on analysis accuracy it also provided a correction of calibration drift during the course of each sample batch analysis.

9.3 Preliminary Results

Preliminary results for the extended Ellett line transect without the on-shelf G station data are shown in Figures 1. Concentrations of nitrate are highest in the deepest stations in the Iceland basin whilst the silicate concentrations reach their highest values in the Rockall Trough. Nitrate exceeds 20 µM in the Iceland Basin (IB) but not in the Rockall Trough (RT) whilst silicate values exceed 20µM at the greatest depths in the RT and only attain 14-15 µM in the IB. In general these values are higher than those suggested for the region by Fogelqvist *et al.* (2003), see section 4.3.2. Concentrations of phosphate appear similar between the two areas. In both areas and for all nutrients that appears to be a sharp increase in concentration below 800 m water depth.

Nutrient profiles across the Extended Ellett Line transect during D340

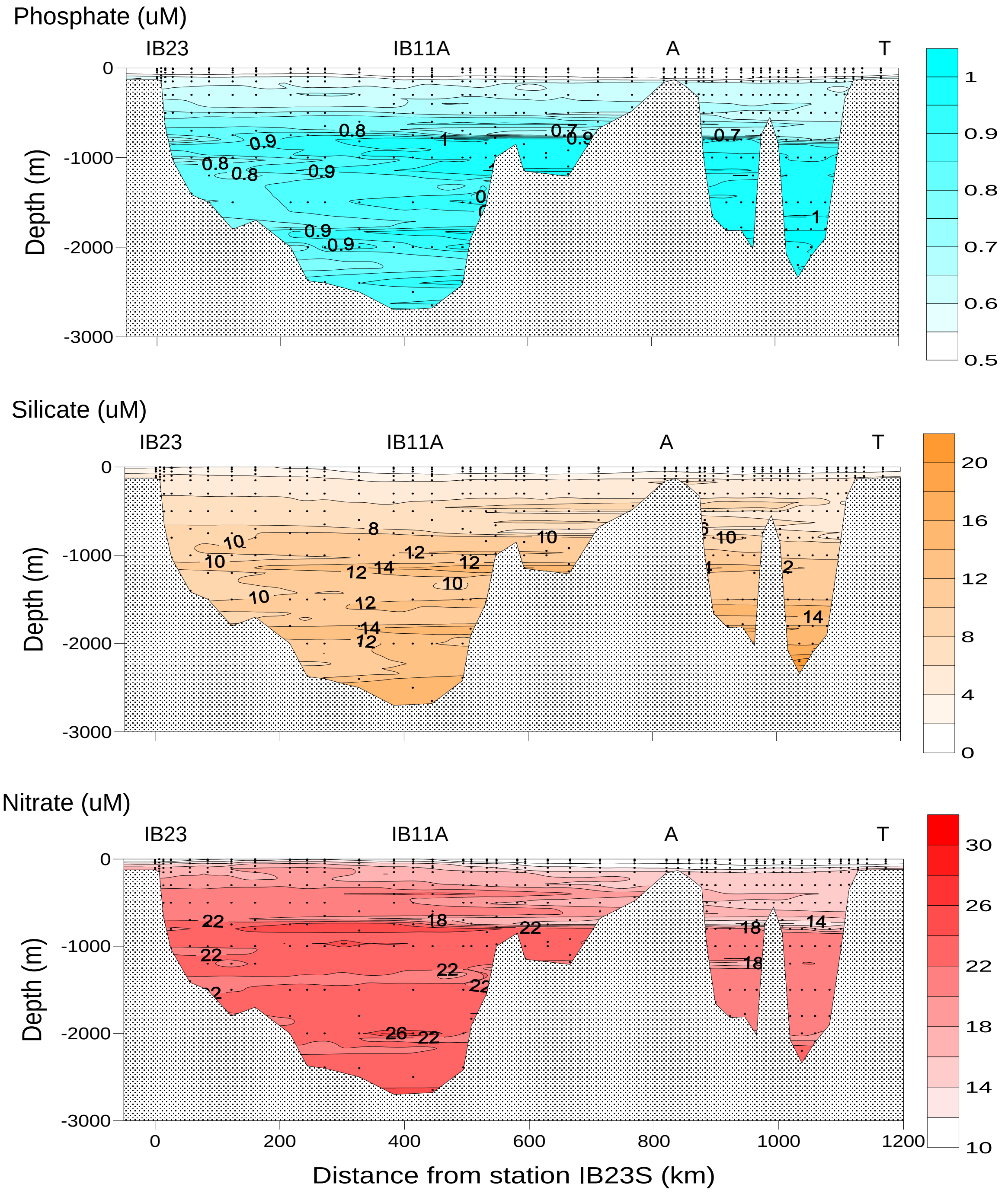


Figure 1. Nutrient sections along the Extended Ellett Line

10 Dissolved Inorganic Carbon, Total Alkalinity, Particulate Inorganic Carbon sampling and pH

Victoire Rerolle, NOCS

(PI: Eric Achterberg, NOCS)

10.1 Introduction

The carbonate system is a key component of the chemical perspective of oceanography as it plays an important role in the ocean's capacity to take up atmospheric CO_2. Dissolved inorganic carbon (DIC) is present in seawater in three forms (CO_{2aq}, HCO_3^- and CO_3^{2-}) which are in equilibrium on timescales longer than a few minutes. In oceanography, the carbonate system can be determined by four parameters: DIC, pCO_2, alkalinity and pH.

This project aims to determine the carbonate chemistry through DIC, alkalinity, PIC and pH measurements.

10.2 Method

10.2.1 Sampling

Profiles of DIC, TA and PIC were sampled from the Titanium and Stainless Steel CTDs (see Table 10.1 for list of the stations and depths sampled).

DIC/alkalinity sampling

A piece of silicone tubing was used for the sampling and care was taken to prevent any air bubbles being trapped in the sample. The sample was stored in a borosilicate glass bottle (250 mL), which was rinsed once with the sample in order to remove traces of a previous sample. The tubing was inserted at the bottom of the bottle which was then filled, and water was left to overflow by at least half a bottle volume. The glass stopper was inserted in the bottle in order to remove the stopper volume and a head space of 1% (2.5 mL) was allowed for water expansion. The sample was then poisoned with a saturated solution of mercuric chloride (7g/100 mL) in a 0.02% volume ratio (50 µL) in order to prevent any biological activity in the stored sample. The bottle was air-tight sealed with a glass stopper and shaken to mix the mercuric chloride homogeneously.

Water for DIC/alkalinity measurements was stored in a dark place for analysis back at NOCS.

PIC sampling

Water was sampled in 500 ml polyethylene bottles. Water was filtrated directly after sampling.

During the cruise, underway DIC/alkalinity and PIC samples were taken from the non-toxic seawater supply (intake at ~5m depth) (see Table 10.2) as well as from the tow fish (at the same time as chlorophyll samples, see Massay and Richier and Table 10.3).

10.2.2 PIC filtration

A volume of water ranging from 100 mL to 550 mL (depending on biomass in water) was filtered through polycarbonate filters (0.2 µm, 25mm, Whatman). The filters were then stored at -20^{o}C. Filters will be used for PIC measurements on return to NOCS.

10.2.3 pH measurement

A potentiometric pH system was installed on the non-toxic sea water supply and run continuously during the cruise. Some pH profiles have been measured as well (see Table 10.1).

The potentiometric method for the determination of pH in seawater consists of the measurement of the electromotive force (EMF) of a cell composed of a silver/silver chloride electrode and a glass pH electrode. The instrument used for the determination of pH was the Idronaut Ocean Seven 320 CTD.

Station	Date	Depth (m)	DIC/TA	PIC	pH
IB22X	11.6.09	1	*	*	*
		40	*		*
		80	*	*	*
		110	*		*
		140	*	*	*
IB17	12.6.09	2	*	*	*
		25	*	*	*
		50	*	*	*
		100	*	*	*
		400	*	*	*
		600			*
		800	*		*
		1200	*		*
		1790	*	*	*
IB12	12.6.09	5	*	*	*
		20	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		400	*		*
		750	*	*	*
		1000	*		*
		2000	*	*	*
		2730	*	*	*
IB11	14.6.09	5	*	*	*
		25	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		300	*		*
		780	*	*	*
		1000	*		*
		2000	*	*	*
		2650	*	*	*
IB5	15.6.09	5	*	*	*
		27	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		300	*	*	*
		500	*		*
		850	*	*	*
		1000	*		*
		1142	*	*	*
E	16.6.09	5	*	*	*
		30	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		300	*	*	*
		500	*	*	*
		800	*		*
		1000	*	*	*
		1640	*	*	*
H	17.6.09	5	*	*	*
		25	*	*	*
		50	*		*
		100	*		*
		150	*		*
		300	*		*
		500	*		*
		700	*	*	*
		1000	*		*
		1200	*		*
		1500	*		*
		2005	*	*	*
K	19.6.09	5	*	*	*
		30	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		300	*	*	*
		500	*	*	*
		700	*		*
		765	*	*	*
Q	20.6.09	5	*	*	*
		18	*	*	*
		50	*	*	*
		100	*	*	*
		150	*	*	*
		200	*	*	*
		294	*	*	*
CD3	21.6.09	5	*	*	*
		12	*	*	*
		50	*	*	*
		150	*	*	*
		500	*	*	*
		1598	*	*	*
CD5	21.6.09	5	*	*	*

Table 10.1. List of the stations and depths sampled for DIC/TA and PIC measurements

Station	Date	Time	Depth (m)	DIC/TA	PIC
IB23S	10.6.09	23:10	Surface	*	*
IB20S	11.6.09	09:59	Surface	*	*
IB19S	11.6.09	11:29	Surface	*	*
	11.6.09	14:15	Surface	*	*
IB18	11.6.09	16:05	Surface	*	*
	11.6.09	18:35	Surface	*	*
IB16	12.6.09	01:35	Surface	*	*
IB14	12.6.09	12:05	Surface	*	*
IB13	12.6.09	15:20	Surface	*	
IB11A	14.6.09	07:45	Surface	*	*
	14.6.09	10:15	Surface	*	*
IB10	14.6.09	17:58	Surface	*	*
IB9	14.6.09	21:09	Surface	*	*
IB6	15.6.09	07:26	Surface	*	*
IB4A	15.6.09	13:18	Surface	*	
IB4	15.6.09	16:56	Surface	*	*
IB3	15.6.09	21:15	Surface	*	*
	16.6.09	01:09	Surface	*	
B	16.6.09	09:15	Surface	*	*
C	16.6.09	11:00	Surface	*	*
C (BIS)	16.6.09	13:06	Surface	*	*
D	16.6.09	15:10	Surface	*	
	17.6.09	10:46	Surface	*	*
G	17.6.09	12:14	Surface	*	*
I	19.6.09	13:26	Surface	*	
J	19.6.09	16:24	Surface	*	*
	19.6.09	21:19	Surface	*	*
P	20.6.09	11:48	Surface	*	
R	20.6.09	16:09	Surface	*	*
S	20.6.09	17:46	Surface	*	*
T	20.6.09	20:15	Surface	*	*
	21.6.09	08:56	Surface	*	*
	21.6.09	10:56	Surface	*	*
	21.6.09	12:50	Surface	*	
	21.6.09	14:45	Surface	*	*
	21.6.09	16:57	Surface	*	*
D4A	22.6.09	09:30	Surface	*	*
CD1	22.6.09	10:36	Surface	*	*
CD2	22.6.09	12:06	Surface	*	*

Table 10.2 List and position of the non-toxic underway samples

Station	Date	Time	Depth (m)	DIC/TA	PIC
UW1	12.6.09	14:30	Surface	*	*
UW2	13.6.09	15:45	Surface	*	*
UW4	15.6.09	02:35	Surface	*	
UW5	16.6.09	00:40	Surface	*	
UW6	17.6.09	11:08	Surface	*	*
UW7	17.6.09	15:08	Surface	*	*
UW8	17.6.09	19:00	Surface	*	
UW10	18.6.09	07:00	Surface	*	
UW11	20.6.09	07:20	Surface	*	
UW12	20.6.09	11:00	Surface	*	
UW13	20.6.09	15:21	Surface	*	*
UW14	20.6.09	19:00	Surface	*	*
UW15	20.6.09	23:00	Surface	*	*
UW16	21.6.09	03:00	Surface	*	
UW17	21.6.09	07:00	Surface	*	*
UW18	23.6.09	07:00	Surface	*	*
UW19	23.6.09	11:00	Surface	*	*
UW20	23.6.09	15:00	Surface	*	*
UW21	23.6.09	19:00	Surface	*	*
UW22	23.6.09	23:00	Surface	*	*
UW23	24.6.09	03:00	Surface	*	

Table 10.3 Tow fish underway sampling file names, dates and time.

11 Iron Biogeochemistry

Sebastian Steigenberger, Chris Marsay, Khairul Nizam Mohamed; NOCS (PI: Eric Achterberg)

Sampling for trace metals in the clean container

11.1 Introduction

It is well established that iron availability is of great importance in regulating primary productivity in the High Nutrient Low Chlorophyll (HNLC) regions of the Southern Ocean and Northwest Pacific. However there is also evidence that phytoplankton primary production in other regions, including the high latitude North Atlantic, can periodically be subject to iron limitation. In the latter case, such conditions are most likely to be observed in summer following the spring bloom, and are thought to result from Fe:nutrient supply ratios being below those needed for optimal phytoplankton growth, and exacerbated by enhanced Fe:nutrient export ratios

The main sources of iron to the euphotic zone of the open ocean are from atmospheric inputs and from upwelling and mixing of deeper ocean water. Whereas much of the North Atlantic receives relatively large amounts of atmospheric dust each year through inputs of Saharan dust, leading to surface water dissolved iron concentrations of up to 2nM, the atmospheric supply of iron to the high latitude (higher than 60^o) North Atlantic is estimated to be only 30% higher than that to the Southern Ocean, a major HNLC region.

The relative rates at which iron and macronutrients (N, P, Si) are recycled from sinking particulate material will also have an effect on whether or not iron limitation occurs. A recent study in an area with HNLC characteristics found an increasing Fe:C ratio in particulate material with depth, suggesting a preferential regeneration of carbon over iron in sinking particulate material, which would amplify any effect of low Fe:nutrient supply ratios.

The deficiency of dissolved iron appears to limit the growth of phytoplankton over several large areas of the open ocean with high nitrate and low chlorophyll (HNLC) contents (Martin and Fitzwater 1988, Martin and Gordon 1988, Martin *et al.* 1989, 1990, 1991). Based on thermodynamic calculations of speciation measurements, it is predicted that > 99% of Fe in seawater is complexed by organic ligands of unknown origin (Gledhill and Van den Berg 1994, Van den Berg 1995, Rue and Bruland 1995, Wu and Luther 1995, Rue and Bruland 1997). Laboratory and field experiments have provided evidence suggesting that some components of the natural organic Fe-binding ligand pool in seawater consist of siderophores (Haygood *et al.* 1993, Rue and Bruland 1995, Wilhelm *et al.* 1998, Hudson 1998, Hutchins *et al.* 1999).

Under iron-limiting growth conditions (< 10^{-5} mol dm^{-3}), most microorganisms use a high-affinity iron acquisition system involving the production of iron(III)-specific extracellular chelators (siderophores) for iron uptake at low concentrations. The iron-siderophore complex is actively taken up by the cell. Once inside the cell, iron is released from the complex and utilized in cellular metabolism (Neilands 1973). Siderophores (from the Greek: “iron carriers”) are low-molecular-weight organic compounds (500 - 1500 Da). The biosynthesis of siderophores is regulated by iron concentration in solution, and the stability constants for iron siderophore complex formation are of the order of 10^{30} or higher (Neilands 1995). Hence, it can be concluded that siderophores are produced by several species of bacteria, fungi, blue-green algae, and eukaryotic organisms.

Another trace metal, aluminium, does not have the same biological impact as iron. Like iron, it is a major component element of the continental crust, yet only nanomolar concentrations of the dissolved metal are found in surface ocean waters. It has been shown that dissolved aluminium concentrations in open ocean surface waters can be used to estimate atmospheric dust fluxes to these areas, and thus it can serve as a tracer of atmospheric inputs of iron and other biolimiting (Zn, Co, Cu) trace elements. Comparison of Fe:Al ratios in atmospheric dust and dissolved in seawater can therefore provide information about the degree to which iron is utilised

Furthermore, relative concentrations of aluminium to other metals (V, Pb) in aerosol samples can give information about whether the source of atmospheric inputs is crustal (e.g. dust blown from deserts and other arid regions) or industrial (burning of fossil fuels).

11.2 Methods

11.2.1 Sampling

Water column samples were collected at selected CTD stations along the transect using the titanium-frame CTD, which was fitted with trace metal clean 10L OTE (Ocean Technology Equipment) sampling bottles with external springs, modified for trace metal work. At these stations twelve of the sample bottles were designated for trace metal use and samples were collected at up to twelve depths, depending on water depth at each station. The trace metal sample bottles were then transferred to a clean van on the back deck for sample processing. In addition, underway samples were collected along the transect using a towfish deployed off the port side of the ship. Near-surface seawater (~2 metre depth) was pumped into the clean van using a diaphragm pump connected to the ship's compressed air and samples collected every one to two hours while the ship was in transit.

To collect aerosol samples, two separate samplers were set up on the monkey island. The first was a low-volume air sampling system, consisting of four filter holders connected to two pumps and a wind speed/direction sensor, designed to switch on whenever the relative wind was blowing from $<90^o$ either side of the front of the ship and at >2m/s. Unfortunately an unresolved problem meant that data collected by the system (flow rates, times of pumps turning on and off) could not be saved and so the low volume sampling was not successfully carried out.

In addition a high volume aerosol sampler was used to collect samples on acid-washed Whatman filters for Alex Baker at the University of East Anglia (UEA). This system was not automated and the pump had to be manually turned on and or off depending on conditions.

To study the concentrations of trace metals in suspended particles in the water column, particles were collected from filtering a few hundred litres of seawater using in situ pump systems (Stand Alone Pump Systems; SAPS, Challenger Oceanic) deployed on a plastic coated line. For each deployment (twice, each time directly following a titanium frame CTD deployment), two SAPS were deployed on the same line from the aft starboard crane; one deployed just below the chlorophyll maximum depth and the second deployed 100m deeper. Pumps were set to run for two hours each time. Due to no pre-filter sub-assemblies being available for loading a second filter, each SAPS housing was loaded with just one filter, an acid-washed 293mm Whatman polycarbonate 1.0µm Nucleopore membrane. Volumes of seawater filtered ranged from 190 L to 538 L.

Station	**Date**	**Location**
IB12SAPS	13/06/09	Iceland Basin
ESAPS	17/06/09	Ellett Line

Table 11.1: Location of SAPS sampling stations

11.2.2 Incubation for siderophore production

An aliquot of seawater were enriched with glucose solution, ammonium chloride and sodium dihydrogen phosphate (*Gledhill et al.,* 2004) resulting in a final concentration of 8.1×10^{-3} M, 2×10^{-4} M, 2×10^{-5} M, respectively and passed through sterilised 0.2 µm, 25mm cellulose sodium acetate filters (Sartorius) into sterilised Teflon bottles. Samples were incubated at 16^0C in the dark with regular shaking for 2-3 days. An unadulterated seawater sample (no nutrient additions) was also incubated to act as a procedural blank. Bacterial growth was monitored using a spectrophotometer at 600 nm every day. For flow cytometry samples, 1-3 ml samples was collected from each incubation bottles into vial. PFM was added to fix the bacteria growth by using sterilize filter and syringe (1 ml samples add 100 µl, final concentration 1%) and frozen at -80^0C until further processing and analysis on shore.

After the incubation period, samples were filtered (0.2 µm, 47 mm cellulose acetate, Whatman) to remove remaining bacteria cells. An aliquot of filtered samples was passed over a pre-washed polystyrenedivinylbenzene solid phase extraction (SPE) cartridge (Isolute ENV+, 200mg x 3ml). Cartridges loaded with sample were rinsed with 11.2 mM ammonium carbonate (2 ml) to remove excess salts and frozen at -20^{0}C until further processing and analysis on shore.

11.2.3 Sample processing

From the titanium frame rosette bottles, both unfiltered and filtered samples were collected (for total trace metals and dissolved trace metals respectively) in 125mL Nalgene LDPE bottles. Unfiltered samples were collected directly from the rosette bottles. Filtered samples were collected through a Sartobran 300 MF 0.2µm filter cartridge under slight positive pressure (oxygen-free N_2). Underway samples were also collected in 125mL Nalgene LDPE bottles, using a Sartobran 300MF 0.2µm filter cartridge. All water samples were acidified to pH~2 Nitric acid (Romil UpA) within twelve hours of collection. Unfiltered samples will be left for >6 months before analysis.

The SAPS filter holders were transferred to the clean van immediately after recovery, where any water remaining in the filter housing was drained using a vacuum pump. The filters were then folded into quarters, bagged and labelled and stored in the -20^{o}C freezer.

High volume aerosol samples were transferred to the clean van, where each filter was removed from the holder, folded in half and stored in the -20^{o}C freezer in a Ziploc bag.

11.2.4 Analysis

All analysis is to be carried out back at NOCS (except high volume aerosol samples, which will be analysed at UEA) by inductively coupled plasma mass spectrometry (ICP-MS). SAPS samples will be digested using high purity reagents (HCl, HNO_3, HF). It is also hoped to analyse the water column samples specifically for aluminium by Flow Injection Analysis (FIA).

Samples for direct siderophore analysis were collected from 55 % light depth, relative to surface water irradiation, using OTE bottles mounted on the Titanium frame CTD. Acid washed polyethylene carboys (rinsed with Milli-Q water 18.2 MΩ cm) were used to recover seawater from the OTE bottles. Seawater for the pre-concentration of siderophores was filtered through 0.2 µm cellulose acetate cartridge filters (Sartorius) into acid washed polyethylene carboys. An aliquot of filtered seawater was passed over a pre-washed polystyrenedivinylbenzene solid phase extraction (SPE) cartridge (Isolute ENV+, 200mg x 3ml). Cartridges loaded with sample were rinsed with 11.2 mM ammonium carbonate (2 ml) to remove excess salts and frozen at -20^{0}C until further processing and analysis on shore.

11.3 Results

7 profiles were sampled (see Table 11.2 and Fig.11.1) from the Ti-frame CTD and 70 underway samples (Fig.1) from the tow-fish. The samples will be analysed in the lab at NOCS (Southampton).

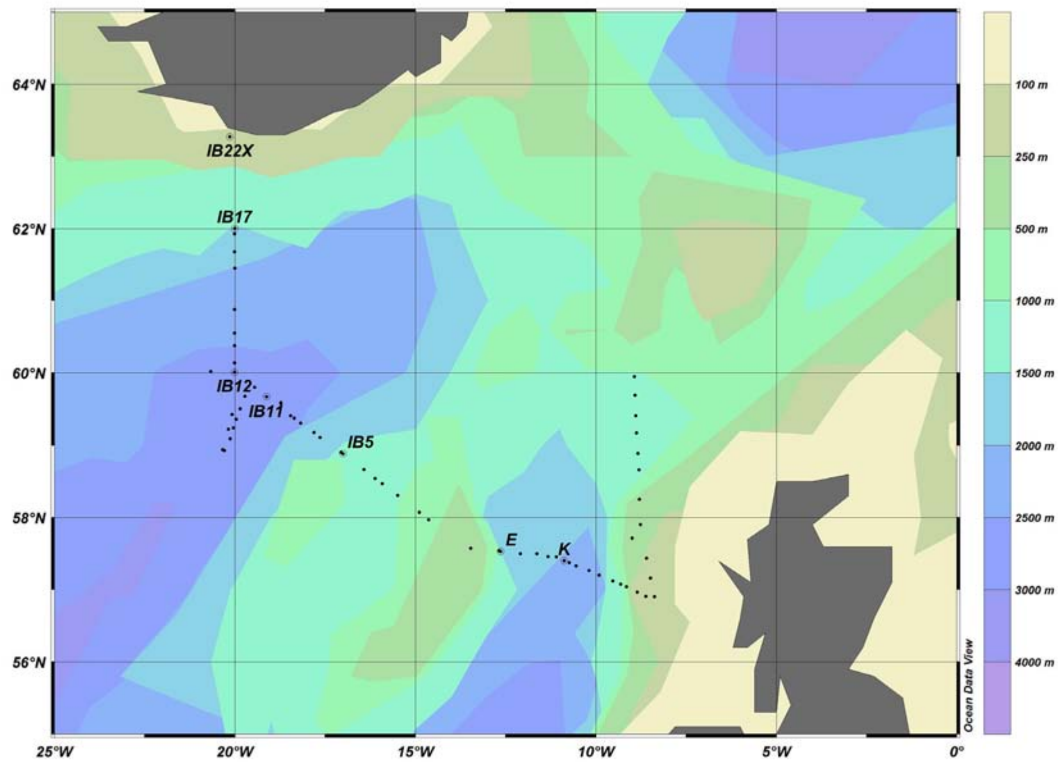


Figure 11.1: Cruise track with positions of underway samples and Ti-frame CTDs

Date	Station	Depths (m)
11/06/09	IB22X	5, 40, 80, 110, 140
11/06/09	IB17	5, 25, 40, 80, 150, 300, 500, 700, 800, 1000, 1200, 1790
12/06/09	IB12	5, 10, 20, 80, 150, 300, 400, 500, 750, 1000
14/06/09	IB11	5, 10, 25, 80, 150, 300, 400, 600, 780, 1000
15/06/09	IB5	5, 10, 27, 80, 150, 300, 400, 600, 850, 1141
16/06/09	E	5, 10, 30, 50, 100, 150, 300, 400, 800, 1000, 1640
19/06/09	K	5, 30, 50, 100, 150, 300, 500, 700, 765

Table 11.2: List of stations which were sampled for dissolved/total iron

11.4 References

Achterberg E. P., Holland T. W., Bowie A. R., Mantoura R. F. C., Worsfold P. J., 2001, *Determination of iron in seawater*, Anal. Chim. Acta, 442, 1-14

Boyer G. L., Gillam A. K., Trick C. G., 1987, *Iron chelation and uptake*, [in:]Van Baalen C., Fay P., *The Cyanobacteria*, Elsevier Science, New York, 415 – 436

Gledhill M., Van den Berg C. M. G., 1994, *Determination of complexation of iron(III) with natural organic complexing ligands in seawater using cathodic stripping voltammetry*, Mar. Chem., 47, 41 – 54

Gledhill, M. et al., 2004. Production of siderophore type chelates by mixed bacterioplankton population in nutrient enriched seawater incubations. Marine Chemistry, 88: 75-83.

Haygood M. G., Holt P. D., Butler A., 1993, *Aerobactin production by a planktonic Vibrio sp.*, Limnol. Oceanogr., 38, 1091 – 1097

Hudson R. J. M., 1998, *Which aqueous species control the rates of trace metal uptake by aquatic biota? Observations and predictions of non–equilibrium effects*, Science Total Environm., 219, 95 – 115

Hutchins D. A., Witter A. E., Butler A., Luther III G. W., 1999, *Competition among marine phytoplankton for different chelated iron species*, Nature, 400, 858 – 861

Martin J. H., Fitzwater S. E., 1988, *Iron deficiency limits phytoplankton growth in the north-east Pacific subarctic,* Nature, 331, 341 – 343

Martin J. H., Gordon R. M., 1988, *Northeast Pacific iron distributions in relation to phytoplankton productivity*, Deep-Sea Res., 35, 177 – 196

Martin J. H., Gordon R. M., Fitzwater S. E., 1990, *Iron in Antarctic waters*, Nature, 345, 156 – 158

Martin J. H., Gordon R. M., Fitzwater S. E., 1991, *The case of iron*, Limnol. Oceanogr., 36, 1793 – 1802

Martin J. H., Gordon R. M., Fitzwater S. E., Broenkow W. W., 1989, *VERTEX: phytoplankton/iron studies in the Gulf of Alaska*, Deep-Sea Res., 36, 649–680

Neilands J. B., 1973, *Microbial iron transport compounds (siderochromes),* Inorg. Biochem., 1, 167 – 202

Neilands J. B., 1995, *Siderophores: structure and function of microbial iron transport compounds*, J. Biol. Chem., 270 (45), 26723 – 26726

Rue E. L., Bruland K. W., 1995, *Complexation of iron(III) by natural organic ligands in the Central North Pacific as determined by a new competitive ligand equilibration/adsorptive cathodic stripping voltammetry method,* Mar. Chem., 50, 117 – 138

Rue E. L., Bruland K. W., 1997, *The role of organic complexation on ambient iron chemistry in the equatorial Pacific Ocean and the response of a mesoscale iron addition experiment*, Limnol. Oceanogr., 42, 901 – 910

Van den Berg C. M. G., 1995, *Evidence for organic complexation of iron in seawater,* Mar. Chem., 50, 139 – 157

Wilhelm S. W., MacAuley K., Trick C. G., 1998, *Evidence for the importance of catechol-type siderophores in the iron–limited growth of a cyanobacterium*, Limnol. Oceanogr., 43, 992 – 997

Wu J. F., Luther G. W., 1995, *Complexation of Fe(III) by natural organic ligands in the northwest Atlantic Ocean by a competitive ligand equilibrium method and a kinetic approach*, Mar. Chem., 50, 159 – 177

12 Detection of Siderophore Biosynthetic Genes

Shady Amin, SDSU

(PI: David Green, SAMS)

12.1 Introduction

Iron is an essential element for photosynthesis and respiration and limits primary productivity and bacterial growth in much of the ocean due to its poor solubility and resultant exceedingly low concentration. To alleviate limitation of this key micronutrient, many marine heterotrophic bacteria and some cyanobacteria produce siderophores, small organic molecules that tightly bind iron and thereby increase its solubility. Although siderophores have been isolated from numerous strains of free-living marine bacteria, their importance in bacterial-algal mutualism has only recently been elucidated. In particular, the dicitrate siderophore vibrioferrin (VF) was shown to enhance algal iron uptake via a photochemical reaction that functions to recycle iron species within the surface boundary layer of algal cells. In order to estimate and understand the importance of this process, a measurement of VF producers in the ocean is required. Quantifying the biosynthetic operon responsible for VF production in particulate and in free-living bacteria will allow for an initial estimate of how common is VF in oceanic waters and its distribution with either algal cells as lab cultures suggest or in free-living bacteria.

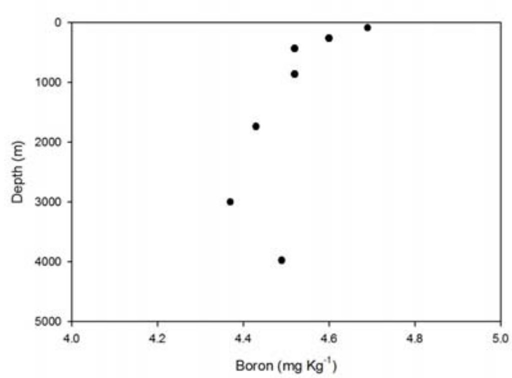


Figure 12.1

While there has been extensive interest in the use of boron as a surrogate of pH in paleoclimate studies in the context of climate change-related questions, the high (0.4 mM) concentration in seawater and the depth-independent (non-nutrient-like, Figure 12.1) concentration profile of this element have led to boron being neglected as a potentially biologically relevant element in the ocean. However, recent advances in genomics, trace element detection, biochemistry, and natural products discovery have renewed interest in this previously largely neglected element.

