

# Cruise Report

JR 276 “DIMES UK 2.5”

RRS James Clark Ross, 9 April  
2011 – 26 April 2011

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## 1.1 SCIENTIFIC PERSONNEL

These came from University of East Anglia (UEA), Southampton University and National Oceanography Centre (NOCS), Woods Hole Oceanographic Institution (WHOI), and the British Antarctic Survey (BAS), as follows:

PSO	Andy Watson	UEA
Physical Oceanography	Penny Holliday	NOCS
	Jean-Baptiste Sallée	BAS
	Emily Shuckburgh	BAS
	David Smeed	NOCS
	Christopher O'Donnell	UEA
	Peggy Courtois	NOCS
VMP	Alex Brearly	NOCS
	Katy Sheen	NOCS
Tracer measurements	Marie-José Messias	UEA
	Jim Ledwell	WHOI
	Stephen Woodward	UEA
	Brian Guest	WHOI
	Andrew Brousseau	UEA
	Neill Mackay	UEA
NMF technical support	Terry Edwards	NOCS
	Christopher Barnard	NOCS
BAS technical support	Johnnie Edmonston (ITE)	BAS
	Paul Woodroffe (AME)	BAS

## 1.2 SHIPS PERSONNEL

Graham P Chapman	Master
Timothy S Page	Chief Officer
Simon D Evans	2nd Officer
Peter J Rosewall	3rd Officer
John Summers	Deck Officer
Charles A Waddicor	ETO (Coms)
David J Cutting	Chief Engineer
Glynn Collard	2nd Engineer
James C Ditchfield	3rd Engineer
Steven J Eadie	4th Engineer
Simon A Wright	Deck Engineer
Nicholas J Dunbar	ETO (Eng)
James S Gibson	Purser
Frances E Colgan	Doctor
George M Stewart	Bosun
Derek G Jenkins	Bosun's Mate
Clifford Mullaney	SG1
Colin J Leggett	SG1
John P O'duffy	SG1
John J McGowan	SG1
Phillip J Inglis	SG1
Mark A Robinshaw	MG1
Ian B Herbert	MG1
Keith A Walker	Cook
Barry D Hoult	2nd Cook
Kenneth Weston	Senior Steward
James Newall	Steward
Derek W Lee	Steward
Thomas R Patterson	Steward
George W Brown	Cadet
Paul A Cuthill	Cadet

### 1.3 DIMES OBJECTIVES

JR276 was part of the DIMES project, “Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean”, which is a joint UK and US project, funded by the National Science Foundation in the US and NERC in the UK. The objective of DIMES is “to test and, if necessary, redefine the present paradigm of Southern Ocean mixing by obtaining the first systematic measurements of mixing processes in two contrasting regimes (the SE Pacific and the SW Atlantic) of the Antarctic Circumpolar Current (ACC)”. The methods used are (1) the release of an inert chemical tracer,  $CF_3SF_5$  (tri-fluoromethyl sulphur pentafluoride) in the SE Pacific sector west of Drake Passage and following its dispersion horizontally and laterally as it transits the SE Pacific, Drake passage and the Scotia Sea, (2) The use of fine structure and microstructure measurements from LADCP, CTD and free-falling microstructure probes, (3) the deployment of a substantial array of moorings in the east of Drake Passage to observe the relationship between eddy activity, internal wave activity and vertical and horizontal mixing (4) the release of numerous floats both neutral density type RAFOS floats and surface drifters and (5) interpretation of model data.

The original plan for the DIMES field program is shown in fig 1.4.1, showing the geographic location of the program and the time line of the project.

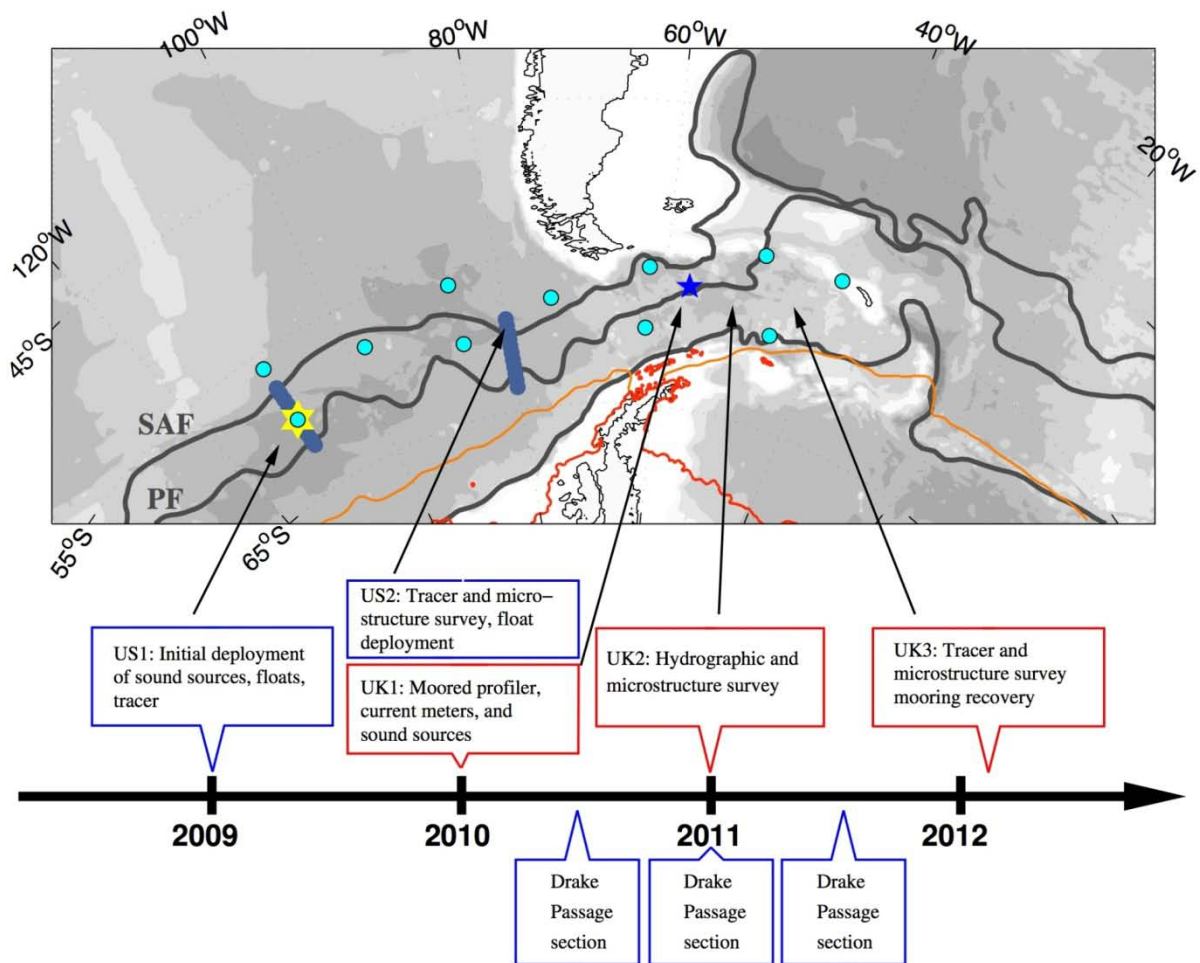


Figure Error! No text of specified style in document.-1.4.1 Original plan for the DIMES program, showing approximate location of cruises and time line

## 1.4 CRUISE OBJECTIVES

Cruise UK 2, a moorings cruise with and hydrographic, tracer and microstructure survey, was undertaken by *RRS James Cook* in November 2010-January 2011. The moorings work was finished as planned, but unfortunately due to engine problems, the planned hydrographic and tracer work could not be completed. Because of the time-critical nature of the project, with released tracers and floats beginning to make their way through Drake Passage and the end of 2010 and beginning of 2011, NERC and BAS were willing to give additional ship time. The present cruise, JR 276, was scheduled and labelled DIMES cruise “UK2.5”. Its mission was to complete the survey of tracer and turbulent microstructure activity to the west of Drake Passage along a meridional section at 78°W, from 56.5°S to 64°S, We designate this section S3, (the third UK Dimes section). Additionally, two days extra ship time were granted to complete the CLIVAR repeat section SR1 to the east of Drake Passage, which has been done most years by a team from NOC aboard the *Ross*, but which was cancelled in the present year. We designate the part of this section that we were to do SR1b. Completion of SR1 with measurement of tracers and microstructure fits well with the objectives of the DIMES project. Figure 1.4.2 shows the location of the two sections and the stations planned.

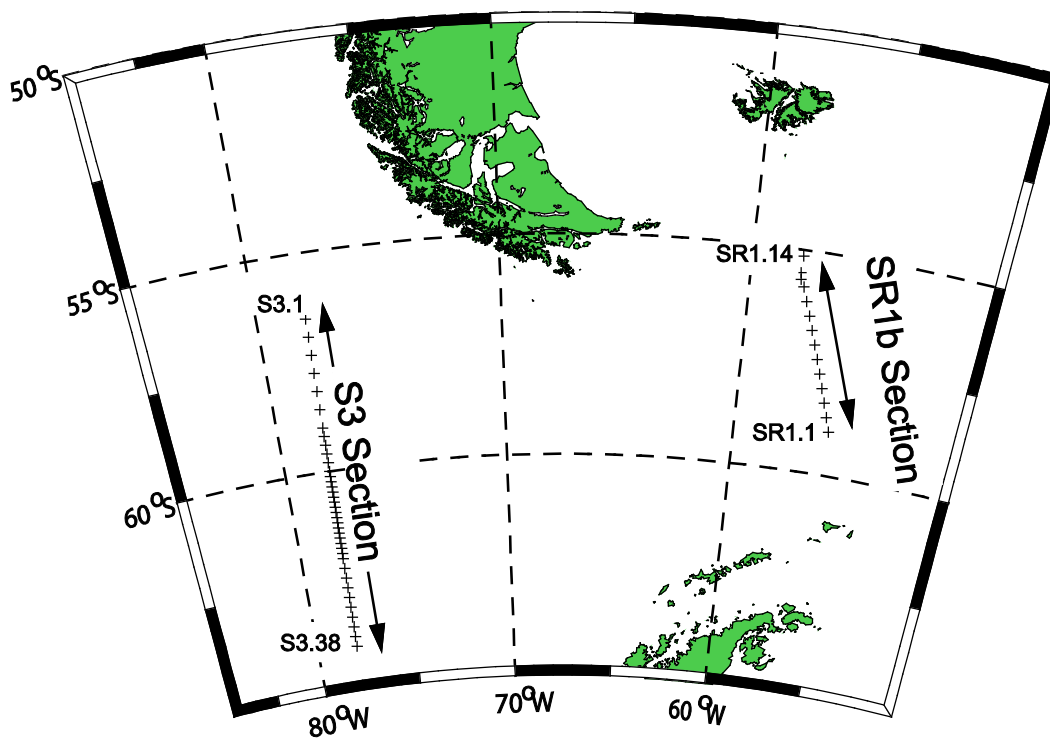


Figure 1.4.2: location of CTD/Tracer stations on JR 276

Additionally, it was planned to release several clusters of surface drifters and RAFOS neutrally buoyant floats as part of the “AARDVARK” project to observe dispersion properties along coherent structures of hyperbolic points in the flow field.

In summary the principal objectives of JR276 were:

- (1) Tracer survey of S3 section to determine vertical, latitudinal spread of tracer, and the scale of any remaining streaks of tracer. Determining the streakiness required that at least some of the section be sampled with highest practical resolution, which we took to be approx 1/8 degree.

- (2) Survey of SR1 section to determine horizontal and latitudinal spread of tracer east of Drake Passage
- (3) CTD and underway survey of detailed hydrography on these sections.
- (4) LADCP and VMP observations along both sections to observe the turbulence believed to cause vertical mixing and its variation with location in the region of Drake Passage.
- (5) Release of groups of “AARDVARK” drifters and RAFOS floats to study horizontal dispersion.

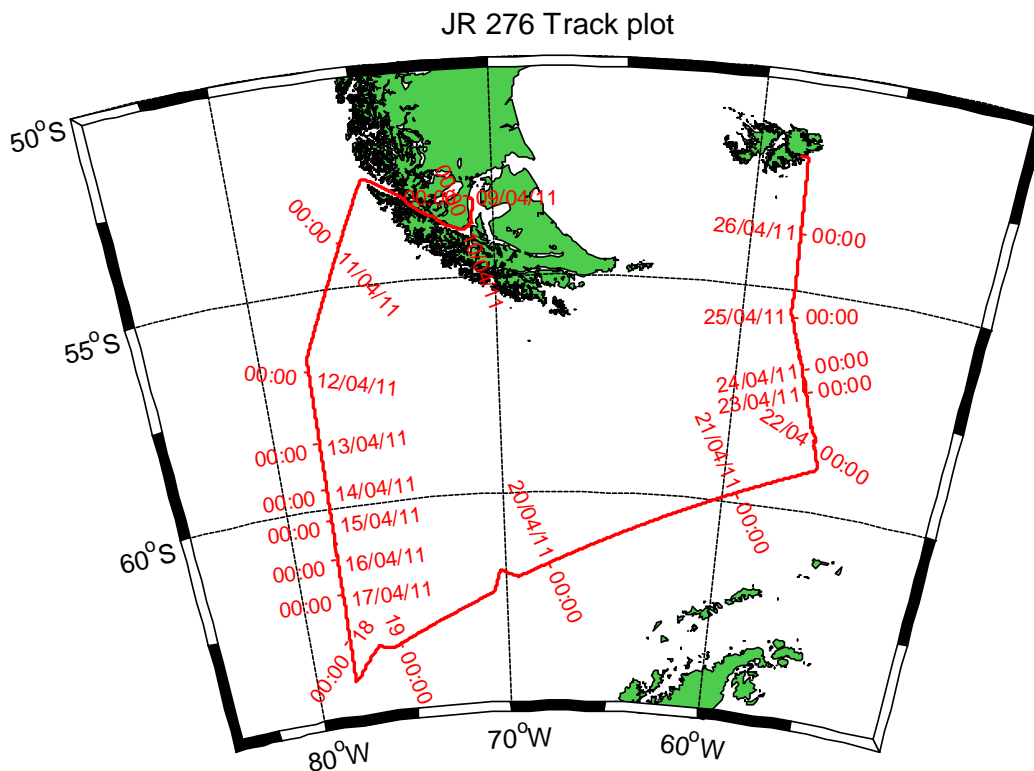
In addition we undertook sampling for surface total alkalinity and total carbon dioxide for the UK ocean acidification program.

### 1.5. CRUISE ITINERARY

Date	Time (GMT)	Action
09/04/2011	20:00	Depart Punta Arenas, Chile
10/04/2011	15:00	Leave western entrance, Magellan Strait
11/04/2011	15:30	Commence S3 section
18/04/2011	14:00	Depart S3 section
21/04/2011	09:30	Commence SR1b section
25/04/2011	16:30	Depart SR1b section
26/04/2011	11:15	Dock Mare Harbour, FI

Time and position of the deployments, recoveries and samples taken is given in the event log, appendix XXXX.

### 1.6 CRUISE TRACK



**1.7 CRUISE NARRATIVE** Fig 1.6.1 Track plot for the cruise, positions shown at each midnight GMT.



We departed Punta Arenas at 17:00 Ship's time (local Chilean time) 09/04/2011, 20:00 GMT. Our departure was delayed somewhat as we waited for the arrival of a shipment of gear from Southampton including the CTD rosette and Niskin bottles to be used on our cruise, delivered by truck on the last stage of its journey. In the end we did not wait for a long-delayed shipment of air freight from the UK containing spares for the UEA tracer team on board. These were deemed to be non-essential and the necessity to not further delay our very full cruise programme had priority.

The ship departed the western exit of Magellan Strait at 15:00 GMT on 10/04. We headed for the northern end of S3, arrived at our first station, 56.5°S, 78°W, at 15:30 on 11/04. Weather was good throughout the steam with moderate swell.

We worked on this section until 18/04, approximately 14:00, completing 38 stations and 7 VMP profiles. The spacing of the stations commenced at 0.5°, then Throughout this period the weather was good, with light to moderate swell enabling continuous operations. We encountered some problems with the CTD wire and termination that are detailed in the technicians report. These caused us to abort CTD casts 002 and 016, and cost a few hours of science time, but no other holdups.

We then steamed to the east of Drake Passage. On the way two diversions were made to launch clusters of AARDVARK drifters, and on the second deployment, RAFOS floats. During the steam eastward the swell was again very light and wind conditions near-calm, ideal for the deployment of these drifters.

We commenced work on the SR1b section, which is part of the CLIVAR SR1 repeat section that has been occupied annually by NOC scientists since 1993 at 09:30 on 21/04/2011. Stations were spaced at 20 Nm intervals and approximately every other station was accompanied by a VMP profile. Again, we experienced some problems with CTD electrical connections which necessitated a re-termination, and one cast returned minus one niskin bottle which had simply disappeared from the rosette. The weather deteriorated on 22/04 and from 23:00 until 12:30 on 23/04 we were unable to work and held station. Recommencing work we completed the section as planned and added two further stations to the northern end to take us closer to Burdwood Bank.

The NOC VMP performed 14 profiles, most of which went according to plan. Most of the deployments were timed to come up at night because it was much easier to spot the instrument at the surface with the aid of its flashing light then. However, at no point did we have any real difficulty to find the VMP even when it surfaced in the day. The last three profiles each had some anomalies however, with the VMP apparently dropping its weights prematurely on profiles 12 and 13, and apparently not correctly releasing one weight on profile 14, so that it remained on the bottom until the magnesium soluble link dissolved, after which it was recovered without difficulty.

Having used every second of time allotted to us, and completed our programme with the addition of two stations, we departed our last work site on at 1630 on 25/04/11 and docked in Mare Harbour, FI, at 1130 the following morning.

## **1.8 CRUISE RECOMMENDATIONS**



## 2. UNDERWAY DATA

*Peggy Courtois, Christopher O'Donnell (adapted from JCR195 report)*

### 2.0 Data Acquisition

The underway data were logged in ascii scs files located under:  
*jr1b.jcr.nerc-bas.ac.uk:/san/datavol/data/cruise/jcr/current/scs/Compress/*  
This was mounted on the linux box NOSEA2, such as:  
*/mnt/data/cruise/jcr/current/scs/Compress/*  
which was linked by:

*/local/users/pstar/jr276/data/*

For what follows, ~ will represent the following location: */local/users/pstar/jr276/cruise/*.

The raw SCS data with the ACO extension were located in *~/scs\_raw\_ship/*, but are not easily parsed. The SCS files are cleaned up using *sed* scripts. At the beginning of the cruise or if the *sed* scripts hang, type:

*sedexec\_stopall*

*sedexec\_startall*

This will restart all the *sed* scripts and create the ACO files from scratch from the beginning of the cruise in *~/data/scs\_sed/*. These files are versions of the ACO files with commas, colons, characters, etc removed, so they are plain numerical files that can be loaded into Matlab. To check that *sed* is running use the unix command 'top' and watch for *sed* entries appearing every 10 seconds or so. If no *sed* is present then start and stop the *sed* scripts using the commands shown above.

In order to make loading subsets of files acceptably fast in Matlab, the cleaned ACO files are converted to Matlab and are located in *~/data/scs\_mat/\*.mat*.

Before running the daily processing, go into Matlab and type *update\_allmat*, this will update all the mat files. Note that some of the scripts that access SCS files (eg. *msposinfo*) automatically run the Matlab update first.

The raw and processed data are located in the following directories:

*~/data/surfmet/*

*~/data/ocl/*

*~/data/nav/gyros*

*~/data/nav/seapos*

*~/data/nav/ash*

*~/data/sim/*

*~/data/em120*

### 2.1 Navigation system

## 1. Instrumentation

### Seapath system

A Seapath 200 system is used on the *RRS James Clark Ross*. The data are logged via the 'seatex' scs data stream at 1Hz. In addition to position the Seapath system outputs heave and roll via the seatex-psxn.ACO files. Another system for measuring pitch and roll is the tsshrp system, but there is no indication of which channels are which. Heave sensors from both systems are located in the grav room. The data from this system are contained in `~/data/nav/seapos`.

### Ashtech

The Ashtech used to be the primary system for obtaining the most accurate measurement of the ship's heading and has been replaced by the Seapath and tsshrp systems. The data from this system are contained in `~/data/nav/ash`.

### Gyro

The ships gyro on the bridge was logged via the scs data stream as 'gyros at 1Hz'. The data from this system are contained in `~/data/nav/gyros`

## 2. Data processing

Every day the data were downloaded using the following commands in matlab, where *jd* is the Julian day:

```
% Setup path and variables:
m_setup
day = jd; mday_00('pos',day)
day = jd; mday_00('ash',day)
day = jd; mday_00('gyr',day)
```

The previous commands are wrapped in the more general command:

```
mday_00_get_all(jd)
```

Then, the matlab script *mgyr\_01.m* is used to discard data cycles with repeat or backwards time jumps, whereas *mash\_01.m* will merge on gyro data, construct ash gyro difference and clean up the data. The output file is averaged into 2 minute sections.

```
day = jd; mgyr_01
day = jd; mash_01
```

Use *mday\_00\_clean\_all.m* to remove data outside defined ranges and repeated data cycles.

The matlab command *mplxied.m* is an interactive script to remove apparent spikes. Note that it is important to rename the file *pos\_jr276\_d\*\_edit.nc* into *pos\_jr276\_d\*.nc*, before using *mplxied.m* otherwise it will be overwritten. All output files are then appended into one file, such as:

```
day = jd; mday_02('M_ASH', 'ash', day)
day = jd; mday_02('M_GYS', 'gyr', day)
day = jd; mday_02('M_POS', 'pos', day)
```

The navigation data are then averaged over 30 seconds using *mbest\_all.m*. Note that the daily navigation file *pos\_jr276\_01.nc* must exist and be up to date.

```
day = jd; mbest_all
```

Step	Command	Input file	Output file	Comments
1	m_setup			Setup path and variables
2	mday_00		ash_jr276_d*_raw.nc pos_jr276_d*_raw.nc gyr_jr276_d*_raw.nc	Download the raw data
3	mgyr_01	ash_jr276_d*_raw.nc	gyr_jr276_d*.nc	Discard repeated data cycles
4	mash_01	ash_jr276_d*_raw.nc	ash_jr276_d*_edt.nc ash_jr276_d*.nc	Merge on gyro data, construct ash-gyro difference
5	mday_00_clean_all	pos_jr276_d*_raw.nc	pos_jr276_d*_edit.nc	Sets data to absent outside defined ranges
6	mplxeyed	pos_jr276_d*( <u>edit</u> ).nc	pos_jr276_d*.nc	Remove apparent spikes.
7	mday_02	pos_jr276_d*.nc ash_jr276_d*_raw.nc gyr_jr276_d*_raw.nc	pos_jr276_01.nc ash_jr276_01.nc gyr_jr276_01.nc	Append files
8	mbest_all	pos_jr276_01.nc	bst_jr276_01.nc pos_276_spd.nc pos_jr195_ave.nc	Creates a bestnav file over 30 seconds

On the Julian day 106, Seatex had to be rebooted as it was giving wrong values (lat, lon = 1000). Spurious data were removed from *pos\_jr276\_d106\_raw.nc* using *mplxeyed.m*. The removed data are kept in memory in *mplxeyed\_date\_time\_pos\_jr276\_d106.nc*.

### 3. Preliminary results

Figure II.1.1, shows the track of the *RRS James Clark Ross* from both systems, Seatex in blue and Ashtech in red, while Figure II.1.2 shows the best navigation after processing data.

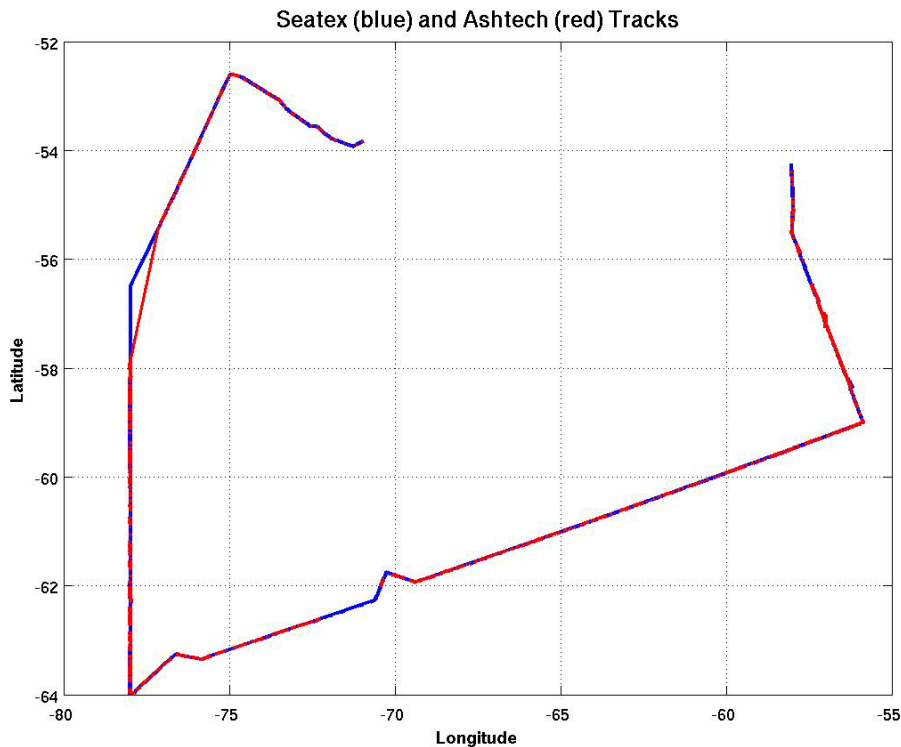


Figure II.1.1: Track of the RRS James Clark Ross from the Seatex (in blue) and the Ashteck (in red) systems.

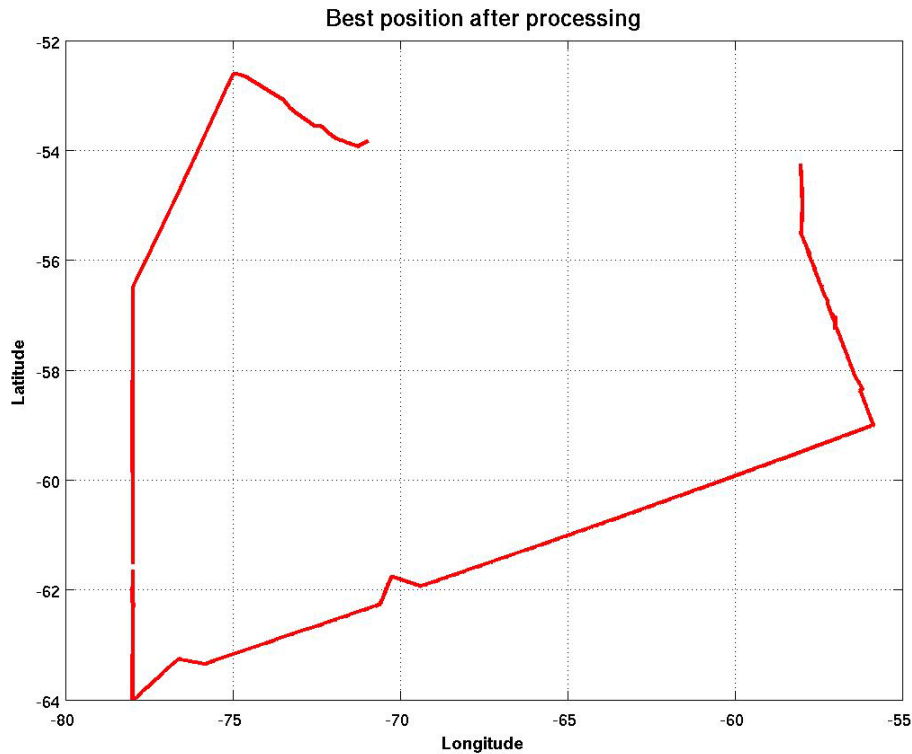


Figure II.1.2: Track of the RRS James Clark Ross after processing.

## 2.2 Surface meteorological sampling system

### 1. Instrumentation

The RRS *James Clark Ross* is instrumented with a variety of meteorological sensors to measure; air temperature and humidity, atmospheric pressure, short wave radiation (TIR), photosynthetically active radiation (PAR) and wind speed and direction. These are logged as part the 'oceanlogger' and 'met' systems at 2 second intervals. The oceanlogger also recorded the underway salinity and sea surface temperature. These data will be discussed separately. The meteorological instruments were mounted on the ship's foremast (Figure II.2.1) in order to obtain the best exposure. The estimated heights of the instruments above the foremast platform were: Sonic anemometer, 0.65 m; air temperature and humidity 0.25 m and the irradiance sensors 0.2 m. The barometers were located in the ocean logger display cabinet in the UIC.

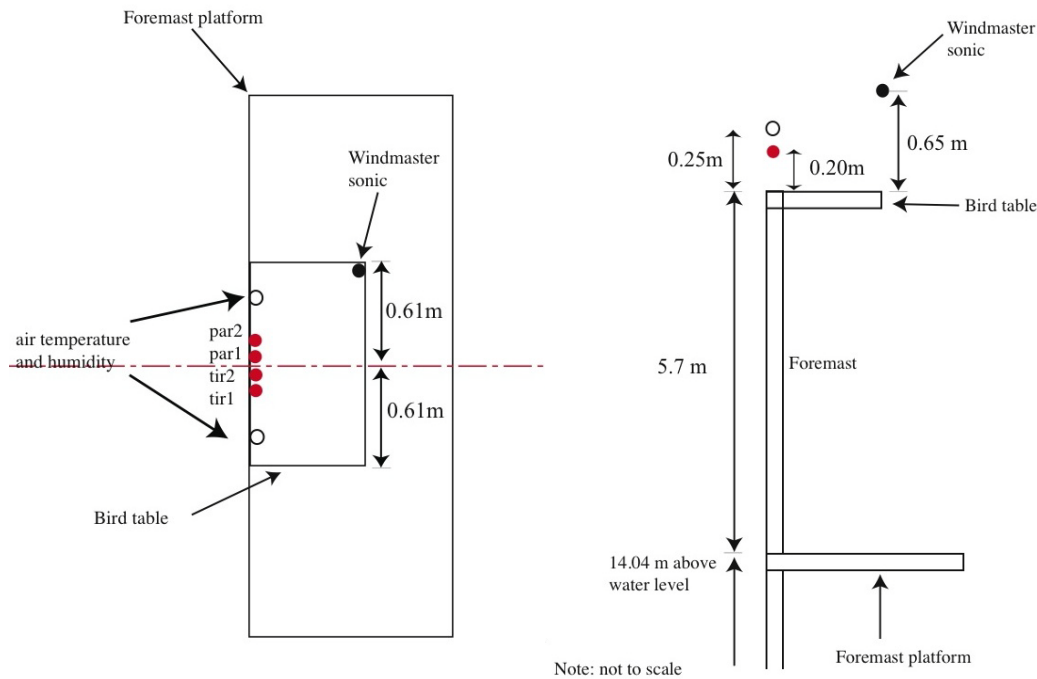


Figure II.2.2: Schematic of the sensor positions on the foremast: left - plan view; right - side view.

The following table provides the serial numbers of the various instruments used for the surface meteorological sampling system. A much more complete table can be found in the JCR195 cruise report.

Instruments	Serial number	Serial number	Instrument type
Barometer	145002	145003	Vaisala PTB210
Humidity / Temp (sec)	18109036		Rotronic MP100
TIR	990684		Kipp & Zonen SP Lite
PAR	990069		Kipp & Zonen PARLite

The raw and processed data can be found in `~/data/met/surfmet`.

## 2. Data processing

The met raw data were downloaded with the matlab script `mday_00.m`:

```
day = jd; mday_00('ash', day)
```

The script `mday_00_clean_all.m` was used to remove data outside defined ranges and repeated data cycles. Then, `mplxied.m` was used to remove apparent spikes. Again, note that it is important to rename the file `met_jr276_d*_edit.nc` into `met_jr276_d*.nc`, before using `mplxied.m` otherwise it will be overwritten. The raw data were appended every day using `mday_02.m`:

```
day = jd; mday_02('M_MET', 'met', day)
```

The command *mtruew\_01.m* calculates the true wind speed and direction. The wind direction is defined as the direction the wind is going to, rather the meteorological convention of direction coming from.

Step	Command	Input file	Output file	Comments
1	m_setup			Setup path and variables
2	mday_00		met_jr276_d*_raw.nc	Download the raw data
3	mday_00_clean_all	met_jr276_d*_raw.nc	met_jr276_d*_edit.nc	Sets data to absent outside defined ranges
4	mplxyed	met_jr276_d*( <u>edit</u> ).nc	met_jr276_d*.nc	Sets data to absent outside defined ranges
5	mday_02	met_jr276_d*_raw.nc	met_jr276_01.nc	Append files
6	mtruew_01	bst_jr276_01.nc met_jr276_01.nc	met_jr276_true.nc	True wind processing

### 3. Preliminary results

The wind direction and speed has been plotted in the two following figures.

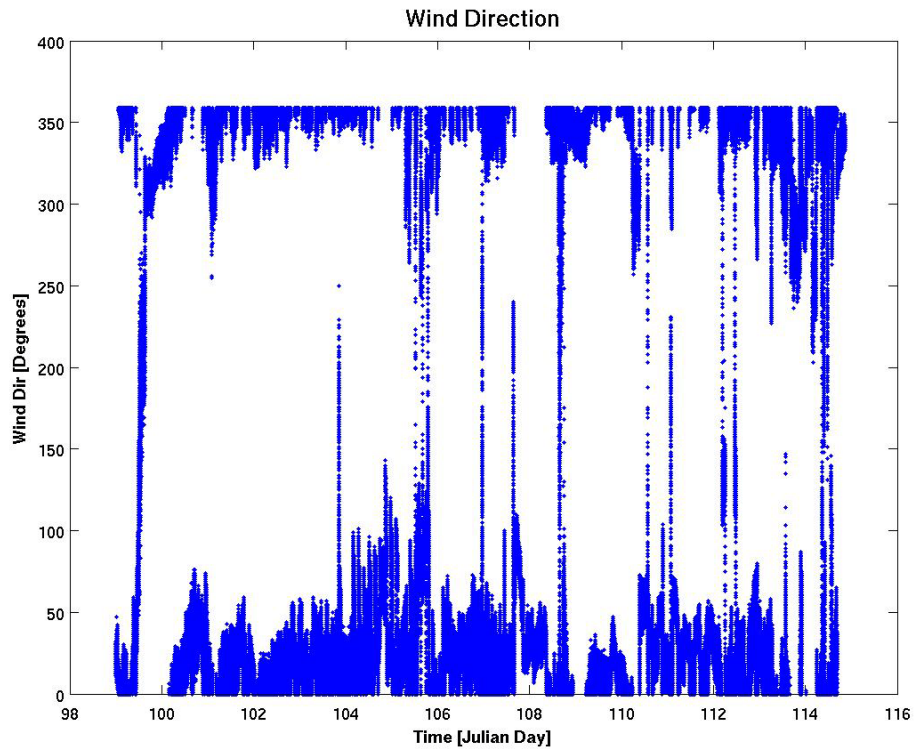


Figure II.2.2: Wind direction during the cruise JR276.



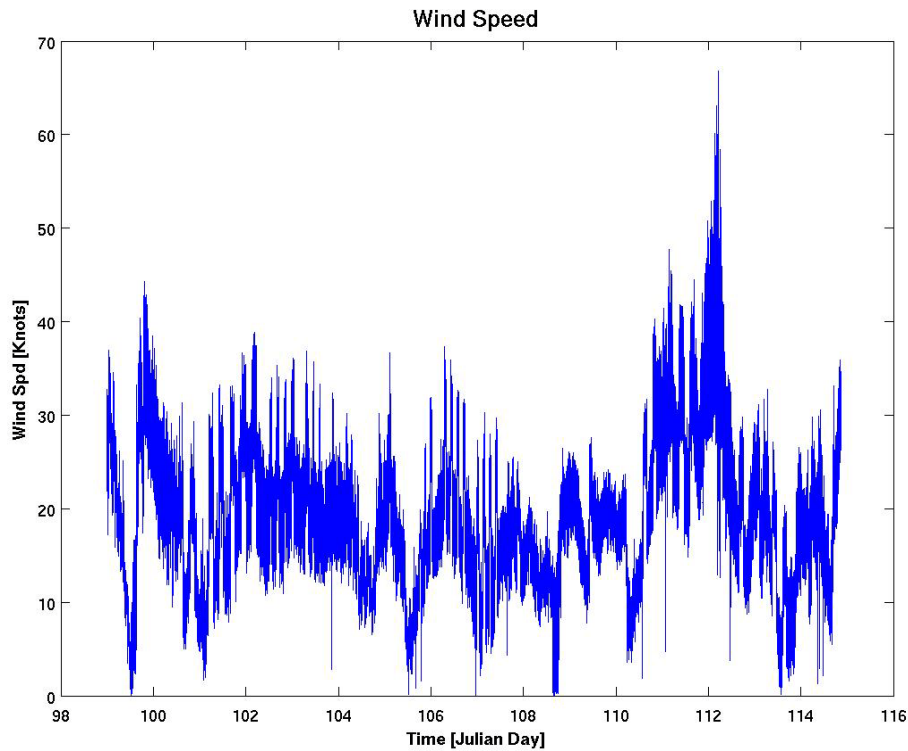


Figure II.2.3: Wind speed during the cruise JR276.

## 2.3 Bathymetry

Bathymetry data were measured every 7 seconds by a Kongsberg EA600 single beam echo sounder and were processed daily. The data were transferred from the *sos* system to MSTAR format using the MSTAR routine *mday\_00.m*, where *jd* is the Julian day.

```
day = jd; mday_00('sim',day)
```

The above command is wrapped in *mday\_00\_get\_all.m*. The file *sim\_jr276\_d\*\_raw.nc* containing the raw data for the Julian day *j\** is then created in *~/data/sim/*. The raw daily file contains; time (seconds), depth (feet), depth (m) and depth (fathoms). Depths outside the range of 0.0001 to 12000 m and 0.0001 to 50000 feet are set to absent data using *mday\_clean\_all.m*.

The daily data file was plotted and any outliers were interactively selected and set to absent data values using the matlab script *mplxied.m*. Note that only the depth in meters has been cleaned up. After plotting/cleaning the *sim\_jr276\_d\*\_edit.nc* files must be moved to *sim\_jr276\_d\*.nc*. This can be done in matlab, with the following command:

```
!mv pos_jr195_d324_edit.nc pos_jr195_d324.nc
```

The position data from the *seapath* system were merged on the bathymetry data and the corrected depths calculated from the carter tables using *mmerge\_sim\_nav\_01.m*. This step must be done after the seapos file has been cleaned up.

Then, the files were appended all together using the command *mday\_02.m*.

Step	Command	Input file	Output file	Comments
1	<i>m_setup</i>			Setup path and variables
2	<i>mday_00</i>		<i>sim_jr276_d*_raw.nc</i>	Download the raw data

3	mday_00_clean_all	sim_jr276_d*_raw.nc	sim_jr276_d*_edit.nc	Sets data to absent outside defined ranges
4	mplxied	sim_jr276_d*(.nc)	sim_jr276_d*.nc	Sets data to absent outside defined ranges
5	mmerge_sim_nav_01.m	sim_jr276_d*.nc pos_jr276_d*.nc	sim_jr276_d*.nc	Merge on position to the depth file and correction of the depth
6	mday_02	sim_jr276_d*.nc	sim_jr276_01.nc	Append files

Figure II.3.1 shows the bathymetry along the track of the *RRS James Clark Ross* during the two week cruise.

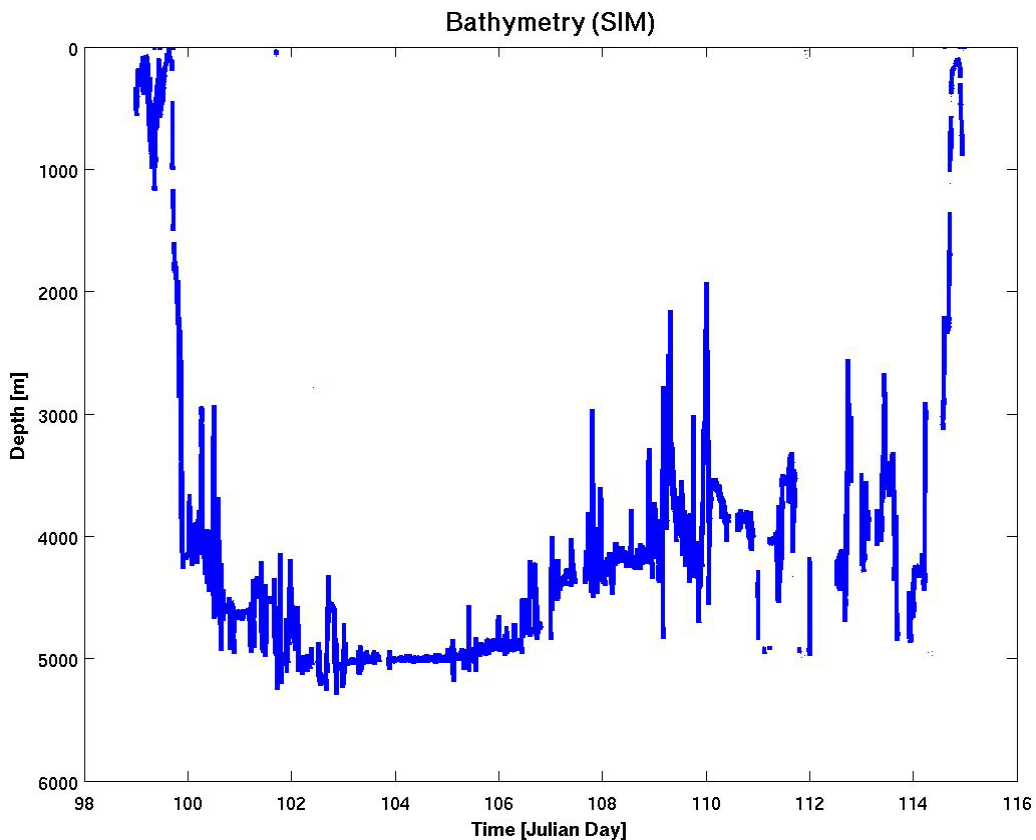


Figure II.3.1: Depth along the ship track, after cleaning.

## 2.4 Swath bathymetry

The swath bathymetry was given by a Kongsberg EM120 multi beam echo sounder, which was turned off during the VMP casts to prevent any interference with the later instrument. The data were downloaded and processed every day, but at a very basic level. No processing of the swath has been done yet. This can be done by either using the Caris HIPS SIPS software (at the NOC) or by using the free software MB Systems.

As previously described in the latter section, the data were downloaded into `~/data/em120/` using the matlab script `mday_00.m`. The raw daily file contains time (seconds) and depth (m). After renaming the raw file into `em120_jr276_d*.nc`, the data were plotted and cleaned using `mplxied.m`. Then, all files were appended altogether through `mday_02.m`.

Step	Command	Input file	Output file	Comments
1	m_setup			Setup path and variables
2	mday_00		em120_jr276_d*_raw.nc	Download the raw data
3	mplxyed	em120_jr276_d*_raw.nc	em120_jr276_d*.nc	Sets data to absent outside defined ranges
4	mday_02	em120_jr276_d*.nc	em120_jr276_01.nc	Append files

Figure II.4.1 shows the bathymetry along the track of the *RRS James Clark Ross* during the two week cruise.

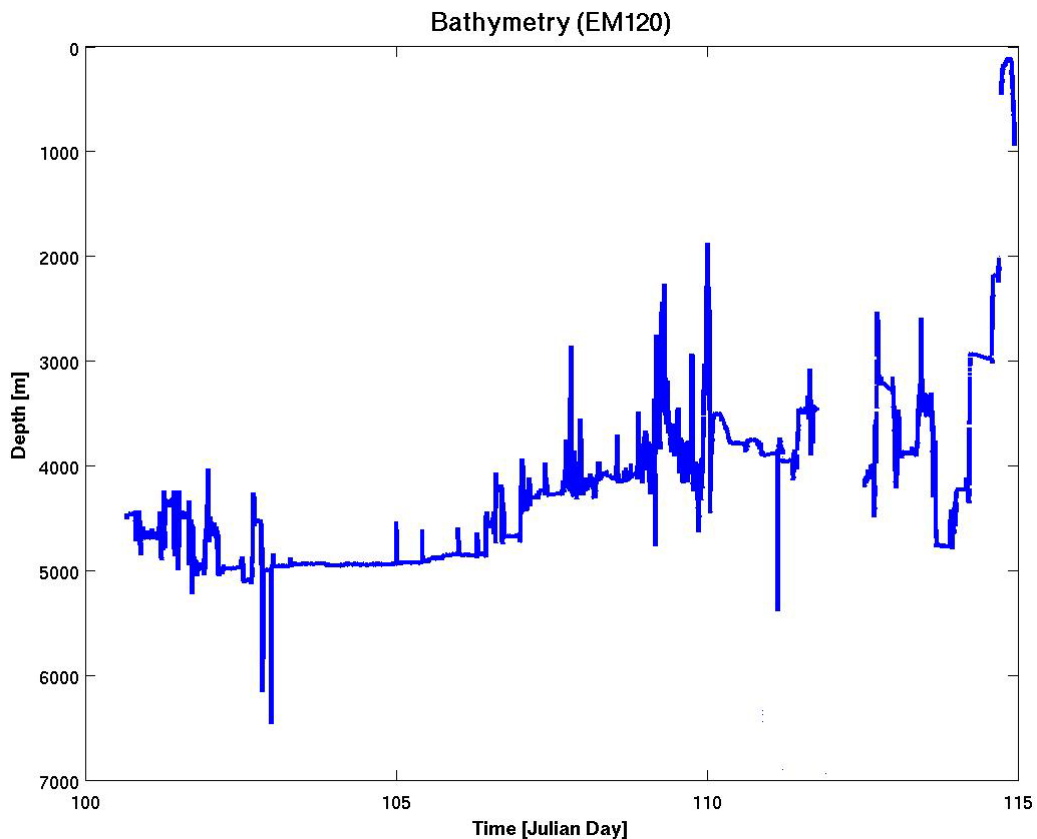


Figure II.4.1: Depth along the ship track, after cleaning.

## 2.5 Underway measurements

### 1. Instrumentation

Near surface oceanographic parameters were measured by sensors located on the non-toxic supply. These included a Fluorometer which measures fluorescence and a SBE45 thermosalinograph measuring conductivity and water temperature at the point it reaches the instrument. The salinity was calculated in real time using the SBE45 housing temperature and conductivity measurements. The sea surface temperature (SST) was measured by a PRT100 temperature sensor located close to the non-toxic supply intake on the hull at a depth on 6m. The following table sums up the instruments used as well as their associated serial number.