Most recently, we became interested in boron-binding siderophores (Fe^{3+} chelators) of marine bacteria. The first such case was a surprise finding of a compound similar to the known siderophore vibrioferrin produced in parallel to this chelator by cultures of a *Marinobacter* sp. DG 893. Borate occurring either naturally in seawater or in the borosilicate glass of the used flasks competed with Fe^{3+} for binding to these ligands. A more systematic investigation subsequently revealed that a number of siderophores, such as rhizoferrin and petrobactin, share this hitherto unrecognized property with vibrioferrin, with the relevant functionality being the availability of a vicinal dianionic oxygen containing binding group (i.e., citrate or catecholate) in the siderophore backbone. In contrast, hydroxamate siderophores, such as aerobactin, which lack this functional group do not bind boron. The biological significance of this feature remains at the moment unknown, but considering the abundance of boron in the ocean and the importance of siderophores to marine microbial trace element acquisition it is likely to be very relevant. To probe the possible biological role of boron, a detailed profiling of its distribution relative to chlorophyll is essential.

12.2 Method

Sampling and sample processing – Seawater samples were drawn off from various depths, particularly surface waters, chlorophyll maxima, deep chlorophyll maxima and below the thermocline. Samples were collected in polypropylene jerry cans and were immediately filtered onto 47 mm GFC filters (Whatman) to separate algal cells and other particulate matter. The filtrate was then passed through a 0.22 µm sterivex cartridge to collect free-living bacterial cells. Replicates were collected when possible. Samples were immediately then stored at -80 ^{o}C.

Sampling for boron measurement was done as previously described and seawater was stored in cryovials previously washed with 2N nitric acid. Samples were immediately then stored at -80 ^{o}C awaiting ICP-MS measurements.

12.3 Further work

In order to detect VF biosynthetic operon (*pvsABCDE*), qRT-PCR will be used upon leaving the ship. Using fluorescent dyes incorporated into the assay will allow for quantification of genes-of-interest copy numbers relative to total 16S rRNA. For boron measurements, samples will be filtered onto 0.2 µm PVDF filters that were pre-washed with 2N nitric acid. Boron in the filtrates will be measured using the ICP-MS facility at SAMS.

13 Primary production and key metabolic proteins in marine microbial communities: the role of iron availability

Anna Macey and Sophie Richier, NOCS

(PIs: Tom Bibby and Mark Moore, NOCS)

Filtering for phytoplankton

13.1 Protein and RNA sampling

13.1.1 Introduction

The diversity of marine microbial communities is poorly understood. However, microbial processes catalyse biochemical cycles on global scales. Despite this diversity the protein catalysts that perform the chemistry of these reactions are highly conserved. Iron (Fe) is a fundamental requirement for high rates of production due to the abundance of Fe-containing protein catalysts in the photosynthetic apparatus of photosynthetic cells (Shi, T., Sun, Y., Falkowski, P.G., 2007. IMS101. Environmental Microbiology 9 (12), 2945-2956, doi:10.1111/j.1462-2920.2007.01406.x.)

Thus Fe availability has the potential to limit the abundance of these proteins and set a limit on metabolic activity and hence primary production within the ocean. Primary production in the ocean is usually quantified through basic methods in oceanography (e.g. chlorophyll content, photosynthetic efficiency (Fv/Fm), satellite pictures). We propose to investigate the photosynthetic process at a physiological and molecular level in order to better understand the role of iron availability on photosynthetic activity. Quantification of both key metabolic genes and related proteins in samples taken from Fe-replete and Fe-deplete regions of the oceans will be performed to provide such information.

13.1.2 Sampling for proteins and RNA

Water samples were collected from the titanium CTD (Table 1) and the tow fish (Table 2). From the CTD, samples were collected from the surface (1, 2 or 5m) and chlorophyll maximum (CM). In the absence of a CM, water samples were taken from the bottom of the mixed layer depth. Samples from the tow fish (see section by Steigenberger for details of the Towfish) were collected in the clean container. Samples were collected in polyethylene carboys. For RNA and protein samples a volume of water ranging from 750mL to 2L (depending on biomass in seawater) was filtered in triplicate for 1 hour through GF/F filters (0.7 µm, 25mm, Whatman). The filters were then snap-frozen in liquid nitrogen and stored at -80^{o}C. Filters will be used for RNA and protein extractions on return to the NOCS.

13.1.3 Auxiliary measurements

Auxiliary samples were also taken from the titanium CTD (Table 1) and towfish (Table 2) at the same time as sampling for RNA and protein. The following were taken:

Flow cytometry samples - 1.8mL water samples were taken and fixed with paraformaldehyde (final concentration 1%). The samples were kept overnight at 4°C and then at -80 °C. Samples will be analysed back at the NOCS.

Chlorophyll$_a$ samples – 500mL water samples were filtered on GF/F filters (0.7 µm, 25mm, Whatman) and frozen at -20 °C pending analyses at the NOCS.

Dissolved inorganic nutrients – 30 ml seawater was filtered through 0.2 µm and kept frozen at -20 °C. Samples will be analysed at the NOCS for nitrate, phosphate and Silicate.

Phytoplankton samples – 100mL seawater samples were fixed with 2 ml acidified lugol's solution (final concentration 2%) in amber bottles and kept at room temperature. Enumeration of samples will be performed at NOCS.

13.2 Active chlorophyll fluorescence measurements

Active chlorophyll *a* fluorescence is a non-invasive method of probing phytoplankton photophysiology by providing information on the functioning of photosystem II within the photosynthetic apparatus (Kolber et al. 1998; Suggett et al. 2005). Changes in biophysical parameters measured by active fluorescence techniques can then be used to infer the factors influencing phytoplankton growth in situ, including nutrient and light availability/stress (e.g. Greene et al. 1994). During D340a two active chlorophyll fluorometers were employed in a variety of modes including; continuous underway measurements and analysis of discrete samples from CTDs, towfish samples and incubation experiments. Instruments used for active fluorescence measurements were the FAST*tracka*™ I Fast Repetition Rate (FRR) fluorometer, manufactured by Chelsea Technologies Group (CTG)(UK) and the Fluorescence Induction and Relaxation (FIRe) fluorometer, manufactured by SATLANTIC (Canada).

13.2.1 Underway measurements on ships non-toxic supply

A CTG FAST*tracka*™ I FRRf was connected to the ships non-toxic supply within the bottle annex in order to monitor the physiological state of photosystem II (PSII) within the surface phytoplankton population throughout the study area. The instrument was run in auto-ranging mode. Saturation of variable chlorophyll fluorescence was performed using 100 flashlets of 1.1µs duration with a 2.8µs repetition rate. Subsequent relaxation of fluorescence was monitored using flashlets provided at 98.8μs spacing, giving a total relaxation protocol length of around 2ms. The data were stored internally on the instrument and downloaded throughout D340 (Table 13.3). Instrument optics were cleaned daily as fouling of optics has previously been observed if left uncleaned for 2-3 days (Moore, D321a). A total of 9 files were collected. Data will be analysed using custom software in a Matlab™ environment.

13.2.2 Discrete measurements from CTDs, towfish and bioassays

Discrete samples from titanium CTD casts (Table 13.1), the towfish samples (Table 2) and all the Fe addition bioassays (Section 13.1.3) were run through both active fluorometers. Samples were allowed to relax in the dark for >30 minutes prior to being measured. Data from both instruments were analysed using custom codes within Matlab™.

13.3 Iron addition bioassay experiments

Anna Macey, Sebastian Steigenberger and Sophie Richier

Nutrient addition bioassay experiments were performed to investigate the dependence of iron (Fe) on phytoplankton physiology at a molecular level, growth and nutrient drawdown.

Strict controls were required to avoid contamination of incubation containers and sampled water. Incubations were performed in acid washed 4.5 l polycarbonate bottles. Bottle filling and all manipulation steps including spiking and sub-sampling were performed within the dedicated Class-100 air filtered clean container. Samples were collected from the trace metal clean tow fish. Following filling, bottles were sealed with Parafilm, then double bagged before being incubated on deck at sea surface temperature.

A total of three experiments lasting 5 days each were carried out on D340a. The experimental design involved the incubation of 10 bottles in 2 sets of 5 replicates (control and +Fe). 2 bottles from each set were sub-sampled on day 1 (T1), day 3 (T2) and day 5 (T3). The remaining 3 bottles from each set were sampled on day 5 (see table 5 for sampling routine). All samples from the bioassay experiments will be analysed on return to the NOCS.

13.4 Tables

Station	Date	Depth (m)	Protein	RNA	Chorophyll	FRRf	Lugols	FCM
IB22X	11.6.09	1	*		*	*		*
		40	*		*	*		*
		80			*	*		*
		110			*	*		*
		140			*	*		*
IB17	12.6.09	2	*		*	*		*
		25	*		*	*		*
		50			*	*		*
		80			*	*		*
		100			*	*		*
IB12	12.6.09	5	*		*	*		*
		20	*		*	*		*
		50			*	*		*
		100			*	*		*
		150			*	*		*
IB11	14.6.09	5	*	*	*	*		*
		25	*	*	*	*		*
		50			*	*		*
		100			*	*		*
		150			*	*		*
IB5	15.6.09	5	*	*	*	*		*
		27	*	*	*	*		*
		50			*	*		*
		100			*	*		*
		150			*	*		*
E	16.6.09	5	*	*	*	*	*	*
		30	*	*	*	*	*	*
		50			*	*	*	*
		100			*	*	*	*

Table 13.1. CTD station numbers, locations and samples

Station	Date	Time	Depth (m)	Protein	RNA	Chlorophyll	FRRf	Lugols	FCM	Nutrients
UW1	12.6.09	14:30	Surface	*		*	*			
UW2	13.6.09	15:45	Surface	*	*	*	*		*	*
UW3	14.6.09	02:30	Surface	*	*	*	*		*	
UW4	15.6.09	02:35	Surface	*	*	*	*		*	*
UW5	16.6.09	00:40	Surface	*	*	*	*		*	
UW6	17.6.09	11:08	Surface	*	*	*	*	*	*	*
UW7	17.6.09	15:08	Surface	*	*	*	*	*	*	*
UW8	17.6.09	19:00	Surface	*	*	*				
UW9	18.6.09	03:00	Surface	*	*	*	*	*	*	*
UW10	18.6.09	07:00	Surface	*	*	*	*	*	*	
UW11	20.6.09	07:20	Surface	*	*	*	*	*	*	*
UW12	20.6.09	11:00	Surface	*	*	*	*	*	*	*
UW13	20.6.09	15:21	Surface	*	*	*	*	*	*	*
UW14	20.6.09	19:00	Surface	*	*	*	*	*	*	*
UW15	20.6.09	23:00	Surface	*	*	*	*	*	*	*
UW16	21.6.09	03:00	Surface	*	*	*	*	*	*	*
UW17	21.6.09	07:00	Surface	*	*	*	*	*	*	*
UW18	23.6.09	07:00	Surface	*	*	*	*	*	*	*
UW19	23.6.09	11:00	Surface	*	*	*	*	*	*	*
UW20	23.6.09	15:00	Surface	*	*	*	*	*	*	*
UW21	23.6.09	19:00	Surface	*	*	*	*	*	*	*
UW22	23.6.09	23:00	Surface	*	*	*	*	*	*	*
UW23	24.6.09	03:00	Surface	*	*	*	*	*	*	*

Table 13.2. Underway sampling times and samples taken.

File Name	Start Date	End Date	Start Time	End Time
UW1	10.6.09	10.6.09	17:12	21:00
UW2	10.6.09	11.6.09	21:30	12:32
UW3	11.6.09	12.6.09	13:34	00:24
UW4	12.6.09	13.6.09	00:32	01:20
UW5	13.6.09	16.6.09	01:26	01:10
UW6	16.6.09	20.6.09	01:46	20:47
UW7	20.6.09	22.6.09	21:26	07:05
UW8	22.6.09	23.6.09	07:13	12:52
UW9	23.6.09	24.6.09	12:59	12:23

Table 13.3. Underway sampling file names, dates and time.

	IE1	IE2	IE3
Sampling Location		60° N, 20° W	
Sampling Method	Trace clean fish	Trace clean fish	Trace clean fish
Start Date	11-6-09	12-6-09	17-6-09
End Date	15-6-09	16-6-09	21-6-09

Table 13.4. Sampling locations and dates for bioassay experiments

	T0	T1	T2	T3
Protein	*			*
RNA	*			*
Chlorophyll	*			*
Flow Cytometry	*	*	*	*
Lugol's	*			*
Nutrients	*	*	*	*
FRRf	*	*	*	*
Iron	*	*	*	*

Table 13.5. Samples taken during incubation experiments

13.5 References

Greene, R.M., Kolber, Z., Swift, D.G., Tindale, N.W. and Falkowski, P.G. (1994) Physiological limitation of phytoplankton photosynthesis in the eastern equatorial Pacific determined from variability in the quantum yield of fluorescence. *Limnol. Oceanogr.* 39 1061-1074

Kolber, Z., Prasil, O. and Falkowski P. G. (1998) Measurements of variable chlorophyll fluorescence using fast repetition rate techniques: Defining methodology and experimental protocols. *Biochim Biophys Acta* 1367: 88–106.

Shi T., Sun Y., Falkowski P.G. (2007) Effects of iron limitation on the expression of metabolic genes in the marine cyanobacterium Trichodesmium erythraeum IMS101. *Environmental Microbiology* 9: 2945-2956

Suggett, D.J., Moore, C.M., Oxborough, K. and Geider, R.J. (2005) Fast Repetition Rate (FRR) Chlorophyll *a* fluorescence induction measurements. Chelsea Technologies Group. http://www.chelsea.co.uk/Technical%20Papers/FRRFmethodsManual.pdf

14 Factors controlling Calcification in Planktonic Foraminifera

David Aldridge, NOCS

(Supervisors: Duncan Purdie and Toby Tyrrell, NOCS)

Figure 14.1 Deploying the plankton net

14.1 Introduction

The ongoing acidification of the oceans is lowering the calcium carbonate ($CaCO_3$) saturation state. This may have detrimental impacts on shell forming marine organisms such as planktonic foraminifera, which comprise a significant fraction, 23-56%, of the total open ocean marine $CaCO_3$ flux (Schiebel, 2002). Recent studies have found either $CaCO_3$ saturation states (Barker and Elderfield, 2002; Moy *et al.*, 2009) or growth conditions (deVilliers, 2004) to be correlated with shell weights of foraminifera. The aim of this study is to investigate the role of latitudinal variations in $CaCO_3$ saturation states, in addition to variations in growth conditions, on the calcification rates (indicated by shell weights) of a range of species of planktonic foraminifera within the North Atlantic Ocean.

14.2 Method

Samples were taken at the stations shown in Table 14.1 and collected using a zooplankton net with a half meter diameter opening and a 120 um pore size. The net was towed horizontally at a low velocity (approximately 1 knot) above the thermocline for 3-5 minutes; the use of a flowmeter allowed for the quantification of water flowing through the nets. Seawater samples were immediately preserved with 40% formaldehyde, buffered with sodium tetraborate, giving a final concentration of 2% (25ml of 40% formaldehyde per 500ml seawater sample).

Final analysis of samples (species identification and shell weight analysis) will take place at NOCS. This data will then be compared to *in situ* measurements taken during the research cruise. These measurements will include: temperature, salinity, nutrients (phosphate and nitrate), chlorophyll *a*, dissolved inorganic carbon (DIC) and total alkalinity (TA).

Station	Time in	Time Out	Time in water
IB23S	1206	1210	4 m 23 s
IB19S	1337	1341	4 m 48 s
IB17	2149	2153	4 m 53 s
IB16	0319	0324	5 m 48 s
IB14	1121	1126	5 m 23 s
IB13	1756	1800	4 m 13 s
IB10	1959	2004	5 m 03 s
IB6	0756	0800	4 m 31 s
IB4	1824	1828	4 m 41 s
IB2	0215	0220	4 m 28 s
K	1938	1942	4 m 18 s
R	1639	1644	4 m 55 s
T	2054	2059	5 m 06 s

Table 14.1: Zooplankton net deployment details

14.3 References

Barker, S; Elderfield, H. (2002). Foraminiferal calcification response to glacial–interglacial changes in atmospheric CO2. *Science* 297: 833–836.

de Villiers, S. (2004). Optimum growth conditions as opposed to calcite saturation as a control on the calcification rate and shell-weight of marine foraminifera. *Marine Biology* 144: 45-49.

Moy, A.D; Howard, W.R; Bray, S.G; Trull, T.W. (2009). Reduced calcification in modern Southern Ocean planktonic foraminifera. *Nature Geoscience* 2: 276-280.

Schiebel, R. (2002). Planktic foraminiferal sedimentation and the marine calcite budget. *Global Biogeochemical Cycles* 16: 1065, doi: 10.1029/ 2001GB001459.

15 DMS analysis

Andrew Mogg, SAMS

(PIs: Angela Hatton, David Green & Mark Hart)

15.1 Introduction

15.1.1 DMS sampling

Samples for climatic feedback gas dimethyl sulphide (DMS), its precursor molecule dimethylsulphoniopropionate (DMSP) and its oxidation product dimethylsulphoxide (DMSO) were taken from a range of depths along the Extended Ellett Line, in an attempt to quantify their concentrations along the transect. Samples were taken from morning CTDs daily between stations 'IB1' and 'T'. Sample depths were: Surface, Chlorophyll maximum, 50m 100m, and Bottom. Samples of DMS and DMSOd(dissolved) were analysed immediately in two gas chromatographs(GCs). Samples of DMSOp (particulate), DMSPp and DMSPd were stored for later analysis. See Table 15.1 for sample details.

15.1.2 Incubation experiments

In the latter part of the cruise, whole seawater incubations were initiated on the Wyville Thompson Ridge to characterise the sulphur metabolism of natural algae and associated bacteria in the presence of antibiotics and added DMSP. See Table 15.2 for details of incubation and sample list.

15.2 Method

15.2.1 DMS sampling

DMS samples were drawn off first from the CTD Niskin bottles into 250ml glass stoppered sampling bottles. To sample, a piece of rubber tubing, approximately 15cm long, was attached to the Niskin bottle nozzle. Before the samples were drawn any air in the tube was displaced by opening the valve of the Niskin bottle. The sample bottles were rinsed twice and then the tube was lowered into the bottom of the bottle and the bottle allowed to overflow without bubbling. The bottle was then capped with its ground glass stopper. This process was repeated on all 5 CTD bottles.

The samples were kept in the cold and dark and analysed as soon as possible.

15.2.2 Analysis system

Samples were analysed on a pair of GCs: a Varian 3400 series with an flame photodetector (FPD) for high sulphur concentration detection and a Varian 3400CX series with a pulse flame photodetector for low sulphur concentration detection. The GCs were calibrated daily with a range of standards.

As DMS sulphur is present as a dissolved gas in nanomolar concentrations in seawater, samples were first injected into a sealed purge tube, where they were sparged with oxygen-free nitrogen to purge the DMS off and into a liquid nitrogen cooled cryotrap loop (-150C). The cryotrap concentrated the DMS for 17-30 minutes (depending on sample size) and is then rapidly warmed up in boiling water to release the DMS in the GC.

15.2.3 DMS analysis

A known volume of sample (30-50mls) was drawn up into a syringe and injected through an AP depth filter into the injection port of a sealed purge tube. The filter was removed and stored for later DMSPp analysis. The process was repeated with another known volume of sample for DMSOp. 2mls of deionised water were then injected to rinse the injection port. The sample in the purge tube (60-100mls) was then bubbled with oxygen-free nitrogen at a rate of 60mls/min for 30 minutes. After this time, the cryotrap was immersed in a freshly boiled kettle of water to release the DMS into the GC. DMS sulphur was returned as a peak area, and concentrations were determined using a calibration curve.

After the DMS had been purged off, the sample was split evenly for DMSOd and DMSPd analysis.

15.2.4 DMSOd analysis

The DMSOd sample earlier purged of DMS was analysed using the DMSO reductase enzymatic method. Briefly, the sample was injected into a purge tube containing 2mls of DMSOr solution (25 µg cm-^{3} DMSO reductase, 30 mM EDTA, and 540 pM) FMN) and mixed through the action of 60mls/minute oxygen-free nitrogen, which also promoted microaerophilic conditions. The mixture was illuminated with three 60W equivalent daylight bulbs. Under these conditions, EDTA forms radicals which reduce FMN to FMN H_2. FMN H_2 may then act as an electron donor to DMSOreductase, catalyzing the reduction of DMSO to DMS. The DMS is then analysed as previously described.

15.2.5 Sample storage

DMSOd samples were frozen at -20C until they could be thawed and analysed as previously described. Samples of DMSPd and DMSPp were added to 60ml vial containing 1ml of 10M NaOH, topped up to the brim with deionised water and capped with gastight crimp tops. The purpose of NaOH was to prevent further biological action, lyse cells and convert DMSP into DMS for later anaylsis. Samples for DMSOp were stored in 15ml falcon tubes containing 9mls of 50mM Tris HCL buffer and 1ml of 10M NaOH. All samples were stored in the dark.

15.3 Incubation experiment

15.3.1 Incubations

Four triplicate 2l incubations were initiated using 40l of 150µm filtered bulk water from the chlorophyll maximum (19m) of station D4A on the Wyville Thompson Ridge, in 1140m o water. Incubations were treated as follows:

-3x whole seawater, untreated (-1,-2,-3)

-3x whole seawater, antibiotic treated to a final concentration 50μg/ml each of chloramphenicol and streptomycin (AB1, AB2, AB3)

-3x whole seawater, treated to a final concentration of 1.5μM DMSP (P1, P2, P3).

-3x whole seawater, treated to a final concentration of 50μg/ml each of chloramphenicol and streptomycin, and 1.5μM DMSP (AB+P1, AB+P2, AB+3).

Incubations were set up in a random sequence incubated in fibreglass tanks with a constant supply of fresh seawater and 50% light screens. The incubations were sampled for DMS, DMSP and DMSO immediately after treatment, then once every 24 hours at the same time point to give a T0, T1, T2 time series. Replicate samples for phytoplankton, dissolved organic carbon (DOC), fluorescence in-situ hybridisation (FISH, duplicate) and RNA/DNA denaturing gradient gel electrophoresis (DGGE) were taken from the bulk water at T0, whilst triplicate samples for DGGE were taken from individual incubations after DMS analysis on T1 and T2.

DMS analysis

Samples were analysed for DMS as previously described.

DMSOd analysis

Samples were analysed for DMSO as previously described.

15.3.2 Sample storage

DMSOp, DMSPp, and DMSPd were stored in NaOH for later analysis as previously described.

For phytoplankton: 100 ml samples were taken and stored using a 1:100 dilution of both lugols iodine and formaldehyde (triplicates for lugols, triplicates for formaldehyde, from bulk water).

For DOC, 10 ml samples were taken and filtered through ashed GF/F filters into an ashed glass DOC vial (triplicate from bulk water). 11μl of orthophosphoric acid was added to fix the sample, and the vial was sealed by melting the neck and twisting shut. The samples were then stored in the dark.

For FISH, 9mls of sample were taken and fixed with 1 ml of formaldehyde for at least 1 hour, The fixed samples were then filtered onto a 47mm 0.2 μm polycarbonate filter and the formaldehyde rinsed off by filtering 10 mls of deionised water. The samples were then stored at -20C.

For DGGE, 30 mls of sample were taken and filtered onto a 25mm 0.2 μm polycarbonate filter. The filter was then stored at -20C.

15.4 Tables and notes

The Varian 3400CX series GC lost its ignitor coil on the 17th of June, and as such was out of action until the 25th of June, when a replacement ignitor coil was shipped out and installed. The majority of DMS analysis was conducted on the 3400 series GC.

Date	Station	Sample	Depth	DMS(nM)	DMSOd(nM)	DMSPp vol(ml)	DMSPd vol(ml)	DMSOp vol(ml)
10/06/2009	**IB23S**	Surface	10	-	2.56	40	40	40
	IB23S	Chl max	30	-	24.26	40	40	40
	IB23S	50m	50	-	-	40	40	40
	IB23S	100m	100	-	-	40	40	40
	IB23S	bottom	120	-	23.93	40	40	40
11/06/2009	**IB20S**	Surface	5	-	0.80	40	40	40
	IB20S	Chl max	20	-	-	40	40	40
	IB20S	50m	50	-	6.80	40	40	40
	IB20S	100m	100	-	-	40	40	40
	IB20S	bottom	1402	-	6.81	40	40	40
12/06/2009	**IB14**	Surface	5	-	-	40	40	40
	IB14	Chl max	18	-	13.62	40	40	40
	IB14	50m	50	-	6.46	40	40	40
	IB14	100m	100	-	12.76	40	40	40
	IB14	bottom	2000	-	7.59	40	40	40
14/06/2009	**IB11**	Surface	5	12.81	75.61	50	40	50
	IB11	Chl max	25	0.54	1.94	50	40	50
	IB11	50m	50	0.38	-	50	40	50
	IB11	100m	100	-	7.15	50	40	50
	IB11	bottom	2650	-	-	50	40	50
15/06/2009	**IB5**	Surface	5	25.92	62.69	50	40	50
	IB5	Chl max	27	19.95	41.60	50	40	50
	IB5	50m	50	0.10	8.52	50	40	50
	IB5	100m	100	-	19.72	50	40	50
	IB5	bottom	1141	-	9.82	50	40	50
16/06/2009	**C**	Surface	5	16.60	-	50	40	50
	C	Chl max	16	12.01	22.74	50	40	50
	C	50m	50	-	5.96	50	40	50
	C	100m	100	-	9.95	50	40	50
	C	bottom	294	-	7.43	50	40	50
17/06.2009	**F**	Surface	5	23.90	9.83	30	20	30
	F	Chl max	13	3.38	8.18	50	40	50
	F	50m	50	-	-	50	40	50
	F	100m	100	-	51.89	50	40	50
	F	bottom	1800	-	-	50	40	50
19/06/2009	**I**	Surface	5	-	-	30	20	30
	I	Chl max	30	-	-	30	20	30
	I	50m	50	-	-	50	40	50
	I	100m	100	-	-	50	40	50
	I	bottom	742	-	-	50	40	50
20/06/2009	**O**	Surface	5	1.46	-	30	20	30
	O	Chl max	25	-	-	30	20	30
	O	50m	50	-	-	50	40	50

	O	100m	100	-	2.054	50	40	50
	O	bottom	1914	-	-	50	40	50

Table 15.1: Ellett Line DMS Transect

Date	Time (hours)	Treatment	DMS(nM)	DMS(nMs)	DMSPp vol (ml)	DMSPd vol(ml)	DMSOp vol	DOC sample (ml)	Phyto-plankton sample (ml)	FISH sample (ml)	DGGE sample (ml)
22 June	0	-1	9.08	-	50	40	50	10	100	9	30
	0	-2	7.72	5.52	50	40	50	10	100	9	30
	0	-3	8.92	7.08	50	40	50	10	100	9	30
	0	AB1	3.76	2.61	50	40	50				
	0	AB2	9.12	8.11	50	40	50				
	0	AB3	10.10	9.25	50	40	50				
	0	P1	35.02	166.55	40	1	40				
	0	P2	48.23	143.97	20	1	20				
	0	P3	52.07	163.12	20	1	20				
	0	AB+P1	57.59	125.65	20	1	20				
	0	AB+P2	44.20	129.79	20	1	20				
	0	AB+P3	45.81	166.67	20	1	20				
23 June	24	-1	12.30	7.43	50	40	50				30
	24	-2	14.42	25.29	50	40	50				30
	24	-3	15.48	8.30	50	40	50				30
	24	AB1	1.22	7.61	50	40	50				30
	24	AB2	3.37	8.39	50	40	50				30
	24	AB3	2.88	2.58	50	40	50				30
	24	P1	433.18	12.99	10	1	10				30
	24	P2	220.89	68.94	5	1	5				30
	24	P3	654.86	76.84	5	1	5				30
	24	AB+P1	53.04	24.13	15	1	15				30
	24	AB+P2	45.67	128.03	15	1	15				30
	24	AB+P3	57.55	47.76	15	1	15				30
24 June	48	-1	16.96		50	40	50				30
	48	-2	17.12		50	40	50				30
	48	-3	19.10		50	40	50				30
	48	AB1	-		50	40	50				30
	48	AB2	1.73		50	40	50				30
	48	AB3	1.81		50	40	50				30
	48	P1	960.34		5	1	5				30
	48	P2	788.17		3	1	3				30
	48	P3	967.55		3	1	3				30
	48	AB+P1	28.23		15	1	15				30
	48	AB+P2	16.82		15	1	15				30
	48	AB+P3	11.29		15	1	15				30

Table 15.2: Incubation experiments

16 DMSP Lyase Experiments

Natalie Wager, Heriot-Watt University

(Supervisor Angela Hatton)

16.1 Introduction

The ocean to atmospheric flux of DMS plays an important role in the biogeochemical cycling of Sulphur. Understanding the rate at which DMSP Lyase enzymes convert DMSP into DMS is essential for enhancing our understanding of this complex process. To do this seawater from the chlorophyll max was collected from Niskin bottles at various stations along the transect from Reykjavik to Dunstaffnage. The seawater samples were filtered and then analysed using GC-headspace analysis to identify the DMSP-DMS conversion rate of the DMSP Lyase enzymes.

16.2 Method

16.2.1 Sampling

Three 1.25 litre plastic bottles were used to collect seawater from the CTD at the chlorophyll max from three separate Niskin bottles fired at the same depth. The seawater was collected from the Niskin bottles using a piece of rubber tubing, approximately 15cm long and filtered, using a 150um net, on collection to remove zooplankton from the samples. 1 litre of filtered seawater was measured in a plastic measuring cylinder and then filtered using GF/F 47mm glass Microfibre filters to extract the algal and bacterial cells. Filtering was completed using a vacuum pump and a 2 litre side-arm flask. The filter, containing the required cells, was placed into a 10ml glass vial in 4ml buffer solution (19.1 ml filtered seawater, 0.6 ml Bis Tris). The vial was immediately crimped with a gas tight crimp top and shaken 10 times to ensure the filter was completely saturated with the buffer solution. The initial headspace analysis was then completed as described below. Following the initial head space analysis 20ul of the sample was extracted using a 30ul glass syringe and 20ul of 5mM DMSP (32.38mg/ml stock) was added. A control, containing similar conditions with the exemption of the filtered cells, was also performed.

16.2.2 GC Calibration

The GC machine was calibrated using the following standards:

Standard Concentration (µM)	NaOH (µl)	DW (µl)	Total Volume (µl)	DMSP Added (µl)
1.67	500	3498.33	4000	6
5	500	3495.00	4000	5
10	500	3490.00	4000	10
15	500	3485.00	4000	15
20.1	500	3479.90	4000	20.1

Both the integer and the gradient of the line created from the calibrations were used to calculate the quantity of DMS produced at each time period during the experiments.

16.2.3 Headspace analysis

Headspace analysis was completed at the following intervals: 0 minutes (immediately after crimping of the glass vial); 20 minutes (after DMSP addition) and then every 20 minutes after this, up to 120 minutes.

Method GC-NL: The prep system was set to purge and the loop placed into liquid Nitrogen for approximately 8 seconds, the Nitrogen heater was then switched on (-155-165). 100 µl headspace from the vial is extracted using a 100ul glass syringe and injected into the purge tube. The headspace was purged for 2 minutes. During this period the computer was set entering correct date, time and name for standard for future reference and the kettle was boiled ready for injection. Each time headspace was removed from a vial, 100ul of air was injected back to prevent a vacuum occurring. After 2 minutes the Nitrogen heater was turned off, the computer was set to inject and the GC machine was switched on. The prep system was then set to inject and the loop was removed from the liquid Nitrogen into boiling water in the kettle (for 7-10 seconds).

The quantities of DMS (µM) produced were plotted against time to illustrate the rate at which DMS is cleaved from DMSP by DMSP Lyase enzymes.

Triplicates were completed for each station to enhance the accuracy and reliability of the data, along with a control containing similar conditions but excluding filtered cells.

16.3 Results

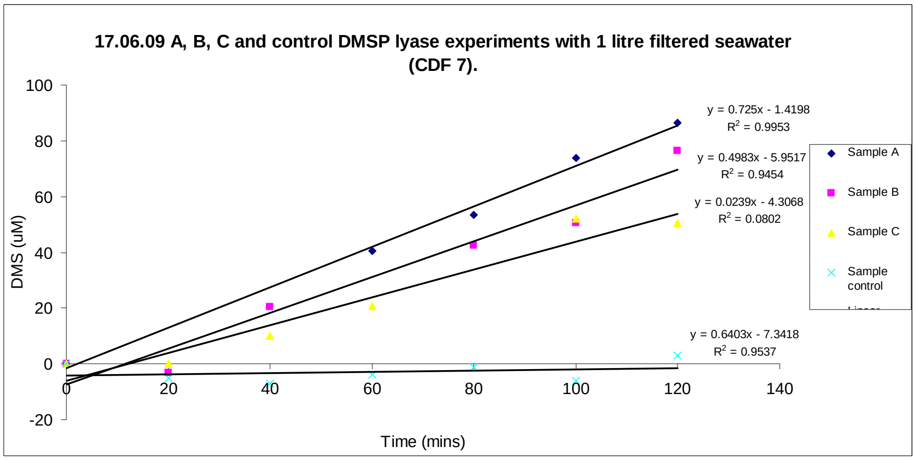


Figure 16.1. This graph displays in triplicate the rate at which 5mM of DMSP is converted to DMS by DMSP Lyase enzymes at CTD Station F.

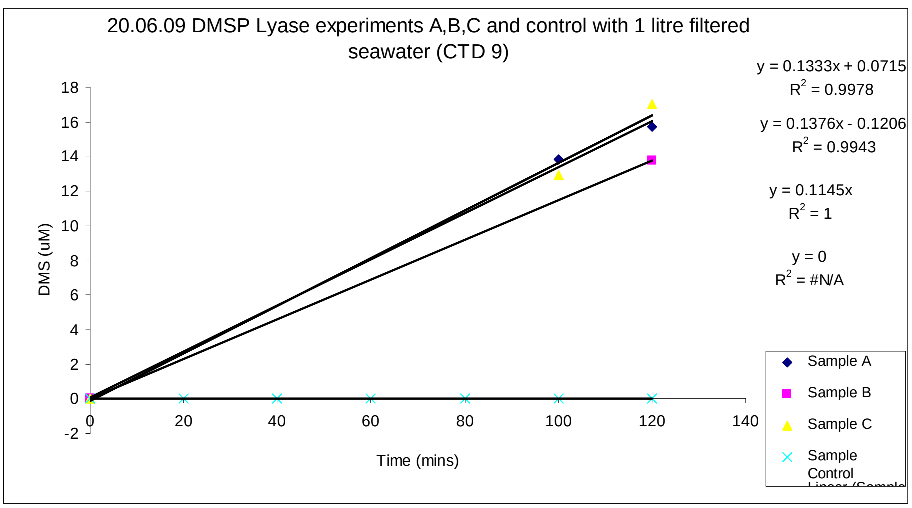


Figure 16.2. This graph displays in triplicate the rate at which 5mM of DMSP is converted to DMS by DMSP Lyase enzymes at CTD Station O.

17 CTD Technical data

Jon Short (NMFSS)

CTDs were deployed using the ship fitted winch (standard CTD cable until CTD Cast 034 after which point the Fibre Optic CTD cable was used due to "birds-nesting" of the wire) and the starboard gantry. The CTD "railway track" was used to allow the stainless steel and Titanium CTDs to be swapped over quickly.

17.1 CTD Instrumentation

A total of 88 CTD profiles were carried out, 79 with the Stainless Steel frame and 7 with the Titanium frame. The stainless steel frame and configuration were as follows:

• Sea-Bird 9/11 *plus* CTD System

• 24 by 20L Ocean Test Equipment External Spring Water Samplers until cast 022 when they were replced with 24 10L Ocean Test Equipment External Spring Water Samplers on the stainless frame – the Titanium frame used 24 10L Ocean Test Equipment External Spring metal free water samplers.

• Sea-Bird 43 Oxygen Sensor

• Chelsea MKIII Aquatracka Fluorometer

• Chelsea MKII Alphatracka 25cm path Transmissometer

• OED LADCP Pressure Case Battery Pack

• Benthos Altimeter

The pressure sensor was located 30cm from the bottom of the water samplers, and 119cm from the top of the water samplers when using the 10l bottles.

In addition the Stainless Steel frame used;

• RD Instruments Workhorse 300 KHz Lowered ADCP (downward-looking)

17.2 CTD Instrument Configuration

The Sea-Bird CTD configuration can be found in the relevant con files on the D340 SeaBird data disk. The Stainless CTD calibration details were as follows:-

```
PSA file: C:\Program Files\Sea-Bird\SeasaveV7\D340\Data\D340.psa

Date: 06/23/2009

Instrument configuration file: C:\Program Files\Sea-
Bird\SeasaveV7\D340\D340 SS.con

Configuration report for SBE 911plus/917plus CTD
------------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
```

```
NMEA position data added      : Yes
NMEA depth data added         : No
NMEA time added               : No
NMEA device connected to      : deck unit
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 4105
   Calibrated on : 19th mar 09
   G             : 4.39453600e-003
   H             : 6.48516422e-004
   I             : 2.36542375e-005
   J             : 2.16839133e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 3052
   Calibrated on : 13th Mar 09
   G             : -1.01174190e+001
   H             : 1.41053652e+000
   I             : 1.22363879e-004
   J             : 6.45200898e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 90573
   Calibrated on : 20 Oct 2008
   C1            : -4.666978e+004
   C2            : -2.615846e-001
   C3            : 1.373870e-002
   D1            : 3.884300e-002
   D2            : 0.000000e+000
   T1            : 3.015158e+001
   T2            : -3.442071e-004
   T3            : 4.048350e-006
   T4            : 2.094500e-009
   T5            : 0.000000e+000
   Slope         : 0.99987000
   Offset        : -0.40170
   AD590M        : 1.280800e-002
   AD590B        : -9.338280e+000

4) Frequency 3, Temperature, 2

   Serial number : 4116
   Calibrated on : 31st Mar 09
   G             : 4.42605566e-003
   H             : 6.84566196e-004
```

```
   I              : 2.45362594e-005
   J              : 2.02890935e-006
   F0             : 1000.000
   Slope          : 1.00000000
   Offset         : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 2580
   Calibrated on : 13th Mar 09
   G             : -1.03509359e+001
   H             : 1.52178267e+000
   I             : 3.06222787e-004
   J             : 6.65767743e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

   Serial number : 0709
   Calibrated on : 28 may 08
   Equation      : Sea-Bird
   Soc           : 4.29400e-001
   Offset        : -4.95700e-001
   A             : 1.33110e-003
   B             : 1.51160e-004
   C             : -3.22560e-006
   E             : 3.60000e-002
   Tau20         : 1.58000e+000
   D1            : 1.92630e-004
   D2            : -4.64800e-002
   H1            : -3.30000e-002
   H2            : 5.00000e+003
   H3            : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

   Serial number : 112522
   Calibrated on : 1 mar 04
   Scale factor  : 15.000
   Offset        : 0.000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

   Serial number : 088195
   Calibrated on : 27 May 2008
   VB            : 0.175800
   V1            : 2.072600
   Vacetone      : 0.272400
   Scale factor  : 1.000000
   Slope         : 1.000000
   Offset        : 0.000000
```

```
10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

    Serial number        : 5
    Calibrated on        : 14 apr 08
    M                    : 0.49580100
    B                    : 0.99722200
    Calibration constant : 100000000000.00000000
    Multiplier           : 0.99990000
    Offset               : 0.00000000

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

    Serial number        : 1
    Calibrated on        : 18 nov 08
    M                    : 0.45817400
    B                    : 1.56845000
    Calibration constant : 100000000000.00000000
    Multiplier           : 0.99820000
    Offset               : 0.00000000

12) A/D voltage 6, User Polynomial

    Serial number : 167
    Calibrated on : 13 may 08
    Sensor name   : BBRTD
    A0            : 0.00040222
    A1            : 0.00338000
    A2            : 0.00000000
    A3            : 0.00000000

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar

    Serial number : 161048
    Calibrated on : 28 may 08
    M             : 23.6477
    B             : -0.4966
    Path length   : 25.000

---------------------------------------------
Pump Control
   This setting is only applicable to a custom build of the SBE 9plus.
   Enable pump on / pump off commands: NO
---------------------------------------------
Data Acquisition:
   Archive data:                    YES
   Delay archiving:                 NO
   Data archive:                    C:\Program
Files\Sea-Bird\SeasaveV7\D340\D340_CTD_072.hex
   Timeout (seconds) at startup:    20
   Timeout (seconds) between scans: 20
---------------------------------------------
Instrument port configuration:
   Port      = COM1
   Baud rate = 19200
   Parity    = N
   Data bits = 8
   Stop bits = 1
```

```
---------------------------------------------
Water Sampler Data:
   Water Sampler Type:   SBE Carousel
   Number of bottles:    36
   Port:                 COM3
   Enable remote firing: NO
   Firing sequence:      User input
   Tone for bottle fire confirmation uses PC internal speakers.
---------------------------------------------
Header information:
   Header Choice = Prompt for Header Information
      prompt 0 = Ship: RRS Discovery
      prompt 1 = Cruise: D340
      prompt 2 = Cast Number:
      prompt 3 = Station:
      prompt 4 = Latitude:
      prompt 5 = Longtitude:
      prompt 6 = Date (Julian Day):
      prompt 7 = Time (G.M.T.):
      prompt 8 = Depth:
      prompt 9 = P.S.O. Toby Sherwin
      prompt 10 = Operator:
---------------------------------------------
TCP/IP - port numbers:
   Data acquisition:
      Data port:            49163
      Status port:          49165
      Command port:         49164
   Remote bottle firing:
      Command port:         49167
      Status port:          49168
   Remote data publishing:
      Converted data port:  49161
      Raw data port:        49160
---------------------------------------------
Miscellaneous data for calculations
   Depth and Average Sound Velocity
      Latitude when NMEA is not available: 0.000
   Average Sound Velocity
      Minimum pressure [db]:               20.000
      Minimum salinity [psu]:              20.000
      Pressure window size [db]:           20.000
      Time window size [s]:                60.000
   Descent and Acceleration
      Window size [s]:                     2.000
   Plume Anomaly
      Theta-B:                             0.000
      Salinity-B                           0.000
      Theta-Z / Salinity-Z                 0.000
      Reference pressure [db]              0.000
   Oxygen
      Window size [s]:                     2.000
      Apply hysteresis correction:         1
      Apply Tau correction:                1
   Potential Temperature Anomaly
      A0:                                  0.000
      A1:                                  0.000
```

```
      A1 Multiplier:                       Salinity
---------------------------------------------
Serial Data Output:
   Output data to serial port: NO
---------------------------------------------
Mark Variables:
   Variables:
   Digits   Variable Name [units]
   ------   ---------------------
   0        Scan Count
   4        Depth [salt water, m]
   7        Conductivity [S/m]
   5        Salinity [PSU]
---------------------------------------------
Shared File Output:
   Output data to shared file: NO
---------------------------------------------
TCP/IP Output:
   Raw data:
      Output raw data to socket:              NO
      XML wrapper and settings:               NO
      Seconds between raw data updates:       2.000
   Converted data:
      Output converted data to socket:        YES
      XML format:                             YES
      Seconds between converted data updates: 2.000
      Variables:
      Digits   Variable Name [units]
      ------   ---------------------
      4        Depth [salt water, m]
      4        Pressure, Digiquartz [db]
      5        Temperature [ITS-90, deg C]
      5        Temperature, 2 [ITS-90, deg C]
      5        Temperature Difference, 2 - 1 [ITS-90, deg C]
      7        Conductivity [mS/cm]
      7        Conductivity, 2 [mS/cm]
      7        Conductivity Difference, 2 - 1 [mS/cm]
      5        Salinity [PSU]
      5        Salinity, 2 [PSU]
      5        Salinity Difference, 2 - 1 [PSU]
      6        Oxygen, SBE 43 [ml/l]
      5        Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
      5        Beam Transmission, Chelsea/Seatech/Wetlab CStar [%]
      3        Altimeter [m]
---------------------------------------------
SBE 11plus Deck Unit Alarms
   Enable minimum pressure alarm:    NO
   Enable maximum pressure alarm:    NO
   Enable altimeter alarm:           NO
---------------------------------------------
SBE 14 Remote Display
   Enable SBE 14 Remote Display:     NO
---------------------------------------------
PC Alarms
   Enable minimum pressure alarm:    NO
   Enable maximum pressure alarm:    NO
   Enable altimeter alarm:           NO
```

```
   Enable bottom contact alarm:      NO
   Alarm uses PC sound card.
---------------------------------------------
Options:
   Prompt to save program setup changes: YES
   Automatically save program setup changes on exit: NO
   Confirm instrument configuration change: YES
   Confirm display setup changes: YES
   Confirm output file overwrite: YES
   Check scan length: YES
   Compare serial numbers: YES
   Maximized plot may cover Seasave: NO
```

And the Titanium frame configuration;

```
PSA file: C:\Program Files\Sea-Bird\SeasaveV7\D340\Data\D340.psa

Date: 06/23/2009

Instrument configuration file: C:\Program Files\Sea-
Bird\SeasaveV7\D340\D340 TIT.con

Configuration report for SBE 911plus/917plus CTD
------------------------------------------------

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

1) Frequency 0, Temperature

   Serial number : 4380
   Calibrated on : 9th January 2009
   G             : 4.37208414e-003
   H             : 6.54932584e-004
   I             : 2.36994910e-005
   J             : 1.85148767e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 2165
   Calibrated on : 30/4/09
   G             : -1.07763557e+001
   H             : 1.48190500e+000
   I             : -2.55452179e-003
   J             : 2.52181195e-004
```

```
   CTcor          : 3.2500e-006
   CPcor          : -9.57000000e-008
   Slope          : 1.00000000
   Offset         : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 93896
   Calibrated on : 27 May 2008
   C1             : -8.331332e+004
   C2             : -3.281962e-001
   C3             : 2.216060e-002
   D1             : 2.906000e-002
   D2             : 0.000000e+000
   T1             : 3.005232e+001
   T2             : -3.843669e-004
   T3             : 4.436390e-006
   T4             : 0.000000e+000
   T5             : 0.000000e+000
   Slope          : 0.99999000
   Offset         : -1.39810
   AD590M         : 1.289250e-002
   AD590B         : -8.106440e+000

4) Frequency 3, Temperature, 2

   Serial number : 4383
   Calibrated on : 7/4/09
   G              : 4.39884574e-003
   H              : 6.55750785e-004
   I              : 2.44567368e-005
   J              : 2.06041020e-006
   F0             : 1000.000
   Slope          : 1.00000000
   Offset         : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 2164
   Calibrated on : 30/4/09
   G              : -9.93396028e+000
   H              : 1.36974324e+000
   I              : -2.65227233e-003
   J              : 2.43844517e-004
   CTcor          : 3.2500e-006
   CPcor          : -9.57000000e-008
   Slope          : 1.00000000
   Offset         : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

   Serial number : 0363
   Calibrated on : 19/2/09
   Equation       : Sea-Bird
   Soc            : 3.24300e-001
   Offset         : -6.45200e-001
   A              : -1.74890e-003
```

```
   B              : 1.44090e-004
   C              : -3.18240e-006
   E              : 3.60000e-002
   Tau20          : 1.65000e+000
   D1             : 1.92630e-004
   D2             : -4.64800e-002
   H1             : -3.30000e-002
   H2             : 5.00000e+003
   H3             : 1.45000e+003

7) A/D voltage 1, Free

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

   Serial number : 088163
   Calibrated on : 27 May 08
   VB            : 0.076200
   V1            : 1.972200
   Vacetone      : 0.125600
   Scale factor  : 1.000000
   Slope         : 1.000000
   Offset        : 0.000000

9) A/D voltage 3, Altimeter

   Serial number : 619211949
   Calibrated on : 1 Mar 04
   Scale factor  : 15.000
   Offset        : 0.000

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

    Serial number        : 6
    Calibrated on        : 26 Oct 07
    M                    : 0.45562700
    B                    : 1.70243600
    Calibration constant : 1000000000000.00000000
    Multiplier           : 0.99980000
    Offset               : 0.00000000

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

    Serial number        : 1
    Calibrated on        : 18 nov 08
    M                    : 0.45817400
    B                    : 1.56845000
    Calibration constant : 100000000000.00000000
    Multiplier           : 0.99820000
    Offset               : 0.00000000

12) A/D voltage 6, Transmissometer, Chelsea/Seatech/Wetlab CStar

    Serial number : 161/2642/002
    Calibrated on : 4/9/96
    M             : 21.1488
    B             : -0.4653
    Path length   : 25.000
```

```
13) A/D voltage 7, User Polynomial

    Serial number : 168
    Calibrated on : 10/10/06
    Sensor name   : BBRTD
    A0            : 0.00000365
    A1            : 0.00298900
    A2            : 0.00000000
    A3            : 0.00000000

---------------------------------------------
Pump Control
   This setting is only applicable to a custom build of the SBE 9plus.
   Enable pump on / pump off commands: NO
---------------------------------------------
Data Acquisition:
   Archive data:                    YES
   Delay archiving:                 NO
   Data archive:                    C:\Program
Files\Sea-Bird\SeasaveV7\D340\D340_CTD_072.hex
   Timeout (seconds) at startup:    20
   Timeout (seconds) between scans: 20
---------------------------------------------
Instrument port configuration:
   Port      = COM1
   Baud rate = 19200
   Parity    = N
   Data bits = 8
   Stop bits = 1
---------------------------------------------
Water Sampler Data:
   Water Sampler Type:   SBE Carousel
   Number of bottles:    36
   Port:                 COM3
   Enable remote firing: NO
   Firing sequence:      User input
   Tone for bottle fire confirmation uses PC internal speakers.
---------------------------------------------
Header information:
   Header Choice = Prompt for Header Information
      prompt 0 = Ship: RRS Discovery
      prompt 1 = Cruise: D340
      prompt 2 = Cast Number:
      prompt 3 = Station:
      prompt 4 = Latitude:
      prompt 5 = Longtitude:
      prompt 6 = Date (Julian Day):
      prompt 7 = Time (G.M.T.):
      prompt 8 = Depth:
      prompt 9 = P.S.O. Toby Sherwin
      prompt 10 = Operator:
---------------------------------------------
TCP/IP - port numbers:
   Data acquisition:
      Data port:            49163
      Status port:          49165
```

```
      Command port:         49164
   Remote bottle firing:
      Command port:         49167
      Status port:          49168
   Remote data publishing:
      Converted data port:  49161
      Raw data port:        49160
---------------------------------------------
Miscellaneous data for calculations
   Depth and Average Sound Velocity
      Latitude when NMEA is not available: 0.00000000
   Average Sound Velocity
      Minimum pressure [db]:               20.00000000
      Minimum salinity [psu]:              20.00000000
      Pressure window size [db]:           20.00000000
      Time window size [s]:                60.00000000
   Descent and Acceleration
      Window size [s]:                     2.00000000
   Plume Anomaly
      Theta-B:                             0.00000000
      Salinity-B                           0.00000000
      Theta-Z / Salinity-Z                 0.00000000
      Reference pressure [db]              0.00000000
   Oxygen
      Window size [s]:                     2.00000000
      Apply hysteresis correction:         1
      Apply Tau correction:                1
   Potential Temperature Anomaly
      A0:                                  0.00000000
      A1:                                  0.00000000
      A1 Multiplier:                       Salinity
---------------------------------------------
Serial Data Output:
   Output data to serial port: NO
---------------------------------------------
Mark Variables:
   Variables:
   Digits   Variable Name [units]
   ------   ---------------------
   0        Scan Count
   4        Depth [salt water, m]
   7        Conductivity [S/m]
   5        Salinity [PSU]
---------------------------------------------
Shared File Output:
   Output data to shared file: NO
---------------------------------------------
TCP/IP Output:
   Raw data:
      Output raw data to socket:              NO
      XML wrapper and settings:               NO
      Seconds between raw data updates:       2.00000000
   Converted data:
      Output converted data to socket:        YES
      XML format:                             YES
      Seconds between converted data updates: 2.00000000
      Variables:
```

```
      Digits   Variable Name [units]
      ------   ---------------------
      4        Depth [salt water, m]
      4        Pressure, Digiquartz [db]
      5        Temperature [ITS-90, deg C]
      5        Temperature, 2 [ITS-90, deg C]
      5        Temperature Difference, 2 - 1 [ITS-90, deg C]
      7        Conductivity [mS/cm]
      7        Conductivity, 2 [mS/cm]
      7        Conductivity Difference, 2 - 1 [mS/cm]
      5        Salinity [PSU]
      5        Salinity, 2 [PSU]
      5        Salinity Difference, 2 - 1 [PSU]
      6        Oxygen, SBE 43 [ml/l]
      5        Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
      5        Beam Transmission, Chelsea/Seatech/Wetlab CStar [%]
      3        Altimeter [m]
---------------------------------------------
SBE 11plus Deck Unit Alarms
   Enable minimum pressure alarm:    NO
   Enable maximum pressure alarm:    NO
   Enable altimeter alarm:           NO
---------------------------------------------
SBE 14 Remote Display
   Enable SBE 14 Remote Display:     NO
---------------------------------------------
PC Alarms
   Enable minimum pressure alarm:    NO
   Enable maximum pressure alarm:    NO
   Enable altimeter alarm:           NO
   Enable bottom contact alarm:      NO
   Alarm uses PC sound card.
---------------------------------------------
Options:
   Prompt to save program setup changes: YES
   Automatically save program setup changes on exit: NO
   Confirm instrument configuration change: YES
   Confirm display setup changes: YES
   Confirm output file overwrite: YES
   Check scan length: YES
   Compare serial numbers: YES
   Maximized plot may cover Seasave: NO
```

17.3 Script files

The script file for the RDI LADCP was changed for CTD cast 009 to this;

```
PS0
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
```

```
EZ0011111
TE00:00:01.00
TP00:01.00
WD111100000
WF0500
WN016
WP00001
WS1000
WV250
WJ1
WW1
WZ30
SM1
SA001
SW05000
CK
CS
```

The script file used for the cast up to this point was;

```
PS0
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0011111
TE00:00:01.00
TP00:01.00
LD111100000
LF0500
LN016
LP00001
LS1000
LV250
LJ1
LW1
LZ30,220
SM1
SA001
SW05000
CK
CS
```

18 Moorings report

Rob McLachlan (NMFSS)

Sediment trap coming on board

18.1 Introduction

A total of 4 sediment trap moorings were recovered from the Iceland Basin which had data belonging to an Oceans2025 Theme 3 project. In addition it was intended to turn round an ADCP mooring on the Wyville Thomson Ridge. In the event this mooring failed to come up and it was replaced by one of the Iceland Basin ADCPs.

18.2 Diary of events.

18.2.1 13/6/2009, STNW.

Arrived on station and started comms at 06.16, comms established straight away and the release command was sent at 06.17. Good ranges received.

First buoyancy on board at 07.27, stopped off on deck to move the scrolling to the side of the winch as shackles and links would not go through. All on board at 07.59.

Removed sediment trap bottles and put the lids on all, stored in the fridge.

Washed down current meter and release. Stopped current meter at 10.00 GMT.

18.2.2 13/6/2009 STC

Started comms at 12.11 GMT, comms established with no problems. Good ranges were received and the release command was sent at 12.13.30, the range didn't change for the first 4 release command sends.

First buoyancy on board at 13.28.

Bad tangle along the 1000m length towards the bottom, the RCM was recovered, and then the 6 pack of glass then the release and then the sediment trap.

Removed sediment trap bottles, put lids on and stored in the fridge.

Washed down current meter and release. Current meter stopped at 18.00 GMT.

18.2.3 13/6/2009 STS

Started comms at 19.13, good comms received straight away and the release command was sent at 19.16, good set of ranges gathered and an accent rate of 65m/min was established.

First buoyancy on deck at 20.20, all on deck at 20.40.

Removed sediment trap bottles, put lids on and stored in the fridge, some confusion over the labels/notes.

Release and current meter washed down, current meter turned off at 10.00 on the 14/6/2009.

18.2.4 14/6/2009 STNE

Arrived at mooring site and started comms at 13.56. No ranges were received. The release command was sent at 13.58 and we continued to send the release command until 14.05, still no ranges were received or confirmation of release. At this point we moved the ship closer and started again, we still had no ranges or confirmation of release. We moved the ship closer again and started comms but to no avail, the two deck units on board and both transducer cables were used.

At 14.45 the mooring was spotted on the surface.

The mooring had obviously released, probably using the back up PP3 battery.

Recovery commenced with the first pack of buoyancy on board at 15.05. The release was on board at 15.23, all went well.

The sediment trap bottles were removed from the traps, lids on and then refrigerated,

Current meter and release washed down.

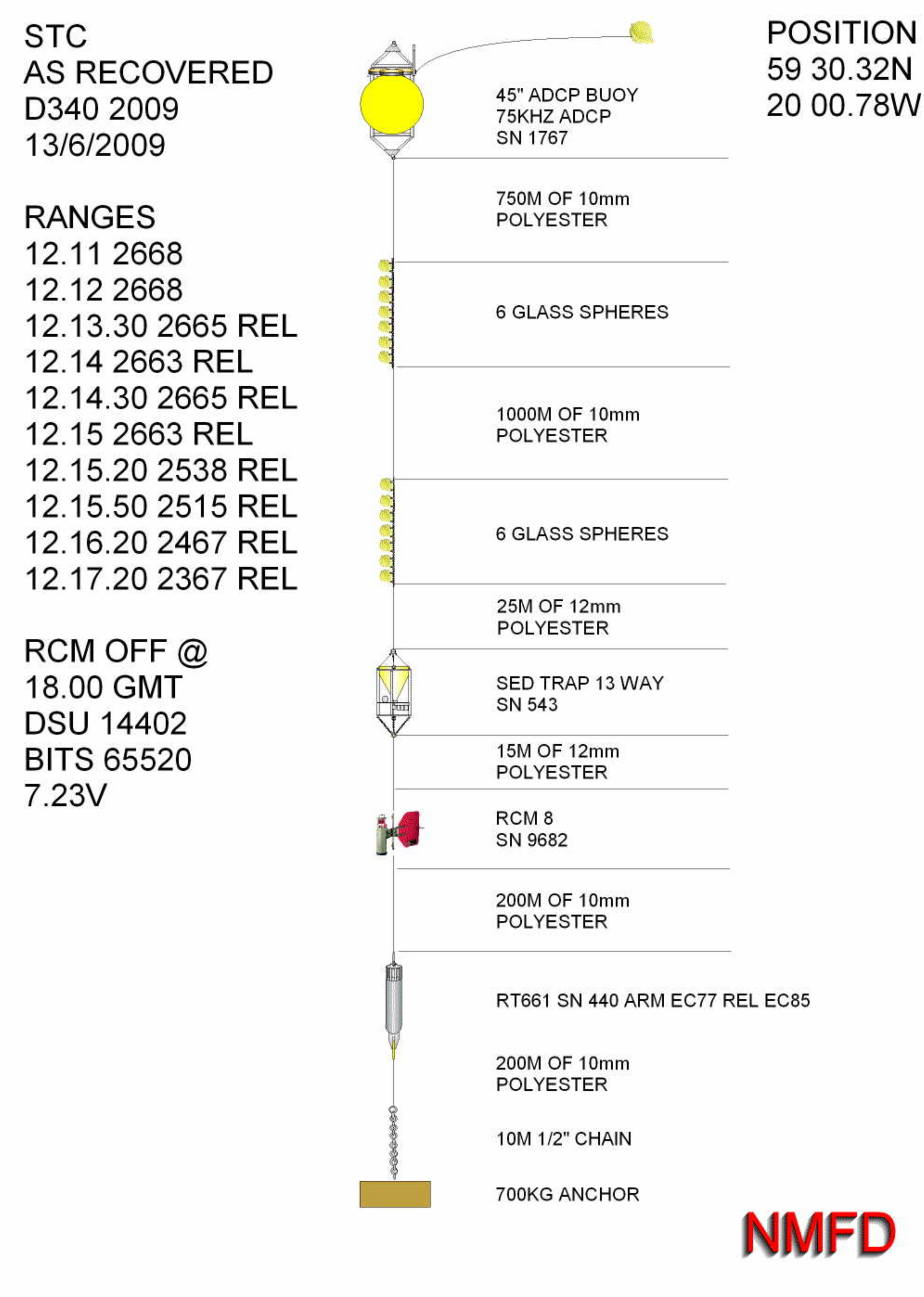
Current meter turned off at 19.00.

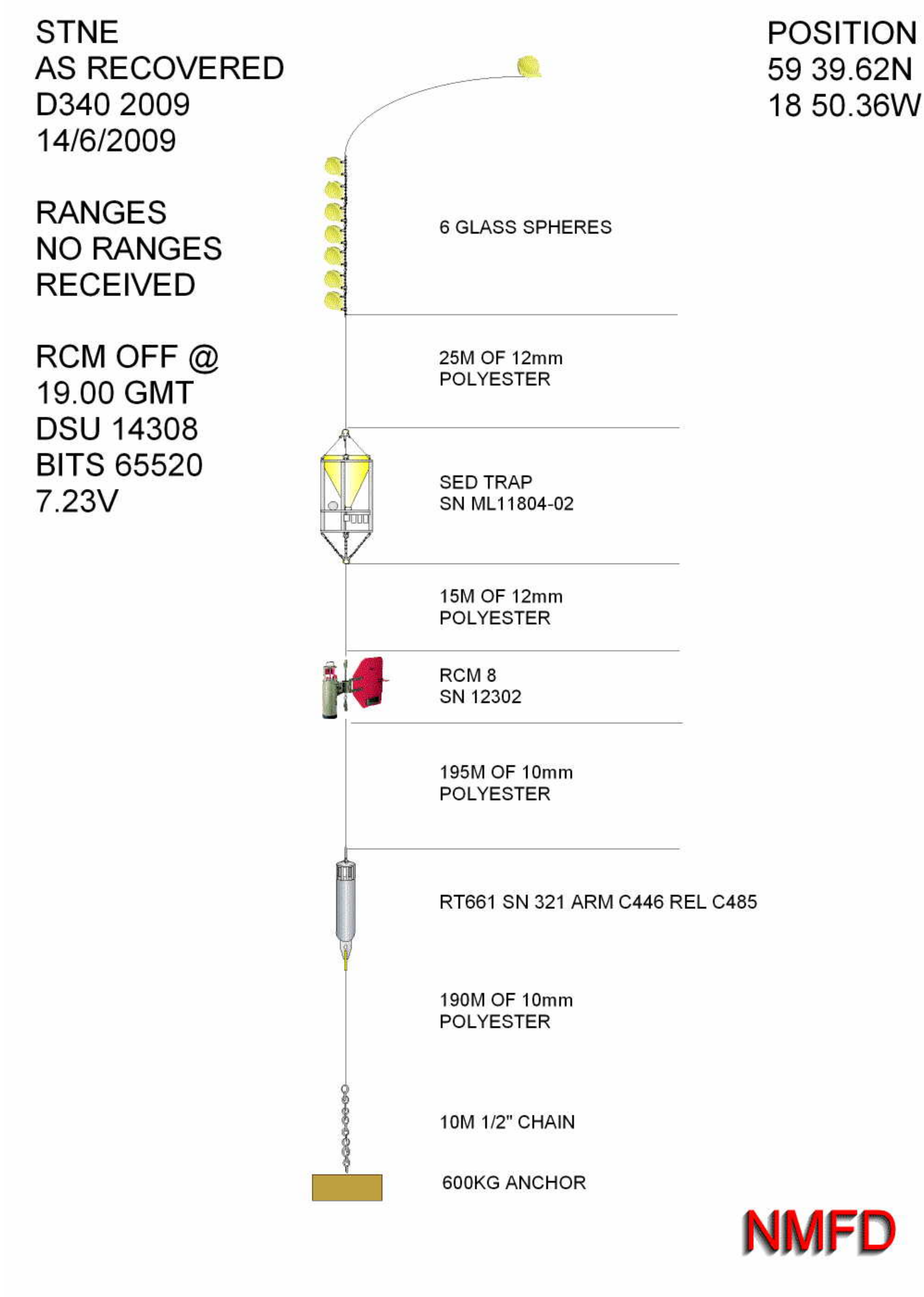
The data from the ADCP recovered from mooring STC was downloaded on this day, a backup copy saved on the on board computing system.