Parameters	Serial numbers	Instruments
Barometer	145002 145003	Vaisala PTB210
Humidity / Temp (sec)	18109036	Rotronic MP100
Thermosalinograph	4524698-0016	SeaBird SBE 45
Fluorometer	6456 rtx	Turner Designs 10-AU-005-CE
TIR	990684	Kipp & Zonen SP Lite
PAR	990069	Kipp & Zonen PARLite

## 2. Data processing

The data were downloaded and processed into `~/data/ocl/`, using `mday_00.m`. All data outside the following ranges were set to absent, by running `mday_clean_all.m`:

Air temperature: -50 to 50 degreesC

Humidity: 0.1 to 110 %

TIR: -50 to 1500

PAR: 0.0001 to 50

Then, the output files were then copied into `ocl_jr276_d*.nc`, which were plotted and cleaned using the matlab script `mplxied.m`. Every single daily oceanlogger file was merged onto the navigation file, by running `mmerge_ocl_nav.m`. Then, all files were appended altogether through `mday_02.m`. The next step was to create a 30 second navigation file using `mocl_00_jr276.m`.

During the JR276 cruise, sea water was sampling every 4 hours. Then the conductivity was analysed using a salinometer (see Section 3.1). The conversion of the conductivity into salinity was done using the definition and the algorithm of practical salinity formulated and adopted by the Unesco/ICES/SCOR/IAPSO Joint Panel on Oceanographic Tables and Standards. Finally, all salinity values from the sea water samples were put into a CSV file (bottle salinity, year, jday, hour, minute, crate number, bottle number). This latter file was next read into mstar using `mocl_01_jr276.m`. The script `mocl_02_jr276.m` merges the bottle data with the 30 second average OCL data. Finally, `mocl_CTD_01_jr276.m` and `mocl_CTD_02_jr276.m` extract and merge the data from the CTD casts onto the OCL data.

The sequence of the processing is sums up in the following table.

Step	Command	Input file	Output file	Comments
1	<code>m_setup</code>			Setup path and variables
2	<code>mday_00</code>		<code>ocl_jr276_d*_raw.nc</code>	Download the raw data

3	mday_00_clean_all	ocl_jr276_d*_raw.nc	ocl_jr276_d*_edit.nc	Sets data to absent outside defined ranges
4	mplxyed	ocl_jr276_d*.nc	ocl_jr276_d*.nc	Sets data to absent outside defined ranges
5	mmerge_ocl_nav	ocl_jr276_d*.nc	ocl_jr276_d*.nc	Merge position onto the oceanlogger file
6	mday_02	ocl_jr276_d*.nc	ocl_jr276_01.nc	Append files
7	mocl_00_jr276	ocl_jr276_01.nc	ocl_jr276_ave.nc	Create a 30 second nav file from 1-Hz data
8	mocl_01_jr276	all_ocl_salts_jr276.csv	ocl_jr276_samps.nc	Read the csv file into mstar
9	mocl_02_jr276	ocl_jr276_samps.nc ocl_jr276_ave.nc	ocl_jr276_merge.nc	Merge bottle data with the 30 second average OCL data
10	mocl_CTD_01_jr276	ctd_jr276_d*_2db.nc	ctd5db_jr276.nc	Extract data from CTD cast for depth range 4 to 6 m
11	mocl_CTD_02_jr276	ctd5db_jr276.nc ocl_jr276_ave.nc	ocl_jr276_CTD_merge.nc	Merge the data with the OCL data

### 3. Preliminary results

Air temperature and air pressure are plotted in Figure II.5.1. Figure II.5.2 shows the flow rate, fluor and PAR parameters, whereas the sea surface temperature and salinity and depicted in Figure II.5.3.

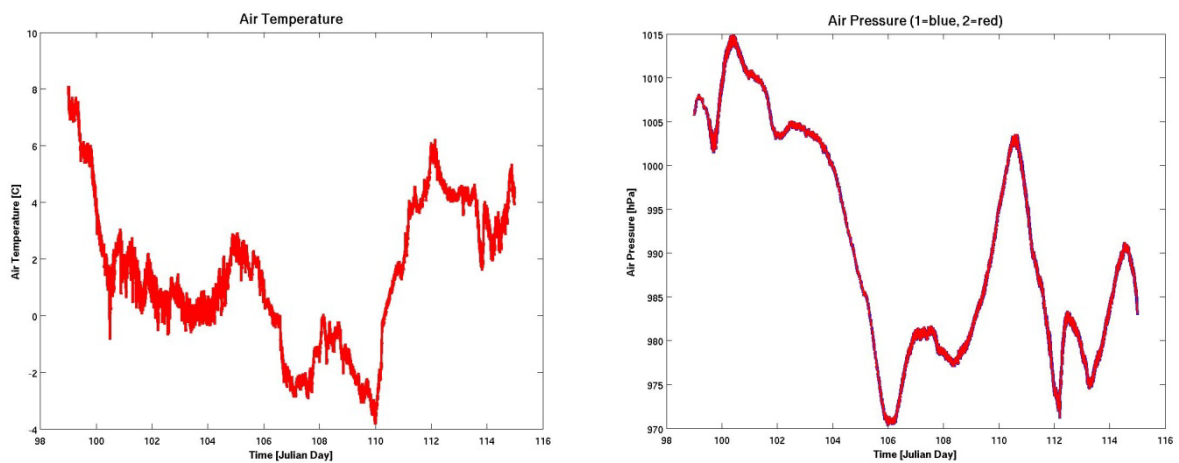


Figure II.5.1.

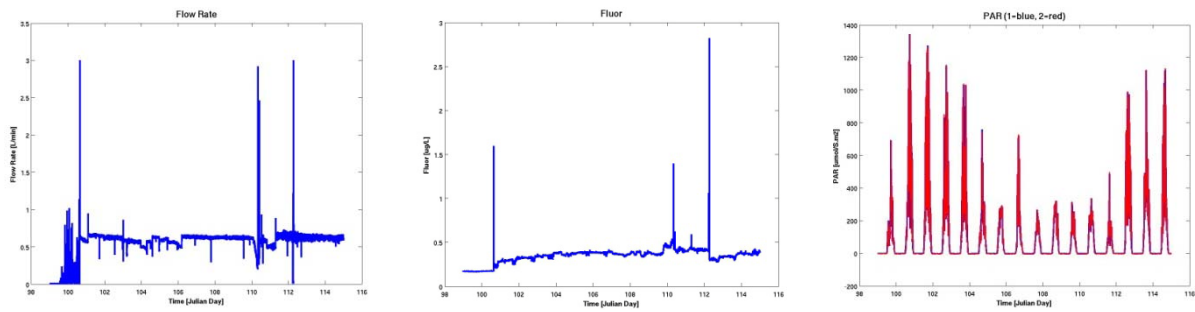


Figure II.5.2.

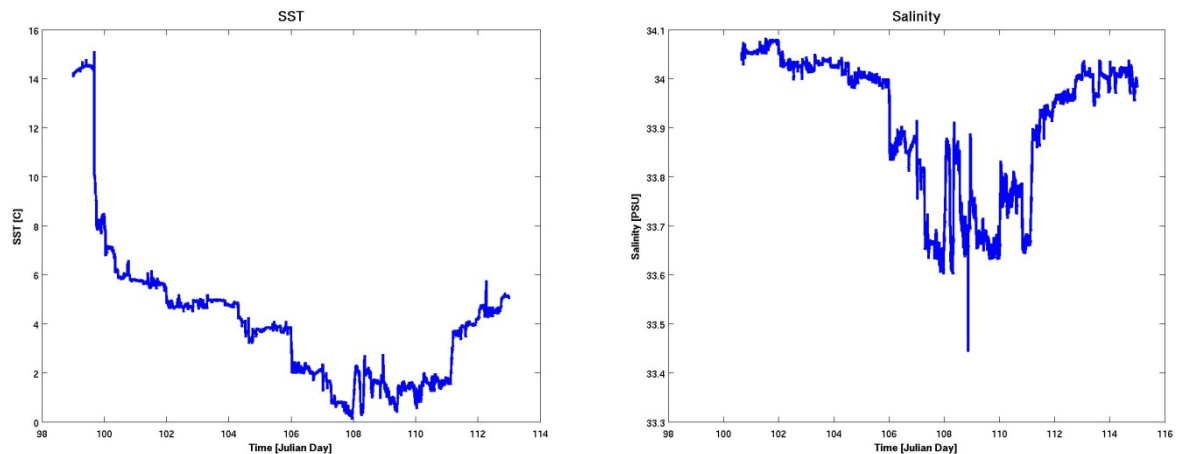


Figure II.5.1.

## 2.6. VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER

*Penny Holliday, Alex Brearley*

### 2.6.1 Introduction

A 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP was used during this cruise. This has also been used on JR139 (in Dec 2005, Chief Scientist Stansfield), JR161 (Oct-Dec 2006, Shreeve), JR165 (Feb 2007, Shoosmith), JR193 (Dec 2007, Quartly), JR177 (Jan 2008, Tarling), JR218 (Oct 2008, Woodward) and JR200 (Mar 2009, Korb), JR195 (Yelland). The OS75 is capable of profiling to deeper levels in the water column than the previous 150 kHz ADCP and can also be configured to run in either narrowband or broadband modes.

### 2.6.2 Instrumentation

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

The OS75 transducer on the *JCR* is aligned at approximately 60 degrees relative to the centre line. This differs from the recommended 45 degrees. Shortly after sailing for JR139, the hull depth was measured by Robert Patterson (Chief Officer), and found to be 6.47m. Combined

with a value for the distance of the transducer behind the seachest window of 100-200mm and a window thickness of 50mm, this implies a transducer depth of 6.3m. This is the value assumed for JR200, but note that the ship was very heavily laden during cruise JR139, and for other cruises it may be shallower.

During the trials cruise (JR139), it was noted that the OS75 causes interference with most of the other acoustic instruments on *JCR*, including the EM120 swath bathymetry system. To circumvent this, the ADCP pinging can be synchronised with the other acoustic instruments using the SSU. This issue was investigated in detail on JR218. On JR276 the Swath was used during the CTD transect but the ADCP was run unsynchronised, pinging every approximately 3.1 seconds. In shallow water the ADCP was set in bottom track mode with varying depths (and therefore ping rates).

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

### **2.6.3 Configuration**

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The OS75 ran in two modes during JR276: narrowband with bottom-tracking on and narrowband with bottom-tracking off. While bottom tracking the maximum water depth was set to 800m (50 bins, each 16 metres). Water-tracking was always fifty 16 metre bins. SSU was not used. Narrowband profiling was enabled with an 8 metre blanking distance. The 'set modes' configuration files, as described in JR195 report, were used during the cruise.

Reducing the maximum water depth to less than twice the actual water depth (as measured by the EA600) has two significant advantages (see JR218 report for full details). Firstly it speeds up the ping rate as the instrument spends less time waiting for echoes. The second advantage is that the instrument stops listening before it can hear double-bottom echoes (sounds that goes transducer-bottom-surface-bottom-transducer). This leads to cleaner plots of the water column velocities.

Salinity at the transducer was set to zero, and Beam 3 misalignment was set to 60.08 degrees (see above discussion).

Data logging was stopped and restarted once every 2 days to keep files to a manageable size for processing..

### **2.6.4 Outputs**

The ADCP writes files to a network drive that is samba-mounted from the Unix system. The raw data (.ENR and .N1R) are also written to the local PC hard drive. For use in the matlab scripts the raw data saved to the PC would have to be run through the VMDas software again to create the .ENX files. When the Unix system is accessed (via samba) from a separate networked PC, this enables post-processing of the data without the need to move files.

Output files are of the form JR276\_XXX\_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte.

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

.N1R (NMEA telegram + ADCP timestamp; ASCII)

.ENR (Beam co-ordinate single-ping data; binary). These two are the raw data, saved to both disks

.VMO (VmDas configuration; ASCII)

.NMS (Navigation and attitude; binary)

.ENS (Beam co-ordinate single-ping data + NMEA data; binary)

.LOG (Log of ADCP communication and VmDas error; ASCII)

.ENX (Earth co-ordinate single-ping data; binary). This is read by matlab processing

.STA (Earth co-ordinate short-term averaged data; binary)

.LTA (Earth co-ordinate long-term averaged data; binary).

.N1R and .ENR files are saved to the secondary file path and can be reprocessed by the software to create the above files.

### 2.6.5 CODAS/Hawaii processing.

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

Each 2-day file was processed separately and each produced a separate water- or bottom-tracking calibration (Table 2.6.1) which can be compared to those found previously (Table 2.6.2). The files are approximately 48 hours long (note that ensemble count in \*out cal files does not make sense, neither does the jday range, so the time and "ncols" information in the \*.nc files is recorded below). The median value of the bottom track calibration (file 009) was considered most useful, because this was closest to the values in the second half of file 009 where data were less noisy, and was close to the mean of the water track calibrations.

Water track mode average:   amplitude = 1.0179   phase = -1.1023  
 Bottom track mode:         amplitude = 1.0116   phase = -1.0564

File NNN	BT/WT	Amplitude		Phase				ncols	Start Date	End Date
		Median	Mean	s.d.	Median	Mean	s.d.			
001	WT	1.0115	1.0102	0.0052	-1.1840	-1.0827	0.3047	304	101 15:44	102 16:59
002	WT	1.0085	1.0097	0.0127	-1.2330	-1.0861	0.2849	593	102 17:09	104 18:29
003	WT	1.0140	1.0131	0.0066	-1.0935	-1.0267	0.2873	515	104 18:39	106 13:29
004	WT	1.0170	1.0167	0.0069	-1.1005	-1.1059	0.3452	608	106 13:36	108 16:11
005	WT	1.0385	1.0385	0.0163	-1.8015	-1.8015	0.5989	514	108 16:20	110 11:05
006	WT	1.0330	1.0294	0.0086	-0.3320	-0.5258	0.0086	573	110 11:14	112 10:54
007	WT	1.0090	1.0122	0.0179	-0.2620	-0.7264	0.0179	630	112 11:04	114 15:32
008	WT	1.0135	1.0135	0.0033	-1.4635	-1.4635	0.3005	310	114 15:39	115 17:24
<b>009</b>	<b>BT</b>	<b>1.0116</b>	<b>1.0208</b>	<b>0.0192</b>	<b>-1.0564</b>	<b>-0.7575</b>	<b>0.0192</b>	<b>210</b>	<b>115 17:32</b>	<b>116 10:57</b>

Table 2.6.1 Calibrations derived from the CODAS processing. *BT* indicates bottom tracking mode, and *WT* indicates water tracking.

cruise	date	bot/water	mean amplitude	mean angle	notes
JR195	Nov 2009	water	1.0155	-0.2060	CODAS processing
<b>JR195</b>	<b>Nov 2009</b>	<b>bottom</b>	<b>1.0381</b>	<b>+0.6080</b>	<b>CODAS processing</b>
JR200	Mar-Apr 2009	water	1.0150	-0.0876	
JR177	Jan 2008	water	1.0124	-0.0559	
JR165	Mar-Apr 2007		1.0127	-0.0078	
JR158	Feb 2007	water	1.0161	+0.1245	
<b>JR161</b>	<b>Oct-Dec 2006</b>	<b>bottom</b>	<b>1.0127</b>	<b>-0.0481</b>	

Table 2.6.2. Mean calibration results for JR276 and previous cruises.



Below is a summary of the processing steps. [UH HTML documentation in /local/users/pstar/cruise/sw/uh\_adcp/programs/adcp\_doc/index.html].

1) Created once at start of cruise

```
~/data/vmadcp/jr276_os75
```

```
~/data/vmadcp/jr276_os75/rawdata
```

2) For dataset NNN (eg NNN = 002),

copy raw data files (ENX, NIR, etc) from /mnt/data/cruise/jcr/current/adcp into

```
/local/users/pstar/jr276/data/vmadcp/jrCCC_os75/rawdata
```

file names like OS75\_JR276NNN\_000000.ENX

NNN increments each time the ADCP logging is re-started. **Data logging was stopped and started once every two days.** The 000000 increments each time a new file is started, when the previous one reaches 10 Mb.

All raw files are automatically transferred to /mnt/data/cruise/jcr/current/adcp (i.e. on jrlb)

3) **cd ~pstar/jr276/data/vmadcp/jr276\_os75**

cshell script in /local/users/pstar/cruise/data/exec

**vmadcp\_movescript**

redistributes raw data from rawdata to rawdataNNN; rawdataNNN is created if necessary.

(may need to edit movescript so that it parses the file names correctly)

4) **adcptree.py jrCCCNnnbenx --datatype enx**

Note nb for narrowband ping, and that the -- datatype has two dash characters

5) **cd jrCCCNnnbenx** copy in a **q\_py.cnt** file. Generally, you only need to edit the dbname and datadir for each NNN. An example q\_py.cnt file is

```
# q_py.cnt is
```

```
## comments follow hash marks; this is a comment line
```

```
--yearbase 2011
```

```
--dbname jr276001nnx
```

```
--datadir
```

```
/local/users/pstar/cruise/data/vmadcp/jr276_os75/rawdata001
```

```
#--datafile_glob "*.LTA"
```

```
--datafile_glob *.ENX
```

```
--instname os75
```

```
--instclass os
```

```
--datatype enx
```

```
--auto
```

```
--rotate_angle 0.0
```

```
--pingtype nb
```

```
--ducer_depth 5
```

```
#--verbose
```

```
# end of q_py.cnt
```

```
# end of q_py.cnt
```

At the start of the cruise check **yearbase**, **dbname**, **os75** or **os150** and datatype **enx** (**glob**

**ENX**). Dbname should be of form jrCCCNnnPTT where P is n for narrowband, b for

broadband. The instrument should be operated in narrow unless there is a good reason to

choose broad. TT is "nx" for ENX; "ns" for ENS; "nr" for ENR; "lt" for LTA; "st" for STA.

Standard processing is to process ENX. As far as I can tell, dbname must not exceed 11

chars. So if we use 9 for jr195NNNn, there are only two left to identify ENX, ENS, LTA, STA

6) still in directory ~data/vmadcp/jr276\_os75/jr276001nbenx

**quick\_adcp.py --cntfile q\_py.cnt** (*"killed matlab engine" is the normal message received*)

This takes a minute or two per 24 hours of ENX data. Note --cntfile has two dash characters

7) To see the BT (bottom track) or WT (water track) calibration, look at the ascii output of jr276001nbenx/cal/\*/\*out (note that a calibration is not always achieved, for example if the ship has made no manoeuvres while the ADCP is in water tracking mode, so there may be no \*out file). Note also that additional calibration information maybe saved after flags applied after gautoedit process.

8) To access data in Matlab

**matlab &**

**>> m\_setup**

**>> codaspaths**

Manually clean up data by applying flags to suspected bad data cycles.

**>> cd data/vmadcp/jr276\_os75/jr276001nbenx/edit**

**>> gautoedit**

Clean up data. Select day and step (typically 0.1 or 0.2 days) to view, then "show now".

"show now" may have to be done twice to get the surface velocity plot. "show next" to step

through the file. "Del bad times" sets "bad" flags for a section of time, or for a whole profile.

"rzap" allows single bins to be flagged. Note that "list to disk" must be clicked each time for the flags to be saved.

9) Applying edits identified in gautoedit

The gautoedit process in Matlab sets flags, but doesn't change the data. To apply the flags and recalculate a calibration,

**quick\_adcp.py --cntfile q\_pyedit.cnt** (*note two dashes before cntfile*)

where q\_pyedit.cnt contains

```
# q_pyedit.cnt is
```

```
## comments follow hash marks; this is a comment line
```

```
--yearbase 2009
```

```
--steps2rerun apply_edit:navsteps:calib:matfiles
```

```
--instname os75
```

```
--auto
```

```
# end of q_pyrot.cnt
```

10) To get data into MSTAR:

**>> cd /local/users/pstar/cruise/data/vmadcp/jr276\_os75/jr276NNNnbenx**

**>> mcod\_01**

produces output file

os75\_jr276NNNnnc.nc

which has a collection of vars of dimensions Nx1 1xM NxM

**>> mcod\_02**

will calculate water speed and ship speed and get all the vars onto an NxM grid.

This step makes data available for comparison with LADCP data.

11) Append individual 48-hour files using  
>>**mcod\_mapend**

12) **cd /local/users/pstar/cruise/data/vmadcp/jr276\_os75/jr276NNNnbenx**

In directory apply the final cal **ONLY ONCE** (adjustments are cumulative, so if this step is done twice, the cal is applied twice) when you have done the edits and applied the time-varying heading adjustment. After inspecting the cal out files, and deciding what the amplitude and phase of the calibration should be:

**quick\_adcp.py --cntfile q\_pyrot.cnt** (note two dashes before cntfile), where q\_pyrot.cnt contains:

```
# q_pyrot.cnt is
## comments follow hash marks; this is a comment line
--yearbase 2011
--rotate_angle -1.0564
--rotate_amp 1.0116
--steps2rerun rotate:navsteps:calib
--auto
# end of q_pyrot.cnt
```

Final calibration values used were those given by the JR276 Bottom Track data.

13) In each directory re-create Matlab files:

```
>>cd /local/users/pstar/cruise/data/vmadcp/jr276_os75/jr276NNNnbenx
>>mcod_01
>>mcod_02
```

Then remove and recreate the appended matlab file:

```
>>cd /local/users/pstar/cruise/data/vmadcp/jr276_os75
>>!/bin/rm os75_jr276nnx_01.nc
>>mcod_mapend
```

## 2.7 DIC/ALK Sampling

Emily Shuckburgh and Andy Watson

### 2.7.1 Introduction

We filled bottles 34-58 according to the instructions with underway water, overfilling the bottle 3 times and ensuring there were no bubbles in the sample. We removed 5ml of water from each bottle with a pipette and added 100 micro litres of mercuric chloride. The stopper was carefully inserted, covered in silicon grease and the bottle sealed with several loops of tape.

### 2.7.2 Data

Below is a list of the date and time at which each sample was taken. A record of latitude, longitude, water temperature and salinity was also kept and can be obtained from the

underway records. Samples were taken approximately every 12 hours, except when weather conditions meant it was determined to be unsafe to take samples.

Bottle number	Date	Time (GMT)
34	102	6:38
35	102	19:08
36	103	6:33
37	103	20:13
38	104	5:25
39	104	20:17
40	105	5:30
41	105	23:09
42	106	5:55
43	106	20:46
44	107	5:30
45	108	2:06
46	108	5:43
47	109	1:34
48	109	4:27
49	109	20:13
50	110	4:20
51	110	19:46
52	111	8:57
53	111	19:32
54	112	5:52
55	113	23:28
56	114	7:20
57	115	6:35
58	116	4:11

### 2.7.3 Comments

Whilst every effort was made to ensure no bubbles entered the samples, it was noted on examination at the end of the cruise that many of the samples contained bubbles. It is not clear whether these bubbles are due to poor sampling technique or a consequence of the sample bottles reaching ambient air temperature.

## 3.1 Salinity

### *Introduction*

Discrete salinity samples were taken throughout the cruise for two purposes: the calibration of CTD salinity profiles (see section 4.1) and the calibration of underway TSG data (see section 2.5). These were then analysed using a salinometer on board. The following section outlines the aims of the sampling, the method of sampling and the method of sample processing.

### *Aim*

The aim of the discrete salinity samples was to provide accurate information for the calibration of salinity data provided by CTD casts and underway TSG. This allowed for the processing of said data while the cruise was in progress so that the results could inform day-to-day planning.