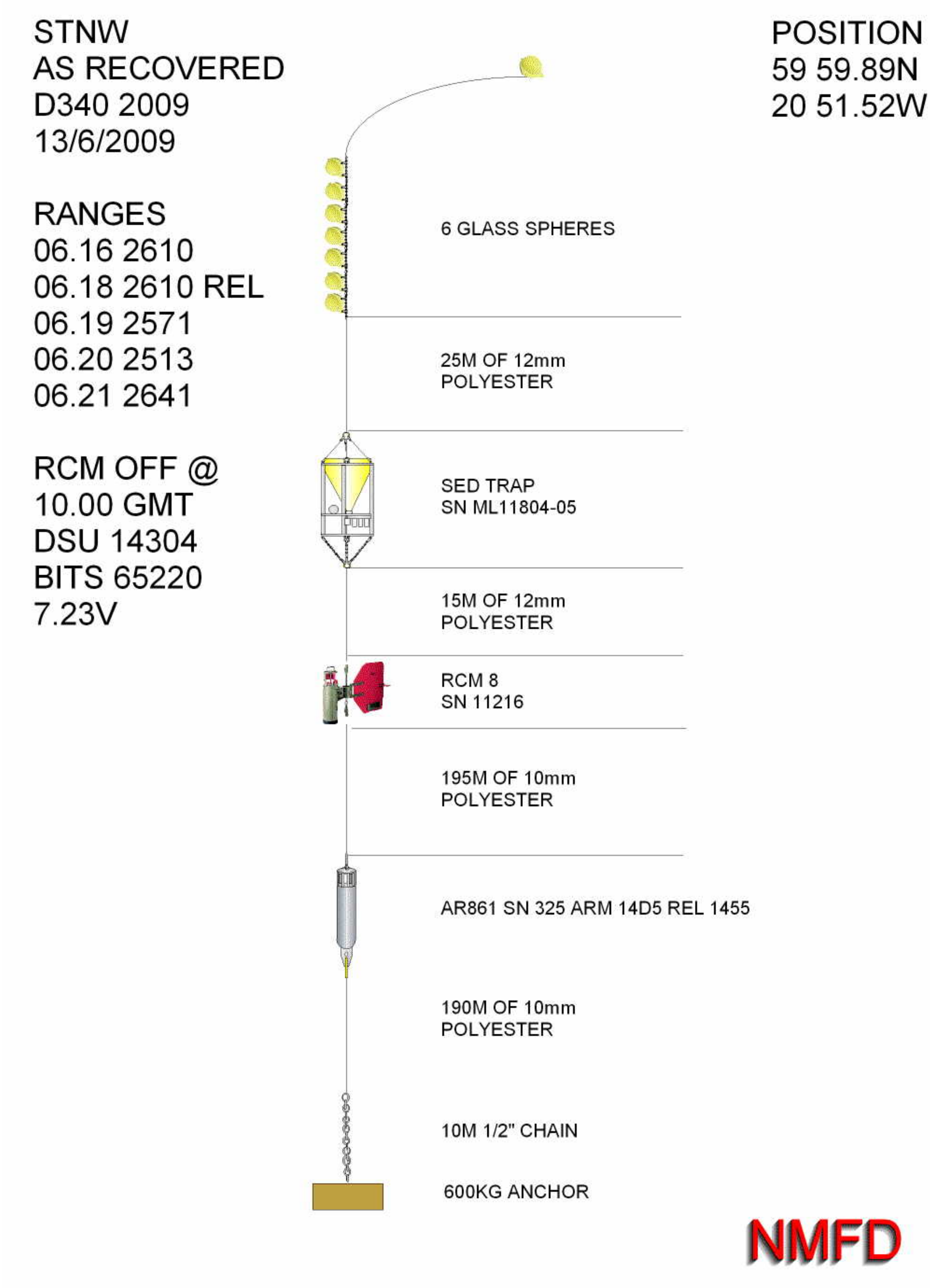
18.2.5 23/6/2009

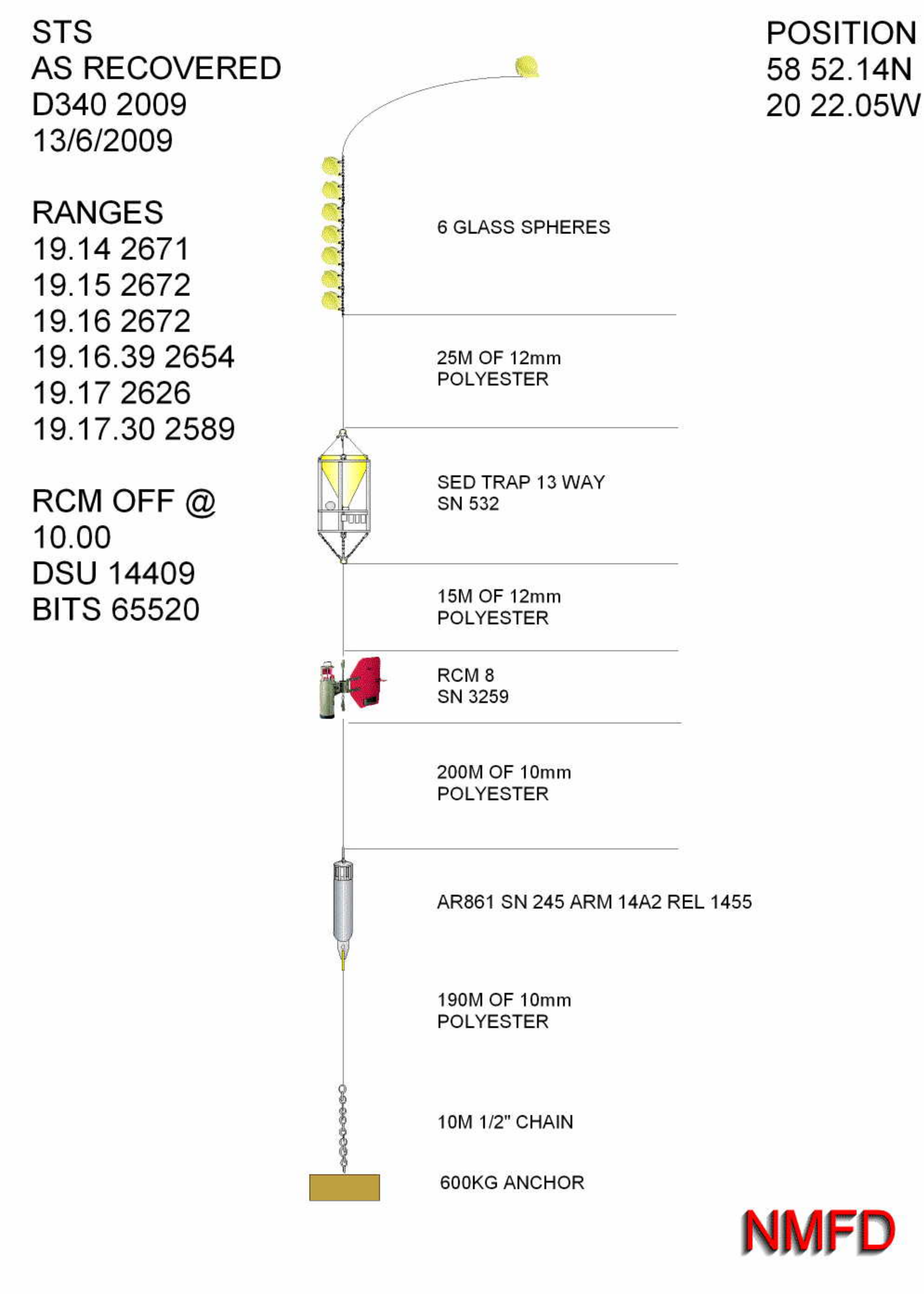
Due to the SAMS ADCP mooring not being recovered, we built a replacement mooring using the recovered ADCP and associated equipment.

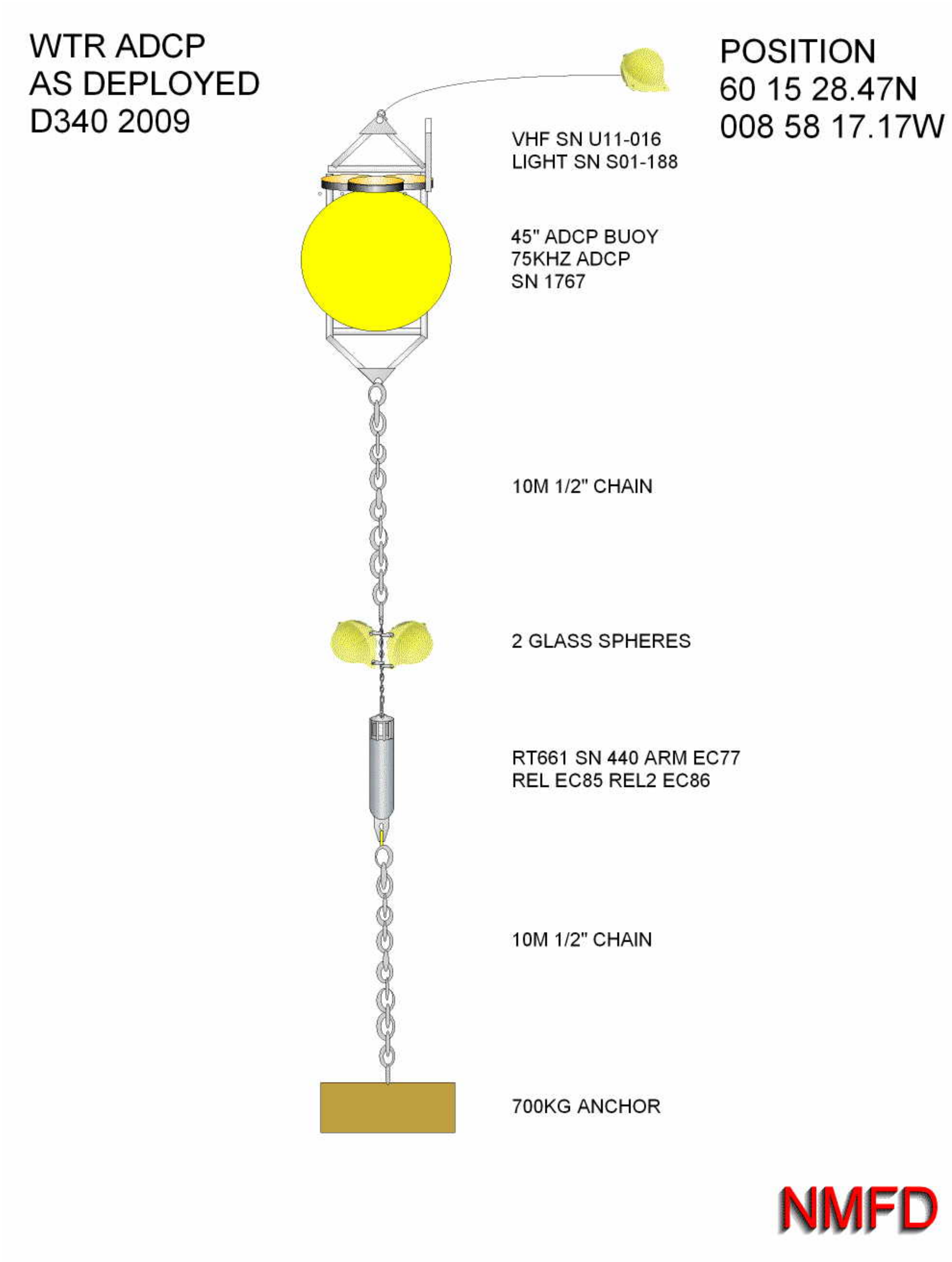
The mooring was deployed without incident and the release was ranged on the way to the seabed giving good ranges.


STC
AS RECOVERED
D340 2009
13/6/2009
RANGES
12.11 2668
12.12 2668
12.13.30 2665 REL
12.14 2663 REL
12.14.30 2665 REL
12.15 2663 REL
12.15.20 2538 REL
12.15.50 2515 REL
12.16.20 2467 REL
12.17.20 2367 REL
RCM OFF @
18.00 GMT
DSU 14402
BITS 65520
7.23V
POSITION
59 30.32N
20 00.78W
45" ADCP BUOY
75KHZ ADCP
SN 1767
750M OF 10mm
POLYESTER
6 GLASS SPHERES
1000M OF 10mm
POLYESTER
6 GLASS SPHERES
25M OF 12mm
POLYESTER
SED TRAP 13 WAY
SN 543
15M OF 12mm
POLYESTER
RCM 8
SN 9682
200M OF 10mm
POLYESTER
RT661 SN 440 ARM EC77 REL EC85
200M OF 10mm
POLYESTER
10M 1/2" CHAIN
700KG ANCHOR
NMFD


STNE
AS RECOVERED
D340 2009
14/6/2009
RANGES
NO RANGES
RECEIVED
RCM OFF @
19.00 GMT
DSU 14308
BITS 65520
7.23V
POSITION
59 39.62N
18 50.36W
6 GLASS SPHERES
25M OF 12mm
POLYESTER
SED TRAP
SN ML11804-02
15M OF 12mm
POLYESTER
RCM 8
SN 12302
195M OF 10mm
POLYESTER
RT661 SN 321 ARM C446 REL C485
190M OF 10mm
POLYESTER
10M 1/2" CHAIN
600KG ANCHOR
NMFD


STNW
AS RECOVERED
D340 2009
13/6/2009
POSITION
59 59.89N
20 51.52W
RANGES
06.16 2610
06.18 2610 REL
06.19 2571
06.20 2513
06.21 2641
RCM OFF @
10.00 GMT
DSU 14304
BITS 65220
7.23V
6 GLASS SPHERES
25M OF 12mm
POLYESTER
SED TRAP
SN ML11804-05
15M OF 12mm
POLYESTER
RCM 8
SN 11216
195M OF 10mm
POLYESTER
AR861 SN 325 ARM 14D5 REL 1455
190M OF 10mm
POLYESTER
10M 1/2" CHAIN
600KG ANCHOR
NMFD


STS
AS RECOVERED
D340 2009
13/6/2009
RANGES
19.14 2671
19.15 2672
19.16 2672
19.16.39 2654
19.17 2626
19.17.30 2589
RCM OFF @
10.00
DSU 14409
BITS 65520
POSITION
58 52.14N
20 22.05W
6 GLASS SPHERES
25M OF 12mm
POLYESTER
SED TRAP 13 WAY
SN 532
15M OF 12mm
POLYESTER
RCM 8
SN 3259
200M OF 10mm
POLYESTER
AR861 SN 245 ARM 14A2 REL 1455
190M OF 10mm
POLYESTER
10M 1/2" CHAIN
600KG ANCHOR
NMFD


WTR ADCP
AS DEPLOYED
D340 2009
POSITION
60 15 28.47N
008 58 17.17W
VHF SN U11-016
LIGHT SN S01-188
45" ADCP BUOY
75KHZ ADCP
SN 1767
10M 1/2" CHAIN
2 GLASS SPHERES
RT661 SN 440 ARM EC77
REL EC85 REL2 EC86
10M 1/2" CHAIN
700KG ANCHOR
NMFD

18.3 Instrumentation

18.3.1 Sediment traps.

Four sediment traps were recovered; all had worked well with no problems.

The samples were removed, checking that the numbers tallied with the supplied paperwork. The lids were screwed on and the samples were refrigerated.

The operations files were not downloaded on board and will need to be done when back in the UK.

18.3.2 Current meters.

Four current meters (Aanderaa RCM 8,s) were recovered. All were washed down and were turned off as detailed below.

None of the data was downloaded on board and will need to be done when back in the UK.

Serial Number	Date Switched Off	Time Switched Off	Dsu Number	Bits
9682	13/6/2009	18.00	14402	65520
12302	14/6/2009	19.00	14308	65520
11216	13/6/2009	10.00	14394	65520
3259	14/6/2009	10.00	14409	65520

18.3.3 ADCP

One ADCP was recovered this cruise, SN 1767. The data was downloaded and backed up on the ships system.

The ADCP was removed from the buoy and had new batteries installed. The ADCP was then tested and set up for deployment on the WTR.

The ADCP was deployed on the 23rd June 2009.

18.3.4 Acoustic releases

Four releases were used on this trip; all recovered from the Station India moorings.

SN’s 440, 321, 245 and 325.

All worked well giving good ranges apart from SN 321, this was deployed on STNE. During recovery the release did not give any ranges or confirmation of release even though it had releases.

Sn 321 was serviced and had new batteries installed along with 440 and they were both wire tested to 1200m. 440 gave good ranges and confirmation of release but there was nothing received from 321. Upon recovery both had fired. 440 was subsequently deployed on the WTR ADCP mooring.

Natural Environment Research Council Southampton Oceanography Centre

National Marine Facilities

MORS SYSTEMS
Operational Sheet

CRUISE D340 **DATE 23RD JUNE 2009**

TYPE	**RT 661 B2S-DDL**
FUNCTION	**RELEASE TRANSPONDER RT661 - B**
SERIAL No.	**440**
Delivery	**FEB 2001**

Int Frequency	**Reply Frequency**
FR1 = 9.0khz	**FT1 = 10.0khz**
FR2 = 10.0khz	**FT2 = 9.0khz**
FR3 =14.5khz	
FR4 = 15.5khz	**FT4 =10.0khz**

FT0,FT5,FT6,FT7,FT8,FT9,FT10,FT11,FT15 = 12.0khz

Function / Code	**TT301**	**Reply**	**Specifications**
WINDOW	EC77	FT0	Wait time sec Active sec
ON FR1-FR2	EC78	FT0	
OFF FR1-FR2-PINGER	EC79	FT0	
RELEASE 1 (W)	EC85	FT0-FT5	
RELEASE 2 (W)	EC86	FT0-FT6	
DIAGNOSTIC(W)	EC87	FT0-FT7	Measure delay sec Vert offset sec
PYROTECHNIC(W)	EC91	FT0-FT11	Wait time s Pulse s
PINGER (W)	EC94	FT0-FT4	Pulse width Ms Recur sec

Power Configuration	3 banks of 6 alkaline D installed. 1 bank of 1 Alkaline PP3 installed.
Power partition	Standby - power motor
Diagnostic Measure	t(FT7) - t(FT0) - 3s (13 s in horizontal position)
Cells voltage (V)	Diagnostic measure x 4.1
Batteries fitted	**Date:** 23rd June 2009.
Wire test	**Date:** 23rd June 2009, 1200m.
Functions check :	**Date:** 23rd June 2009.
Deployed Mooring	**Date:** 23rd June 2009.
Recovery limit	**Date:** 23rd June 2011.
Recovered	**Date:**

19 Computing

A description of the computing system and the underway sensor package by Chris Barnard is given in the appendices.

Several DVDs were produced at the end of leg A, one of which went to BODC. They contained the following data. Their i.d.s are given in italic and top directories in Courier font:

DVD: CTD_and_moorings

```
CTD_and_moorings\CTD
CTD_and_moorings\CTD1
CTD_and_moorings\CTD2
CTD_and_moorings\ladcp
CTD_and_moorings\moorings
CTD_and_moorings\CTD\24Hz_despiked_uncalibrated
CTD_and_moorings\CTD\24Hz_undespiked_uncalibrated
CTD_and_moorings\CTD\2db_despiked_uncalibrated
CTD_and_moorings\CTD\Btl
CTD_and_moorings\CTD\ladcp_data_files
CTD_and_moorings\CTD\Plots
CTD_and_moorings\CTD\Salinity calibration
CTD_and_moorings\CTD\surfer_plots
CTD_and_moorings\CTD\Plots\24Hz_despiked
CTD_and_moorings\CTD\Plots\24Hz_raw
CTD_and_moorings\CTD\Plots\2db_despiked
CTD_and_moorings\CTD\Plots\TS_toby
CTD_and_moorings\CTD\Salinity calibration\D340 autosal data
CTD_and_moorings\ladcp\Data
CTD_and_moorings\ladcp\Log
CTD_and_moorings\moorings\adcp
```

DVD: OS150

```
OS150\OS150
OS150\SBWR
```

DVD: OS75

DVD: Underway

```
underway\techsas_data
```

DVD: Workingarea

```
workingarea\blog_files
workingarea\cruise_report
workingarea\DATA
workingarea\DMS
workingarea\ladcp_processing
workingarea\logs
workingarea\matlab
workingarea\Photos
workingarea\satellite images
workingarea\underway
workingarea\vmadcp_processing
workingarea\blog_files
```

```
workingarea\cruise_report
workingarea\DATA\CTD
workingarea\DATA\UNDERWAY
workingarea\DATA\CTD
workingarea\ladcp_processing
workingarea\logs
workingarea\matlab
workingarea\Photos
workingarea\satellite images
workingarea\vmadcp_processing
```

Appendix 1

D340a Event Log

D340a Event Log

Evt No.	Date	Station	Latitude	Longitude	Sounding (m)	Time IN	Time bottom	Time OUT	Activity	Comments
001	10/06/09	TEST	63° 37' 07.40'' N	22° 35' 45.58'' W	154	15:06	15:16	15:28	CTD Test	Stainless Steel (SS)
002	10/06/09	TEST	63° 37' 06.97'' N	22° 35' 49.11'' W	153	15:14		06:26 25/06/09	PES deployment	Out of water on 25/06/09 at station 1G Lat:56° 39' 58.21''N Long: 06° 08'03.12''W
003	10/06/09	TEST	63° 37' 06.97'' N	22° 35' 49.11'' W	153	15:40		16:04	Plankton net test	
004	10/06/09	IB23S	63° 19.33' N	20° 13.06' W	123	23:20	23:29	23:49	CTD001	SS
005	10/06/09	IB23S	63° 19.30' N	20° 13.00 W	~125	23:40		06:10 25/06/09	Iron fish deployment	Out of water on 25/06/09 at station 1G Lat:56° 39' 58.21''N Long: 06° 08'03.12''W
006	11/06/09	IB23S	63° 18.90' N	20° 13.01' W	126	00:04		00:11	Plankton Net #1	
007	11/06/09	IB22X	63° 15.84' N	20° 08.07' W	153	01:04	01:20	01:51	CTD002	Titanium (Ti). Problem with primary temp sensor on vane
008	11/06/09	IB22S	63° 12.97' N	20° 04.29' W	690	02:48	03:19	04:03	CTD003	SS
009	11/06/09	IB21S	63° 08.04'N	19° 54.82' W	1043	05:18	05:44	06:28	CTD004	SS
010	11/06/09	IB20S	62° 54.91' N	19° 32.95' W	1417	08:18	08:50	09:49	CTD005	SS
011	11/06/09	IB19S	62° 39.92' N	19° 39.84' W	1694	11:29	12:07	13:22	CTD006	SS
012	11/06/09	IB19S	62° 40.15' N	19° 40.14' W	1691	13:33		13:41	Plankton Net #2	
13	11/06/09	IB18S	62° 19.98' N	19° 50.16' W	1807	15:54	16:38	17:33	CTD007	SS
014	11/06/09	IB17	61° 59.98' N	19° 59.93' W	1812	19:42	20:23	21:32	CTD008	Titanium
015	11/06/09	IB17NET	61° 59.70' N	19° 59.90' W	~1810	21:49		21:54	Plankton Net #3	
016	12/06/09	IB16	61° 30.01' N	20° 00.02' W	2229	00:53	01:40	03:06	CTD009	SS
017	12/06/09	IB16NET	61° 29.63' N	19° 59.46' W	2255	03:15		03:23	Plankton Net #4	
018	12/06/09	IB15	61° 15.03' N	19° 59.94' W	2421	04:59	05:47	07:16	CTD010	SS
019	12/06/09	IB14	60° 59.89' N	20° 00.16' W	2433	08:56	09:44	11:00	CTD011	SS
020	12/06/09	IB14NET	60° 59.80' N	20° 00.70' W	~2435	11:15			Plankton Net #5	Lost from shackle
021	12/06/09	IB14NET	60° 59.78' N	20° 00.72' W	2437	12:10		12:17	Plankton Net #6	End lat: 60° 59.64' N. End lon: 20° 00.72' W
022	12/06/09	IB13	60° 30.11' N	20° 00.16' W	2556	15:19	16:12	17:32	CTD012	SS
023	12/06/09	IB13NET	60° 31.20' N	20° 00.00' W	~2550	17:53		18:06	Plankton Net #7	End lat: 60° 31.10' N. End lon: 19° 59.50' W
024	12/06/09	IB12	60° 00.17' N	20° 00.27' W	2758	21:28	22:20	23:43	CTD013	Ti
025	13/06/09	IB12SAP	60° 02.95' N	20° 02.41' W	2736	00:44		03:13	SAP	2 SAPS deployed (30 and 130 m depth)

Evt No.	Date	Station	Latitude	Longitude	Sounding (m)	Time IN	Time bottom	Time OUT	Activity	Comments
026	13/06/09	STNW	59° 59.6' N	20° 52.2' W		06:14		08:00	Mooring recovery	Time in = acoustic release in water Grappled at 07:20 Time out = all on deck
027	13/06/09	STC	59° 30.60' N	20° 00.96' W	2796	12:10		15:20	Mooring recovery	Time in = acoustic release in water Grappled at 13:23 Time out = all on deck
028	13/06/09	STS	58° 52.08' N	20° 22.48' W	2881	19:16		21:20	Mooring recovery	Time in = acoustic release in water Grappled at 20:13 Time out = all on deck
029	14/06/09	IB11A	59° 50.03' N	19° 33.59' W	2729	06:13	07:05	08:30	CTD014	SS
030	14/06/09	IB11	59° 40.03' N	19° 07.36' W	2713	10:37	11:30	12:55	CTD015	Ti
031	14/06/09	STNE	59° 39.61' N	18° 50.89' W	2689	13:58		15:22	Mooring recovery	Release code sent 13:58. Surfaced without responding ~14:50. Grappled ~ 15:00 at 59° 39.70' N 18° 50.40' W. All on deck 15:22
032	14/06/09	IB10	59° 24.02' N	18° 25.07' W	2465	17:38	18:28	19:41	CTD016	SS
033	14/06/09	IB10NET	59° 23' 52.89'' N	18° 24' 37.96'' W	2445	19:58		20:04	Plankton Net #8	End lat:59° 23' 50.46'' N. End lon: 18° 24' 27.40'' W
034	14/06/09	IB9	59° 19.88' N	18° 13.99 W	1855	21:12	21:48	22:55	CTD017	SS
035	15/06/09	IB8	59° 12.06' N	17° 53.17' W	1553	00:26	01:03	02:08	CTD018	SS
036	15/06/09	IB7	59° 07.04' N	17° 40.20' W	989	03:27	03:52	04:37	CTD019	SS
037	15/06/09	IB6	58° 57.01' N	17° 11.15' W	892	06:42	07:05	07:44	CTD020	SS
038	15/06/09	IB6NET	58° 56.90' N	17° 10.78' W	902	07:57		08:02	Plankton Net #9	End Lat: 58° 56.86' N End Lon:17° 10.71' W
039	15/06/09	IB5	58° 53.01' N	17° 00.10' W	1169	09:45	10:12	11:12	CTD021	Ti
040	15/06/09	IB4A	58° 41.61' N	16° 30.16' W	1195	13:24	13:57	14:52	CTD022	SS. Rosette fitted with 10 litre Niskins.
041	15/06/09	IB4	58° 30.016' N	16° 00.075' W	1194	16:59	17:33	18:14	CTD023	SS
042	15/06/09	IB4NET	58° 29.998' N	15° 59.793' W	1202	18:24		18:28	Plankton Net #10	End Lat: 58° 29.969' N. End Lon: 15° 59.719' W
043	15/06/09	IB3	58° 15.03' N	15° 19.64' W	658	21:05	21:24	21:57	CTD024	SS
044	16/06/09	IB2	57° 27.11' N	14° 35.03' W	444	01:06	01:25	02:02	CTD025	SS
045	16/06/09	IB2NET	57° 57.35' N	14° 34.10' W	446	02:15		02:20	Plankton Net #11	End Lat: 57° 57.31' N. End Lon: 14° 33.99' W
046	16/06/09	IB1	57°40.06' N	13° 54.09 'W	148	05:14	05:23	05:38	CTD026	SS
047	16/06/09	A	57° 34.98 'N	13° 38.03 'W	109	07:01	07:08	07:20	CTD027	SS
048	16/06/09	B	57° 34.06' N	13° 20.13' W	181	08:47	08:57	09:16	CTD028	SS
049	16/06/09	C	57° 33.27' N	12° 59.66' W	304	13:07	13:22	13:48	CTD029	SS

Evt No.	Date	Station	Latitude	Longitude	Sounding (m)	Time IN	Time bottom	Time OUT	Activity	Comments
050	16/06/09	D	57° 32.50’ N	12° 51.94’ W	1127	15:04	15:34	16:21	CTD030	SS
051	16/06/09	E	57° 31.98’ N	12° 38.02’ W	1666	18:05	18:45	19:44	CTD031	Ti
052	17/06/09	E	57° 32.07’ N	12° 38.07’ W	1676	04:20		06:58	SAPS	2 SAPS deployed at 5-m and 150m End lat:57°31.53’N End long:12°37.95’W
053	17/06/09	F	57° 30.59’ N	12° 14.73’ W	1820	08:48	09:27	10:36	CTD032	SS
054	17/06/09	G	57° 29.63’ N	11° 50.90’ W	1838	12:01	12:46	13:58	CTD033	SS
055	17/06/09	H	57° 28.90’ N	11° 31.95’ W	2067	22:22	23:04	00:14	CTD034	SS
056	19/06/09	I	57° 28.02 ‘N	11° 18.90’ W	758					Wire came off traction winch
057	19/06/09	I	57° 28.02’ N	11° 19.05’ W	774	13:08	13:40	14:25	CTD035	SS
058	19/06/09	J	57° 27.96’ N	11° 04.90’ W	587	15:45	16:09	16:44	CTD036	SS
059	19/06/09	K	57° 23.94’ N	10° 52.08’ W	792	18:18	18:42	19:21	CTD037	SS
060	19/06/09	K	57° 23.87‘ N	10° 52.51’ W	776	19:38		19:43	Plankton Net # 11	End Lat:57° 23.84’ N. End Long:10° 52.72’ W
061	19/06/09	L	57° 22.00’ N	10° 40.07’ W	2162	21:04	21:44	22:59	CTD038	SS
062	20/06/09	M	57° 18.05’ N	10° 22.97’ W	2236	00:57	01:47	03:25	CTD039	Ti
063	20/06/09	N	57° 13.98’ N	10° 02.69’ W	2126	04:55	05:53	06:56	CTD040	SS
064	20/06/09	O	57° 09.03’ N	09° 41.89’ W	1948	08:29	09:12	10:24	CTD041	SS
065	20/06/09	P	57° 06.08’ N	09° 25.59’ W	1486	11:36	12:09	13:10	CTD042	SS
066	20/06/09	Q	57° 03.04’ N	09° 12.80’ W	297	14:18	14:32	14:58	CTD043	SS
067	20/06/09	R	56° 59.93’ N	08° 59.83’ W	132	15:59	16:11	16:28	CTD044	SS
068	20/06/09	RNET	56° 59.76’ N	08° 59.69’ W	130	16:39		16:44	Plankton Net #12	End Lat: 56°59.81’ N End Long:8° 59.82’W
069	20/06/09	S	56° 56.77’ N	08° 46.98’ W	124	17:50	17:58	18:12	CTD045	SS
070	20/06/09	T	56° 50.21’ N	08° 19.99’ W	128	20:10	20:19	20:39	CTD046	SS
071	20/06/09	TNET	56° 50.21’ N	08° 19.99’ W	128	20:39			Plankton Net #13	
072	21/06/09	D6	60° 12.40’ N	08° 57.45’ W	561	16:03	16:23	16:49	CTD047	SS
073	21/06/09	D5A	60° 13.12’ N	08° 58.42’ W	731	17:16	17:40	17:59	CTD048	SS
074	21/06/09	D5	60° 13.78’ N	08° 59.42’ W	1038	18:16	18:42	19:21	CTD049	SS
075	21/06/09	D4	60° 15.01’ N	09° 00.34’ W	1244	19:51	20:24	20:49	CTD050	SS
076	21/06/09	D3	60° 15.67’ N	09° 00.47’ W	1088	21:10	21:36	21:57	CTD051	SS

Evt No.	Date	Station	Latitude	Longitude	Sounding (m)	Time IN	Time bottom	Time OUT	Activity	Comments
077	21/06/09	D2	60° 16.59' N	09° 00.69' W	819	22:23	22:42	23:25	CTD052	SS
078	22/06/09	D1	60° 17.592' N	09° 01.054'W	565	00:00	00:24	00:38	CTD053	SS
079	22/06/09	D0	60° 20.057' N	09° 01.669' W	513	00:18	01:41	02:12	CTD054	SS
080	22/06/09	DD	60° 23.273' N	09° 02.212' W	399	03:03	03:22	03:36	CTD055	SS
081	22/06/09	D3	60° 15.71' N	09° 00.55' W	1086	04:46	05:13	05:35	CTD056	SS
082	22/06/09	WTR	60° 14.68' N	09° 00.32' W	1292	06:03			Mooring recovery	Mooring initially responded, release signal first sent at 06:03 but failed after continued attempts
083	22/06/09	D4A	60° 14.40' N	08° 59.88' W	1278	07:31	08:02	08:58	CTD057	SS
084	22/06/09	WTR	60° 14.72' N	09° 00.72' W	1285	09:25			Mooring recovery	09:41 – no response to release signal
085	22/06/09	CD1	60° 17.51' N	09° 07.80' N	943	10:31	10:54	11:15	CTD058	SS
086	22/06/09	CD2	60° 16.12' N	09° 12.32' W	1643	11:49	12:30	13:34	CTD059	SS
087	22/06/09	CD3	60° 14.88' N	09° 17.09' W	1609	14:17	14:52	15:36	CTD060	SS
088	22/06/09	CD4	60° 13.60' N	09° 21.62' W	1493	16:17	16:52	17:20	CTD061	SS
089	22/06/09	CD5	60° 11.52' N	09° 29.45' W	1132	18:03	18:32	19:13	CTD062	SS
090	22/06/09	CD6	60° 21.27' N	09° 26.55' W	1211	20:30	20:56	21:54	CTD063	SS
091	22/06/09	CD7	60° 19.14' N	09° 21.20' W	1595	22:38	23:13	23:45	CTD064	SS
092	23/06/09	CD8	60° 17.52' N	09° 16.68' W	1678	00:26	01:04	01:53	CTD065	SS
093	23/06/09	CD9	60° 14.97' N	09° 09.49' W	1521	02:43	03:22	03:49	CTD066	SS
094	23/06/09	CD10	60° 13.45' N	09° 04.63' W	1053	04:27	04:56	05:28	CTD067	SS
095	23/06/09	WTR	60° 14.80' N	09° 00.35' W	1271	06:04			Mooring recovery	06:04 release signal sent but no response
096	23/06/09	EG1	60° 15.52' N	09° 07.48' W	1636	07:23			CTD068	SS
097	23/06/09	EG2	60° 14.81' N	09° 03.68' W	1396	09:30	10:14	10:41	CTD069	SS
098	23/06/09	EG4	60° 14.53' N	08° 54.65' W	1209	11:24	11:59	12:36	CTD070	SS
099	23/06/09	EG5	60° 14.55' N	08° 48.71' W	1029	13:20	13:43	14:12	CTD071	SS
100	23/06/09	EG3	60° 14.72' N	09° 00.87' W	1297	15:39	16:13	16:56	CTD072	SS. Acoustic release test cast.
101	23/06/09	WTR	60° 15.62' N	08° 58.25' W	1148	17:31			Mooring deployment	
102	24/06/09	14G	56° 48.50' N	08° 09.96' W	127	14:25	14:34	14:56	CTD073	SS

Evt No.	Date	Station	Latitude	Longitude	Sounding (m)	Time IN	Time bottom	Time OUT	Activity	Comments
103	24/06/09	13G	56° 47.04’ N	08° 00.00’ W	120	15:50	15:55	16:00	CTD074	SS
104	24/06/09	12G	56° 45.55’ N	07° 50.00’ W	45	16:50	16:57	17:05	CTD075	SS
105	24/06/09	11G	56° 43.92’ N	07° 39.85’ W	67	17:52	17:59	18:10	CTD076	SS
106	24/06/09	10G	56° 44.00’ N	07° 30.14’ W	230	18:55	19:06	19:35	CTD077	SS
107	24/06/09	9G	56° 43.96’ N	07° 19.75’ W	157	20:29	20:35	20:47	CTD078	SS
108	24/06/09	8G	56° 43.93’ N	07° 10.03’ W	175	21:38	21:44	21:52	CTD079	SS
109	24/06/09	7G	56° 43.96’ N	07° 00.10’ W	137	22:45	22:53	23:15	CTD080	SS
110	25/06/09	6G	56° 44.05’ N	06° 45.14’ W	22	00:30	00:35	00:45	CTD081	SS
111	25/06/09	5G	56° 44.03’ N	06° 36.02’ W	67	01:32	01:38	01:43	CTD082	SS
112	25/06/09	4G	56° 44.05’ N	06° 27.11’ W	104	02:33	02:44	03:01	CTD083	SS
113	25/06/09	3G	56° 42.59’ N	06° 21.98’ W	72	03:39	03:46	03:53	CTD084	SS
114	25/06/09	2G	56° 41.07’ N	06° 17.06’ W	36	04:29	04:37	04:42	CTD085	SS
115	25/06/09	1G	56° 48.02’ N	06° 08.01’ W	178	05:30	05:46	06:07	CTD086	SS

Appendix 2
D340a CTD Log Sheets

Key to acronyms and abbreviations

I/W = in water
O/W = out of water

Sal = salinity
DO = dissolved oxygen
Chl = chlorophyll
POC/PON = particulate organic carbon / particulate organic nitrogen
DMS = dimethyl sulphide
PIC = particulate organic carbon
DIC/Alk = dissolved inorganic carbon / alkalinity
FRRF = fast repetition rate fluorometry
FCM = flow cytometry
Nut = nutrients
Fe = iron
Fe lig = iron ligands
SBG = siderophore biosynthetic genes
Prot = protein
RNA = ribonucleic acid
Plankt = phytoplankton abundance

Shaded rows of CTD logs indicate problems with bottle firings.
Auxiliary sampling for chlorophyll, dissolved inorganic nutrients and phytoplankton was also carried out when flow cytometry samples were taken.

D340a CTD log sheet

Station	TEST	CTD No	TEST	Date	10/06/09	CTD type:
Lat	63° 37' 07.40'' N	Event No	001	Time I/W	15:06 GMT	SS ■
Lon	22° 35' 45.58'' W	Depth	154 m	Time bottom	15:16 GMT	Ti □
Filename	D340_TEST.hex	Cast Depth	140 m	Time O/W	15:28 GMT	
Weather	Calm, sunny, sea state 2					
Comments	Several bottles did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	140	~15:16																		1
2	2	2	140	~15:16																		2
3	3	3	140	~15:16																		3
4	4	4	140	~15:16																		4
5	5	5	140	~15:16																		5
6	6	6	140	~15:16																		6
7	7	7	140	~15:16																		7
8	8	8	140	~15:16																		8
9	9	9	140	~15:16																		9
10	10	10	140	~15:16																		10
11	11	11	140	~15:16																		11
12	12	12	140	~15:16																		12
13	13	13	140	~15:16																		13
14	14	14	140	~15:16																		14
15	15	15	140	~15:16																		15
16	16	16	140	~15:16																		16
17	17	17	140	~15:16																		17
18	18	18	140	~15:16																		18
19	19	19	140	~15:16																		19
20	20	20	140	~15:16																		20
21	21	21	140	~15:16																		21
22	22	22	140	~15:16																		22
23	23	23	140	~15:16																		23
24	24	24	140	~15:16																		24
			Analyst																			

D340a CTD log sheet

Station	IB23S	CTD No	001	Date	10/06/09	CTD type: SS ■ Ti □
Lat	63° 19.34' N	Event No	004	Time I/W	23:20 GMT	
Lon	20° 13.06 ' W	Depth	123 m	Time bottom	23:29 GMT	
Filename	D340_CTD_001.hex	Cast Depth	120 m	Time O/W	23:49 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	120	23:20					X													1
2	2	2	120	23:20		X																2
3	3	3	120	23:20	X									X								3
4	4	4	120	23:20			X	X														4
5	5	5	100	23:34					X													5
6	6	6	100	23:34										X								6
7	7	7	100	23:34			X	X														7
8	8	8	100	23:34																		8
9	9	9	50	23:39					X													9
10	10	10	50	23:39										X								10
11	11	11	50	23:39	X		X	X														11
12	12	12	50	23:39	X																	12
13	13	13	30	23:41					X													13
14	14	14	30	23:41										X								14
15	15	15	30	23:41			X	X														15
16	16	16	30	23:41																		16
17	17	17	10	23:44					X													17
18	18	18	10	23:44		X																18
19	19	19	10	23:44										X								19
20	20	20	10	23:44	X		X	X														20
21	21	21	2	23:47																		21
22	22	22	2	23:47																		22
23	23	23	2	23:47																		23
24	24	24	2	23:47																		24
			Analyst		Estelle	Karl	Jamie	Tim	Andy					Tim								

D340a CTD log sheet

Station	IB22X	CTD No	002	Date	11/06/09	CTD type: SS □ Ti ■
Lat	63° 15.84' N	Event No	007	Time I/W	01:04 GMT	
Lon	20° 08.07' W	Depth	153 m	Time bottom	01:20 GMT	
Filename	D340_CTD_002t.hex	Cast Depth	141 m	Time O/W	01:51 GMT	
Weather	Calm					
Comments	Problem with primary vane temp sensor. Fluorometer and altimeter cables swapped.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	141	01:25												X						1
2	2	2	141	01:25												X						2
3	3	3	141	01:26												X						3
4	4	4	141	01:26												X						4
5	5	5	141	01:26										X		X						5
6	13	13	141	01:27	X		X			X	X	X	X									13
7	6	6	110	01:32										X		X						6
8	14	14	110	01:32			X				X	X	X									14
9	7	7	82	01:37										X		X						7
10	15	15	82	01:37			X			X	X	X	X						X	X		15
11	16	16	82	01:37	X														X	X		16
12	8	8	40	01:42										X		X						8
13	17	17	40	01:42			X				X	X	X									17
14	9	9	2	01:47										X		X						9
15	18	18	2	01:47			X			X	X	X	X						X	X		18
16	19	19	2	01:48	X														X	X		19
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Anna			Victoire	Victoire	Anna	Anna	Tim		Seb-astian			Anna	Anna		

D340a CTD log sheet

Station	IB22S	CTD No	003	Date	11/06/09	CTD type:
Lat	63° 12.97' N	Event No	008	Time I/W	02:48 GMT	SS ■
Lon	20° 04.29' W	Depth	690 m	Time bottom	03:19 GMT	Ti □
Filename	D340_CTD_003.hex	Cast Depth	683 m	Time O/W	04:03 GMT	
Weather	Calm					
Comments	Bottle number 6 did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	683	03:19	X									X								1
2	2	2	683	03:20																		2
3	3	3	502	03:28																		3
4	4	4	502	03:28										X								4
5	5	5	302	03:37	X									X								5
6	6	6	302	03:37																		6
7	7	7	153	03:44																		7
8	8	8	153	03:44										X								8
9	9	9	102	03:48																		9
10	10	10	102	03:49										X								10
11	11	11	52	03:53	X																	11
12	12	12	52	03:53										X								12
13	13	13	22	03:56																		13
14	14	14	22	03:56										X								14
15	15	15	5	03:59	X																	15
16	16	16	5	03:59										X								16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB21S	CTD No	004	Date	11/06/09	CTD type:
Lat	63° 08.06' N	Event No	009	Time I/W	05:18 GMT	SS ■
Lon	19° 54.81' W	Depth	1042 m	Time bottom	05:44 GMT	Ti □
Filename	D340_CTD_004.hex	Cast Depth	1025 m	Time O/W	06:28 GMT	
Weather	Calm					
Comments	Bottle 1 did not fire. Bottle 15 did not close properly.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1025	05:46																		1
2	2	2	1025	05:46	X									X								2
3	3	3	800	05:52	X									X								3
4	4	4	800	05:53																		4
5	5	5	500	06:02	X									X								5
6	6	6	500	06:02																		6
7	7	7	300	06:08	X									X								7
8	8	8	300	06:08																		8
9	9	9	150	06:13										X								9
10	10	10	150	06:13																		10
11	11	11	99	06:17										X								11
12	12	12	99	06:17																		12
13	13	13	50	06:21										X								13
14	14	14	50	06:21																		14
15	15	15	13	06:24																		15
16	16	16	13	06:24										X								16
17	17	17	5	06:26	X																	17
18	18	18	5	06:26																		18
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB20S	CTD No	005	Date	11/06/09	CTD type: SS ■ Ti ☐
Lat	62° 54.91' N	Event No	010	Time I/W	08:18 GMT	
Lon	19° 32.94' W	Depth	1417 m	Time bottom	08:50 GMT	
Filename	D340_CTD_005.hex	Cast Depth	1402 m	Time O/W	09:49 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1402	08:51					X													1
2	2	2	1402	08:52	X									X								2
3	3	3	1000	09:01										X								3
4	4	4	1000	09:02																		4
5	5	5	700	09:10	X									X								5
6	6	6	700	09:10		X																6
7	7	7	500	09:16										X								7
8	8	8	500	09:16				X														8
9	9	9	300	09:23	X									X								9
10	10	10	300	09:23		X		X														10
11	11	11	200	09:27																		11
12	12	12	200	09:27											X			X				12
13	13	13	150	09:31										X								13
14	14	14	150	09:31			X	X														14
15	15	15	100	09:35					X					X								15
16	16	16	100	09:35			X	X														16
17	17	17	50	09:39					X					X	X			X				17
18	18	18	50	09:39	X	X	X	X														18
19	19	19	20	09:42					X						X			X				19
20	20	20	20	09:42			X	X														20
21	21	21	10	09:45												X						21
22	22	22	10	09:45	X									X	X			X				22
23	23	23	5	09:47					X					X	X			X				23
24	24	24	5	09:47			X	X														24
			Analyst		Estelle	Karl	Jamie	Jamie	Andy					Tim	Shady	Khairul		Shady				

D340a CTD log sheet

Station	IB19S	CTD No	006	Date	11/06/09	CTD type: SS ■ Ti ☐
Lat	62° 39.92' N	Event No	011	Time I/W	11:29 GMT	
Lon	19° 39.84' W	Depth	1694 m	Time bottom	12:07 GMT	
Filename	D340_CTD_006.hex	Cast Depth	1672 m	Time O/W	13:22 GMT	
Weather	Calm					
Comments	Bottles 13 and 19 were leaking. Replicate of salinity taken from bottle 2.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1672	12:08										X								1
2	2	2	1672	12:08	X																	2
3	3	3	1500	12:14										X								3
4	4	4	1500	12:14																		4
5	5	5	1200	12:25										X								5
6	6	6	1200	12:25	X																	6
7	7	7	1000	12:34										X								7
8	8	8	1000	12:34																		8
9	9	9	750	12:43										X								9
10	10	10	750	12:43																		10
11	11	11	700	12:47	X																	11
12	12	12	700	12:47		X																12
13	13	13	500	12:54																		13
14	14	14	500	12:54		X		X						X								14
15	15	15	300	13:00				X						X								15
16	16	16	300	13:00	X																	16
17	17	17	150	13:06			X	X						X								17
18	18	18	150	13:06																		18
19	19	19	100	13:10										X								19
20	20	20	100	13:10		X	X	X														20
21	21	21	50	13:13			X	X						X								21
22	22	22	50	13:13																		22
23	23	23	20	13:16			X	X						X								23
24	24	24	5	13:18	X	X	X	X						X								24
			Analyst		Estelle	Karl	Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB18S	CTD No	007	Date	11/06/09	CTD type:
Lat	62° 19.98' N	Event No	013	Time I/W	15:54 GMT	SS ■
Lon	19° 50.16' W	Depth	1807 m	Time bottom	16:33 GMT	Ti □
Filename	D340_CTD_007.hex	Cast Depth	1795 m	Time O/W	17:33 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1795	16:35	X							X		X								1
2	2	2	1795	16:36				X														2
3	3	3	1500	16:44										X								3
4	4	4	1500	16:44																		4
5	5	5	1200	16:50	X									X								5
6	6	6	1200	16:51																		6
7	7	7	1000	16:56										X								7
8	8	8	1000	16:57																		8
9	9	9	750	17:03	X									X								9
10	10	10	750	17:03																		10
11	11	11	500	17:09										X								11
12	12	12	500	17:10				X														12
13	13	13	300	17:16	X									X								13
14	14	14	300	17:16				X														14
15	15	15	150	17:20										X								15
16	16	16	150	17:20			X	X														16
17	17	17	100	17:23										X								17
18	18	18	100	17:23			X	X														18
19	19	19	50	17:26										X								19
20	20	20	50	17:27			X	X														20
21	21	21	25	17:29										X								21
22	22	22	25	17:29			X	X														22
23	23	23	5	17:31	X									X								23
24	24	24	5	17:31			X	X				X										24
			Analyst		Estelle		Jamie	Jamie				Anna		Tim								

D340a CTD log sheet

Station	IB17	CTD No	008	Date	11/06/09	CTD type:
Lat	61° 59.98' N	Event No	014	Time I/W	19:42 GMT	SS □
Lon	19° 59.93' W	Depth	1812 m	Time bottom	20:23 GMT	Ti ■
Filename	D340_CTD_008t.hex	Cast Depth	1790 m	Time O/W	21:32 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	13	13	1790	20:23	X					X	X											13
2	1	1	1790	20:23										X		X	X					1
3	2	2	1200	20:36										X		X	X					2
4	14	14	1200	20:36	X						X											14
5	3	3	1000	20:43										X		X	X					3
6	15	15	800	20:50		X					X											15
7	4	4	800	20:50										X		X	X					4
8	5	5	700	20:54										X		X	X					5
9	16	16	600	21:00	X						X											16
10	6	6	500	21:04										X		X	X					6
11	17	17	400	21:08		X				X	X											17
12	7	7	300	21:11										X		X	X					7
13	8	8	150	21:16										X		X	X					8
14	18	18	100	21:19	X		X			X	X	X	X						X			18
15	9	9	80	21:22			X					X	X	X		X	X		X			9
16	19	19	50	21:25			X					X	X						X			19
17	10	10	40	21:26						X	X			X		X	X					10
18	11	11	25	21:29										X		X	X					11
19	20	20	25	21:29			X					X	X						X			20
20	21	21	25	21:29	X														X			21
21	22	22	25	21:29						X	X								X			22
22	12	12	2	21:32			X					X	X	X		X	X					12
23	23	23	2	21:32															X			23
24	24	24	2	21:32						X	X								X			24
			Analyst		Estelle	Karl	Anna			Victoire	Victoire	Anna	Anna	Khairul		Seb-astian	Khairul		Anna			

D340a CTD log sheet

Station	IB16	CTD No	009	Date	12/06/09	CTD type: SS ■ Ti ☐
Lat	61° 30.01' N	Event No	016	Time I/W	00:53 GMT	
Lon	20° 00.02' W	Depth	2229 m	Time bottom	01:40 GMT	
Filename	D340_CTD_009.hex	Cast Depth	2208 m	Time O/W	03:06 GMT	
Weather	Calm					
Comments	Replicate salinity sample taken from bottle 10					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2208	01:41																		1
2	2	2	2208	01:41	X									X								2
3	3	3	1800	01:51																		3
4	4	4	1800	01:51										X								4
5	5	5	1500	02:00																		5
6	6	6	1500	02:00	X									X								6
7	7	7	1000	02:11																		7
8	8	8	1000	02:11										X								8
9	9	9	750	02:18																		9
10	10	10	750	02:18	X									X								10
11	11	11	500	02:26				X														11
12	12	12	500	02:26										X								12
13	13	13	300	02:32				X														13
14	14	14	300	02:33										X								14
15	15	15	150	02:39			X	X														15
16	16	16	150	02:39	X									X								16
17	17	17	100	02:43			X	X														17
18	18	18	100	02:44										X								18
19	19	19	50	02:48			X	X														19
20	20	20	50	02:48										X								20
21	21	21	15	02:57			X	X														21
22	22	22	15	02:57										X								22
23	23	23	5	03:02			X	X														23
24	24	24	5	03:02	X									X								24
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB15	CTD No	010	Date	12/06/09	CTD type: SS ■ Ti ☐
Lat	61° 15.03' N	Event No	018	Time I/W	04:59 GMT	
Lon	19° 59.94' W	Depth	2421 m	Time bottom	05:47 GMT	
Filename	D340_CTD_010.hex	Cast Depth	2370 m	Time O/W	07:16 GMT	
Weather	Calm					
Comments	Bottles 13 and 16 did not close properly. Winch stopped at 100m on upcast 06:47-07:04					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2370	05:48	X									X								1
2	2	2	2370	05:48																		2
3	3	3	2000	05:56										X								3
4	4	4	2000	05:56																		4
5	5	5	1500	06:07	X									X								5
6	6	6	1500	06:07																		6
7	7	7	1000	06:18	X									X								7
8	8	8	1000	06:19																		8
9	9	9	750	06:25										X								9
10	10	10	750	06:26																		10
11	11	11	500	06:33	X									X								11
12	12	12	500	06:33				X														12
13	13	13	300	06:38																		13
14	14	14	300	06:39				X						X								14
15	15	15	150	06:43			X	X						X								15
16	16	16	150	06:43			X	X														16
17	17	17	100	06:47										X								17
18	18	18	100	06:47			X	X														18
19	19	19	50	07:06										X								19
20	20	20	50	07:06			X	X														20
21	21	21	13	07:11										X								21
22	22	22	13	07:11			X	X														22
23	23	23	5	07:15	X									X								23
24	24	24	5	07:15			X	X														24
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB14	CTD No	011	Date	12/06/09	CTD type:
Lat	60° 59.89' N	Event No	019	Time I/W	08:56 GMT	SS ■
Lon	20° 00.16' W	Depth	2433 m	Time bottom	09:44 GMT	Ti □
Filename	D340_CTD_011.hex	Cast Depth	2390 m	Time O/W	11:00 GMT	
Weather	Calm					
Comments	Bottles 1 and 21 leaked					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	2390	09:44	X									X								1
2	2	2	2000	09:54					X													2
3	3	3	2000	09:54										X								3
4	4	4	1500	10:05	X	X																4
5	5	5	1500	10:05										X								5
6	6	6	1000	10:16	X																	6
7	7	7	1000	10:16										X								7
8	8	8	650	10:24		X																8
9	9	9	650	10:24										X								9
10	10	10	500	10:30	X																	10
11	11	11	500	10:30				X						X								11
12	12	12	300	10:36		X																12
13	13	13	300	10:36				X						X								13
14	14	14	150	10:41																		14
15	15	15	150	10:42			X	X						X								15
16	16	16	100	10:46					X													16
17	17	17	100	10:46			X	X						X								17
18	18	18	50	10:50					X													18
19	19	19	50	10:51			X	X						X								19
20	20	20	18	10:54	X				X													20
21	21	21	18	10:54			X	X						X								21
22	22	22	5	10:58					X													22
23	23	23	5	10:58			X	X						X								23
24																						
			Analyst		**Estelle**	**Karl**	**Jamie**	**Jamie**	**Andy**					**Tim**								

D340a CTD log sheet

Station	IB13	CTD No	012	Date	12/06/09	CTD type:
Lat	60° 30.11' N	Event No	022	Time I/W	15:19 GMT	SS ■
Lon	20° 00.16' W	Depth	2543 m	Time bottom	16:12 GMT	Ti □
Filename	D340_CTD_012.hex	Cast Depth	2510 m	Time O/W	17:32 GMT	
Weather	Calm					
Comments	Bottle 24 did not close properly					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	2510	16:13										X								1
2	2	2	2510	16:14	X		X	X														2
3	3	3	2400	16:19										X								3
4	4	4	2000	16:28																		4
5	5	5	2000	16:28		X								X								5
6	6	6	1800	16:34										X								6
7	7	7	1500	16:41	X									X								7
8	8	8	1500	16:41																		8
9	9	9	1000	16:52		X								X								9
10	10	10	820	16:58				X														10
11	11	11	820	16:58		X								X								11
12	12	12	600	17:04	X			X														12
13	13	13	600	17:04		X								X								13
14	14	14	300	17:11				X						X								14
15	15	15	150	17:17										X								15
16	16	16	150	17:17	X		X	X														16
17	17	17	100	17:21										X								17
18	18	18	100	17:21			X	X														18
19	19	19	50	17:24										X								19
20	20	20	50	17:24			X	X														20
21	21	21	18	17:27										X								21
22	22	22	18	17:27			X	X														22
23	23	23	3	17:29	X		X	X						X								23
24	24	24	3	17:29			X	X														24
			Analyst		**Estelle**	**Karl**	**Jamie**	**Jamie**						**Tim**								

D340a CTD log sheet

Station	IB12	CTD No	013	Date	12/06/09	CTD type: SS ☐ Ti ■
Lat	60° 00.17' N	Event No	024	Time I/W	21:28 GMT	
Lon	20° 00.27' W	Depth	2758 m	Time bottom	22:20 GMT	
Filename	D340_CTD_013t.hex	Cast Depth	2695 m	Time O/W	23:43 GMT	
Weather	Short swell					
Comments	* PIC: unsure whether bottle 23 or 24 was sampled at 5 metres.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	13	13	2695	22:25	X					X	X											13
2	14	14	2000	22:35	X						X											14
3	15	15	1000	22:57	X						X											15
4	1	1	1000	22:57										X		X	X					1
5	16	16	750	23:03						X	X											16
6	2	2	750	23:03										X		X	X					2
7	3	3	500	23:11										X		X	X					3
8	4	4	400	23:15										X		X	X					4
9	5	5	400	23:15										X		X	X					5
10	6	6	400	23:15										X		X	X					6
11	17	17	400	23:15	X			X			X											17
12	7	7	300	23:20										X		X	X					7
13	8	8	150	23:25										X		X	X					8
14	18	18	150	23:25			X	X		X	X	X	X									18
15	9	9	100	23:31										X		X	X					9
16	19	19	100	23:31	X		X	X		X	X	X	X									19
17	20	20	50	23:35	X		X	X		X	X	X	X									20
18	21	21	20	23:40			X	X		X	X								X			21
19	22	22	20	23:40								X	X						X			22
20	10	10	20	23:40										X		X	X					10
21	11	11	10	23:42										X		X	X					11
22	12	12	5	23:44							X			X		X	X					12
23	23	23	5	23:44			X	X		X*									X			23
24	24	24	5	23:44						X*		X	X						X			24
			Analyst		Estelle		Jamie	Jamie		Victoire	Victoire	Anna	Anna	Tim		Seb-astian	Khairul		Anna			

D340a CTD log sheet

Station	IB11A	CTD No	014	Date	14/06/09	CTD type: SS ■ Ti ☐
Lat	59° 50.03' N	Event No	029	Time I/W	06:13 GMT	
Lon	19° 33.59' W	Depth	2729 m	Time bottom	07:05 GMT	
Filename	D340_CTD_014.hex	Cast Depth	2697 m	Time O/W	08:30 GMT	
Weather	Slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2697	07:06	X	X								X								1
2	2	2	2697	07:06																		2
3	3	3	2500	07:12										X								3
4	4	4	2000	07:22		X																4
5	5	5	2000	07:22										X								5
6	6	6	1500	07:33	X																	6
7	7	7	1500	07:33										X								7
8	8	8	1000	07:44		X																8
9	9	9	1000	07:44										X								9
10	10	10	750	07:51		X																10
11	11	11	750	07:51	X									X								11
12	12	12	500	07:58		X																12
13	13	13	500	07:58				X						X								13
14	14	14	300	08:03				X						X								14
15	15	15	150	08:09			X	X						X								15
16	16	16	150	08:09																		16
17	17	17	100	08:13			X	X						X								17
18	18	18	100	08:13	X																	18
19	19	19	50	08:17			X	X						X								19
20	20	20	50	08:17																		20
21	21	21	26	08:23			X	X						X								21
22	22	22	26	08:23																		22
23	23	23	5	08:27			X	X						X								23
24	24	24	5	08:27	X																	24
			Analyst		Estelle	Karl	Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB11	CTD No	015	Date	14/06/09	CTD type: SS ☐ Ti ■
Lat	59° 40.03' N	Event No	030	Time I/W	10:37 GMT	
Lon	19° 07.36' W	Depth	2713 m	Time bottom	11:29 GMT	
Filename	D340_CTD_015t.hex	Cast Depth	2650 m	Time O/W	12:55 GMT	
Weather	Calm – slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	13	13	2650	11:30	X				X	X	X			X								13
2	14	14	2000	11:44	X	X				X	X			X								14
3	1	1	1000	12:04										X		X	X					1
4	15	15	1000	12:04	X						X											15
5	2	2	780	12:10										X		X	X					2
6	16	16	780	12:10	X	X				X	X											16
7	3	3	600	12:16										X		X	X					3
8	4	4	400	12:22										X		X	X					4
9	5	5	400	12:22												X	X					5
10	6	6	400	12:22												X	X					6
11	7	7	300	12:26										X		X	X					7
12	17	17	300	12:26	X	X				X	X				X			X				17
13	8	8	150	12:31										X		X	X					8
14	18	18	150	12:31							X	X	X									18
15	19	19	100	12:36					X	X	X	X	X	X								19
16	9	9	80	12:39										X		X	X					9
17	20	20	50	12:41					X	X	X	X	X	X								20
18	10	10	25	12:45												X	X					10
19	21	21	25	12:45						X	X											21
20	22	22	25	12:45	X				X			X	X	X	X			X	X	X		22
21	11	11	10	12:49												X	X					11
22	12	12	5	12:51												X	X					12
23	23	23	5	12:51								X	X						X	X		23
24	24	24	5	12:51	X				X	X	X			X	X			X				24
			Analyst		Estelle	Karl			Andy	Victoire	Victoire	Anna	Anna	Tim	Shady	Seb-astian	Khairul	Shady	Anna	Anna		