### ***Sampling Method***

All samples were taken using 200 ml glass sample bottles with plastic lids, supplied by OSIL<sup>1</sup>, in cases of 24 bottles. Each bottle was labelled with a unique number, and in a uniquely numbered case. Log sheets were used to note the case number and bottle number of each sample taken. Bottles were filled in order to leave minimal air for evaporation to occur whilst leaving enough air to allow for adequate mixing of the sample before sampling, in order to counteract any stratification that may have developed. The bottle necks and lids were dried thoroughly before plastic caps, also supplied by OSIL, were placed inside the bottle necks immediately after sampling in order to seal the air within the bottles to counteract evaporation. Obviously the small amount of air sealed in the bottle will have caused a slight salty bias in all samples.

### ***CTD Sampling***

See section 4.1 for a detailed description of CTD deployment. The CTD instrument contains a rosette of 24 niskins, closed at various depths during deployment in order to capture samples of water at those depths. For each CTD cast, the niskins to sample for salinity were decided in order to provide the best coverage of the salinity profile measured by the conductivity probe on the CTD. In practice, this normally meant sampling from the deepest niskins, the shallowest niskins, and some in the middle.

When sampling, the sample bottles were first rinsed a minimum of three times using the water from the niskin to be sampled. This was to minimise contamination of the sample from anything on the inside surface of the bottle. The bottle was then filled as described above, capped and replaced in the relevant case.

### ***TSG Sampling***

See section 2.5 for a detailed description of underway TSG measurements. Underway instruments aboard the ship constantly measured the salinity of the sea water passing through the ship from the immediate surroundings. In order to calibrate these measurements, samples of this water were taken roughly every 4 hours as part of the watchkeepers' duties. The tap supplying the underway water was open constantly and the flow rate was monitored and logged every 4 hours as part of the underway data logging procedure. The sample bottle was filled and emptied 3 times to ensure minimum contamination, before being filled as described above, capped and placed in the relevant case.

### ***Sample Processing***

Once a case of sample bottles was full, it was transferred to the temperature-controlled laboratory, where it remained a minimum of 24 hours before being sampled. This was to ensure that all samples were at the same temperature on

sampling for consistency of measurements. The temperature of the room was monitored and logged every 4 hours as part of the underway data logging procedure. Salinity measurements were taken using a Guildline<sup>2</sup> AutoSal Salinometer, model 8400B, s/n 68959, provided by OSIL.

At the beginning of the cruise, the machine was standardised using a bottle of IAPSO Standard Seawater, batch P151, conductivity ratio  $K_{15} = 0.99997$ , provided by OSIL. At the beginning and end of each sampling run, the standardisation was checked using a bottle of IAPSO Standard Seawater, batch P151, conductivity ratio  $K_{15} = 0.99997$ .

The salinometric analysis was carried out as per the manufacturers recommendations. The sample bottle to be measured was gently agitated by inversion 3 times to remove any stratification. Before any measurements were taken, the measurement cell was filled using the peristaltic pump and flushed three times with the relevant sample in order to avoid any contamination from previous samples. The analyst ensured that no bubbles were present in the cell before measuring the sample. The cell was flushed, filled and then measured a further two times in order to have a total of three measurements for each sample.

This was repeated for each sample in the relevant crate. Once all samples in the crate had been analysed, another bottle of IAPSO Standard Seawater was analysed in the same way as a sample, in order to ascertain whether the Salinometer precision had remained the same throughout the sampling.

All recorded measurements were converted into salinity using the Unesco algorithm for practical salinity (Unesco, 1980).

The accuracy of the results gained is improved by the time averaging and the three separate measurements for each sample. The standardisation check at the beginning and end of the crate gave an idea of how consistent the salinometer precision had been, which should be taken into account in error analysis. The temperature of the water bath in the Salinometer was kept at 20 degrees Celsius throughout the cruise. The temperature of the lab remained fairly constant throughout the cruise, although slight diurnal variations and the effect of the analyst being in the lab during the sampling process could not be avoided. This is not expected to affect the results as the water bath in the salinometer ensures consistency of sampling.

## **References**

1. OSIL  
Culkin House  
C7/C8 Endeavour Business Park  
Penner Road, Havant  
Hampshire PO9 1QN
2. Guildline Instruments Ltd.  
P.O. Box 99, 21 Gilroy St.

Smith Falls, Ontario,  
K7A 4S9

3. National Instruments Corporation Ltd.  
Measurement House, Newbury Business Park  
London Road  
Newbury, Berkshire RG14 2PS

## **3.2 Measurements and distribution of the tracer CF<sub>3</sub>SF<sub>5</sub> – University of East Anglia**

Marie-Jose Messias, Andrew Brousseau, Neill Mackay, Andrew Watson and Steve Woodward

### **3.3.1 Sample collection and Analysis technique**

The released tracer, trifluoromethyl sulphur pentafluoride (CF<sub>3</sub>SF<sub>5</sub>) and two transient tracers (trifluorochloromethane (CFC-13) and dichlorodifluoromethane (CFC-12)) were measured on board by a purge-and-trap gas chromatographic method. The instrumentation was built and developed at the University of East Anglia from the Lamont Doherty Earth Observatory (LDEO) design [Smethie et al., 2000]. The system was set up in the UEA laboratory container which was installed on the after deck of the *RRS James Clark Ross*. A total of 1222 seawater samples including ~10% of duplicates were measured.

#### Sample collection

Water samples were collected from 10 litre bottles as soon as the CTD sampling rosette was on board. The Niskin nitrile 'O' rings were first washed in isopropanol and baked in a vacuum oven for 24 hours to remove susceptible contamination before installation in individual Niskin bottles. The trigger system of the bottles was external. Water samples were collected in 2 liter ground-glass stoppered bottles that were filled from the bottom using Tygon tubing and overflowed 1 time to expel all water exposed to the air. Immediately after sampling, the glass bottles were immersed in a cool box of cold deep seawater in the sampling hangar until the analysis. Ice packs were added as necessary to maintain a temperature below 5°C and prevent degassing.

#### Analysis technique

Sample analysis was performed as soon as possible within 24 hours of the sampling. Samples were introduced to the system by applying nitrogen (N<sub>2</sub>) pressure to the top of the sample bottles, forcing the water to flow through and fill a 1135 cm<sup>3</sup> calibrated volume. The measured volumes of seawater were then transferred to a purge and trap system, entering the sparge tower under vacuum. The water was sparged with a N<sub>2</sub> flow at 270ml/mn for 3 minutes and trapped at -110°C on a Unibeads 3S trap (two inches of 1/8inch tubing) immersed in the headspace of liquid nitrogen. The purge and trap system was interfaced to an Agilent 6890N gas chromatograph with electron capture detector (MicroECD at 320°C). The



traps were heated to 110° C and injected into the gas chromatographs. The CF<sub>3</sub>SF<sub>5</sub>, CFC-13, and CFC-12 separation was achieved using a 1m Porasil B packed pre-column and a 1.5m carbograph AC main column. A six inches molecular sieve post column was used to remove N<sub>2</sub>O. Examples of the resulting chromatograms are displayed figure 1. The three columns were kept in the oven at 75°C. The carrier gas, N<sub>2</sub>, was cleaned by a series of purifying traps (VICI nitrogen purifier and oxygen trap). The running time per sample is ~9 minutes.

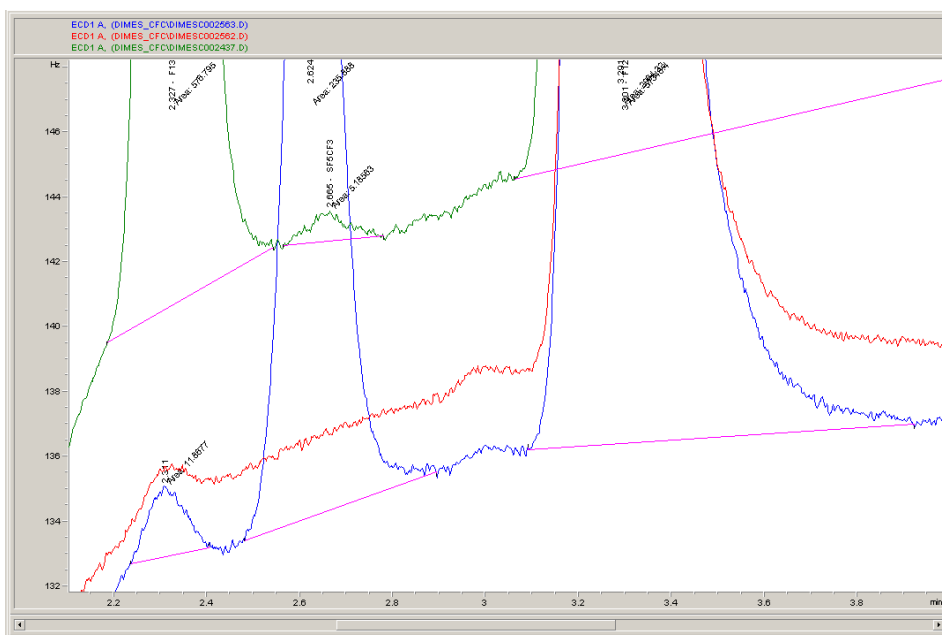
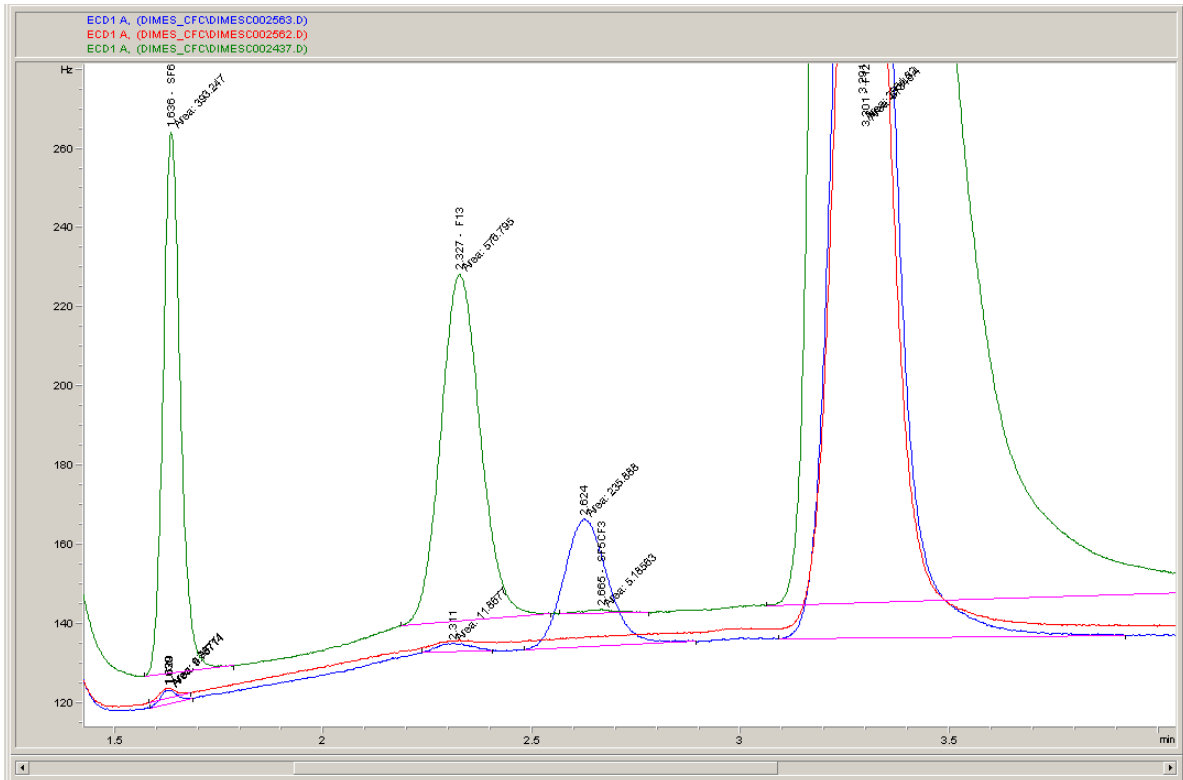


Figure 1: examples of chromatograms, (a) near-surface chromatogram (green)s, showing SF<sub>6</sub>, CFC-13, background CF<sub>3</sub>SF<sub>5</sub> (very small peak) and CFC-12 (left to right). Blue is a chromatogram at the target density, and red is a deep sample that is tracer free.

### Calibration

The CF<sub>3</sub>SF<sub>5</sub>, CFC-13, CFC-12 concentrations in air and water were calculated using external gaseous standards. We use two working standards supplied respectively by NOAA (Brad Hall, March 2010) and WHOI (5B tank from Jim Ledwell, August 2010). The NOAA standard is clean air enriched in CF<sub>3</sub>SF<sub>5</sub> inside a 29L Aculife-treated aluminium cylinders calibrated for SF<sub>6</sub> and CFC-12 by NOAA (Table 1). The WHOI standard is nitrogen enriched in CF<sub>3</sub>SF<sub>5</sub> inside a 10L steel cylinder. Its CF<sub>3</sub>SF<sub>5</sub> concentration was estimated by gravimetry at WHOI and checked by Ed Busenberg (Jim Ledwell, pers. communication). The NOAA standard was intercalibrated against the WHOI standard for CF<sub>3</sub>SF<sub>5</sub> during the JC054 cruise in January 2010 with our instrument. The tracer was found to give a nearly linear response over a large range but was best fitted by a polynomial of order two (figure 2). The routine calibration curves were made by multiple injections of 9 different volumes (0.1, 0.25, 0.3, 0.5, 1, 2, 3, 5, 8 ml) of standard that span the range of tracers measured in the water for CF<sub>3</sub>SF<sub>5</sub>. Multiple injections of large loops of standard, up to 136 ml were made to calibrate CFC-12 and CFC-13 in surface waters as the large volume of sea-water required for the tracer was inappropriate for surface seawater measurements of CFC-12 and CFC-13. Routine calibration curves were made when time permitted. The changes in the sensitivity of the system were tracked by measuring a fixed volume of standard gas in between stations (Figure 3) and used to adjust the calibration curves respectively. The calibration precision was better than 1% for the tracer CF<sub>3</sub>SF<sub>5</sub> and for CFC-13, CFC-12 levels at the target density range. For high surface values of CFC-12 and CFC-13 the calibration precision was estimated to be only 5 %.

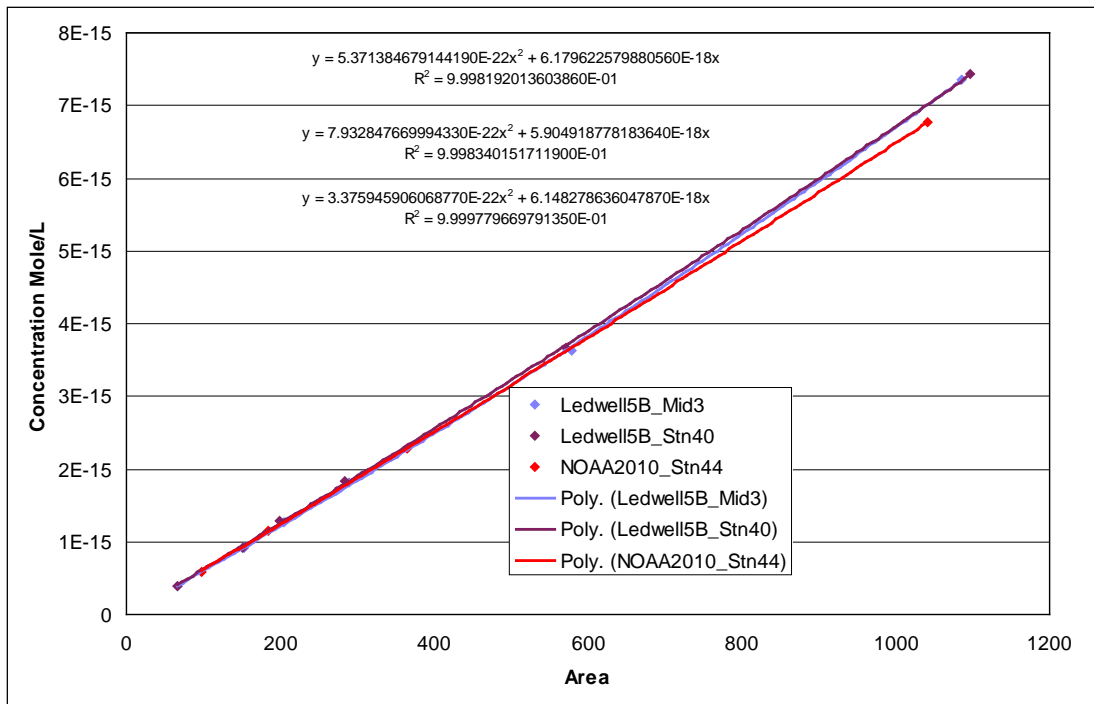


Figure 2: Examples of calibration curves for  $\text{CF}_3\text{SF}_5$  tracer during JR276

	Mixing ratio ppt	Std Dev	Calibration
CFC-12	513.9	1.3	Scale NOAA 2001
CFC-13	2	---	Estimated from literature for air, Busenberg , 2008
$\text{CF}_3\text{SF}_5$	63.9	0.1	Intercalibration with Ledwell 5B tank 7/01/2011

Table 1: Concentrations of the working standard NOAA tank # ALL-072115

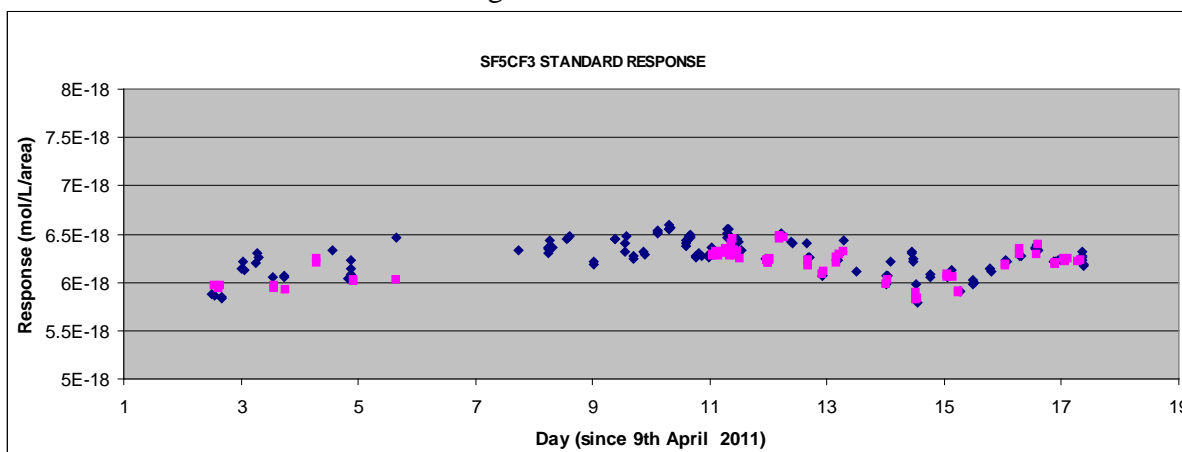


Figure 3: Instrument response for  $\text{CF}_3\text{SF}_5$  for the WHOI (blue) and NOAA (pink) standards. The data between day 5.65 and 7.7 were not used as they were affected by a leak on the standard gas circuit.

### Detection limit

An unusually large volume of water (1135 ml) was analysed in order to increase the detection limit of the tracer in water as less tracer was released than originally planned. The detection limit for  $\text{CF}_3\text{SF}_5$  was 0.005 fmol/l.

### Precision and accuracy

The precision (or reproducibility) for the water samples measurements can be determined from replicate samples drawn on the same Niskin. In total, 106 duplicate samples were drawn from the rosette spanning the all range of concentrations encountered along the cruise. The average standard deviation for duplicates was 0.005 fmol/L (or 1% if greater) for  $\text{CF}_3\text{SF}_5$ , 0.03 fmol/L for CFC-13 and 0.008 pmol/L for CFC-12.

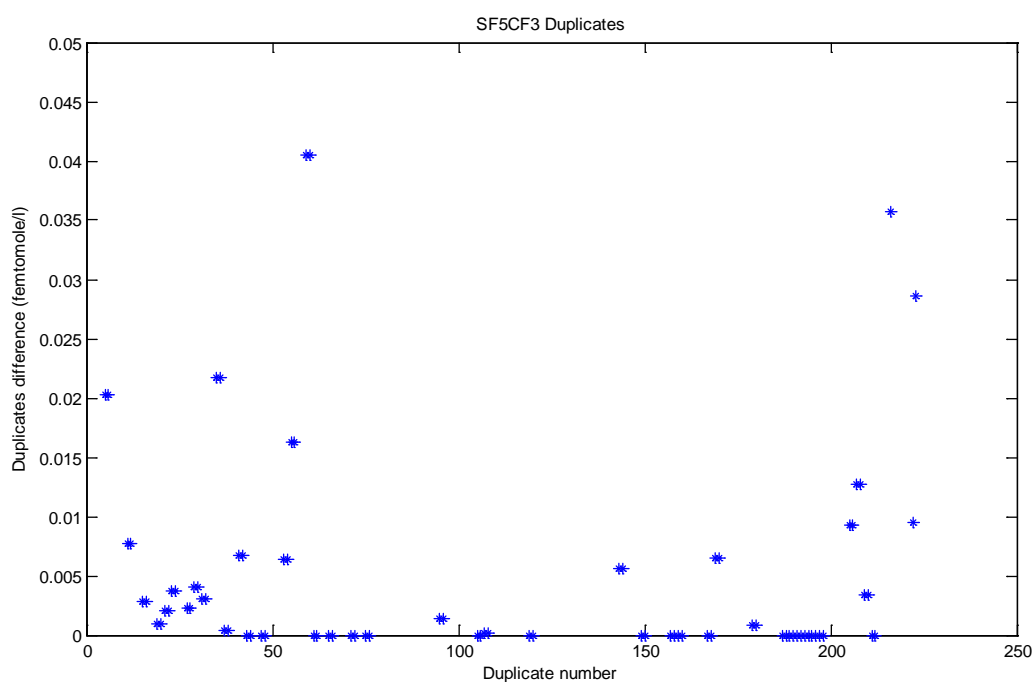


Figure 4: differences between duplicates of  $\text{CF}_3\text{SF}_5$

For the tracer, no blank correction was applied as no trace of  $\text{CF}_3\text{SF}_5$  was detected in the samples from depth. The CFC-13 and CFC-12 total blanks could not be assessed as we did not sample CFC free water. The circuit water of the instrument showed a contamination level of 0.0015 pmol/l for CFC-12 (none for CFC-13) which was subtracted from the final data set.

Sparging efficiency was determined by successive resparging of a single sample until complete no further compound could be detected. The final data set was corrected for sparging efficiency accordingly (table 2).