D340a CTD log sheet

Station	IB10	CTD No	016	Date	14/06/09	CTD type: SS ■ Ti ☐
Lat	59° 24.02' N	Event No	032	Time I/W	17:38 GMT	
Lon	18° 25.07' W	Depth	2465 m	Time bottom	18:28 GMT	
Filename	D340_CTD_016.hex	Cast Depth	2389 m	Time O/W	19:41 GMT	
Weather	Calm – very slight swell					
Comments	Bottles 2 and 17 did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2389	18:29	X									X								1
2	2	2	2389	18:29																		2
3	3	3	2000	18:38	X									X								3
4	4	4	2000	18:39																		4
5	5	5	1500	18:50	X									X								5
6	6	6	1500	18:50																		6
7	7	7	1000	19:02										X								7
8	8	8	1000	19:02																		8
9	9	9	700	19:10	X									X								9
10	10	10	700	19:10																		10
11	11	11	500	19:16										X								11
12	12	12	500	19:16				X														12
13	13	13	300	19:21										X								13
14	14	14	300	19:21				X														14
15	15	15	150	19:26										X								15
16	16	16	150	19:26			X	X														16
17	17	17	100	19:31																		17
18	18	18	100	19:31			X	X						X								18
19	19	19	50	19:35										X								19
20	20	20	50	19:35			X	X														20
21	21	21	18	19:37										X								21
22	22	22	18	19:37			X	X														22
23	23	23	5	19:39	X									X								23
24	24	24	5	19:39			X	X														24
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB9	CTD No	017	Date	14/06/09	CTD type:
Lat	59° 19.88' N	Event No	034	Time I/W	21:12 GMT	SS ■
Lon	18° 13.99' W	Depth	1855 m	Time bottom	21:48 GMT	Ti □
Filename	D340_CTD_017.hex	Cast Depth	1832 m	Time O/W	22:55 GMT	
Weather	Calm – slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1832	21:49	X									X								1
2	22	22	1832	21:49																		22
3	2	2	1500	21:57										X								2
4	3	3	1500	21:57																		3
5	4	4	1000	22:07										X								4
6	5	5	1000	22:07																		5
7	6	6	740	22:13	X									X								6
8	7	7	740	22:13																		7
9	8	8	500	22:20										X								8
10	9	9	500	22:20																		9
11	10	10	300	22:26	X									X								10
12	11	11	300	22:26																		11
13	12	12	150	22:30										X								12
14	13	13	150	22:30																		13
15	14	14	100	22:34										X								14
16	15	15	100	22:34	X																	15
17	16	16	50	22:37										X								16
18	17	17	50	22:37																		17
19	18	18	25	22:40										X								18
20	19	19	25	22:40																		19
21	20	20	5	22:42	X									X								20
22	21	21	5	22:49																		21
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB8	CTD No	018	Date	15/06/09	CTD type:
Lat	59° 12.06' N	Event No	035	Time I/W	00:26 GMT	SS ■
Lon	17° 53.17' W	Depth	1553 m	Time bottom	01:03 GMT	Ti □
Filename	D340_CTD_018.hex	Cast Depth	1533 m	Time O/W	02:08 GMT	
Weather	Slight swell. Rain.					
Comments	Bottle 4 was leaking					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1533	01:03										X								1
2	2	2	1533	01:03	X																	2
3	3	3	1000	01:15	X									X								3
4	4	4	1000	01:15																		4
5	5	5	840	01:22										X								5
6	6	6	840	01:22																		6
7	7	7	500	01:31										X								7
8	8	8	500	01:31	X			X														8
9	9	9	300	01:37										X								9
10	10	10	300	01:37				X														10
11	11	11	150	01:43										X								11
12	12	12	150	01:43			X	X														12
13	13	13	100	01:47																		13
14	14	14	100	01:47	X		X	X						X								14
15	15	15	50	01:51										X								15
16	16	16	50	01:52			X	X														16
17	17	17	30	01:55																		17
18	18	18	30	01:55																		18
19	19	19	25	01:58																		19
20	20	20	25	01:58																		20
21	21	21	20	02:00										X								21
22	22	22	20	02:00			X	X														22
23	23	23	5	02:05										X								23
24	24	24	5	02:05	X		X	X														24
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB7	CTD No	019	Date	15/06/09	CTD type:
Lat	59° 07.04’ N	Event No	036	Time I/W	03:27 GMT	SS ■
Lon	17° 40.20’ W	Depth	997 m	Time bottom	03:52 GMT	Ti □
Filename	D340_CTD_019.hex	Cast Depth	989 m	Time O/W	04:37 GMT	
Weather	Slight swell					
Comments	Bottles 2 and 21did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	978	03:53	X									X								1
2	2	2	978	03:53																		2
3	3	3	780	03:59																		3
4	4	4	780	03:59	X									X								4
5	5	5	660	04:04	X																	5
6	6	6	660	04:04										X								6
7	7	7	600	04:07																		7
8	8	8	600	04:07																		8
9	9	9	500	04:12																		9
10	10	10	500	04:12	X									X								10
11	11	11	300	04:18																		11
12	12	12	300	04:18	X									X								12
13	13	13	150	04:22																		13
14	14	14	150	04:22										X								14
15	15	15	100	04:26																		15
16	16	16	100	04:26										X								16
17	17	17	50	04:30																		17
18	18	18	50	04:30										X								18
19	19	19	20	04:32																		19
20	20	20	20	04:32										X								20
21	21	21	5	04:36																		21
22	22	22	5	04:36	X									X								22
23	23	23																				23
24	24	24																				24
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB6	CTD No	020	Date	15/06/09	CTD type:
Lat	58° 57.01’N	Event No	037	Time I/W	06:42 GMT	SS ■
Lon	17° 11.15’W	Depth	892 m	Time bottom	07:05 GMT	Ti □
Filename	D340_CTD_020.hex	Cast Depth	882 m	Time O/W	07:44 GMT	
Weather	Slight swell					
Comments	Bottle 1 did not fire. Bottles 2 and 8 did not close properly.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	882	07:06										X								1
2	2	2	882	07:06																		2
3	3	3	853	07:09										X								3
4	4	4	853	07:09	X																	4
5	5	5	500	07:17										X								5
6	6	6	500	07:17	X																	6
7	7	7	300	07:24	X									X								7
8	8	8	300	07:24																		8
9	9	9	150	07:30										X								9
10	10	10	150	07:30																		10
11	11	11	100	07:34										X								11
12	12	12	100	07:34																		12
13	13	13	50	07:37										X								13
14	14	14	50	07:37	X																	14
15	15	15	20	07:40										X								15
16	16	16	20	07:40																		16
17	17	17	5	07:43										X								17
18	18	18	5	07:43	X																	18
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB5	CTD No	021	Date	15/06/09	CTD type: SS ☐ Ti ■
Lat	58° 53.01' N	Event No	039	Time I/W	09:45 GMT	
Lon	17° 00.10' W	Depth	1169 m	Time bottom	10:12 GMT	
Filename	D340_CTD_021t.hex	Cast Depth	1141 m	Time O/W	11:12 GMT	
Weather	Calm					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1	12	12	1141	10:14												X	X					12
2	13	13	1141	10:14	X				X	X	X											13
3	14	14	1000	10:18	X						X											14
4	11	11	850	10:24												X	X					11
5	15	15	850	10:24						X	X											15
6	10	10	600	10:31												X	X					10
7	16	16	500	10:35	X			X			X											16
8	7	7	400	10:40												X	X					7
9	8	8	400	10:40												X	X					8
10	9	9	400	10:40												X	X					9
11	6	6	300	10:45												X	X					6
12	17	17	300	10:45				X		X	X				X			X				17
13	5	5	150	10:50												X	X					5
14	18	18	150	10:50			X	X		X	X	X	X									18
15	19	19	100	10:54			X	X	X	X	X	X	X									19
16	4	4	80	10:57												X	X					4
17	20	20	50	11:00	X		X	X	X	X	X	X	X		X			X				20
18	21	21	27	11:03					X	X	X	X	X		X			X				21
19	22	22	27	11:03			X	X											X	X		22
20	3	3	27	11:04												X	X					3
21	2	2	10	11:06												X	X					2
22	1	1	5	11:08												X	X					1
23	23	23	5	11:08	X				X	X	X	X	X		X			X				23
24	24	24	5	11:08			X	X											X	X		24
			Analyst		**Estelle**		**Jamie**	**Jamie**	**Andy**	**Victoire**	**Victoire**	**Anna**	**Anna**		**Shady**	**Seb-astian**	**Khairul**	**Shady**	**Anna**	**Sophie**		

D340a CTD log sheet

Station	IB4	CTD No	022	Date	15/06/09	CTD type: SS ■ Ti ☐
Lat	58° 41.61' N	Event No	40	Time I/W	13:24 GMT	
Lon	16° 30.16' W	Depth	1195 m	Time bottom	13:57 GMT	
Filename	D340_CTD_022.hex	Cast Depth	1184 m	Time O/W	14:52 GMT	
Weather	Slight swell. Overcast/Bright					
Comments	Replicate salinity sample taken from bottle 19					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1	1	1	1184	13:57	X									X								1
2	2	2	1184	13:57		X																2
3	3	3	1000	14:03	X									X								3
4	4	4	1000	14:03																		4
5	5	5	950	14:08										X								5
6	6	6	950	14:08		X																6
7	7	7	750	14:14	X									X								7
8	8	8	750	14:14		X																8
9	9	9	500	14:20										X								9
10	10	10	500	14:20		X		X														10
11	11	11	300	14:28										X								11
12	12	12	300	14:28				X														12
13	13	13	150	14:34										X								13
14	14	14	150	14:34			X	X														14
15	15	15	100	14:39										X								15
16	16	16	100	14:39			X	X														16
17	17	17	50	14:42	X									X								17
18	18	18	50	14:42			X	X														18
19	19	19	20	14:45	X									X								19
20	20	20	20	14:45			X	X														20
21	21	21	5	14:47										X								21
22	22	22	5	14:47			X	X														22
			Analyst		**Estelle**	**Karl**	**Jamie**	**Jamie**						**Tim**								

D340a CTD log sheet

Station	IB4	CTD No	023	Date	15/06/09	CTD type:
Lat	58° 30.016' N	Event No	041	Time I/W	16:59 GMT	SS ■
Lon	16° 00.075' W	Depth	1194 m	Time bottom	17:33 GMT	Ti □
Filename	D340_CTD_023.hex	Cast Depth	1182 m	Time O/W	18:14 GMT	
Weather	Slight swell					
Comments	Bottles 12 and 14 did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1182	17:34	X									X								1
2	2	2	1182	17:34																		2
3	3	3	1100	17:37										X								3
4	4	4	1100	17:37																		4
5	5	5	920	17:42										X								5
6	6	6	920	17:42																		6
7	7	7	700	17:48	X									X								7
8	8	8	700	17:48																		8
9	9	9	500	17:53	X									X								9
10	10	10	500	17:53				X														10
11	11	11	300	17:58				X						X								11
12	12	12	300	17:58																		12
13	13	13	150	18:02			X	X						X								13
14	14	14	150	18:02																		14
15	15	15	100	18:05										X								15
16	16	16	100	18:05	X		X	X														16
17	17	17	50	18:08										X								17
18	18	18	50	18:08			X	X														18
19	19	19	18	18:11										X								19
20	20	20	18	18:11			X	X														20
21	21	21	5	18:13	X									X								21
22	22	22	5	18:13			X	X														22
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB3	CTD No	024	Date	15/06/09	CTD type:
Lat	58° 15.03' N	Event No	043	Time I/W	21:05 GMT	SS ■
Lon	15° 19.64' W	Depth	658 m	Time bottom	21:25 GMT	Ti □
Filename	D340_CTD_024.hex	Cast Depth	650 m	Time O/W	21:57 GMT	
Weather	Calm					
Comments	Bottle 14 did not close properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	651	21:26	X									X								1
2	2	2	651	21:26																		2
3	3	3	500	21:30	X									X								3
4	4	4	500	21:30				X														4
5	5	5	300	21:36										X								5
6	6	6	300	21:36				X														6
7	7	7	150	21:40										X								7
8	8	8	150	21:40			X	X														8
9	9	9	100	21:45	X									X								9
10	10	10	100	21:45			X	X														10
11	11	11	50	21:48										X								11
12	12	12	50	21:48			X	X														12
13	13	13	20	21:50			X	X						X								13
14	14	14	20	21:50																		14
15	15	15	5	21:54	X									X								15
16	16	16	5	21:54			X	X														16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	IB2	CTD No	025	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 27.11' N	Event No	044	Time I/W	01:06 GMT	
Lon	14° 35.03' W	Depth	447 m	Time bottom	01:25 GMT	
Filename	D340_CTD_025.hex	Cast Depth	439 m	Time O/W	02:02 GMT	
Weather	Slight swell					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	439	01:25	X																	1
2	2	2	439	01:25										X								2
3	3	3	300	01:32																		3
4	4	4	300	01:32										X								4
5	5	5	150	01:39																		5
6	6	6	150	01:39										X								6
7	7	7	100	01:44																		7
8	8	8	100	01:44										X								8
9	9	9	50	01:49	X																	9
10	10	10	50	01:49										X								10
11	11	11	20	01:56																		11
12	12	12	20	01:56										X								12
13	13	13	5	01:58	X																	13
14	14	14	5	01:58										X								14
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	IB1	CTD No	026	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 40.06' N	Event No	046	Time I/W	05:14 GMT	
Lon	13° 54.09' W	Depth	148 m	Time bottom	05:23 GMT	
Filename	D340_CTD_026.hex	Cast Depth	140 m	Time O/W	05:38 GMT	
Weather	Slight Swell					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	140	05:24																		1
2	2	2	140	05:24	X									X								2
3	3	3	100	05:27	X									X								3
4	4	4	100	05:27																		4
5	5	5	50	05:30										X								5
6	6	6	50	05:30																		6
7	7	7	20	05:33										X								7
8	8	8	20	05:33																		8
9	9	9	5	05:36	X									X								9
10	10	10	5	05:36																		10
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	A	CTD No	027	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 34.98' N	Event No	047	Time I/W	07:01 GMT	
Lon	13° 38.03' W	Depth	109 m	Time bottom	07:08 GMT	
Filename	D340_CTD_027.hex	Cast Depth	102 m	Time O/W	07:20 GMT	
Weather	Slight swell					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	*Bot. No.*
1	1	1	102	07:09	X									X							1
2	2	2	102	07:09		X	X														2
3	3	3	50	07:12	X	X	X							X							3
4	4	4	50	07:12																	4
5	5	5	20	07:16		X	X							X							5
6	6	6	20	07:16																	6
7	7	7	5	07:18		X	X							X							7
8	8	8	5	07:18	X																8
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					
21																					
22																					
23																					
24																					
			Analyst		Estelle	Jamie	Jamie							Tim							

D340a CTD log sheet

Station	B	CTD No	028	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 34.06' N	Event No	048	Time I/W	08:47 GMT	
Lon	13° 20.13' W	Depth	181 m	Time bottom	08:57 GMT	
Filename	D340_CTD_028.hex	Cast Depth	172 m	Time O/W	09:16 GMT	
Weather	Force 5 wind					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	172	08:57										X								1
2	2	2	172	08:58	X																	2
3	3	3	150	09:01										X								3
4	4	4	150	09:01																		4
5	5	5	100	09:05										X								5
6	6	6	100	09:05	X																	6
7	7	7	50	09:09										X								7
8	8	8	50	09:09																		8
9	9	9	18	09:13										X								9
10	10	10	18	09:13																		10
11	11	11	5	09:15										X								11
12	12	12	5	09:15	X																	12
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	C	CTD No	029	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 33.27' N	Event No	049	Time I/W	13:07 GMT	
Lon	12° 59.66' W	Depth	304 m	Time bottom	13:22 GMT	
Filename	D340_CTD_029.hex	Cast Depth	294 m	Time O/W	13:48 GMT	
Weather	Moderate swell and wind.					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	294	13:23																		1
2	2	2	294	13:23	X			X	X					X								2
3	3	3	150	13:28										X								3
4	4	4	150	13:28		X	X	X							X			X				4
5	5	5	100	13:33										X								5
6	6	6	100	13:33			X	X	X													6
7	7	7	50	13:38	X				X					X								7
8	8	8	50	13:38			X	X							X			X				8
9	9	9	16	13:42					X						X			X				9
10	10	10	16	13:42																		10
11	11	11	16	13:42																		11
12	12	12	16	13:42			X	X						X								12
13	13	13	5	13:46	X		X	X	X					X								13
14	14	14	5	13:46		X									X			X				14
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle	Karl	Jamie	Jamie	Andy					Tim	Shady			Shady				

D340a CTD log sheet

Station	D	CTD No	030	Date	16/06/09	CTD type: SS ■ Ti □
Lat	57° 32.50' N	Event No	050	Time I/W	15:04 GMT	
Lon	12° 51.94' W	Depth	1127 m	Time bottom	15:34 GMT	
Filename	D340_CTD_030.hex	Cast Depth	1086 m	Time O/W	16:21 GMT	
Weather	State state ~ 6					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	1086	15:34																		1
2	2	2	1086	15:34	X									X								2
3	3	3	1000	15:39										X								3
4	4	4	1000	15:39																		4
5	5	5	800	15:46	X									X								5
6	6	6	800	15:46																		6
7	7	7	600	15:54										X								7
8	8	8	600	15:54																		8
9	9	9	500	15:58	X									X								9
10	10	10	500	15:58																		10
11	11	11	300	16:04	X									X								11
12	12	12	300	16:04																		12
13	13	13	150	16:08										X								13
14	14	14	150	16:08																		14
15	15	15	100	16:12										X								15
16	16	16	100	16:12																		16
17	17	17	50	16:15										X								17
18	18	18	50	16:15																		18
19	19	19	20	16:17										X								19
20	20	20	20	16:17																		20
21	21	21	5	16:19	X									X								21
22	22	22	5	16:19																		22
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	E	CTD No	031	Date	16/06/09	CTD type: SS ☐ Ti ■
Lat	57°31.98' N	Event No	051	Time I/W	18:05 GMT	
Lon	12° 38.02' W	Depth	1666 m	Time bottom	18:45 GMT	
Filename	D340_CTD_031t.hex	Cast Depth	1640 m	Time O/W	19:44 GMT	
Weather	Sea state ~ 6					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1640	18:47												X	X					1
2	13	13	1640	18:47						X	X			X								13
3	14	14	1000	19:00		X				X	X			X								14
4	2	2	1000	19:00												X	X					2
5	3	3	800	19:05												X	X					3
6	15	15	800	19:05		X					X			X								15
7	16	16	500	19:14				X		X	X			X								16
8	4	4	400	19:18												X	X					4
9	5	5	400	19:18												X	X					5
10	6	6	300	19:22												X	X					6
11	17	17	300	19:22		X		X			X			X								17
12	7	7	150	19:29												X	X					7
13	18	18	150	19:29	X		X	X		X	X	X	X	X								18
14	8	8	100	19:32												X	X					8
15	19	19	100	19:32	X		X	X		X	X	X	X	X								19
16	9	9	50	19:35												X	X					9
17	20	20	50	19:35			X	X		X	X	X	X	X								20
18	10	10	30	19:39												X	X					10
19	21	21	30	19:39			X	X		X	X											21
20	22	22	30	19:39								X	X	X					X	X		22
21	11	11	10	19:40												X	X					11
22	12	12	5	19:42												X	X					12
23	23	23	5	19:42	X		X	X		X	X											23
24	24	24	5	19:42								X	X	X					X	X		24
			Analyst		Estelle	Karl	Jamie	Jamie		Victoire	Victoire	Anna	Anna	Tim		Seb-astian	Khairul		Anna	Sophie		

D340a CTD log sheet

Station	F	CTD No	032	Date	17/06/09	CTD type: SS ■ Ti ☐
Lat	57° 30.59' N	Event No	052	Time I/W	08:48 GMT	
Lon	12° 14.73' W	Depth	1820 m	Time bottom	09:27 GMT	
Filename	D340_CTD_032.hex	Cast Depth	1800 m	Time O/W	10:36 GMT	
Weather	Force 5/6					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1800	09:28					X													1
2	2	2	1800	09:28	X									X								2
3	3	3	1500	09:36																		3
4	4	4	1500	09:36		X								X								4
5	5	5	1000	09:48																		5
6	6	6	1000	09:48		X								X								6
7	7	7	800	09:56	X																	7
8	8	8	800	09:56										X								8
9	9	9	500	10:04																		9
10	10	10	500	10:04				X						X								10
11	11	11	300	10:10	X																	11
12	12	12	300	10:10				X						X								12
13	13	13	150	10:15											X			X				13
14	14	14	150	10:15			X	X						X								14
15	15	15	100	10:19					X													15
16	16	16	100	10:19			X	X						X								16
17	17	17	50	10:23	X				X						X			X				17
18	18	18	50	10:23			X	X						X							X	18
19	19	19	13	10:29					X													19
20	20	20	13	10:29			X	X						X							X	20
21	21	21	13	10:29					X													21
22	22	22	13	10:29					X						X			X				22
23	23	23	5	10:31	X				X						X			X				23
24	24	24	5	10:31			X	X						X							X	24
			Analyst		Estelle	Karl	Jamie	Jamie	Andy					Tim	Shady			Shady			Tim	

D340a CTD log sheet

Station	G	CTD No	033	Date	17/06/09	CTD type:
Lat	57° 29.63' N	Event No	054	Time I/W	12:01 GMT	SS ■
Lon	11° 50.90' W	Depth	1838 m	Time bottom	12:46 GMT	Ti □
Filename	D340_CTD_033.hex	Cast Depth	1780 m	Time O/W	13:58 GMT	
Weather	Slight swell					
Comments	Replicate salinity sample taken from bottle 7					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	1780	12:50	X									X								1
2	2	2	1780	12:50																		2
3	3	3	1500	12:59										X								3
4	4	4	1500	12:59																		4
5	5	5	1000	13:14	X									X								5
6	6	6	1000	13:14																		6
7	7	7	800	13:22	X									X								7
8	8	8	800	13:22																		8
9	9	9	500	13:30	X									X								9
10	10	10	500	13:30																		10
11	11	11	300	13:36										X								11
12	12	12	300	13:36																		12
13	13	13	150	13:42										X								13
14	14	14	150	13:42																		14
15	15	15	100	13:46										X								15
16	16	16	100	13:46																		16
17	17	17	50	13:50										X								17
18	18	18	50	13:50																		18
19	19	19	21	13:52	X									X								19
20	20	20	21	13:52																		20
21	21	21	5	13:55										X								21
22	22	22	5	13:55																		22
23																						
24																						
			Analyst		**Estelle**									**Tim**								

D340a CTD log sheet

Station	H	CTD No	034	Date	17/06/09	CTD type:
Lat	57° 28.90' N	Event No	055	Time I/W	22:22 GMT	SS ■
Lon	11° 31.95' W	Depth	2067 m	Time bottom	23:04 GMT	Ti □
Filename	D340_CTD_034.hex	Cast Depth	2005 m	Time O/W	00:14 GMT	
Weather	Force 6 wind					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	2005	23:05																		1
2	2	2	2005	23:05	X	X				X	X			X								2
3	3	3	1500	23:16							X			X								3
4	4	4	1500	23:16	X	X																4
5	5	5	1200	23:25						X	X			X								5
6	6	6	1200	23:25																		6
7	7	7	1000	23:31							X			X								7
8	8	8	1000	23:31	X	X																8
9	9	9	700	23:38						X	X			X								9
10	10	10	700	23:38																		10
11	11	11	500	23:45							X			X								11
12	12	12	500	23:45				X														12
13	13	13	300	23:51							X			X								13
14	14	14	300	23:51	X			X														14
15	15	15	150	23:56						X	X			X								15
16	16	16	150	23:56			X	X														16
17	17	17	100	00:00						X	X			X								17
18	18	18	100	00:00			X	X														18
19	19	19	50	00:04						X	X			X								19
20	20	20	50	00:04			X	X														20
21	21	21	25	00:08						X	X			X								21
22	22	22	25	00:08			X	X														22
23	23	23	5	00:11						X	X			X								23
24	24	24	5	00:11	X		X	X														24
			Analyst		**Estelle**	**Karl**	**Jamie**	**Jamie**		**Victoire**	**Victoire**			**Tim**								

D340a CTD log sheet

Station	I	CTD No	035	Date	19/06/09	CTD type: SS ■ Ti □
Lat	57° 28.02' N	Event No	057	Time I/W	13:08 GMT	
Lon	11° 19.05' W	Depth	774 m	Time bottom	13:40 GMT	
Filename	D340_CTD_035.hex	Cast Depth	745 m	Time O/W	14:25 GMT	
Weather	Moderate swell					
Comments	Bottle 3 did not close properly					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	745	13:40										X								1
2	2	2	745	13:40	X				X													2
3	3	3	500	13:50																		3
4	4	4	500	13:50	X									X								4
5	5	5	300	14:00										X								5
6	6	6	300	14:00	X																	6
7	7	7	150	14:07										X								7
8	8	8	150	14:07																		8
9	9	9	100	14:12										X								9
10	10	10	100	14:12					X													10
11	11	11	50	14:16										X								11
12	12	12	50	14:16					X													12
13	13	13	30	14:20										X								13
14	14	14	30	14:20					X													14
15	15	15	5	14:25										X								15
16	16	16	5	14:25	X				X													16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle				Andy					Tim								

D340a CTD log sheet

Station	J	CTD No	036	Date	19/06/09	CTD type: SS ■ Ti □
Lat	57° 27.96' N	Event No	058	Time I/W	15:45 GMT	
Lon	11° 04.90' W	Depth	587 m	Time bottom	16:09 GMT	
Filename	D340_CTD_036.hex	Cast Depth	585 m	Time O/W	16:44 GMT	
Weather	Moderate swell					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	585	16:11	X									X								1
2	2	2	585	16:11																		2
3	3	3	500	16:15										X								3
4	4	4	500	16:15				X														4
5	5	5	300	16:23	X									X								5
6	6	6	300	16:23				X														6
7	7	7	150	16:30										X								7
8	8	8	150	16:30			X	X														8
9	9	9	100	16:33										X								9
10	10	10	100	16:33			X	X														10
11	11	11	50	16:36										X								11
12	12	12	50	16:36			X	X														12
13	13	13	20	16:40										X								13
14	14	14	20	16:40			X	X														14
15	15	15	5	16:42	X									X								15
16	16	16	5	16:42			X	X														16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	K	CTD No	037	Date	19/06/09	CTD type:
Lat	57° 23.94' N	Event No	059	Time I/W	18:18 GMT	SS ☐
Lon	10° 52.08' W	Depth	792 m	Time bottom	18:42 GMT	Ti ■
Filename	D340_CTD_037t.hex	Cast Depth	765 m	Time O/W	19:21 GMT	
Weather	Moderate swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	765	18:44												X	X					1
2	13	13	765	18:44	X	X				X	X			X								13
3	2	2	700	18:47												X	X					2
4	14	14	700	18:47							X			X								14
5	3	3	500	18:54												X	X					3
6	15	15	500	18:54						X	X			X								15
7	4	4	300	19:00												X	X					4
8	16	16	300	19:00	X	X				X	X			X								16
9	5	5	150	19:05												X	X					5
10	17	17	150	19:05	X					X	X			X								17
11	6	6	100	19:08												X	X					6
12	18	18	100	19:08						X	X			X								18
13	7	7	50	19:12												X	X					7
14	19	19	50	19:12		X				X	X			X								19
15	8	8	30	19:13												X	X					8
16	20	20	30	19:13						X	X											20
17	21	21	30	19:13	X									X								21
18	9	9	10	19:15												X	X					9
19	10	10	5	19:19												X	X					10
20	22	22	5	19:19						X	X											22
21	23	23	5	19:19	X									X								23
22																						
23																						
24																						
			Analyst		Estelle	Karl				Victoire	Victoire			Tim		Seb-astian	Khairal					

D340a CTD log sheet

Station	L	CTD No	038	Date	19/06/09	CTD type:
Lat	57° 22.00' N	Event No	061	Time I/W	21:04 GMT	SS ■
Lon	10° 40.07' W	Depth	2162 m	Time bottom	21:44 GMT	Ti ☐
Filename	D340_CTD_038.hex	Cast Depth	2095 m	Time O/W	22:59 GMT	
Weather						
Comments	Bottle 1 did not fire. Bottle 3 did not close properly.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2095	21:48																		1
2	2	2	2095	21:48	X	X								X								2
3	3	3	1800	21:54																		3
4	4	4	1500	22:02		X								X								4
5	5	5	1200	22:11	X									X								5
6	6	6	1200	22:11																		6
7	7	7	1000	22:16										X								7
8	8	8	1000	22:16		X																8
9	9	9	800	22:23										X								9
10	10	10	800	22:23																		10
11	11	11	500	22:31	X									X								11
12	12	12	500	22:31				X														12
13	13	13	300	22:38										X								13
14	14	14	300	22:38				X														14
15	15	15	150	22:42										X								15
16	16	16	150	22:42			X	X														16
17	17	17	100	22:46	X									X								17
18	18	18	100	22:46			X	X														18
19	19	19	50	22:50										X								19
20	20	20	50	22:50			X	X														20
21	21	21	30	22:54										X								21
22	22	22	30	22:54			X	X														22
23	23	23	5	22:55	X									X								23
24	24	24	5	22:55			X	X														24
			Analyst		Estelle	Karl	Jamie	Jamie						Tim								

D340a CTD log sheet

Station	M	CTD No	039	Date	20/06/09	CTD type: SS ☐ Ti ■
Lat	57° 18.05' N	Event No	062	Time I/W	00:57 GMT	
Lon	10° 22.97' W	Depth	2236 m	Time bottom	01:47 GMT	
Filename	D340_CTD_039t.hex	Cast Depth	2200 m	Time O/W	03:25 GMT	
Weather	Moderate swell					
Comments	Samples were also taken from bottles 4-7 by Chris to produce brine (for use on cruise D341)					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	Plankt	Bot. No.
1	1	1	2200	01:48	X									X							1
2	2	2	2000	01:57		X								X							2
3	3	3	1800	02:05										X							3
4	8	8	1500	02:14	X	X								X							8
5	9	9	1300	02:22	X	X															9
6	10	10	1000	02:30	X	X								X							10
7	11	11	800	02:37	X									X							11
8	12	12	500	02:46			X							X							12
9	13	13	500	02:46	X																13
10	4	4	400	02:52																	4
11	5	5	400	02:52																	5
12	6	6	400	02:52																	6
13	7	7	400	02:53																	7
14	14	14	300	02:58			X							X							14
15	15	15	300	02:58	X																15
16	16	16	150	03:05			X							X							16
17	17	17	100	03:09			X							X							17
18	18	18	100	03:10	X																18
19	19	19	50	03:14			X							X						X	19
20	20	20	50	03:14																	20
21	21	21	18	03:19			X							X						X	21
22	22	22	18	03:19																	22
23	23	23	5	03:21			X							X						X	23
24	24	24	5	03:21	X																24
			Analyst		Estelle	Karl	Jamie							Tim						Tim	

D340a CTD log sheet

Station	N	CTD No	040	Date	20/06/09	CTD type: SS ■ Ti ☐
Lat	57°13.98'N	Event No	063	Time I/W	04:55 GMT	
Lon	10°02.69'W	Depth	2126 m	Time bottom	05:53 GMT	
Filename	D340_CTD_040.hex	Cast Depth	2092 m	Time O/W	06:56 GMT	
Weather	Moderate swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	2092	05:54	X									X								
2	2	2	2092	05:54																		
3	3	3	2000	05:57										X								
4	4	4	2000	05:57	X																	
5	5	5	1800	06:03										X								
6	6	6	1800	06:03																		
7	7	7	1500	06:10	X									X								
8	8	8	1500	06:10																		
9	9	9	1000	06:20	X									X								
10	10	10	1000	06:20																		
11	11	11	800	06:25										X								
12	12	12	800	06:25	X																	
13	13	13	500	06:32										X								
14	14	14	500	06:32	X																	
15	15	15	300	06:37										X								
16	16	16	300	06:37	X																	
17	17	17	150	06:42										X								
18	18	18	150	06:42																		
19	19	19	100	06:45										X								
20	20	20	100	06:45																		
21	21	21	50	06:48										X								
22	22	22	50	06:48																		
23	23	23	10	06:51										X								
24	24	24	5	06:54	X									X								
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	O	CTD No	041	Date	20/06/09	CTD type:
Lat	57° 09.033' N	Event No	067	Time I/W	08:29 GMT	SS ■
Lon	09° 41.899' W	Depth	1948 m	Time bottom	09:12 GMT	Ti □
Filename	D340_CTD_041.hex	Cast Depth	1914 m	Time O/W	10:24 GMT	
Weather						
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1914	09:12	X																	1
2	2	2	1914	09:12					X													2
3	3	3	1800	09:17																		3
4	4	4	1800	09:17																		4
5	5	5	1500	09:24																		5
6	6	6	1500	09:24																		6
7	7	7	1000	09:36	X																	7
8	8	8	1000	09:36																		8
9	9	9	800	09:42																		9
10	10	10	800	09:42																		10
11	11	11	500	09:50				X														11
12	12	12	500	09:50	X																	12
13	13	13	300	09:56				X														13
14	14	14	300	09:57										X								14
15	15	15	150	10:02			X	X														15
16	16	16	150	10:02	X																	16
17	17	17	100	10:07			X	X														17
18	18	18	100	10:07					X													18
19	19	19	50	10:11			X	X														19
20	20	20	50	10:11					X					X								20
21	21	21	25	10:14			X	X														21
22	22	22	25	10:14					X					X								22
23	23	23	5	10:17	X		X	X														23
24	24	24	5	10:17					X					X								24
			Analyst		Estelle		Jamie	Jamie	Andy					Tim								

D340a CTD log sheet

Station	P	CTD No	042	Date	20/06/09	CTD type:
Lat	57° 06.08' N	Event No	065	Time I/W	11:36 GMT	SS ■
Lon	09° 25.59' W	Depth	1500 m	Time bottom	12:09 GMT	Ti □
Filename	D340_CTD_042.hex	Cast Depth	1486 m	Time O/W	13:10 GMT	
Weather	Slight swell					
Comments	Bottle 14 did not seal					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1486	12:10										X								1
2	2	2	1486	12:10	X																	2
3	3	3	1200	12:17										X								3
4	4	4	1200	12:17	X																	4
5	5	5	1200	12:17																		5
6	6	6	1000	12:22																		6
7	7	7	1000	12:22										X								7
8	8	8	1000	12:22																		8
9	9	9	800	12:28																		9
10	10	10	800	12:28	X									X								10
11	11	11	500	12:38										X								11
12	12	12	500	12:38				X														12
13	13	13	300	12:45	X			X						X								13
14	14	14	300	12:45																		14
15	15	15	150	12:52										X								15
16	16	16	150	12:52			X	X														16
17	17	17	100	12:56										X								17
18	18	18	100	12:56			X	X														18
19	19	19	50	13:00										X								19
20	20	20	50	13:00			X	X														20
21	21	21	25	13:05										X								21
22	22	22	25	13:05			X	X														22
23	23	23	5	13:07										X								23
24	24	24	5	13:07	X		X	X														24
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	Q	CTD No	043	Date	20/06/09	CTD type:
Lat	57° 03.04' N	Event No	066	Time I/W	14:18 GMT	SS ■
Lon	09° 12.80' W	Depth	297 m	Time bottom	14:32 GMT	Ti ☐
Filename	D340_CTD_043.hex	Cast Depth	294 m	Time O/W	14:58 GMT	
Weather	Slight swell					
Comments	Replicate salinity sample taken from bottle 14					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	294	14:33						X	X			X								1
2	2	2	294	14:33	X		X	X														2
3	3	3	200	14:38						X	X											3
4	4	4	200	14:38																		4
5	5	5	150	14:40						X	X			X								5
6	6	6	150	14:40			X	X							X			X				6
7	7	7	100	14:45						X	X			X								7
8	8	8	100	14:45			X	X														8
9	9	9	50	14:50						X	X			X								9
10	10	10	50	14:50	X		X	X							X			X				10
11	11	11	18	14:53						X	X			X								11
12	12	12	18	14:53			X	X							X			X				12
13	13	13	5	14:56						X	X			X								13
14	14	14	5	14:56	X		X	X							X			X				14
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie		Victoire	Victoire			Tim	Shady			Shady				

D340a CTD log sheet

Station	R	CTD No	044	Date	20/06/09	CTD type:
Lat	56° 59.93' N	Event No	067	Time I/W	15:59 GMT	SS ■
Lon	08° 59.83' w	Depth	132 m	Time bottom	16:11 GMT	Ti ☐
Filename	D340_CTD_044.hex	Cast Depth	122 m	Time O/W	16:28 GMT	
Weather	Slight swell					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	122	16:12	X									X								1
2	2	2	122	16:12																		2
3	3	3	100	16:15	X									X								3
4	4	4	100	16:15		X	X															4
5	5	5	50	16:19										X								5
6	6	6	50	16:19	X	X	X															6
7	7	7	20	16:23										X								7
8	8	8	20	16:23		X	X															8
9	9	9	5	16:25										X								9
10	10	10	5	16:25	X	X	X															10
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle	Jamie	Jamie							Tim								

D340a CTD log sheet

Station	S	CTD No	045	Date	20/06/09	CTD type:
Lat	56° 56.77' N	Event No	069	Time I/W	17:50 GMT	SS ■
Lon	08° 46.98' W	Depth	124 m	Time bottom	17:58 GMT	Ti □
Filename	D340_CTD_045.hex	Cast Depth	114 m	Time O/W	18:12 GMT	
Weather	Slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	114	17:59																		1
2	2	2	114	17:59	X																	2
3	3	3	114	17:59										X								3
4	4	4	100	18:01																		4
5	5	5	100	18:01	X									X								5
6	6	6	50	18:05																		6
7	7	7	50	18:05										X								7
8	8	8	20	18:08	X																	8
9	9	9	20	18:08										X								9
10	10	10	5	18:11	X																	10
11	11	11	5	18:11										X								11
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	T	CTD No	046	Date	20/06/09	CTD type:
Lat	56° 50.21' N	Event No	070	Time I/W	20:10 GMT	SS ■
Lon	08° 19.99' W	Depth	128 m	Time bottom	21:19 GMT	Ti □
Filename	D340_CTD_046.hex	Cast Depth	125 m	Time O/W	20:39 GMT	
Weather	Slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	125	20:21	X																	1
2	2	2	125	20:21																		2
3	3	3	125	20:21																		3
4	4	4	100	20:24			X	X														4
5	5	5	100	20:24																		5
6	6	6	50	20:28			X	X														6
7	7	7	50	20:28	X																X	7
8	8	8	25	20:31			X	X														8
9	9	9	25	20:31																	X	9
10	10	10	5	20:34			X	X														10
11	11	11	5	20:34	X																X	11
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie													Tim	

D340a CTD log sheet

Station	D6	CTD No	047	Date	21/06/09	CTD type:
Lat	60° 12.40’ N	Event No	072	Time I/W	16:03 GMT	SS ■
Lon	08° 57.45’ W	Depth	561 m	Time bottom	16:23 GMT	Ti □
Filename	D340_CTD_047.hex	Cast Depth	557 m	Time O/W	16:49 GMT	
Weather	Slight swell					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	557	16:23	X									X								1
2	2	2	557	16:23		X																2
3	3	3	500	16:26				X						X								3
4	4	4	500	16:26																		4
5	5	5	300	16:32	X			X						X								5
6	6	6	300	16:32		X																6
7	7	7	150	16:36	X		X	X						X								7
8	8	8	150	16:36																		8
9	9	9	100	16:39			X	X						X								9
10	10	10	100	16:39																		10
11	11	11	80	16:41										X								11
12	12	12	80	16:41																		12
13	13	13	50	16:44			X	X						X								13
14	14	14	50	16:44																		14
15	15	15	12	16:46			X	X						X								15
16	16	16	12	16:46																		16
17	17	17	5	16:48	X		X	X						X								17
18	18	18	5	16:48		X																18
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle	Jamie	Karl	Karl						Tim								

D340a CTD log sheet

Station	D5A	CTD No	048	Date	21/06/09	CTD type:
Lat	60° 13.12’ N	Event No	073	Time I/W	17:16 GMT	SS ■
Lon	08° 58.42’ W	Depth	731 m	Time bottom	17:40 GMT	Ti □
Filename	D340_CTD_048.hex	Cast Depth	723 m	Time O/W	17:59 GMT	
Weather	Slight swell					
Comments	No bottles were fired					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D5	CTD No	049	Date	21/06/09	CTD type:
Lat	60° 13.78' N	Event No	074	Time I/W	18:16 GMT	SS ■
Lon	08° 59.42' W	Depth	1038 m	Time bottom	18:42 GMT	Ti □
Filename	D340_CTD_049.hex	Cast Depth	987 m	Time O/W	19:21 GMT	
Weather	Slight swell					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	987	18:42	X									X								1
2	2	2	987	18:42		X																2
3	3	3	900	18:46										X								3
4	4	4	900	18:46																		4
5	5	5	720	18:50	X									X								5
6	6	6	720	18:50		X																6
7	7	7	500	18:56	X			X						X								7
8	8	8	500	18:56																		8
9	9	9	300	19:02	X		X	X						X								9
10	10	10	300	19:02																		10
11	11	11	150	19:06			X	X						X								11
12	12	12	150	19:06																		12
13	13	13	100	19:09			X	X						X								13
14	14	14	100	19:09																		14
15	15	15	80	19:12										X								15
16	16	16	80	19:12																		16
17	17	17	50	19:14			X	X						X								17
18	18	18	50	19:14																		18
19	19	19	16	19:17			X	X						X								19
20	20	20	16	19:17																		20
21	21	21	5	19:20	X		X	X						X								21
22	22	22	5	19:20		X																22
23																						
24																						
			Analyst		Estelle	Jamie	Karl	Karl						Tim								

D340a CTD log sheet

Station	D4	CTD No	050	Date	21/06/09	CTD type:
Lat	60° 15.01' N	Event No	075	Time I/W	19:51 GMT	SS ■
Lon	09° 00.34' W	Depth	1244 m	Time bottom	20:24 GMT	Ti □
Filename	D340_CTD_050.hex	Cast Depth	1175 m	Time O/W	20:49 GMT	
Weather	Slight swell					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D3	CTD No	051	Date	21/06/09	CTD type: SS ■ Ti □
Lat	60° 15.67' N	Event No	076	Time I/W	21:10 GMT	
Lon	09° 00.47' W	Depth	1088 m	Time bottom	21:36 GMT	
Filename	D340_CTD_051.hex	Cast Depth	1074 m	Time O/W	21:57 GMT	
Weather	Slight swell					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D2	CTD No	052	Date	21/06/09	CTD type: SS ■ Ti □
Lat	60° 16.59' N	Event No	077	Time I/W	22:23 GMT	
Lon	09° 00.69' W	Depth	819 m	Time bottom	22:42 GMT	
Filename	D340_CTD_052.hex	Cast Depth	793 m	Time O/W	23:25 GMT	
Weather	Calm					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	793	22:42	X									X								1
2	2	2	793	22:42		X																2
3	3	3	700	22:47										X								3
4	4	4	700	22:47																		4
5	5	5	600	22:51										X								5
6	6	6	600	22:51		X																6
7	7	7	500	22:57	X									X								7
8	8	8	500	22:57				X														8
9	9	9	300	23:03										X								9
10	10	10	300	23:03		X		X														10
11	11	11	150	23:07										X								11
12	12	12	150	23:07			X	X														12
13	13	13	100	23:10	X									X								13
14	14	14	100	23:10			X	X														14
15	15	15	50	23:14										X								15
16	16	16	50	23:14			X	X														16
17	17	17	30	23:18										X								17
18	18	18	30	23:18			X	X														18
19	19	19	5	23:22	X									X								19
20	20	20	5	23:22			X	X														20
21																						
22																						
23																						
24																						
			Analyst		**Estelle**	**Jamie**	**Karl**	**Karl**						**Tim**								

D340a CTD log sheet

Station	D1	CTD No	053	Date	22/06/09	CTD type:
Lat	60° 17.592' N	Event No	078	Time I/W	00:00 GMT	SS ■
Lon	09° 01.054' W	Depth	562 m	Time bottom	00:24 GMT	Ti □
Filename	D340_CTD_053.hex	Cast Depth	560 m	Time O/W	00:38 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D0	CTD No	054	Date	22/06/09	CTD type:
Lat	60° 20.057' N	Event No	079	Time I/W	00:18 GMT	SS ■
Lon	09° 01.669' W	Depth	513 m	Time bottom	01:41 GMT	Ti □
Filename	D340_CTD_054.hex	Cast Depth	500 m	Time O/W	02:12 GMT	
Weather	Calm					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	500	01:41																		1
2	2	2	500	01:41	X			X						X								2
3	3	3	300	01:47				X														3
4	4	4	300	01:47	X									X								4
5	5	5	150	01:52			X	X														5
6	6	6	150	01:52										X								6
7	7	7	100	01:57			X	X														7
8	8	8	100	01:57										X								8
9	9	9	50	02:01			X	X														9
10	10	10	50	02:01										X								10
11	11	11	30	02:03																		11
12	12	12	30	02:03										X								12
13	13	13	24	02:06			X	X														13
14	14	14	24	02:06																		14
15	15	15	5	02:09			X	X														15
16	16	16	5	02:09	X									X								16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim								

D340a CTD log sheet

Station	DD	CTD No	055	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 23.273' N	Event No	080	Time I/W	03:03 GMT	
Lon	09° 02.212' W	Depth	399 m	Time bottom	03:22 GMT	
Filename	D340_CTD_055.hex	Cast Depth	380 m	Time O/W	03:36 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D3	CTD No	056	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 15.71' N	Event No	081	Time I/W	04:46 GMT	
Lon	09° 00.55' W	Depth	1086 m	Time bottom	05:13 GMT	
Filename	D340_CTD_056.hex	Cast Depth	1075 m	Time O/W	05:35 GMT	
Weather	Slight swell					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	D4A	CTD No	057	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 14.40' N	Event No	083	Time I/W	07:31 GMT	
Lon	08° 59.88' W	Depth	1278 m	Time bottom	08:02 GMT	
Filename	D340_CTD_057.hex	Cast Depth	1277 m	Time O/W	08:58 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1277	08:03										X								1
2	2	2	1277	08:03	X																	2
3	3	3	1000	08:10										X								3
4	4	4	1000	08:10																		4
5	5	5	800	08:17										X								5
6	6	6	800	08:17	X																	6
7	7	7	500	08:25										X								7
8	8	8	500	08:25																		8
9	9	9	300	08:31										X								9
10	10	10	300	08:31	X																	10
11	11	11	150	08:36										X								11
12	12	12	150	08:37																		12
13	13	13	100	08:41										X								13
14	14	14	100	08:41																		14
15	15	15	80	08:44										X								15
16	16	16	80	08:44	X																	16
17	17	17	50	08:48										X								17
18	18	18	19	08:52					X													18
19	19	19	19	08:52					X													19
20	20	20	19	08:52					X													20
21	21	21	19	08:52					X													21
22	22	22	19	08:53					X													22
23	23	23	19	08:53										X								23
24	24	24	5	08:56	X									X								24
			Analyst		Estelle				Andy					Tim								

D340a CTD log sheet

Station	CD1	CTD No	058	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 17.51' N	Event No	085	Time I/W	10:31 GMT	
Lon	09° 07.80' W	Depth	1134 m	Time bottom	10:54 GMT	
Filename	D340_CTD_058.hex	Cast Depth	998 m	Time O/W	11:15 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	CD2	CTD No	059	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 16.12' N	Event No	086	Time I/W	11:49 GMT	
Lon	09° 12.32' W	Depth	1718 m	Time bottom	12:30 GMT	
Filename	D340_CTD_059.hex	Cast Depth	1716 m	Time O/W	13:34 GMT	
Weather	Calm					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1	1	1	1716	12:30										X								1
2	2	2	1716	12:30	X																	2
3	3	3	1200	12:42										X								3
4	4	4	1200	12:42																		4
5	5	5	1000	12:48										X								5
6	6	6	1000	12:48	X																	6
7	7	7	800	12:54										X								7
8	8	8	800	12:54																		8
9	9	9	600	12:59										X								9
10	10	10	600	12:59																		10
11	11	11	500	13:04	X									X								11
12	12	12	500	13:04				X														12
13	13	13	300	13:11										X								13
14	14	14	300	13:11				X														14
15	15	15	150	13:16										X								15
16	16	16	150	13:16			X	X														16
17	17	17	100	13:20	X									X								17
18	18	18	100	13:20			X	X														18
19	19	19	50	13:24										X								19
20	20	20	50	13:24			X	X														20
21	21	21	20	13:28										X								21
22	22	22	20	13:28			X	X														22
23	23	23	5	13:31	X									X								23
24	24	24	5	13:31			X	X														24
			Analyst		**Estelle**		**Karl**	**Karl**						**Tim**								

D340a CTD log sheet

Station	CD3	CTD No	060	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 14.88' N	Event No	087	Time I/W	14:17 GMT	
Lon	09° 17.09' W	Depth	1609 m	Time bottom	14:52 GMT	
Filename	D340_CTD_060.hex	Cast Depth	1605 m	Time O/W	15:36 GMT	
Weather	Calm					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1	1	1	1593	14:52	X					X	X											1
2	2	2	500	15:14	X					X	X											2
3	3	3	150	15:22	X					X	X											3
4	4	4	50	15:28						X	X											4
5	5	5	12	15:31						X	X											5
6	6	6	5	15:33	X					X	X											6
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		**Estelle**					**Victoire**	**Victoire**											

D340a CTD log sheet

Station	CD4	CTD No	061	Date	22/06/09	CTD type:
Lat	60° 13.60' N	Event No	088	Time I/W	16:17 GMT	SS ■
Lon	09° 21.62' W	Depth	1493 m	Time bottom	16:52 GMT	Ti □
Filename	D340_CTD_061.hex	Cast Depth	1477 m	Time O/W	17:20 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	CD5	CTD No	062	Date	22/06/09	CTD type:
Lat	60° 11.52' N	Event No	089	Time I/W	18:03 GMT	SS ■
Lon	90° 29.45' W	Depth	1132 m	Time bottom	18:32 GMT	Ti □
Filename	D340_CTD_062.hex	Cast Depth	1070 m	Time O/W	19:13 GMT	
Weather	Calm					
Comments	Bottle 1 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	1070	18:34																		1
2	2	2	1070	18:34	X									X								2
3	3	3	850	18:40	X									X								3
4	4	4	850	18:40																		4
5	5	5	780	18:43										X								5
6	6	6	780	18:43																		6
7	7	7	750	18:46										X								7
8	8	8	750	18:46																		8
9	9	9	600	18:50	X									X								9
10	10	10	600	18:50				X														10
11	11	11	300	18:57	X									X								11
12	12	12	300	18:57				X														12
13	13	13	150	19:01										X								13
14	14	14	150	19:01			X	X														14
15	15	15	100	19:04										X								15
16	16	16	100	19:04			X	X														16
17	17	17	50	19:07										X								17
18	18	18	50	19:07			X	X														18
19	19	19	12	19:10										X								19
20	20	20	12	19:10			X	X														20
21	21	21	5	19:12	X						X			X								21
22	22	22	5	19:12			X	X														22
23																						
24																						
			Analyst		Estelle		Karl	Karl			Victoire			Tim								

D340a CTD log sheet

Station	CD6	CTD No	063	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 21.27' N	Event No	090	Time I/W	20:30 GMT	
Lon	09° 26.55' W	Depth	1211 m	Time bottom	20:56 GMT	
Filename	D340_CTD_063.hex	Cast Depth	1205 m	Time O/W	21:54 GMT	
Weather	Calm					
Comments	Bottles 1 and 17 did not fire					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	1	1	1205	20:56																		1
2	2	2	1205	20:56	X									X								2
3	3	3	1000	21:02										X								3
4	4	4	1000	21:02																		4
5	5	5	800	21:09										X								5
6	6	6	800	21:09																		6
7	7	7	750	21:12										X								7
8	8	8	750	21:12	X																	8
9	9	9	700	21:15										X								9
10	10	10	700	21:15																		10
11	11	11	500	21:21										X								11
12	12	12	500	21:21																		12
13	13	13	300	21:28										X								13
14	14	14	300	21:28	X																	14
15	15	15	150	21:32										X								15
16	16	16	150	21:32																		16
17	17	17	100	21:36																		17
18	18	18	100	21:36	X									X								18
19	19	19	50	21:45										X								19
20	20	20	50	21:45																		20
21	21	21	10	21:49										X								21
22	22	22	10	21:49																		22
23	23	23	5	21:52										X								23
24	24	24	5	21:52	X																	24
			Analyst		Estelle									Tim								

D340a CTD log sheet

Station	CD7	CTD No	064	Date	22/06/09	CTD type: SS ■ Ti □
Lat	60° 19.14' N	Event No	091	Time I/W	22:38 GMT	
Lon	09° 21.20' W	Depth	1595 m	Time bottom	23:13 GMT	
Filename	D340_CTD_064.hex	Cast Depth	1571 m	Time O/W	23:45 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	CD8	CTD No	065	Date	23/06/09	CTD type: SS ■ Ti ☐
Lat	60° 17.52' N	Event No	092	Time I/W	00:26 GMT	
Lon	09° 16.68' W	Depth	1678 m	Time bottom	01:04 GMT	
Filename	D340_CTD_065.hex	Cast Depth	1660 m	Time O/W	01:53 GMT	
Weather	Calm					
Comments	Bottle 1 did not fire. Replicate salinity taken from bottle 10.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/PON	DMS	PIC	DIC/Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1660	01:05																		1
2	2	2	1660	01:05	X																	2
3	3	3	1000	01:20																		3
4	4	4	1000	01:20	X																	4
5	5	5	500	01:33																		5
6	6	6	500	01:33	X																	6
7	7	7	200	01:42																		7
8	8	8	200	01:42	X																	8
9	9	9	5	01:49																		9
10	10	10	5	01:49	X																	10
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	CD9	CTD No	066	Date	23/06/09	CTD type: SS ■ Ti ☐
Lat	60° 14.97' N	Event No	093	Time I/W	02:43 GMT	
Lon	09° 09.49' W	Depth	1521 m*	Time bottom	03:22 GMT	
Filename	D340_CTD_066.hex	Cast Depth	1385 m	Time O/W	03:49 GMT	
Weather	Calm					
Comments	*Shallowing to approx 1370 m during the cast then back up to 1450m. No bottles were fired.					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/PON	DMS	PIC	DIC/Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	CD10	CTD No	067	Date	23/06	CTD type: SS ■ Ti □
Lat	60° 13.45' N	Event No	094	Time I/W	04:27 GMT	
Lon	09° 04.63' W	Depth	1053 m	Time bottom	04:56 GMT	
Filename	D340_CTD_067.hex	Cast Depth	1043 m	Time O/W	05:28 GMT	
Weather	Calm					
Comments	Bottle 1 did not fire properly					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1043	04:56																		1
2	2	2	1043	04:56	X																	2
3	3	3	800	05:02	X																	3
4	4	4	800	05:02																		4
5	5	5	500	05:10	X																	5
6	6	6	500	05:10																		6
7	7	7	200	05:18	X																	7
8	8	8	200	05:18																		8
9	9	9	100	05:22	X																	9
10	10	10	100	05:22																		10
11	11	11	5	05:27	X																	11
12	12	12	5	05:27																		12
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	EG1	CTD No	068	Date	23/06/09	CTD type: SS ■ Ti □
Lat	60° 15.52' N	Event No	096	Time I/W	07:23 GMT	
Lon	09° 07.48' W	Depth	1636 m	Time bottom	08:07 GMT	
Filename	D340_CTD_068.hex	Cast Depth	1590 m	Time O/W	08:54 GMT	
Weather	Calm					
Comments	During the downcast, 60 m from the bottom, there was a period of no depth gain by the CTD					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1590	08:07	X																	1
2	2	2	1590	08:07																		2
3	3	3	1000	08:20	X																	3
4	4	4	1000	08:20																		4
5	5	5	500	08:31	X																	5
6	6	6	500	08:31																		6
7	7	7	100	08:42	X																	7
8	8	8	100	08:42																		8
9	9	9	20	08:47																		9
10	10	10	20	08:47																		10
11	11	11	5	08:51	X																	11
12	12	12	5	08:51																		12
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	EG2	CTD No	069	Date	23/06/09	CTD type:
Lat	60° 14.82' N	Event No	097	Time I/W	09:30 GMT	SS ■
Lon	09° 03.68' W	Depth	1396 m	Time bottom	10:14 GMT	Ti □
Filename	D340_CTD_069.hex	Cast Depth	1397 m	Time O/W	10:41 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	EG4	CTD No	070	Date	23/06/09	CTD type:
Lat	60° 14.53' N	Event No	098	Time I/W	11:24 GMT	SS ■
Lon	08° 54.65' W	Depth	1209 m	Time bottom	11:59 GMT	Ti □
Filename	D340_CTD_070.hex	Cast Depth	1177 m	Time O/W	12:36 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1180	12:00	X																	1
2	2	2	1180	12:00																		2
3	3	3	800	12:10																		3
4	4	4	800	12:10	X																	4
5	5	5	500	12:19																		5
6	6	6	500	12:19	X																	6
7	7	7	100	12:29																		7
8	8	8	100	12:29	X																	8
9	9	9	5	12:33																		9
10	10	10	5	12:33	X																	10
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	EG5	CTD No	071	Date	23/06/09	CTD type: SS ■ Ti □
Lat	60° 14.55' N	Event No	099	Time I/W	13:20 GMT	
Lon	08° 48.71' W	Depth	1031 m	Time bottom	13:43 GMT	
Filename	D340_CTD_071.hex	Cast Depth	1029 m	Time O/W	14:12 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1021	13:44	X																	1
2	2	2	1021	13:44																		2
3	3	3	500	13:55																		3
4	4	4	500	13:55	X																	4
5	5	5	200	14:03																		5
6	6	6	200	14:03	X																	6
7	7	7	5	14:10																		7
8	8	8	5	14:10	X																	8
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	EG3	CTD No	072	Date	23/06/09	CTD type: SS ■ Ti □
Lat	60° 14.72' N	Event No	100	Time I/W	15:39 GMT	
Lon	09° 00.87' W	Depth	1297 m	Time bottom	16:13 GMT	
Filename	D340_CTD_072.hex	Cast Depth	1290 m	Time O/W	16:56 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1290	16:13	X																	
2	2	2	1000	16:27	X																	
3	3	3	800	16:36	X																	
4	4	4	500	16:42	X																	
5	5	5	5	16:53	X																	
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																	

D340a CTD log sheet

Station	14G	CTD No	073	Date	24/06/09	CTD type:
Lat	56° 48.50' N	Event No	102	Time I/W	14:25 GMT	SS ■
Lon	08° 09.96' W	Depth	125 m	Time bottom	14:34 GMT	Ti ☐
Filename	D340_CTD_073.hex	Cast Depth	125 m	Time O/W	14:56 GMT	
Weather	Calm					
Comments						

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1	1	1	125	14:35	X									X								1
2	2	2	125	14:35			X	X														2
3	3	3	100	14:38										X								3
4	4	4	100	14:38				X														4
5	5	5	80	14:40										X								5
6	6	6	80	14:40				X														6
7	7	7	60	14:42										X								7
8	8	8	60	14:42			X	X														8
9	9	9	40	14:44										X							X	9
10	10	10	40	14:44			X	X														10
11	11	11	30	14:46										X								11
12	12	12	30	14:46				X														12
13	13	13	18	14:50										X							X	13
14	14	14	18	14:50			X	X														14
15	15	15	5	14:53																		15
16	16	16	5	14:53	X		X	X						X							X	16
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		**Estelle**		**Karl**	**Karl**						**Tim**							**Tim**	

D340a CTD log sheet

Station	13G	CTD No	074	Date	24/06/09	CTD type:
Lat	56° 47.04' N	Event No	103	Time I/W	15:50 GMT	SS ■
Lon	08° 00.00' W	Depth	120 m	Time bottom	15:55 GMT	Ti ☐
Filename	D340_CTD_074.hex	Cast Depth	117 m	Time O/W	16:00 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Sal**	**DO**	**Chl**	**POC/ PON**	**DMS**	**PIC**	**DIC/ Alk**	**FRRF**	**FCM**	**Nut**	**Boron**	**Fe**	**Fe lig**	**SBG**	**Prot**	**RNA**	**Plankt**	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	12G	CTD No	075	Date	24/06/09	CTD type: SS ■ Ti ☐
Lat	56° 45.55' N	Event No	104	Time I/W	16:50 GMT	
Lon	07° 50.00' W	Depth	45 m	Time bottom	16:57 GMT	
Filename	D340_CTD_075.hex	Cast Depth	40 m	Time O/W	17:05 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	40	16:58	X									X							X	1
2	2	2	40	16:58			X	X														2
3	3	3	30	17:00										X								3
4	4	4	30	17:00			X	X														4
5	5	5	18	17:02										X							X	5
6	6	6	18	17:02			X	X														6
7	7	7	5	17:03	X									X							X	7
8	8	8	5	17:03			X	X														8
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Karl	Karl						Tim							Tim	