Tracer	Sparge efficiency
CFC-13	93 %
CF <sub>3</sub> SF <sub>5</sub>	97 %
CFC-12	89 %

**Table 2.** Sparge efficiencies estimated during JR2764.

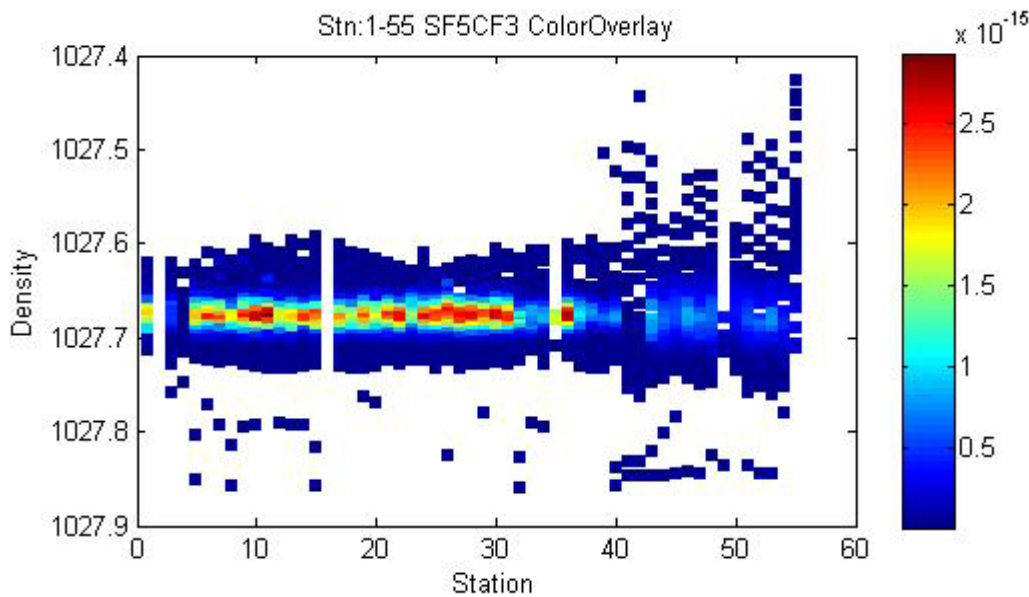


Figure 5: Vertical distribution of tracer in mole/l against potential density during JR276

### 3.3.2 Narrative and Results

The tracer, 76 kg of trifluoromethyl sulphur pentafluoride (CF<sub>3</sub>SF<sub>5</sub>), was released from *R/V Roger Revelle* on the 27.906 kg m<sup>-3</sup> neutral density surface (in UCDW near 1500-m depth) west of the Drake passage in the Antarctic Circumpolar Current near 58°S, 107°W, in early February, 2009 (Ledwell et al 2011). The tracer patch was surveyed one year later during the US2 cruise, in January-February 2010, from *R/V Thomas G. Thompson* West of Drake passage (Fig. 1). The tracer was surveyed on cruise JC054 in December 2010/January 2011, 22 months after the release extending from 58°W east to 79°W in the region of Drake passage with vertical profiles spaced at ~ 1/3 of a degree latitude along 3 meridian sections (60°W, 67°W&79°W). Measurable tracer concentration at was found at virtually every station. On the present cruise, the two sections (at 78°W and the SR1 section at approximately 57°W) again showed measurable tracer at virtually every location.

#### Horizontal Distributions

Column integrals of tracer concentration along the two sections, in nanomoles.m<sup>-2</sup> are presented in figure 3.1. We found that the degree of variation from profile to profile on the parts of S3 that were at the finest resolution was not greatly different from that of the coarser resolution parts, indicating that at some level, even the finest resolution we were able to achieve was not sufficient to fully separate the streakiness that remains. On the other hand this variation was not very large compared to the concentration being measured: the horizontal distributions give the impression of a wide region of relatively high concentrations in which streaks are largely merged but some variation, ~10-20%, of the total column integral, remains. At the Polar Front at 62°S on section S3, and towards the north the concentrations drop substantially, but on S3 they then rise to a substantial peak south of the Polar front and centred at 63°S – possibly an eddy or meander of water derived from north of the PF?

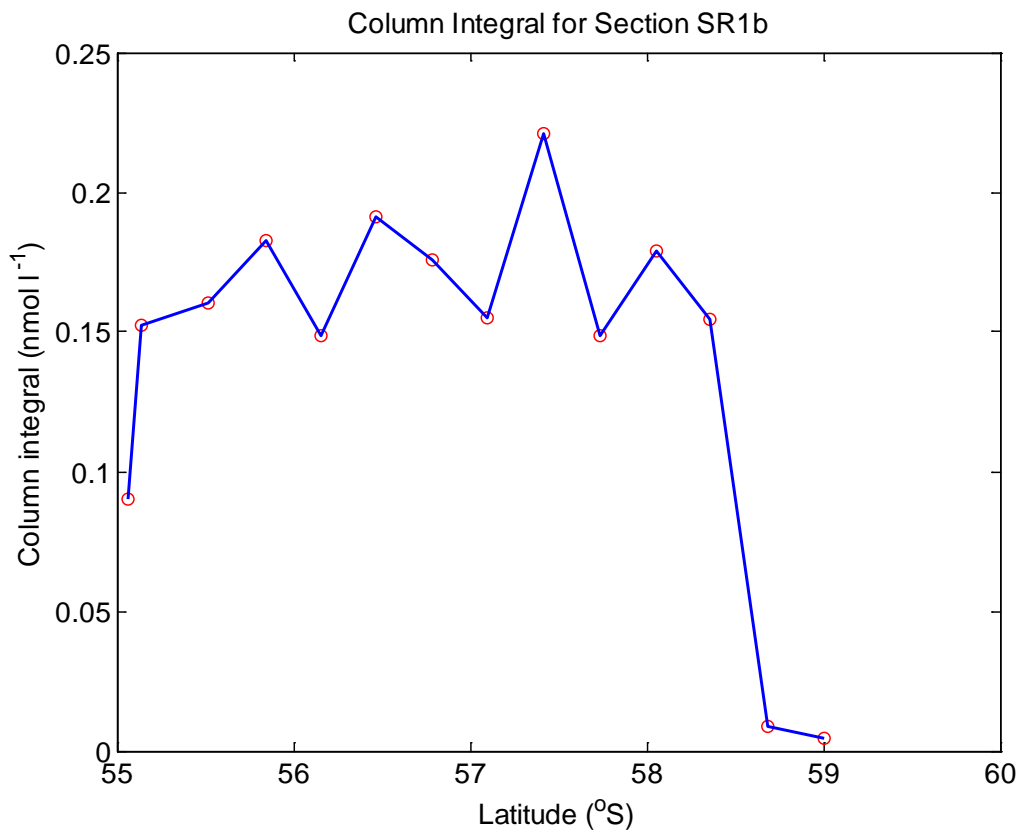
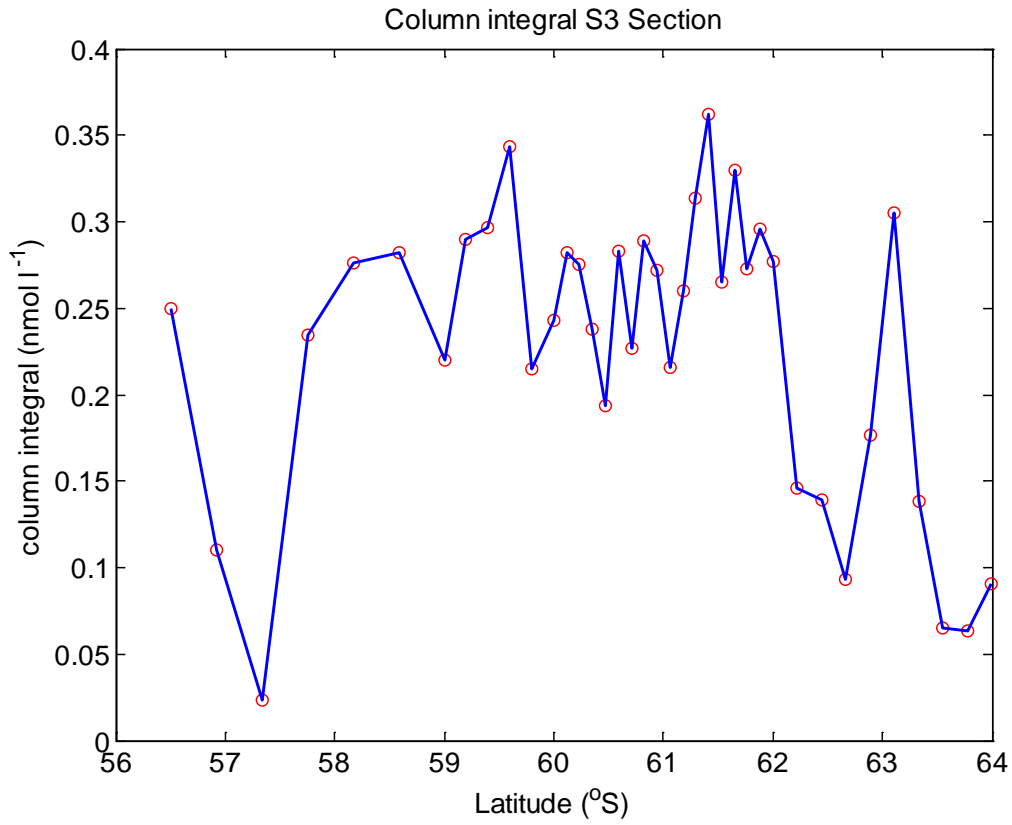


Figure 3.1: column integrals, nanomoles  $m^{-2}$ , for the two sections.

Vertical distributions

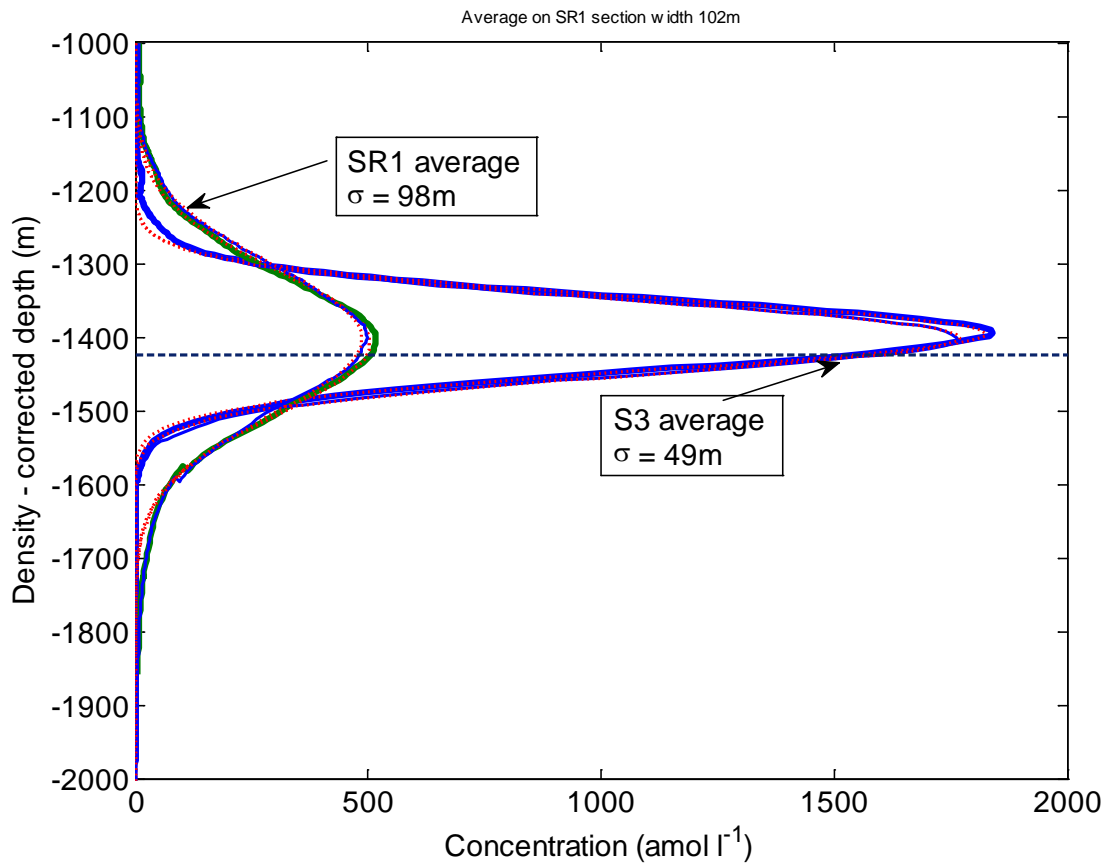


Figure 3.1: column integrals, presented as size of the dots with values in picomoles  $m^{-2}$  in light type, for the three sections.

Figure 3.2: Mean tracer profiles for sections S3 and SR1b, plotted against neutral density and converted to depth using the cruise-mean density-vs-depth profile to convert between the two variables. Gaussians of the form  $C_0 \exp\{0.5[(z-z_{max})/\sigma]^2\}$  were fitted to the profiles, and the values for  $\sigma$  are shown as the widths. The dotted line shows the depth of the  $\gamma_n=27.905$  density level, on which the tracer was released. The tracer appears slightly above the target surface, which may be an artefact of the preliminary calibration of the salinity on the CTD. For comparison, the JC054 section averages and the US 2 cruise average are plotted in fig 3.3 using the same density-depth relation.



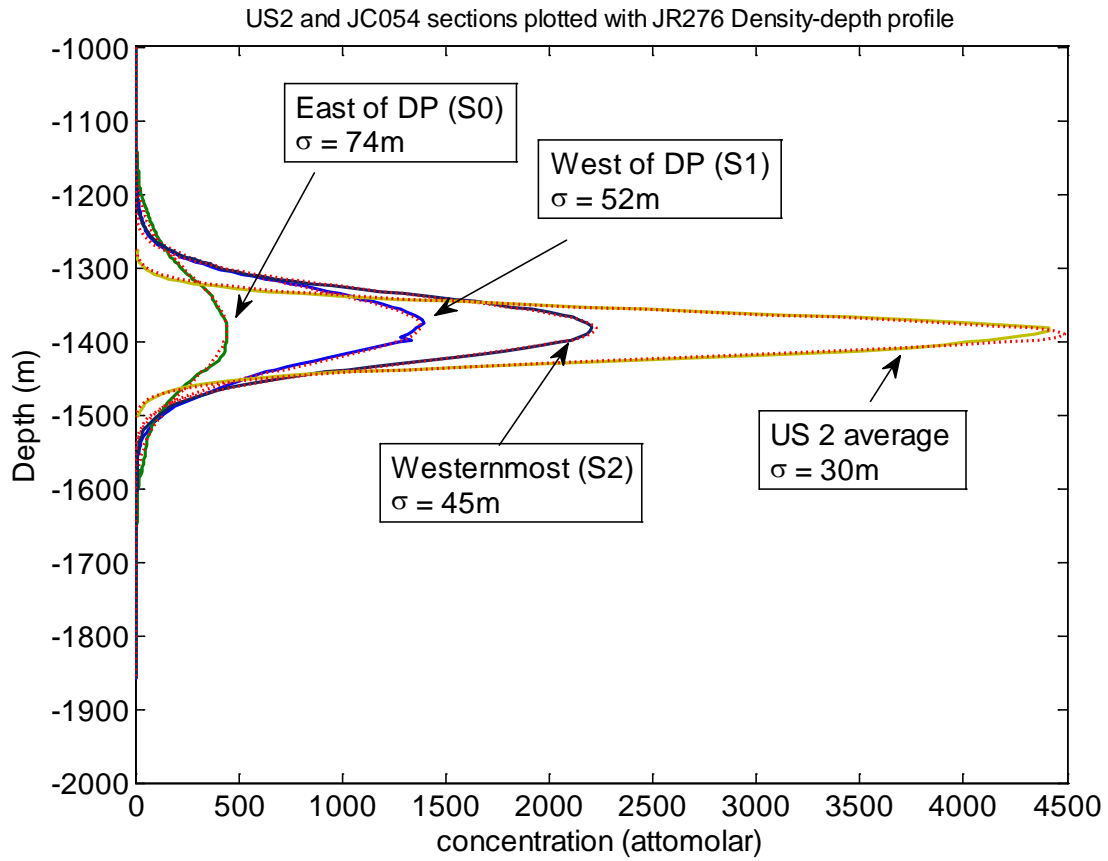
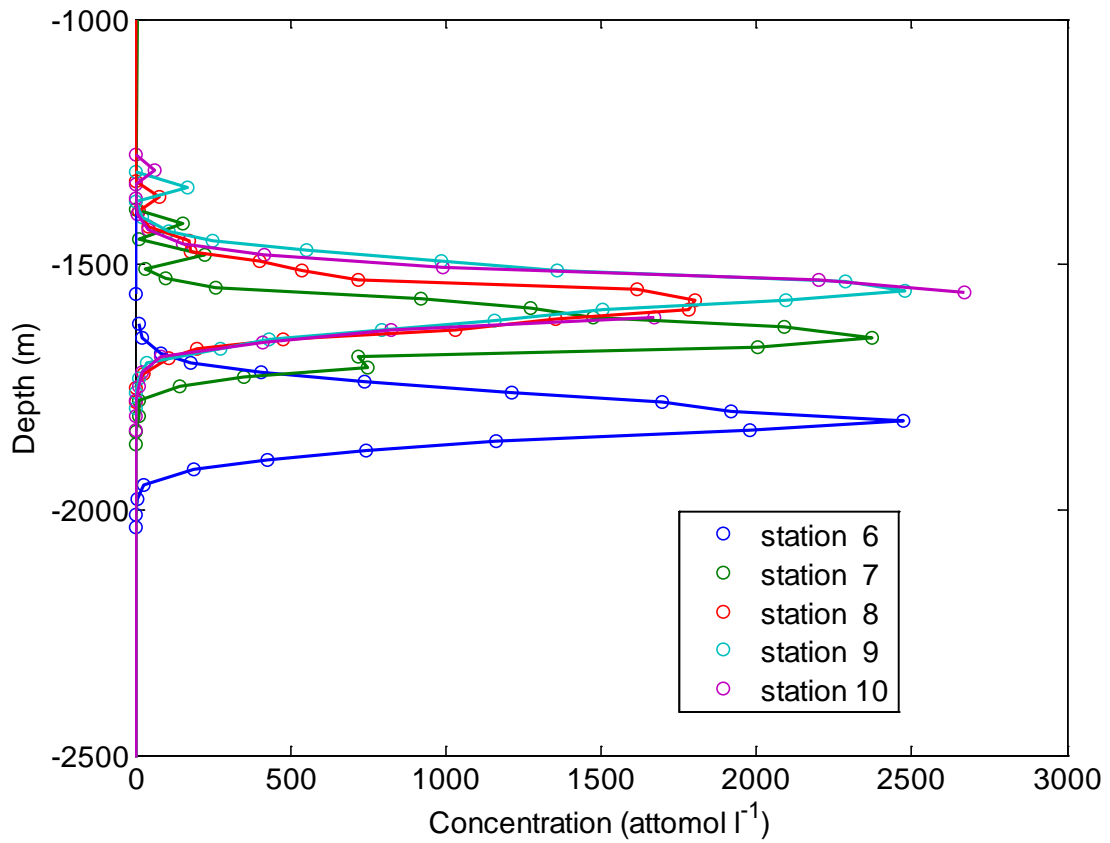
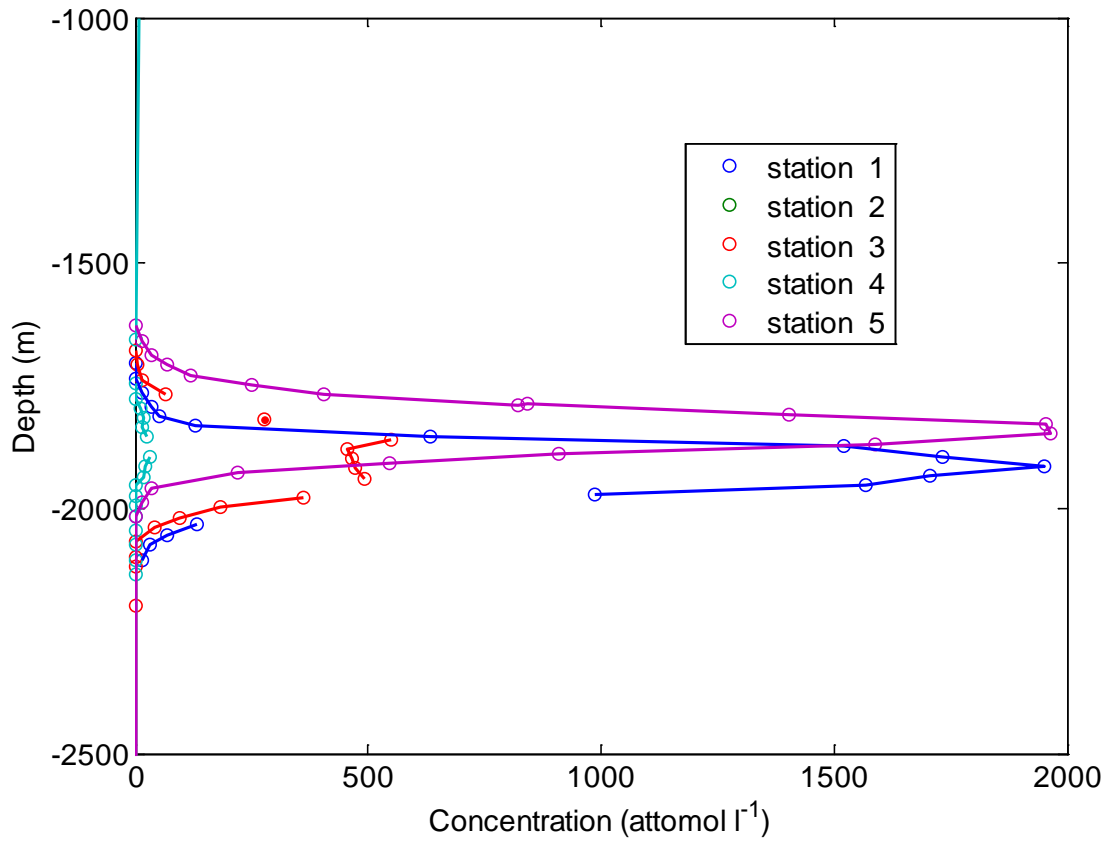
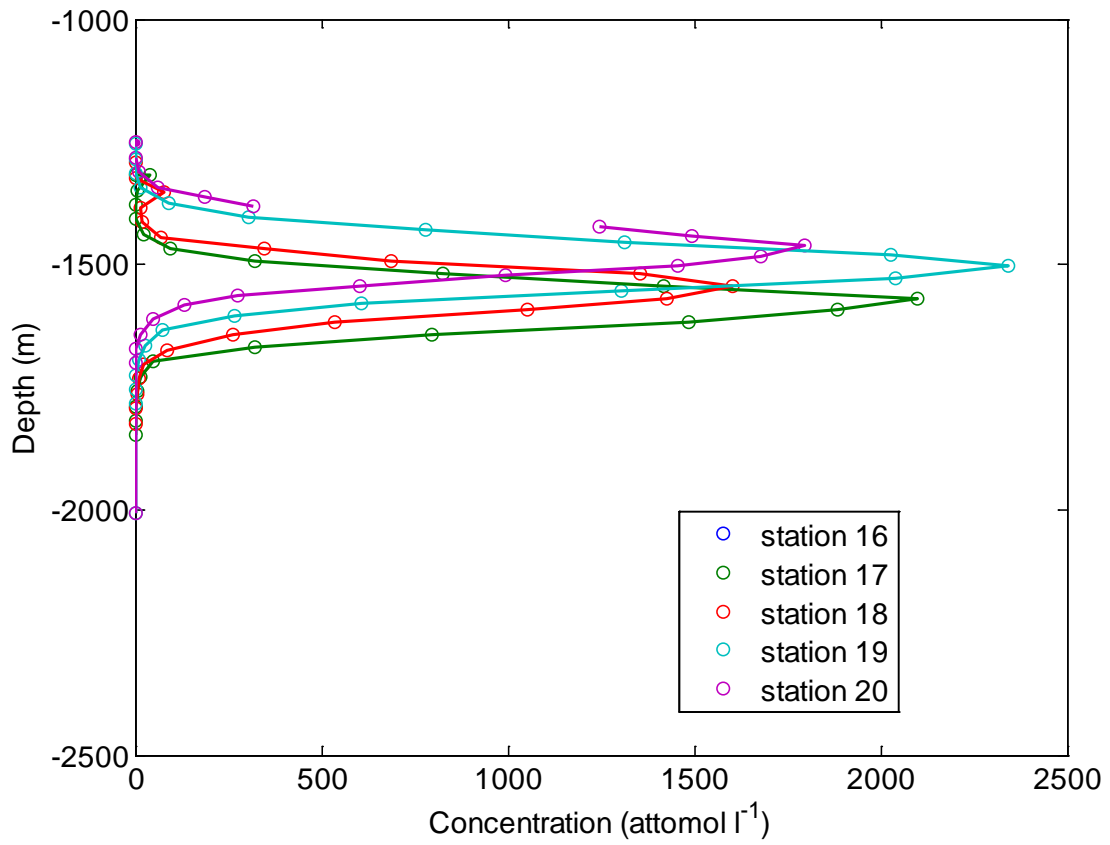
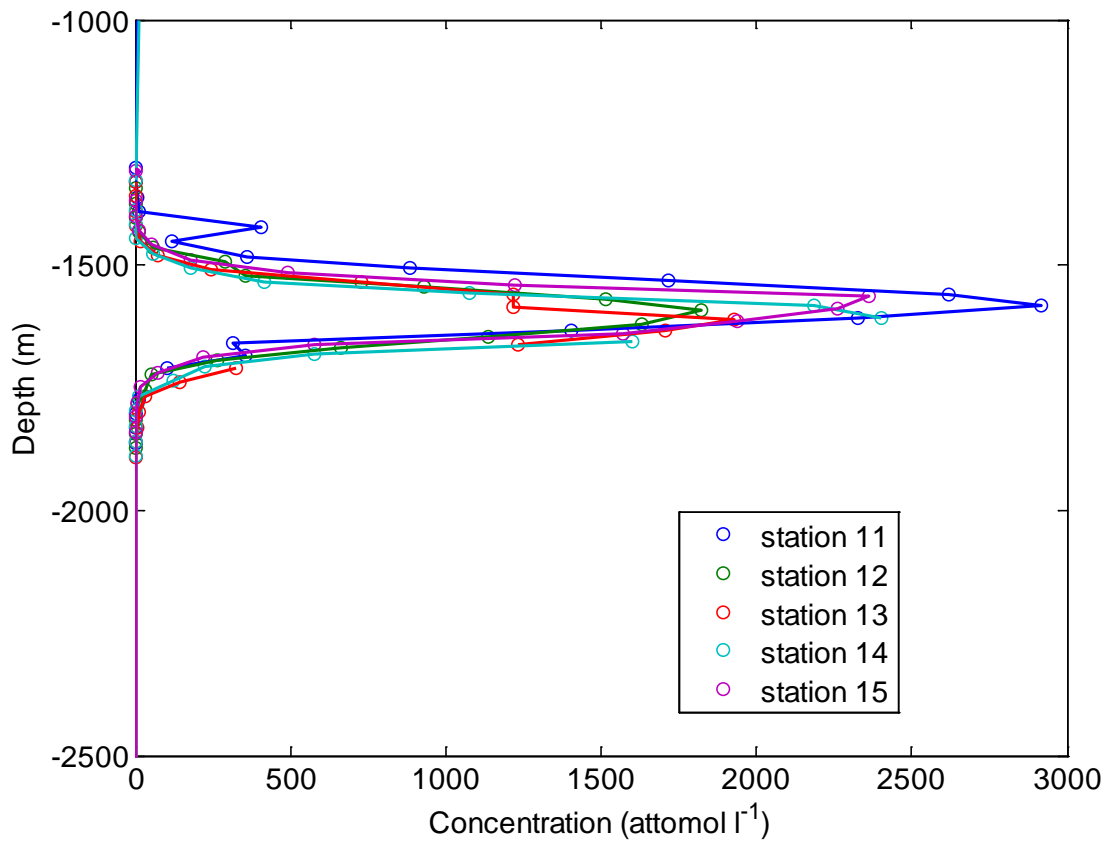
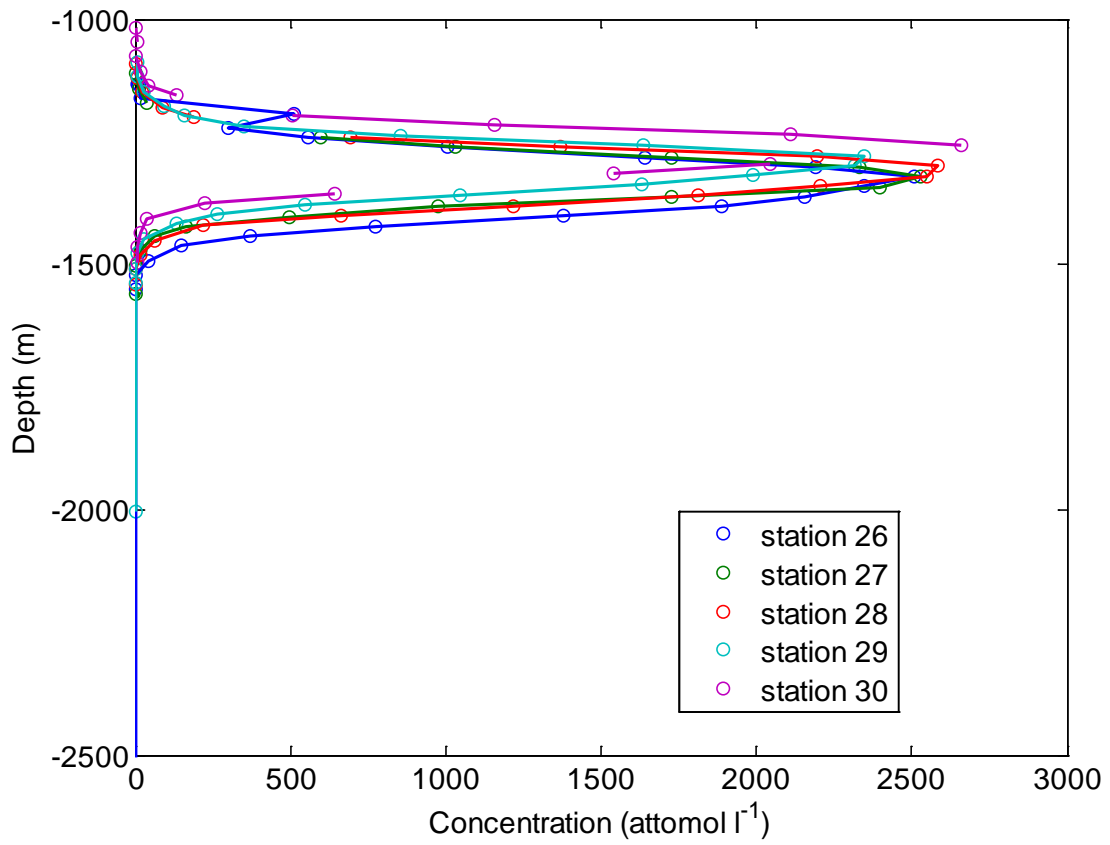
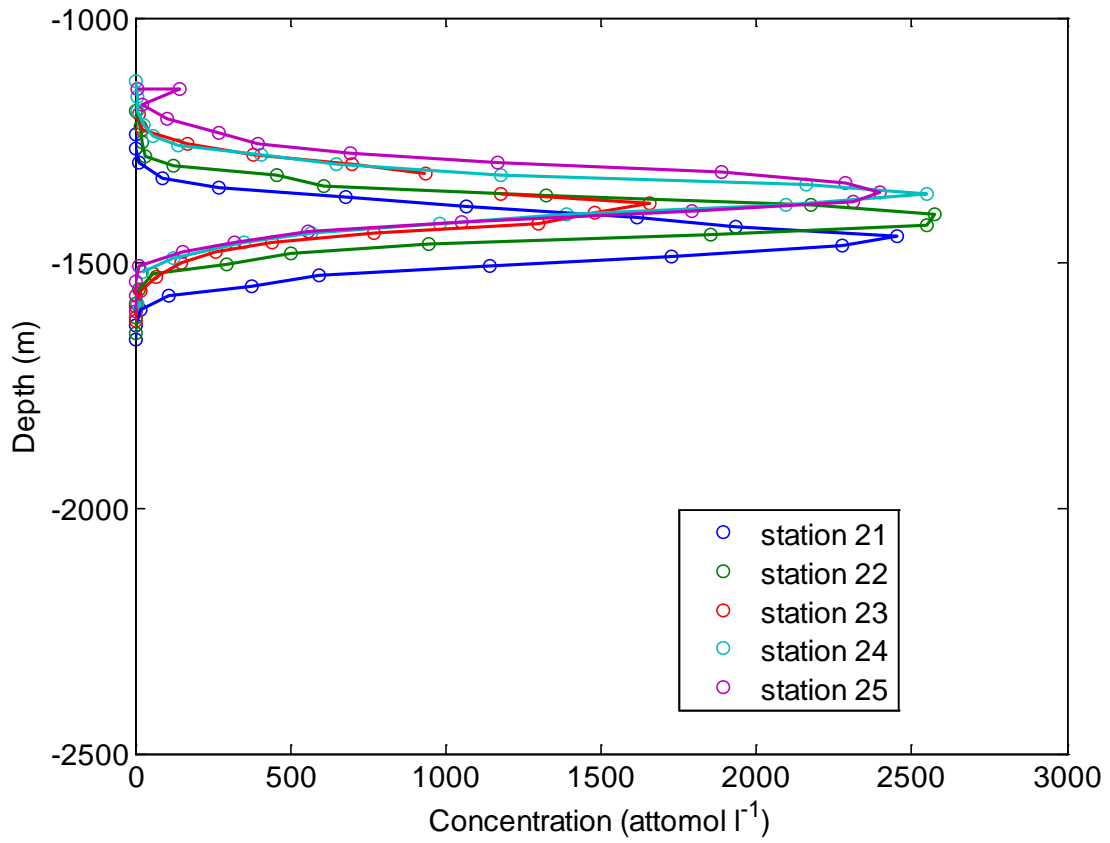


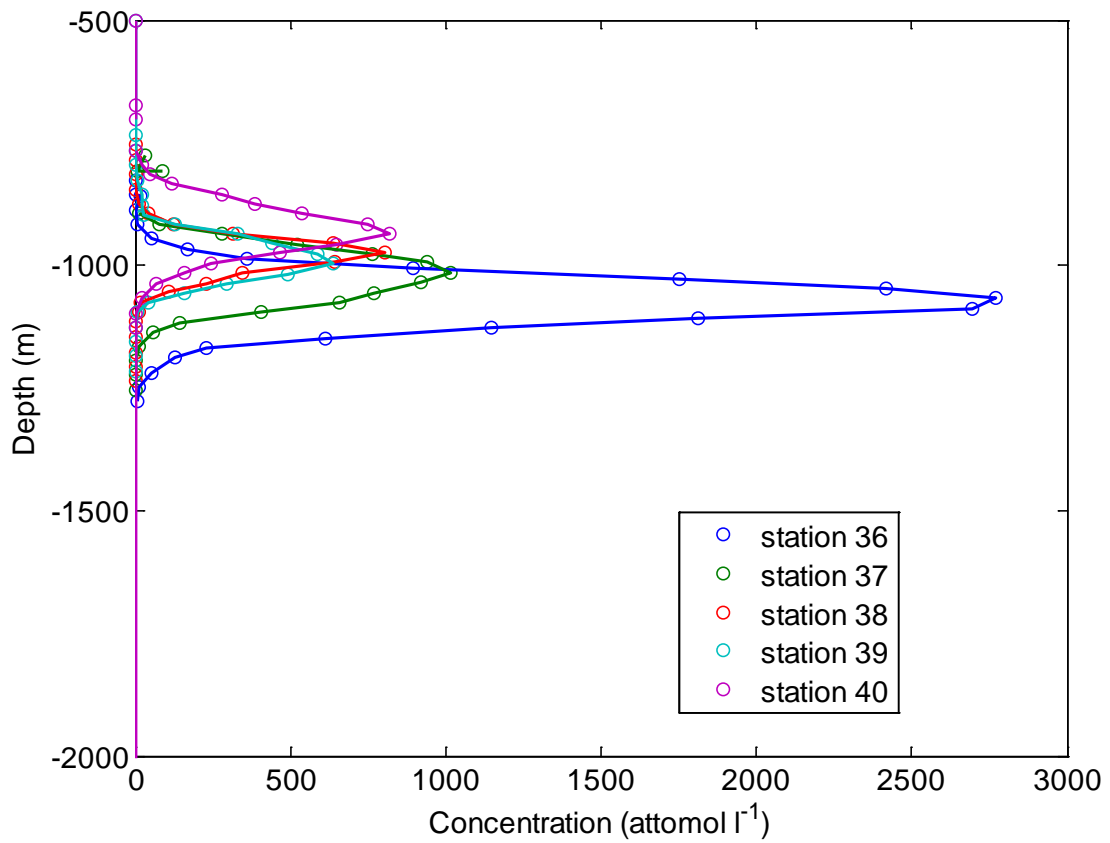
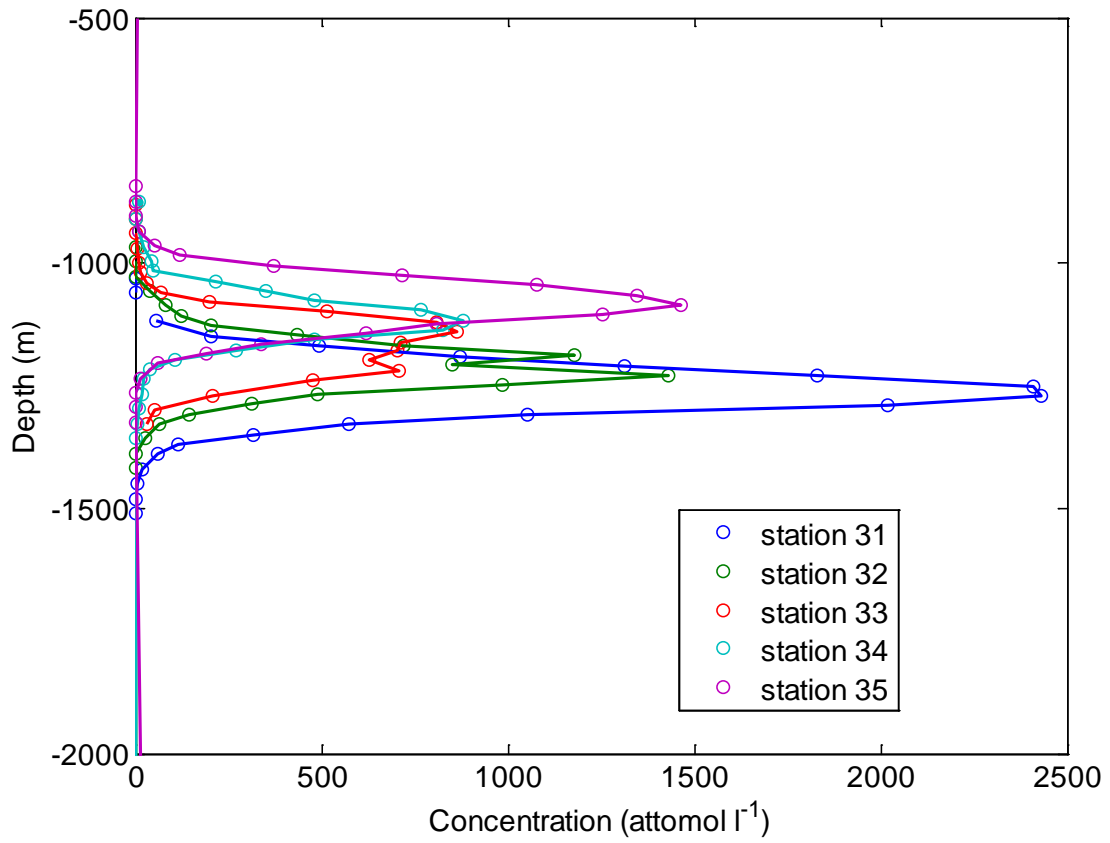
Fig 3.2 The US 2 and JC054 mean section profiles, replotted with the JR276 density-vs-depth relation.

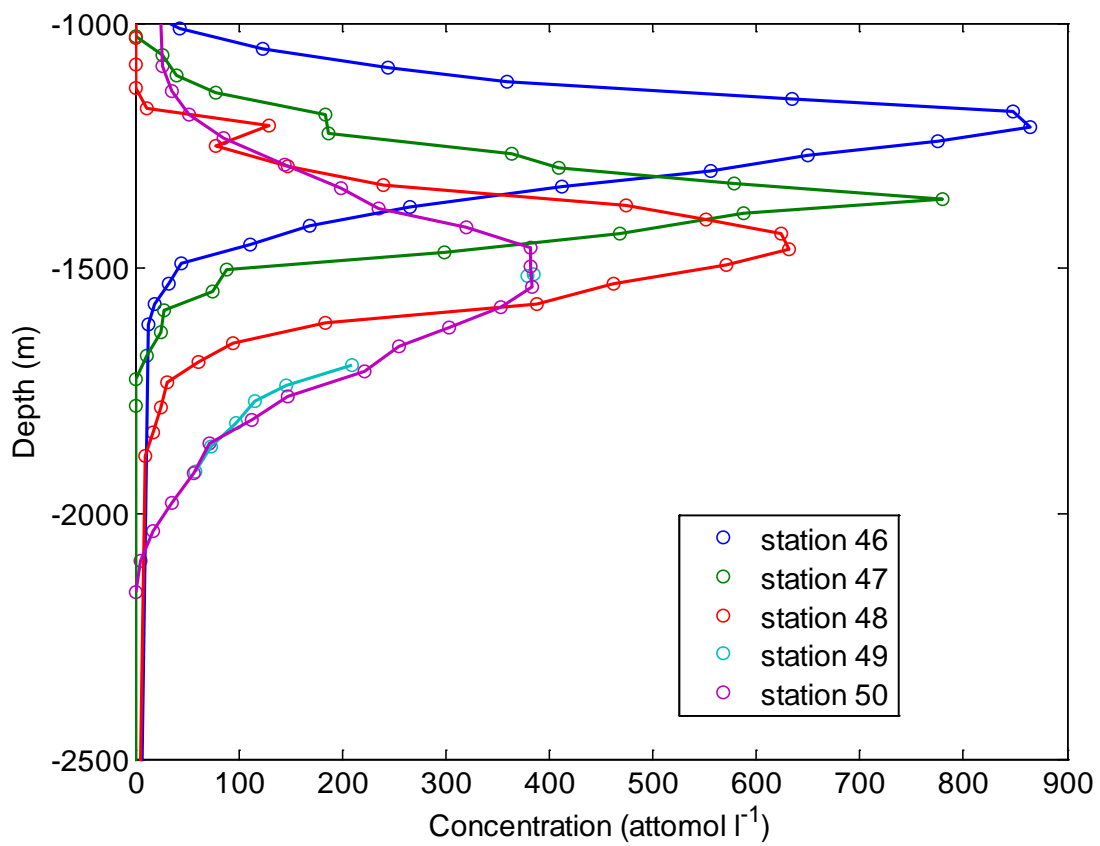
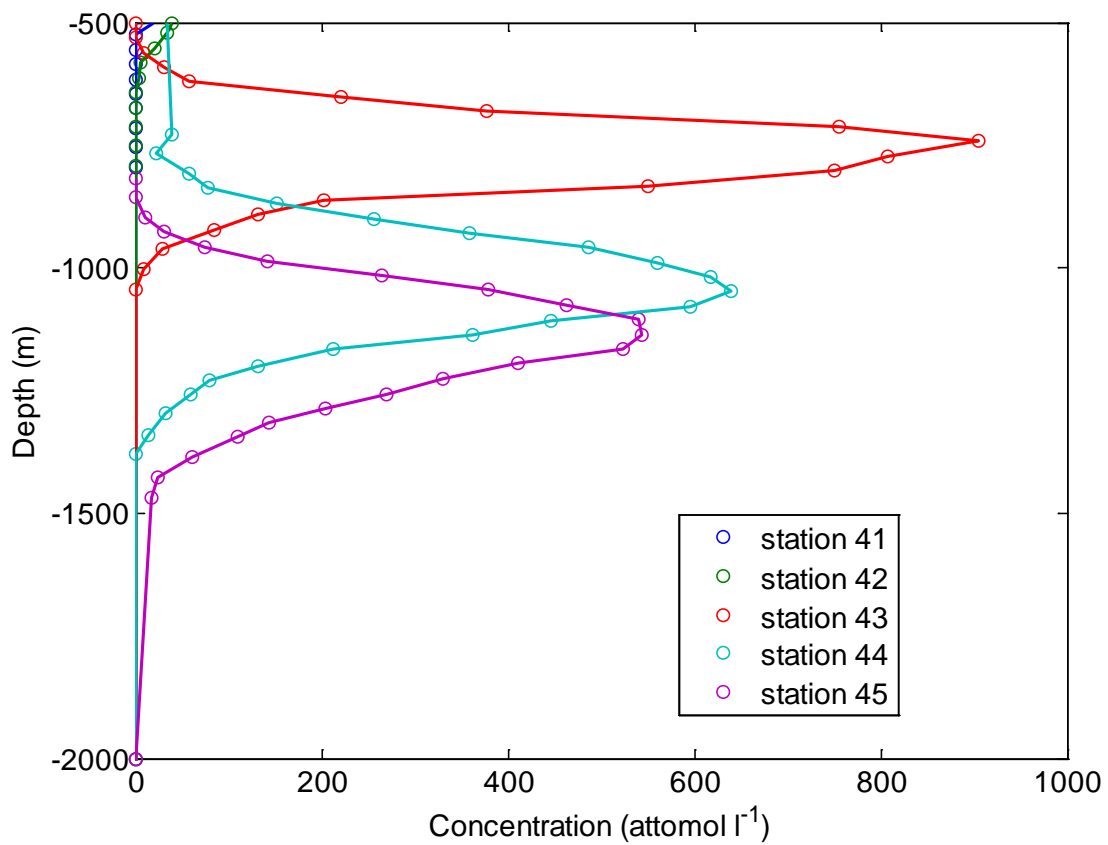
Fig 3.3 below shows the tracer data for each cast plotted as a function of depth (not density corrected) with bottle position and interpolating lines