D340a CTD log sheet

Station	11G	CTD No	076	Date	24/06/09	CTD type: SS ■ Ti ☐
Lat	56° 43.92' N	Event No	105	Time I/W	17:52 GMT	
Lon	07° 39.85' W	Depth	67 m	Time bottom	17:59 GMT	
Filename	D340_CTD_076.hex	Cast Depth	62 m	Time O/W	18:10 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	62	18:00	X																	1
2	2	2	62	18:00																		2
3	3	3	40	18:03																	X	3
4	4	4	40	18:03																		4
5	5	5	18	18:05																	X	5
6	6	6	18	18:05																		6
7	7	7	5	18:08																	X	7
8	8	8	5	18:08	X																	8
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																Tim	

D340a CTD log sheet

Station	10G	CTD No	077	Date	24/06/09	CTD type:
Lat	56° 44.00' N	Event No	106	Time I/W	18:55 GMT	SS ■
Lon	07° 30.14' W	Depth	230 m	Time bottom	19:06 GMT	Ti □
Filename	D340_CTD_077.hex	Cast Depth	220 m	Time O/W	19:35 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	220	19:07	X									X								1
2	2	2	220	19:07																		2
3	3	3	200	19:09										X								3
4	4	4	200	19:09				X														4
5	5	5	180	19:11										X								5
6	6	6	180	19:11																		6
7	7	7	150	19:14										X								7
8	8	8	150	19:14			X	X														8
9	9	9	100	19:17	X									X								9
10	10	10	100	19:17			X	X														10
11	11	11	80	19:21										X								11
12	12	12	80	19:21				X														12
13	13	13	50	19:23										X								13
14	14	14	50	19:23			X	X														14
15	15	15	40	19:25										X							X	15
16	16	16	40	19:25																		16
17	17	17	30	19:27										X								17
18	18	18	30	19:27																		18
19	19	19	18	19:29										X							X	19
20	20	20	18	19:29			X	X														20
21	21	21	5	19:32	X									X							X	21
22	22	22	5	19:32			X	X														22
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim							Tim	

D340a CTD log sheet

Station	9G	CTD No	078	Date	24/06/09	CTD type:
Lat	56° 43.96' N	Event No	107	Time I/W	20:29 GMT	SS ■
Lon	07° 19.75' W	Depth	157 m	Time bottom	20:35 GMT	Ti □
Filename	D340_CTD_078.hex	Cast Depth	154 m	Time O/W	20:47 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	154	20:35																		1
2	2	2	154	20:35	X																	2
3	3	3	40	20:42																	X	3
4	4	4	40	20:42	X																	4
5	5	5	20	20:44																	X	5
6	6	6	20	20:44																		6
7	7	7	5	20:46																	X	7
8	8	8	5	20:46	X																	8
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																Tim	

D340a CTD log sheet

Station	8G	CTD No	079	Date	24/06/09	CTD type: SS ■ Ti □
Lat	56° 43.93' N	Event No	108	Time I/W	21:38 GMT	
Lon	07° 10.03' W	Depth	175 m	Time bottom	21:44 GMT	
Filename	D340_CTD_079.hex	Cast Depth	171 m	Time O/W	21:52 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	7G	CTD No	080	Date	24/06/09	CTD type: SS ■ Ti □
Lat	56° 43.96' N	Event No	109	Time I/W	22:45 GMT	
Lon	07° 00.10' W	Depth	137 m	Time bottom	22:53 GMT	
Filename	D340_CTD_080.hex	Cast Depth	135 m	Time O/W	23:15 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	135	22:54										X								1
2	2	2	135	22:54	X			X														2
3	3	3	120	22:55										X								3
4	4	4	120	22:55				X														4
5	5	5	100	22:57										X								5
6	6	6	100	22:57			X	X														6
7	7	7	80	23:00										X								7
8	8	8	80	23:00			X	X														8
9	9	9	60	23:02										X								9
10	10	10	60	23:02	X																	10
11	11	11	40	23:05										X								11
12	12	12	40	23:05			X	X													X	12
13	13	13	30	23:08										X								13
14	14	14	30	23:08																		14
15	15	15	20	23:10										X								15
16	16	16	20	23:10			X	X													X	16
17	17	17	5	23:13										X								17
18	18	18	5	23:13	X		X	X													X	18
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim							Tim	

D340a CTD log sheet

Station	6G	CTD No	081	Date	25/06/09	CTD type: SS ■ Ti □
Lat	56° 44.05' N	Event No	110	Time I/W	00:30 GMT	
Lon	06° 45.14' W	Depth	29 m	Time bottom	00:35 GMT	
Filename	D340_CTD_081.hex	Cast Depth	27 m	Time O/W	00:45 GMT	
Weather	Calm					
Comments						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	27	00:35																		1
2	2	2	27	00:36																	X	2
3	3	3	15	00:38																		3
4	4	4	15	00:38	X																X	4
5	5	5	5	00:41																		5
6	6	6	5	00:41																	X	6
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																Tim	

D340a CTD log sheet

Station	5G	CTD No	082	Date	25/06/09	CTD type: SS ■ Ti □
Lat	56° 44.03' N	Event No	111	Time I/W	01:32 GMT	
Lon	06° 36.02' W	Depth	71 m	Time bottom	01:38 GMT	
Filename	D340_CTD_082.hex	Cast Depth	69 m	Time O/W	01:43 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	4G	CTD No	083	Date	25/06/09	CTD type: SS ■ Ti □
Lat	56° 44.05' N	Event No	112	Time I/W	02:33 GMT	
Lon	06° 27.11' W	Depth	104 m	Time bottom	02:44 GMT	
Filename	D340_CTD_083.hex	Cast Depth	100 m	Time O/W	03:01 GMT	
Weather	Calm					
Comments	Bottles 1 and 2 were not ultimately sampled					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1	3	3	100	02:45	X									X								3
2	4	4	100	02:45			X	X														4
3	5	5	50	02:49										X								5
4	6	6	50	02:49			X	X														6
5	7	7	40	02:52																		7
6	8	8	40	02:52	X																X	8
7	9	9	12	02:55										X							X	9
8	10	10	12	02:56			X	X														10
9	11	11	5	02:58										X							X	11
10	12	12	5	02:58			X	X														12
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim							Tim	

D340a CTD log sheet

Station	3G	CTD No	084	Date	25/06/09	CTD type: SS ■ Ti □
Lat	56° 42.59' N	Event No	113	Time I/W	03:39 GMT	
Lon	06° 21.98' W	Depth	72 m	Time bottom	03:46 GMT	
Filename	D340_CTD_084.hex	Cast Depth	60 m	Time O/W	03:53 GMT	
Weather	Calm					
Comments	No bottles were fired					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	*Bot. No.*
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst																			

D340a CTD log sheet

Station	2G	CTD No	085	Date	25/06/09
Lat	56° 41.07' N	Event No	114	Time I/W	04:29 GMT
Lon	06° 17.06' W	Depth	36 m	Time bottom	04:37 GMT
Filename	D340_CTD_085.hex	Cast Depth	33 m	Time O/W	04:43 GMT
Weather	Calm				
Comments					

CTD type: SS ■ Ti □

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	33	04:37																	X	1
2	2	2	33	04:37																		2
3	3	3	15	04:39																	X	3
4	4	4	15	04:39																		4
5	5	5	5	04:41	X																X	5
6	6	6	5	04:41																		6
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle																Tim	

D340a CTD log sheet

Station	1G	CTD No	086	Date	25/06/09
Lat	56° 48.02' N	Event No	115	Time I/W	05:30 GMT
Lon	06° 08.01' W	Depth	178 m	Time bottom	05:46 GMT
Filename	D340_CTD_086.hex	Cast Depth	168 m	Time O/W	06:07 GMT
Weather	Calm				
Comments					

CTD type: SS ■ Ti □

Fire Seq	Rosette Pos^n	Bot. No.	Depth (m)	Time (GMT)	Sal	DO	Chl	POC/ PON	DMS	PIC	DIC/ Alk	FRRF	FCM	Nut	Boron	Fe	Fe lig	SBG	Prot	RNA	Plankt	Bot. No.
1	1	1	1680	05:46	X									X								1
2	2	2	1680	05:46																		2
3	3	3	150	05:49										X								3
4	4	4	150	05:49			X	X														4
5	5	5	100	05:53	X									X								5
6	6	6	100	05:53			X	X														6
7	7	7	50	05:57										X								7
8	8	8	50	05:57			X	X														8
9	9	9	40	06:00										X							X	9
10	10	10	40	06:00																		10
11	11	11	12	06:03										X							X	11
12	12	12	12	06:03			X	X														12
13	13	13	5	06:05	X									X							X	13
14	14	14	5	06:05			X	X														14
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
			Analyst		Estelle		Jamie	Jamie						Tim							Tim	

Appendix 3

SAMS salinity calibration protocol

SCOTTISH ASSOCIATION *for* MARINE SCIENCE

Seabird 911plus CTD salinity calibration protocol

Although the Seabird 911*plus* is a very accurate instrument experience shows that regular calibration of the conductivity cell is essential where WOCE/WHP standards are required. Some of the systematic problems that are known to have occurred are:

- damage to the conductivity cell discovered after the cruise
- a non-linear trend in conductivity
- differences in calibration with depth
- (in dual conductivity sensor systems) apparent hysteresis in the *difference* between two cells that may be pressure or temperature related

The causes of these problems are often due to fouling or failure of the cell or a breakdown in the integrity of a connector. These failures may lead to a subtle contamination of the observations that may not be apparent during the cruise.

The procedures outlined below <u>must</u> be adhered to throughout the duration of any SAMS cruise, particularly in oceanic waters where salinity differences are small. This protocol sheet should be displayed in the CTD laboratory during the cruise.

At every station take single water bottle samples for subsequent conductivity calibration as follows:

in water > 1000 m deep:

Take 5 samples: 1 in the surface mixed layer; 1 at the bottom of the profile; and 3 others in intermediate depths in regions where the change in salinity with depth is small. The aim is to gather samples that cover a wide range of the salinities encountered.

in water 500 - 1000 m deep:

Take 4 samples, dropping one of the intermediate samples.

in water 100 - 500 m deep:

Take 3 samples, dropping one of the intermediate samples.

in water < 100 m deep:

Take 2samples that provide as wide a range of pressure and salinity as is practical.

AND on each 4 hour watch:

On one CTD cast take three samples instead of one, from any one of the rosette bottles being sampled.

Sampling procedure:

- Rinse the bottle 3 times with water from the sampled rosette bottle.
- Collect sample.
- Wipe neck of the bottle.
- Insert white cap and place black lid.

Provided this protocol is adhered to on all casts it should not be necessary to sample at any greater density so long as there are no changes to the physical system (e.g. re-termination of the cable) which might require a more thorough check on the first cast following the change.

Summary table:

Cast depth	**Number of samples**	Sample depth		
		Surface mixed layer	Intermediate layers	Bottom layer
<100m	**2**	*widest range of pressure and/or salinities*		
100-500m	**3**	1	1	1
500-1000m	**4**	1	2	1
>1000m	**5**	1	3	1
During each watch (every 4 hours or so), take 2 additional samples from any of the sampled bottles.				

Toby Sherwin and Estelle Dumont

August 2008

Appendix 4

Computing and instrumentation

Computing and Instrumentation Report
Cruise: Discovery 340

For any further information on this report please contact:

Chris Barnard
342/11 National Marine Facilities
National Oceanography Centre
Waterfront Campus
Southampton
SO14 3ZH
+44(2380) 596383
E-mail: cvb@noc.soton.ac.uk

RVS LEVEL C System

Level C - The level C system is a Sun Solaris 10 UNIX Workstation discovery1 also known as ABCGATE. The RVS software suite is available on this machine. This suite of software allows the processing, editing and viewing of all data within the RVS data files. This system also has monitors that allow us to ensure that the level C is receiving data from the level B.

Ifremer Techsas System

The Ifremer data logging system is the system that will inevitably replace the existing Level A + B system while for the most part the Level C will remain as the main system for outputting, viewing and editing the acquired data.

The Techsas software is installed on an industrial based system with a high level of redundancy. The operating system is Red Hat Enterprise Linux Edition Release 3. The system itself logs data on to a RAID 0 disk mirror and is also backed up from the Level C using a 200GB / 400GB LTO 2 Tape Drive. The Techsas interface displays the status of all incoming data streams and provides alerts if the incoming data is lost. The ability exists to broadcast live data across the network via NMEA.

The storage method used for data storage is NetCDF (binary) and also pseudo-NMEA (ASCII). At present there are some issues on some data streams with file consistency between the local and network data sets for the ASCII files. NetCDF is used as the preferred data type as it does not suffer from this issue.

The Techsas data logging system was used to log the following instruments:

1) Trimble GPS 4000 DS Surveyor (converted to RVS format as gps_4kl)
2) Chernikeef EM speed log (converted to RVS format as log_chfl)
3) Ships Gyrocompass (converted to RVS format as gyrol)
4) Simrad EA500 Precision Echo Sounder (ea500l)
5) NMFD Surface-water and Meteorology (SURFMETl) instrument suite
6) ASHTECH ADU-2 Altitude Detection Unit (gps_ash)
7) NMFD Winch Cable Logging And Monitoring CLAM (winch)
8) Ashtech GPS G12 integral to the FUGRO Seastar DGPS receiver (gps_g12l)
9) Seabird SBE45 MicroTSG (seabirdl)

Techsas NetCDF to RVS Data Conversion

The Techsas system is capable of network broadcasts and is now recorded directly to RVS Data streams using an application called fromTechsas which calls a portgrabber application to listen to all the UDP Ports that TECHSAS uses.

An in house application was used to handle the conversion of NetCDF files to the RVS format. This was then parsed back to the data file and was processed as normal. These 2 applications being ncvars and nclistit.

These new binaries require to environment variables in order to function:

$NCBASE – the base for the NetCDF binaries system, set to /rvs/def9

$NCRAWBASE – the base for the raw data files, set to /rvs/pro_data/TECHSAS/T1backup/D40/NetCDF

The existing $PATH variable must also include the path to the nc binaries, the path /rvs/def9/bin was appended to the $PATH variable.

All Techsas data file names are in the format of YYYYMMDD-HHMMSS-name-type.category with the data/timestamp being the time the file was created by Techsas.

The files were each processed in the following way for this cruise:

nclistit 20060813-000001-gyro-GYRO.gyr - | sed s/head/heading > $DARAWBASE/gyro.225

At this stage the data is converted to the correct format and its header replaced by the header required by the RVS software suite.

The file is then passed to the titsil application which simply reads the data from the text file that was created and enters it as records in the RVS data file.

cat $DARAWBASE/gyro.225 | titsil gyronmea –

This command reads the gyro.225 file in the /rvs/raw_data directory and passes it to titsil for input in the gyronmea file. The – dictates that all variables will be included.

The TECHSAS system was set to create a new file for each day, however on days when errors occurred multiple files were created as that is normal practice for Techsas when it is restarted.

Fugro Seastar DGPS Receiver

The Fugro Seastar is the source of custom differential corrections based on its position fixed by its internal Ashtec G12 GPS module. It outputs corrections via RS-232 using the standards RTCM message. The message is distributed among all GPS receivers where they are used to compute their own DGPS positions.

The Fugro Seastar functioned correctly throughout the cruise. There have been issues with this system previously not detecting the correct satellites due to location. However in this instance it performed correctly and differential positions were calculated throughout the cruise.

NetCDF files for this system ADUPOS-G12PAT.gps.

Trimble 4000 DS Surveyor

The Trimble 4000DS is a single antenna survey-quality advanced GPS receiver with a main-masthead antenna. It uses differential corrections from the Fugro Seastar unit to produce high quality differential GPS (DGPS) fixes. It is the prime source of scientific navigation data aboard RRS Discovery and is used as the data source for Navigation on the ships display system (SSDS). This antenna is directly on top of the mast and suffers from negligible interference from other items on the mast. It is also almost directly at the centre point of the ship making it an ideal navigation system.

The Techsas NetCDF File ends with the following extensions :
Position-4000.gps
Satelliteinfo-4000.hps

Ashtec ADU-2

This is a four antenna GPS system that can produce attitude data from the relative positions of each antenna and is used to correct the VMADCP for ship motion. Two antennae are on the Bridge Top and two on the boat deck.
The Ashtec system worked reliably throughout the cruise with some gaps that are quite usual with this system due to the amount of calculations necessary. No Large data gaps are present.
The ADU-2 forms part of the bestnav system which is an assembly of multiple GPS signals including the gyronmea and emlog stream in order to calculate the best possible position, speed heading pitch and roll of the ship. The Ashtech is not as reliable as the G12 and the 4000DS mainly due to its low position on the ship it is hard for this system to maintain locks on satellites when the ship is maneuvering and the bridge and main mast come into its direct line of sight with the satellites.

The Techsas NetCDF File ends with the following extensions :
ADUPOS-PAPOS.gps
gppat-GPPAT.att

Gyronmea

The Gyronmea is a file that receives its data from the Ships gyro compass located on the bridge. There are two such Gyros on the bridge and we are able to use either one of them as a source of heading. The selected Gyro is logged by the TECHSAS system and is used as part of the bestnav calculation.

The NetCDF File for Techsas ends with gyro-GYRO.gyr

RDI Ocean Surveyor 75KHz Vessel Mounted ADCP (VMADCP)

The RDI Ocean Surveyor was setup by the science party at the start of the cruise with a bottom track and water track file that is included with the dataset. The configuration was changed when we left the shelf and went to deeper water. The Ocean surveyors are fed with data from the ships

GPS, Gyro and ADU systems in order so that the system can calculate true speeds and direction of the currents below the ship.

100 Bins
8 Meter Bin Size
8 meter Blank
5.3 Meter Transducer Depth
Hi Resolution (short Range)
Ping as fast as possible.

RDI 150KHz Vessel Mounted ADCP (VMADCP)

The RDI Ocean Surveyor was setup by the science party at the start of the cruise with a bottom track and water track file that is included with the dataset. The configuration was changed when we left the shelf and went to deeper water. The Ocean surveyors are fed with data from the ships GPS, Gyro and ADU systems in order so that the system can calculate true speeds and direction of the currents below the ship.

100 Bins
4 Meter Bin Size
4 meter Blank
5.3 Meter Transducer Depth
Hi Resolution (short Range)
Ping as fast as possible.

Chernikeef EM log

The Chernikeef EM log is a 2-axis electromagnetic water speed log. It measures both longitudinal (forward-aft) and transverse (port – starboard) ships water sped.

The EM log was not calibrated prior to the cruise and was reading at 0.0 knots when alongside. The Chernikeef was accurate at the lower speeds but then an offset was obvious when the speed was increased at 10.6 Knots over ground the speed of the Chernikeef was at 8 Knots.

The system was logged by the TECHSAS logging system.
DYLog-LOGCHF-DYLog

Simrad EA500 Precision Echo Sounder (PES)

The PES system was used throughout the cruise, with a variation between use of the Fish and use of the hull transducer. The PES was deployed on the fish as soon as we stopped to deploy the first CTD. The fish is more accurate than the hull transducer as it is capable of being deployed deeper and is also decoupled from the noise of the ship.

The PES outputs its data to a stream called ea500d1 on the TECHSAS System.

EA500 on Hull Transducer 09 176 000000
EA500 off 09 184150000

Surfmet System

This is the NMFD surface water and meteorology instrument suite. The surface water component consists of a flow through system with a pumped pickup at approx 5m depth. TSG flow is approx 25 litres per minute whilst fluorometer and transmissometer flow is approx 3 l/min. Flow to instruments is degassed using a debubbler with 40 l/min inflow and 10/l min waste flow.

The meteorology component consists of a suite of sensors mounted on the foremast at a height of approx 10m above the waterline. Parameters measured are wind speed and direction, air temperature, humidity and atmospheric pressure. There is also a pair of optical sensors mounted on gimbals on each side of the ship. These measure total irradiance (TIR) and photo-synthetically active radiation (PAR).

The Non Toxic system was enabled as soon as we were far enough away from land.
Surfmet Non Toxic On around 091760000
Surfmet Non Toxic Off (End of Cruise) 09184123500

For Salinity Samples please see the scientists log sheets and report. I intend to perform a regression and trend analysis on the data once I have access to it during the 2nd leg as the SBE45 is quite a new system on board Discovery.

The SBE45 unit was changed prior to sailing as another unit had just been returned from Calibration at Seabird and was available for the cruise while the existing unit was out of calibration.
The Transmissometer was also changed prior to sailing for this reason.
The Light Sensors on the foremast appeared not to be working during the Mobilisation due to a fault in the Starboard TIR Sensor. This was changed for a spare unit and appears that the fault was due to the connector on the new cable system that Kipp and Zonen have now adopted.

Techsas NetCDF Files for Surfmet

Surf-SURFMET.SURFMETv2
MET-SURFMET.SURFMETv2
Light-SURFMET.SURFMETv2
SBE45-SBE45.TSG

Surfmetl is the TECHSAS Logged file
Surftmp is the cleaned file

Surfmet : The Sensor List

Met Platform Sensors

Wind Speed and Direction

Manufacturer : Gill
Model : Windsonic (Option 3)

Ultrasonic Output Rate	1, 2, 4Hz
Wind Speed	Range 0-60 m/s
Wind Direction Range	0-359 no dead band
Operating Temp Range	-35 ºC to +70 ºC
Moisture Protection	IP65
External Construction	Luran
Digital O/P Options	RS232 / 422 / 485 / SDI-12
NMEA O/P	Yes
Analogue Outputs	2 (optional)
Calibration	Generic

Total Incidental Radiation

Manufacturer : Kipp and Zonen
Model Number : CM6B

Spectral range (50%points)	305...2800 nm
Sensitivity	9...15 μV/Wm-2
Impedance	70...100 Ohm
Response time	1/e 5 s, 99 % 55 s
Non-linearity	<1.5 % (<1000 W/m 2)
Tilt error	<1.5 % at 1000 W/m 2
Operating temperature	-40...+90 _C
Temperature dependence of sensitivity	_2 % (-10...+40_C)
Maximum irradiance	2000 W/m2
Directional error	< _20 W/m2 at 1000 W/m2
Weight	0.85 kg
Cable length	10 m

Temperature and Humidity

Manufacturer : Vaisala
Model Number : HMP45A

Relative humidity measurement

HMP45A	
Measurement range	0.8 ... 100 % RH
Accuracy at +20 °C (+68 °F)	± 2 % RH (0 ... 90 % RH)
	± 3 % RH (90 ... 100 % RH)
Sensor	Vaisala HUMICAP® 180

Temperature measurement

HMP45A	
Measurement range	-39.2 ... +60 °C (-38.6 ... +140 °F)
Accuracy +20 °C (+68 °F)	± 0.2 °C (± 0.36 °F)
Sensor	Pt 1000 IEC 751

Operating environment

Temperature	
operation	-40 ... +60 °C (-40 ... +140 °F)
storage	-40 ... +80 °C (-40 ... +176 °F)

Inputs and outputs

Operating Voltage	7 ... 35 VDC
Power consumption	< 4 mA
Output load	> 10 kohm (to ground)
Output scale	-40 ... +60 °C (-40 ... +140 °F) equals to 0...1V
Output signal	resistive 4-wire connection

Photosynthetic Active Radiation

Manufacturer : Skye Instruments
Model Number : SKE 510

Spectral Range	400-700nm
Sensitivity Current	3.5µA/100Wm^2
Sensitivity Voltage	1mV/100Wm^2
Working Range	0 – 5000Wm^2
Linear Error	<0.2%
Absolute Calibration Error	typ <3% max 5%
Cosine Error	3%
Azimuth Error	<1%
Temperature coefficient	+/-0.1%/ºC
Longterm Stability	+/-2%
Response Time	10ns
Internal Resistance	300Ohms
Temperature Range	-35ºC … +70ºC
Humidity Range	0 – 100% RH

Barometric Pressure

Barometric pressure measurement

Pressure range	800 ... 1100 hPa
Accuracy at +20 °C (+68 °F)	±0.3 hPa
Sensor	Vaisala BAROCAP®

Operating environment

Temperature range	-5 ... +45 °C (+23 ... +113 °F)
Humidity range	<80 % RH

Inputs and outputs

Operating voltage	9 ... 16 VDC
Power consumption:	
operation mode	2 mA (typical)
shutdown mode	150 µA (typical)
Output voltage	0 … 2.5 VDC

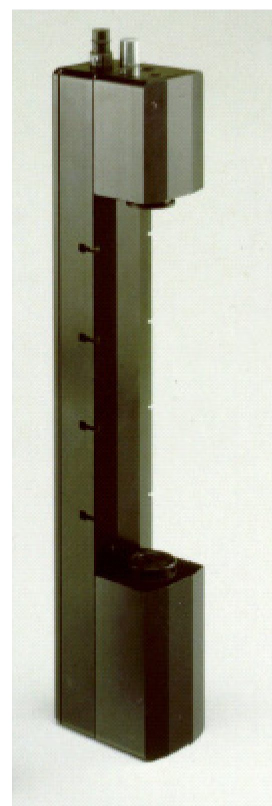
Sea Surface Instruments

Fluorometer

Manufacturer : WetLabs
Model Number : WetStar

Temperature Range	0-30 C
Depth Rating	600m
Response time	0.17s
Input Voltage	7-15vdc
Current Draw	< 40 mA
Output	0-5VDC

Transmissometer



Manufacturer : WetLabs
Model Number : CStar

Pathlength	25cm
Wavelength	660nm
Bandwidth	~ 20nm
Rated Depth	600m
Temperature	0-30ºC
Power Input	7-15VDC
Current Draw	< 40mA
Data Output	0-5Volts
Time Constant	0.167 sec
Temperature Error	0.02 percent F.S./deg C

Seabird Micro TSG SBE45

Measurement Range
Conductivity: 0-7 S/m (0-70 mS/cm)
*Temperature *:* -5 to 35 °C

Initial Accuracy
Conductivity: 0.0003 S/m (0.003 mS/cm)
*Temperature *:* 0.002 °C
Salinity: 0.005 PSU, typical

Typical Stability *(per month)*
Conductivity: 0.0003 S/m (0.003 mS/cm)
*Temperature *:* 0.0002 °C
Salinity: 0.003 PSU, typical

Resolution
Conductivity: 0.00001 S/m (0.0001 mS/cm)
*Temperature *:* 0.0001 °C
Salinity: 0.0002 PSU, typical

Calibration Range
Conductivity: 0-6 S/m (60 mS/cm); physical calibration 2.6-6 S/m (26-60 mS/cm), plus zero conductivity (air)
*Temperature *:* +1 to +32 °C

Time Resolution	1 second
Clock Stability	13 seconds/month
Input Power	8-30 VDC
Acquisition Current	34 mA at 8 VDC; 30 mA at 12-30 VDC
Quiescent Current	10 microamps
Acquisition Rate	1 Hz maximum
Operating Pressure	34.5 decibars (50 psi) maximum
Flow Rate	10 to 30 ml/sec (0.16 to 0.48 gal/min)
Materials	PVC housing
Weight	4.6 kg (10.2 lbs)

Seabird SBE 38 Digital Oceanographic Thermometer

Measurement Range	-5 to +35 °C
Initial Accuracy	± 0.001 °C (1 mK)
Typical Stability	0.001 °C (1 mK) in 6 months, certified
Resolution	0.00025 °C (0.25 mK)
Calibration	-1 to +32 °C
Response Time	500 milliseconds
Self-Heating Error	less than 200 μK

RMS Noise
(at temperature
equivalent of 8.5 °C)

NAvg	**Noise (°C)**
1	0.000673
2	0.000408
4	0.000191
8	0.000133
16	0.000081
32	0.000052

Note:
NAvg = number of A/D cycles per sample.
Interval between samples (seconds)
= (0.133 * **NAvg**) + 0.339

External Power	*RS-232 (standard):* 8 – 15 VDC at 10 milliamps average *RS-485 half-duplex (optional):* 8 – 15 VDC at 6 milliamps average
Materials	Titanium pressure case rated at 10,500 meters (34,400 feet)
Weight	In water: 0.5 kg (1.2 lbs) In air: 0.9 kg (2.0 lbs)

Network Services
Networking worked well throughout the cruise despite a few hiccups with one of the wireless access points on the Forecastle Deck

Data Storage
Two USB external hard drives are being use as a RAID 0 mirror hosted by Discovery3 at the /data32 export. The mirror uses the modern meta device commands available in Solaris 10. This increases storage robustness by providing another layer of redundancy at the online storage level. The maintenance and administration of the disk set is minimal and the performance more than adequate.

All cruise data except for the /rvs path were stored on this storage area. Access was given to scientists to some of the folders via Samba shares.

All CTD, ADCP and LADCP data was backed up to these drives on acquisition.

PSTAR was used directly on data32 directory.
Level C data was logged to the discovery1 internal disk, Techsas backs its data to here under /rvs/pro_data/TECHSAS and also stores it on its own internal raided drive array.

Data Backups
Backups of the Level C data were done twice daily as a tar file to DLT tape and LTO tape. Alternating between the standard backup below and a full /rvs backup. The following paths were included in the tar file:

/rvs/raw_data
/rvs/pro_data
/rvs/def7/control
/rvs/users

In addition to the redundancy provided by the RAID 0 pair, daily backups of the /data32 directory were done by a tar of the file system to the LTO 2 tape. The whole disk was backed up not just current cruise data.

The LTO2 system was backed up on a daily basis in a rolling 2 tape system.

Data Archiving
The proposed data archive will consist of the following components.

1) All CTD data
2) All ADCP data
3) All LADCP Data
4) All TECHSAS NetCDF data files
5) All RVS Data Streams including Listit Text file outputs
6) Moored ADCP Data from STC.

All PSTAR Data will be taken back by hard drive at the end of the cruise as well as Tapes being made as a backup and returned to NOCS.

Appendix 1 Surfmet Sensor Information

Surfmet Sensor Information

Ship	RRS Discovery
Cruise	D340a andb
Technician	Chris Barnard
Date	21/06/09

Manufacturer	Sensor	Serial no	Comments
SeaBird	SBE 38 Digital Thermometer	0476	Remote Seawater Temperature
SeaBird	SBE 45 microTSG	0229	Housing Temperature and Conductivity Swapped Prior to Cruise
Wetlabs	Fluorometer	WS3S-247	
Wetlabs	Transmissometer	CST-113R	Swapped Prior to Cruise
Vaisala	Barometer PTB100A	S361008	Port Foremast
Vaisala	Temp/humidity HMP45	B4950010	Port Foremast
Skye	PAR	28557	Port
Skye	PAR	28556	Starboard
Kipp and Zonen	TIR CMB6	994133	Port
Kipp and Zonen	TIR CMB6	962301	Starboard Swapped Prior to Cruise
Sensors without cal			
Gill	Windsonic	071123	Port Foremast

SPARES

Manufacturer	Sensor	Serial no	Comments
Seabird	SBE 38 Digital Thermometer	416, 475	
Seabird	SBE 45 MicroTSG	0233	
Wetlabs	Fluorometer	N/A	
Wetlabs	Transmissometer	CST-112R, CST-113R	
Vaisala	Barometer PTB100A	S3440012	
Vaisala	Temp/humidity HMP45	C132001	
Skye	PAR	28559	
Skye	PAR	N/A	
Kipp and Zonen	TIR CMB6B	N/A	
Kipp and Zonen	TIR CMB6B	N/A	
Sensors without cal			
Gill	Windsonic	071121	