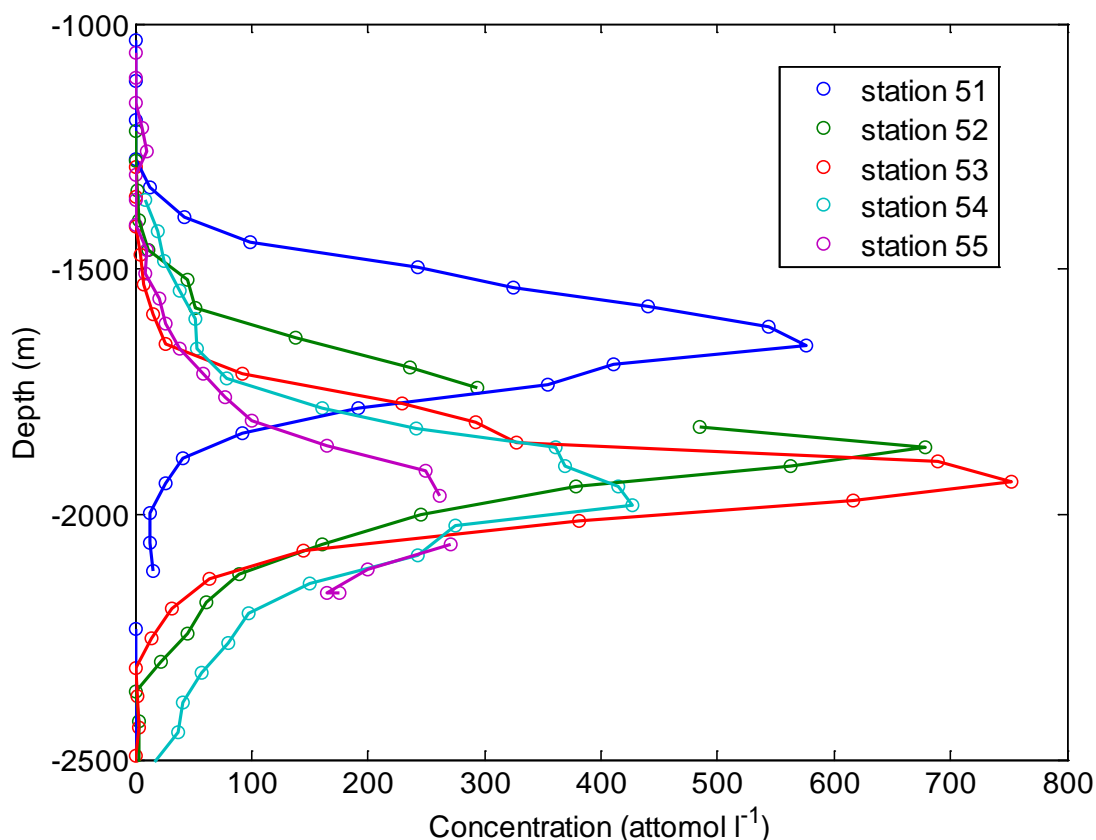












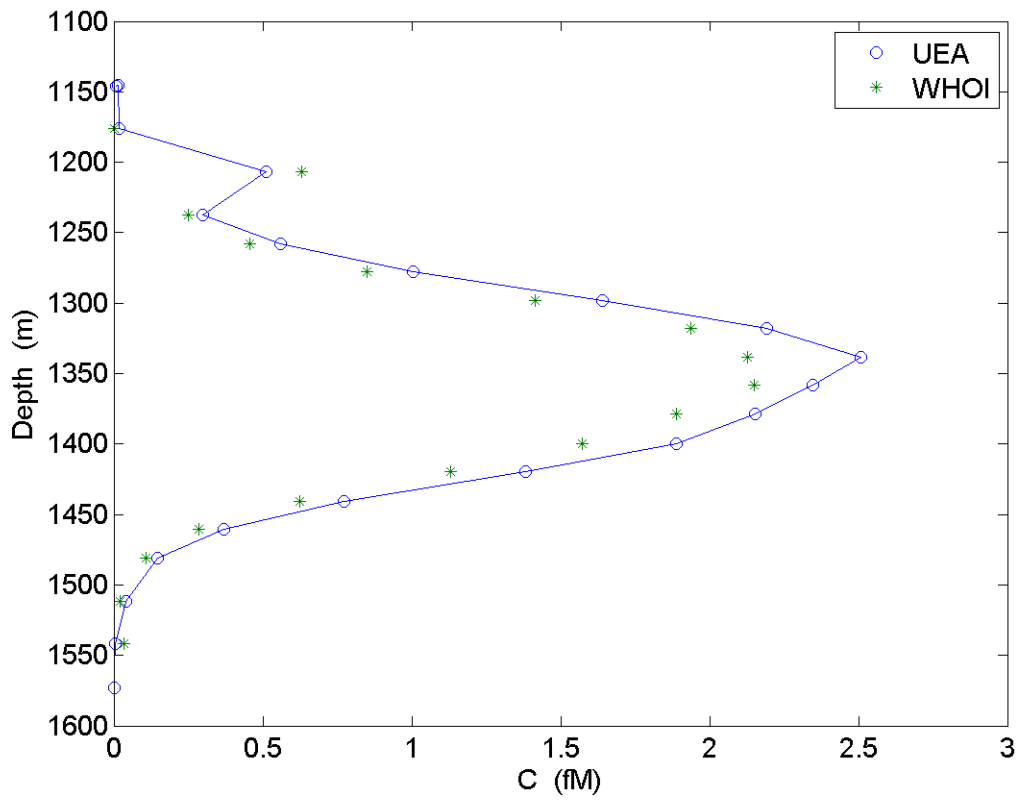
**Acknowledgements:**

We would like to acknowledge the extensive help of all the ship-side staff, the BAS and NMF technicians and the scientific party aboard cruise JR 276: Special thanks to Jim Ledwell and Brian Guest who were part of the night watch for the tracer team.

**Comparison of the UEA and WHOI concentrations**

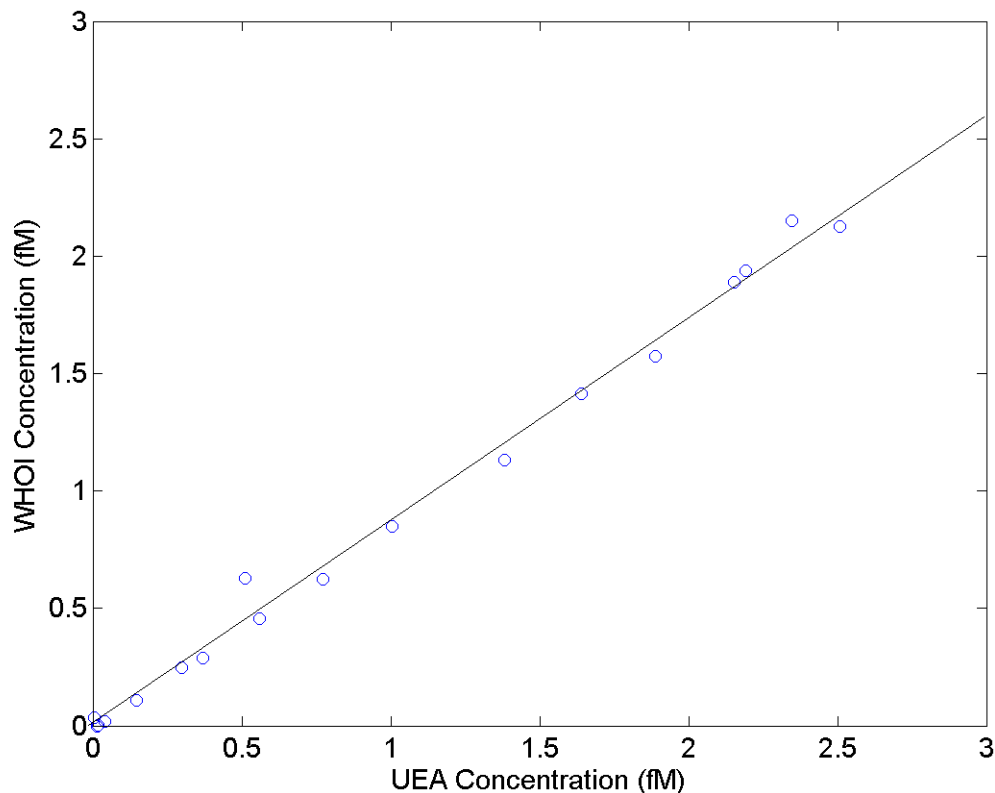
**Cast 026.**

Duplicate samples were taken into 1-liter bottles for Cast 026 for analysis on the WHOI system, after the 2-liter samples for the UEA system were taken. Concentrations were found to be quite different for the two systems (Table 1 and Figs 1 and 2). For the higher concentrations the UEA system gave a value about 15% greater than the WHOI system. For the lower concentrations the difference was greater. The straight line plotted in Fig. 2 has a slope of 1.15, and this would be the correction factor to use if we were relying on the WHOI analysis to give us this profile.



*Fig. x.x.1 Tracer profile from the UEA (o) and WHOI (\*) samples for Cast 026. Niskin 12 is the sample just above 1350 m depth. Niskin 19 gave the spur at around 1200 m.*





*Fig. x.x.2. WHOI Concentration versus UEA Concentration for the tracer, Cast 026. The outlier near 0.5 fM is from Niskin 19. The next to the highest UEA concentration is from Niskin 12. The slope of the line is 1.15.*

There was no 1-liter sample from Niskin 12, taken near the target density surface, because a duplicate was taken into a 2-liter bottle, and not enough water remained for a 1-liter sample. This 2-liter duplicate was run on the WHOI system in lieu of a 1-liter sample. For this sample the UEA analysis was only 9% greater than the WHOI analysis (the next to the last point in Fig. 2), suggesting that some of the difference between the two analyses was due to a difference in the bottles. Perhaps there was less effect due to gas exchange for the 2-liter bottles. The 1-liter bottles have urethane stoppers which might be suspected of taking up tracer, but tests in 2010 indicated that less than 1% of the tracer was lost this way.

Another notable sample is that from Niskin 19. The WHOI concentration is higher than the UEA concentration in this case, and both concentrations are high compared with the surrounding concentrations, leading to a spur near the top of the profile (Fig. 1). One might suspect that the Niskin tripped in the wrong place. We can try to assess this by looking at the CFC-12 concentrations from the UEA system. These do not look terribly anomalous at Niskin 19, when plotted versus Niskin number (Fig. 3). However, if we plot CFC-12 versus tracer, we find that Niskin 19 has both the same CFC-12 and tracer concentration as Niskin 17, suggesting that Niskin 19 tripped with 17 (Fig. 4). We cannot consider this definitive because noise in the CFC-12 seems great enough that this could be an accident of CFC-12 noise. Note that the CFC-12/Tracer plot (Fig. 4) suggests that Niskins 7, 9, 11, 13, and 18 (or 17) all tripped out of order. But the tracer profile in Fig. 1 does not indicate that these tripped out of order.

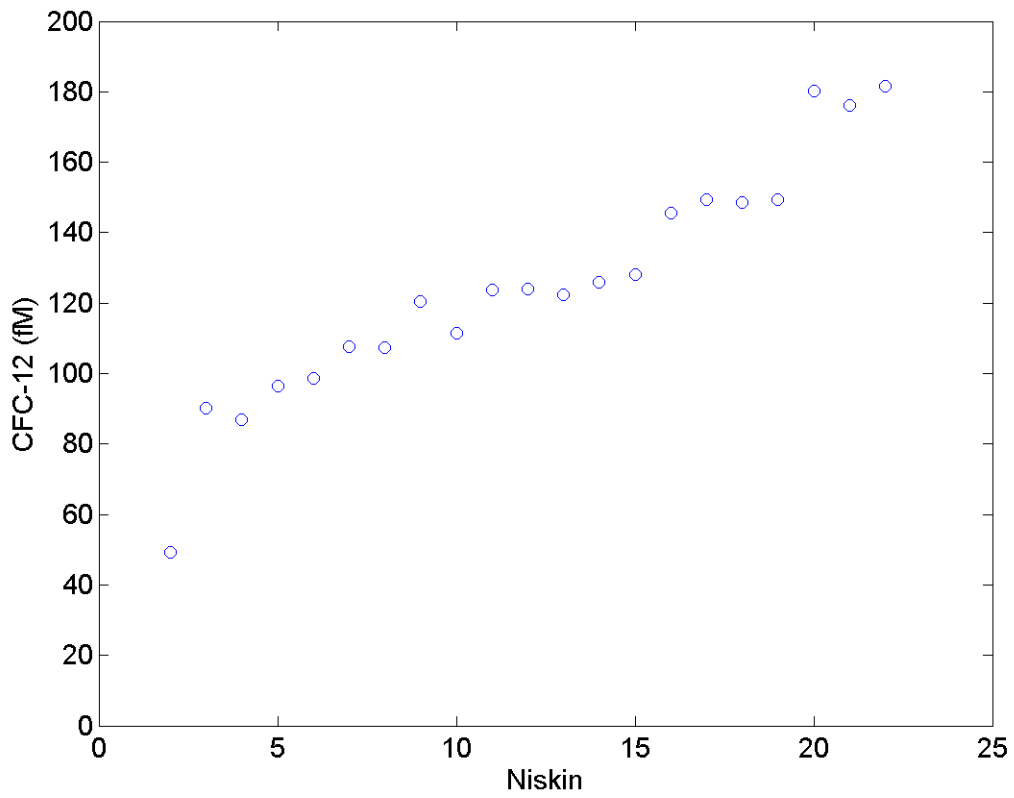


Fig. x.x.3. CFC-12 concentration versus Niskin number, Cast 026. Within the noise, these points look in order.

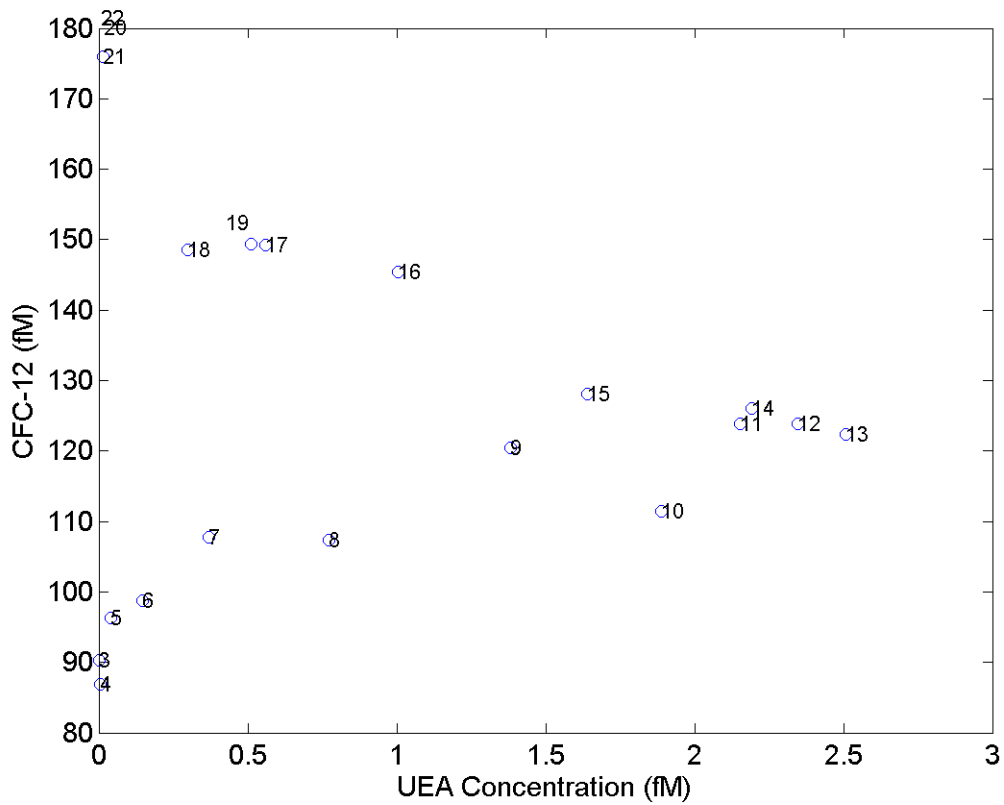


Fig. x.x.4. CFC-12 versus UEA tracer concentration, Cast 026. The numbers of the Niskin bottles are indicated. Niskin 19 is at nearly the same place as Niskin 17 on this plot, with elevated tracer concentration compared with Niskins 18 and 20.

Table x.x.1. Comparison of UEA Concentrations with WHOI concentrations, Cast 026.

Niskin #	Depth (m)	UEA Conc. (aM)	WHOI Conc. (aM)	Ratio UEA/WHOI
1	4996			
2	3055	0		
3	1573	0		
4	1542	3	36	
5	1512	41	20	
6	1481	146	108	1.35
7	1460	370	287	1.29
8	1440	772	623	1.24
9	1420	1381	1131	1.22
10	1400	1890	1573	1.20
11	1378	2153	1889	1.14
12*	1358	2348*	2151*	1.09*
13	1338	2508	2127	1.18
14	1318	2193	1937	1.13
15	1298	1640	1413	1.16
16	1278	1004	849	1.18
17	1258	558	458	1.22
18	1237	299	248	1.20
19	1207	512	629	0.81
20	1176	17	2	
21	1145	15	-4	
22	1146	9	-8	
23	811		-5	
24	7		-13	

\*There was no water left for the 1-L sample, because two 2-liter samples were taken from this Niskin. Hence we ran the second 2-liter sample on the WHOI analysis system to complete the profile.

### Cast 035.

The WHOI tracer analysis system was used for Cast 35 due to a backlog of samples for the UEA system. Samples were taken from the Niskins in the WHOI 1-liter bottles with urethane stoppers. Six duplicates were taken into 2-liter UEA bottles as a check and three of these were run. The vertical profile for the WHOI samples is shown in Fig. x.x.5, along with the 3 UEA duplicates. Again the UEA concentrations are higher than the WHOI concentrations, this time by a factor of 1.13, the slope of the line in Fig. x.x.6. That this factor is lower than the 1.15 for Cast 026 could be due to the drawing of the 1-liter samples before the 2-liter, rather than visa versa. Note that the WHOI sample from Niskin 6 was deemed to have a concentration of 0.062 fM, while the sample UEA sample was deemed to have no tracer. This is a bit puzzling, since the UEA system has a sensitivity of approximately 0.005 fM.

We can only speculate on why there is this difference between the concentrations. Some aspects of the WHOI sampling and analysis procedure that could be checked are:

1. Drift of the standard
  2. A larger effect of the stoppers than found in 2010
  3. Larger losses to the air while sampling than estimated
  4. Less sparge efficiency than measured in 2010
  5. Loss of some of the sample due to too early backflush of the Molecular Sieve precolumn.
- The backflush time was set conservatively based on standard runs, but the time dependence of a standard eluting from the cold trap can be different from that of a sample because the standard goes onto the trap all at once while the sample goes on with a long tail as the sparge tower is flushed with nitrogen. This effect needs to be checked carefully.

In any case, it is recommended that the WHOI concentrations for Cast 035 be multiplied by a factor of 1.13 before being incorporated with the UEA data.

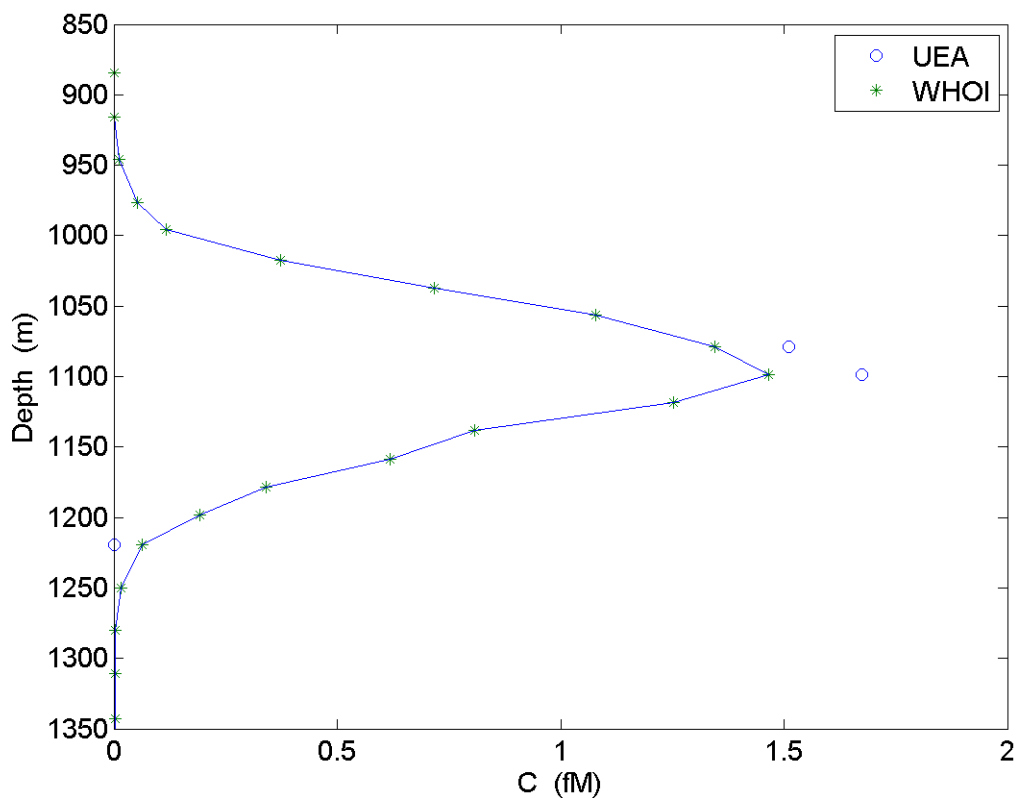


Fig. x.x.5. Vertical tracer profile for Cast 035 from WHOI 1-liter samples and analysis (\*) and three duplicates from UEA 2-liter samples and analysis (o).

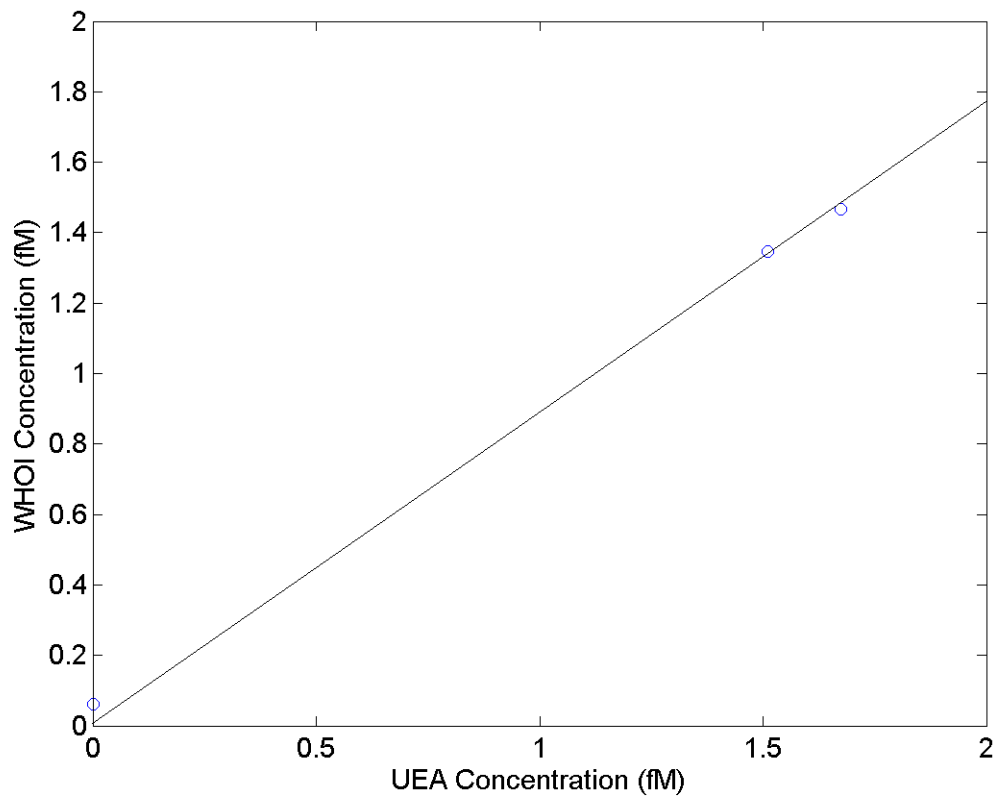


Fig. x.x.6. WHOI Concentration versus UEA Concentration for the tracer, Cast 035. The slope of the line is 1.15.

Table x.x.2. Comparison of UEA Concentrations with WHOI concentrations, Cast 035.

Niskin #	Depth (m)	UEA Conc. (aM)	WHOI Conc. (aM)	Ratio UEA/WHOI
6	1220	0	62	
12	1099	1675	1466	1.14
13	1079	1512	1345	1.12

## 4.1. CTD Operations and Calibration Procedures

*JB Sallée*

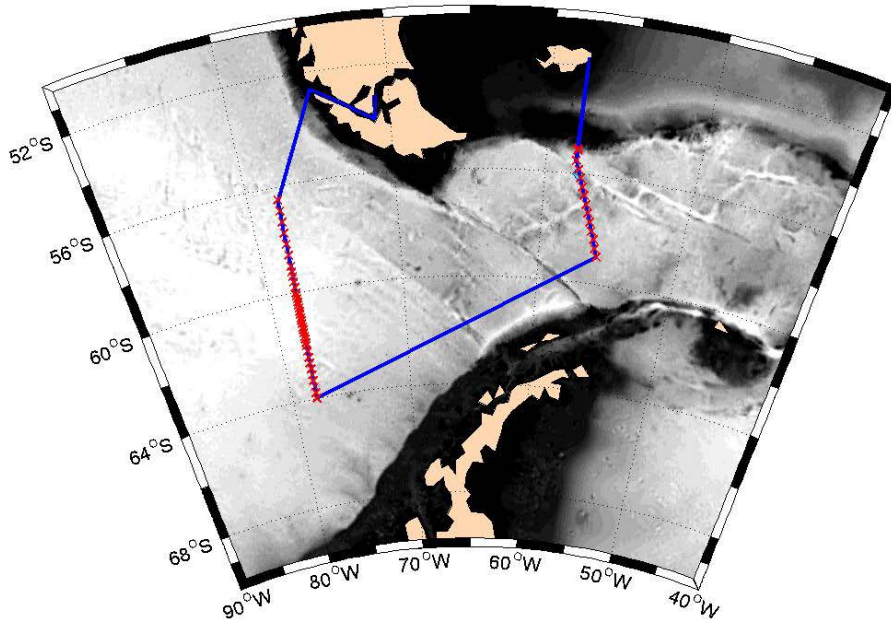


Figure 4.1.2: Cruise track (blue), CTD stations (red cross) and mooring sites (black circle).

### 4.1.1 Introduction and aim

Fifty-five Conductivity-Temperature-Depth (CTD), 24-bottle rosette stations were occupied during cruise JR276 (Table 4.1.1). This 55-cast survey had three main goals for the DIMES program:

- Give the hydrologic context in terms of water mass, front localization and transport, for analysis of the other components of the program: e.g. microstructure measurements; tracer sampling; RAFOS and APEX floats.
- Provide hydrologic sections at chock points of the DIMES program: through the assumed tracer's centre of mass, west of Drake Passage; at Drake Passage; and in the Scotia sea, east of very rough bathymetry features. These sections will eventually feed an inverse model analysis to infer isopycnal and diapycnal mixing in between those sections.
- Measure the isopycnal and diapycnal dispersion of the DIMES tracer, released two years ago west of Drake Passage.

<b>CTD #</b>	<b>time</b>	<b>longitude</b>	<b>latitude</b>	<b>max. pressure</b>
1	11-Apr-2011 15:44:01	-78	-56.5	4565
3	12-Apr-2011 02:07:13	-78	-56.92	2545
4	12-Apr-2011 07:24:30	-78	-57.33	2545
5	12-Apr-2011 12:20:37	-78	-57.75	4549
6	12-Apr-2011 19:16:01	-78	-58.17	2545
7	13-Apr-2011 00:24:05	-78	-58.58	2543
8	13-Apr-2011 06:16:33	-78	-59	5059
9	13-Apr-2011 13:40:33	-78	-59.2	2547
10	13-Apr-2011 17:22:13	-78	-59.4	2547
11	13-Apr-2011 21:09:57	-78	-59.6	2547
12	14-Apr-2011 04:20:58	-78	-59.8	2545
13	14-Apr-2011 08:16:02	-78	-60	2547
14	14-Apr-2011 11:31:48	-78	-60.12	2547
15	14-Apr-2011 15:15:36	-78	-60.24	5015
17	15-Apr-2011 01:44:52	-78	-60.35	2037
18	15-Apr-2011 04:36:48	-78	-60.47	2033
19	15-Apr-2011 07:31:28	-78	-60.59	2037
20	15-Apr-2011 10:27:31	-78	-60.71	2037
21	15-Apr-2011 13:15:21	-78	-60.82	2035
22	15-Apr-2011 16:01:00	-78	-60.94	2035
23	15-Apr-2011 18:48:35	-78	-61.06	2033
24	15-Apr-2011 21:36:18	-78	-61.18	2033
25	16-Apr-2011 00:21:42	-78	-61.29	2035
26	16-Apr-2011 03:40:56	-78	-61.41	4999
27	16-Apr-2011 10:28:57	-78	-61.53	2039
28	16-Apr-2011 13:20:40	-78	-61.65	2033
29	16-Apr-2011 16:06:09	-78	-61.76	2035
30	16-Apr-2011 18:59:59	-78	-61.88	2035
31	16-Apr-2011 21:30:25	-78	-62	2035
32	17-Apr-2011 01:27:51	-78	-62.22	4927
33	17-Apr-2011 08:03:16	-78	-62.44	2037
34	17-Apr-2011 11:21:32	-78	-62.67	2037
35	17-Apr-2011 14:45:03	-78	-62.89	2037
36	17-Apr-2011 18:32:06	-78	-63.11	4749
37	18-Apr-2011 01:05:42	-78	-63.33	2039
38	18-Apr-2011 04:13:37	-78	-63.56	2035
39	18-Apr-2011 07:21:27	-78	-63.78	2037
40	18-Apr-2011 11:15:12	-78	-64	4337
41	21-Apr-2011 09:53:08	-55.86	-59	3831
42	21-Apr-2011 16:07:59	-56.06	-58.68	3805
43	21-Apr-2011 22:14:12	-56.23	-58.36	3951
44	22-Apr-2011 05:34:10	-56.45	-58.05	4005
45	22-Apr-2011 11:31:28	-56.64	-57.73	3515
46	22-Apr-2011 17:31:50	-56.84	-57.42	3509
47	23-Apr-2011 12:24:27	-57.03	-57.09	4223

48	23-Apr-2011 19:18:51	-57.23	-56.78	3227
49	24-Apr-2011 03:12:07	-57.42	-56.47	3951
50	24-Apr-2011 07:00:17	-57.42	-56.47	2193
51	24-Apr-2011 11:29:24	-57.6	-56.15	3563
52	24-Apr-2011 17:00:06	-57.81	-55.84	4845
53	25-Apr-2011 00:43:19	-58.01	-55.52	4299
54	25-Apr-2011 06:09:18	-58	-55.14	2985
55	25-Apr-2011 14:29:46	-57.97	-55.07	2193

Table 4.1.1: List of CTD stations during JR276

#### 4.1.2 General comments significant events

Table 2 refers to significant events that occurred during a CTD station, prior to and / or after the station. There have been several problems with the termination of the CTD during the cruise. Some of these problems were due to shortage within the electric cable between the CTD and the ship. Two occurrences of shortage within the cable at CTD 2 and 16 lead to abortion of the cast. Twice 50 m of cable were chopped to solved the problem. It is not known whether the problem was due to a manufacturer issue or a problem caused by the winch. No other shortages have occurred after cast 16. However, some electric problem caused large spiked in the data (all sensors) from station 43 until the end of the cruise. We chose to not loose time trying investigating the problem. We cleaned the profiles in post-processing. The termination was checked at CTD047 but this not stopped the problem. It is highly recommended that the problem be investigated before next CTD cruise.

##### Comments on CTD bottle firing

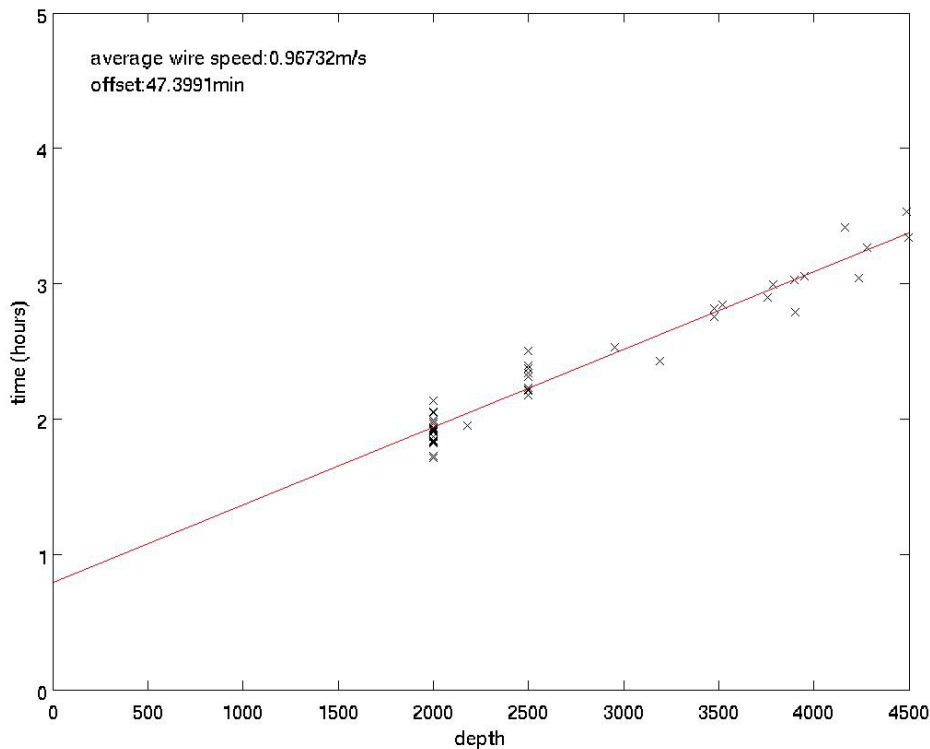
One of the main goal of the water sampling during JC054 was to measure the concentration of the DIMES tracer in the vicinity of the isopycnal were it had been injected two years before:  $\gamma_n=27.9$  (around  $\sigma_0=27.68$ ). Therefore, on each cast the depth of the isopycnal  $\sigma_0=27.68 \text{ kg.m}^{-3}$  was noted during the CTD downcast. Twenty-one bottles were fired at depths centered on the depth of  $\sigma_0=27.68 \text{ kg.m}^{-3}$ , with either 20, 25 of 30 m, 40 m or 60 m in between each bottle, depending on station. Two bottles were allocated to the bottom of the profile, and one to the upper part of the profile.

##### Comments on CTD deployment duration

In stations were we deployed a VMP, the CTD deployment duration had to approximately match the VMP cast duration within 1h30 hours. This was usually not a constraint, the VMP taking always only slightly longer than the CTD. However, CTD049 had to be aborted due to early weight release of the VMP, causing its surfacing much earlier than expected.

CTD deployment duration was about 0.9 m/s with an offset of 47 minutes for various things luding bottle firing.





**Figure 4.1.2: CTD time versus depth during JR276**

**Bottle leaking and firing problems**

We had some problem of bottle leaking or not fired when the CTD were coming back on deck. The tensions of the lanyard have been slightly adjusted on some bottles by making knots. This changes greatly improved the bottle closure.

One bottle (niskin 14) mysteriously disappeared during CTD052. A new bottle has been placed in position 1 (12 liters bottle) and niskin 1 were moved to position 14 (niskin 14 is next to the tracer depth, so we preferred using a robust niskin at position 14).

**Sensor Failures and Post-cruise Calibrations**

There were no CTD sensor failures during the cruise.

**Altimetry**

The Benthos altimeter worked very reliably, obtaining a good bottom return within 80-30 m of the bottom. In calm seas the CTD was worked to around 15 m from the bottom. This was increased to approximately 20 m from the bottom in swell.

<b>Station</b>	<b>comments</b>
CTD002	aborted at 1000 m – termination problem
CTD016	aborted at 1700 m – termination problem. Chop 50 m of cable
CTD043	Oxygen sensor gives bad values from CTD043
CTD047	Spikes on T/S profiles – termination checked Very large spikes in T/S/P
CTD049	CTD aborted to catch VMP.
CTD050	Wire out offset variable throughout cast
CTD052	Bottle 14 gone missing
From CTD053	Bottle 1 moved to position 14, new bottle at position 1

**Station                      Bottle Problems**

CTD001	Bottle 1,2,3 did not fire; Bottle 9, 10 leaked
CTD003	Bottle 10,16,18,23 did not fire
CTD004	Bottle 13 leaked (3 to 4 liters left)
CTD006	Bottle 21 did not close
CTD014	Bottle 21 leaking before opened
CTD015	Bottle 21 did not close
CTD018	Bottle 12 leaking
CTD019	Bottle 22 opened
CTD020	Bottle 21 leaking
CTD022	Bottle 22 leaking
CTD023	Bottle 22 leaking
CTD027	Bottle 18 leaking
CTD028	Bottle 22 leaking
CTD055	Bottle 5 leaking

**Table 4.1.2: significant events and bottle problems during JR276**

### 4.1.3 Instruments and system specification

See NMF's report for a detailed list of instruments on the rosette.

#### Configuration

```

* Sea-Bird SBE 9 Data File:
* FileName = D:\data\jr276\jr276_01.dat
* Software Version Seasave Win32 V 5.39c
* Temperature SN = 4302
* Conductivity SN = 2248
* Number of Bytes Per Scan = 30
* Number of Voltage Words = 4
* Number of Scans Averaged by the Deck Unit = 1
# nquan = 16
# nvalues = 288909
# units = specified
# name 0 = altM: Altimeter [m]
# name 1 = c0mS/cm: Conductivity [mS/cm]
# name 2 = c1mS/cm: Conductivity, 2 [mS/cm]
# name 3 = sbeox0Mm/Kg: Oxygen, SBE 43 [umol/Kg]
# name 4 = par: PAR/Irradiance, Biospherical/Licor
# name 5 = scan: Scan Count
# name 6 = t090C: Temperature [ITS-90, deg C]
# name 7 = t190C: Temperature, 2 [ITS-90, deg C]
# name 8 = prDM: Pressure, Digiquartz [db]
# name 9 = timeS: Time, Elapsed [seconds]
# name 10 = flC: Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
# name 11 = pumps: Pump Status
# name 12 = nbf: Bottles Fired
# name 13 = ptempC: Pressure Temperature [deg C]
# name 14 = xmiss: Beam Transmission, Chelsea/Seatech/Wetlab CStar [%]
# name 15 = flag: 0.000e+00
# span 0 = 0.00, 100.00
# span 1 = 0.071392, 33.964425
# span 2 = 0.024394, 33.830054
# span 3 = 153.558, 418.094
# span 4 = 1.0000e-12, 1.0086e+03
# span 5 = 1, 288909
# span 6 = 0.7546, 8.7053
# span 7 = 0.7563, 8.6324

```

```

# span 8 = -0.613, 4564.438
# span 9 = 0.000, 12037.833
# span 10 = -0.0062, 847.7152
# span 11 = 0, 1
# span 12 = 0, 24
# span 13 = 3.77, 16.76
# span 14 = 2.0523, 101.1159
# span 15 = 0.0000e+00, 0.0000e+00
# interval = seconds: 0.0416667
# start_time = Apr 11 2011 15:44:01
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0 temperature, primary, 4302, 2010-07-16
# sensor 1 = Frequency 1 conductivity, primary, 2248, 25-Jun-10 , cpcor = -9.5700e-08
# sensor 2 = Frequency 2 pressure, 0707-89973, 2007-06-13
# sensor 3 = Frequency 3 temperature, secondary, 4235, 25-Jun-10
# sensor 4 = Frequency 4 conductivity, secondary, 2813, 20-Jul-10 , cpcor = -9.5700e-08
# sensor 5 = Extrnl Volt 0 irradiance (PAR), primary, 7274, 12/1/2009
# sensor 6 = Extrnl Volt 2 Oxygen, SBE, primary, 0676, 09-07-2010
# sensor 7 = Extrnl Volt 3 altimeter
# sensor 8 = Extrnl Volt 4 fluorometer, chelsea, 088-216, 2009-08-27
# sensor 9 = Extrnl Volt 6 transmissometer, primary, CST-396DR, 23/08/2007
# datchv_date = Apr 12 2011 23:33:40, 7.14e
# datchv_in = G:\ctd\jr276\jr276_01.dat G:\ctd\jr276\jr276_01.CON
# datchv_skipover = 0
# celltm_date = Apr 12 2011 23:36:53, 7.14e
# celltm_in = G:\ctd\jr276\jr276_01.cnv
# celltm_alpha = 0.0300, 0.0300
# celltm_tau = 7.0000, 7.0000
# celltm_temp_sensor_use_for_cond = primary, secondary
# alignctd_date = Apr 12 2011 23:43:24, 7.14e
# alignctd_in = G:\ctd\jr276\jr276_01ctm.cnv
# alignctd_adv = sbeox0Mm/Kg 5.000
# file_type = ascii

```

## 4.1.4 Data processing and calibration

### a. Initial Processing using SeaBird Programs

The files output by Seasave (version 7.18) have appendices: .HEX, .HDR, .BL, .CON. The .CON files for each cast contain the calibration coefficients for the instrument. The .HDR files contain the information in the header of each cast file. The .HEX files are the data files for each cast, and are in hex format. The .BL files contain information on bottle firings of the rosette.

Initial data processing was performed on a PC using the Seabird processing software SBE Data Processing, Version 7.18. We used the following options in the given order:

- Data Conversion
- Align CTD
- Cell Thermal Mass

Data Conversion turns the raw data into physical units. It takes the .CON and .HEX files and outputs a file called JC054nnn.cnv, where c08291 is a reference to the

cruise (JC054), and nnn is the station number. The surface soak was removed from the data at this point, and a surface pressure offset (obtained from the first \_30 readings) was applied to the .CON file, which was then saved as JC054nnnp.con.

Align CTD takes the .cnv file and applies temporal shifts to align the sensor readings.

Cell Thermal Mass takes the .cnv files output from Align CTD and makes corrections for the thermal mass of the cell, in an attempt to minimise salinity spiking in steep vertical gradients due to temperature/conductivity mismatch.

## **b. Second processing using MSTAR Programs**

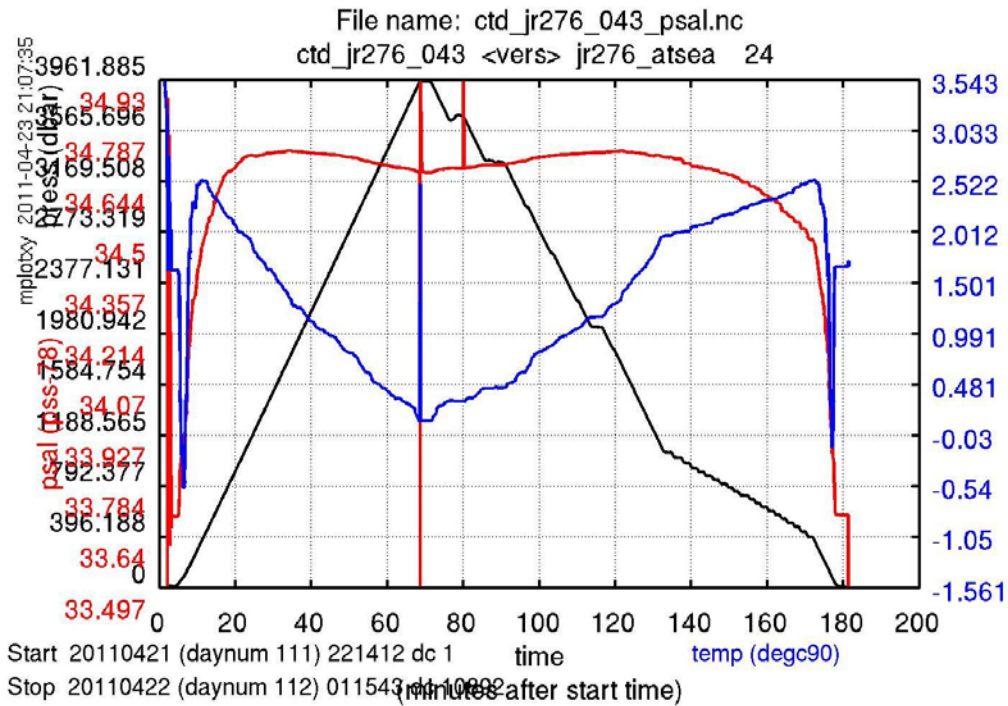
Once pre-processed with the seabird programs, the .cnv and .BL files were transferred from the “CTD computer” to the “NOSEA1 sun machine” where we applied a series of processing using MSTAR programs. Below is a list of ctd and bottle processing we applied to each cast:

1. Create an empty bottle netcdf file with all the list of variables needed (msam\_01.m)
2. Read CTD data from the .cnv file and write them into a netcdf “raw” file: ctd\_jc054\_nnn\_raw.nc (mctd\_01.m)
3. Rename variables from SBE original names to mstar variable names, and apply a hysteresis correction for oxygen (mctd2a.m and mctd2b.m)
4. Average to 1hz, calculate practical salinity and potential temperature, and create the new files: ctd\_jc054\_nnn\_1hz.nc and ctd\_jc054\_nnn\_psal.nc (mctd\_03.m)
5. Create an empty dcs file, which is used to store information about start, bottom and end of good data in the ctd file: dcs\_jc054\_nnn.nc (mdcs\_01.m)
6. Populate dcs file with data to identify bottom, start and end of the cast (mdcs\_02.m and mdcs\_03.m)
7. From GPS processed file (posmvpos), merge positions onto ctd start, bottom and end times. Create the file dcs\_jc054\_nnn.pos (mdcs\_04.nc)
8. Apply the positions to all other netcdf files created (mdcs\_05.nc)
9. Extract downcast data from the “\_psal.nc” file, sort, interpolate gaps and average to 2dbar (mctd\_04.m)
10. Read the .BL file from seabird and create a fir file: fir\_jc054\_nnn\_bl.nc (mfir\_01.m)
11. Merge time from ctd onto fir file using scan number (mfir\_02.m)
12. Merge ctd fir data onto “fir” file and paste ctd “fir” data into “sam” file (mfir\_03.m and mfir\_04.m)
13. Extract data from the techsas file for times from the start to the end of the 1hz ctd file +/- 10 minutes (mwin\_01.m)
14. Merge winch wireout onto “fir” file and paste them into “sam” file (mwin\_03.m and mwin\_04.m)
15. Once salinity from the bottles were analyzed, data were copied into a file: sal\_jc054\_nnn.nc (msal\_01.m)
16. Salinity were then paste into “sam” files (msal\_02.m)

17. Once tracer concentration were analyzed, data were copied into a file:  
cfc\_jc054\_nnn.nc (mcfc\_01.nc)
18. Tracer concentrations were then paste into “sam” files (mcfc\_02.m)
  
19. Create a file bot\_jc054\_nnn.nc with information about bottle position on  
rosette and bottle flag (WOCE flag: 2 if good – 9 if bad) (mbot\_01.m)
20. Bottle flags were then paste into “sam“ files (mbot\_02.m)
  
21. Finally, we calculated the residuals between bottle salinity and ctd salinity  
and paste them into “sam” file (msam\_02.m)

All profiles were visually checked using a suite of plots (theta-S; profiles versus depth; profiles versus scan number) to detect any possible anomaly. Profiles were also plotted on top of each for different stations, to detect possible sensor drift (mplot\_ctdck.m)

In a number of casts, localized small spikes have been detected on the salinity/conductivity profiles (see Figure 4.1.3). Those spike were removed (replaced by NaN) using the routine mplxyed.m.



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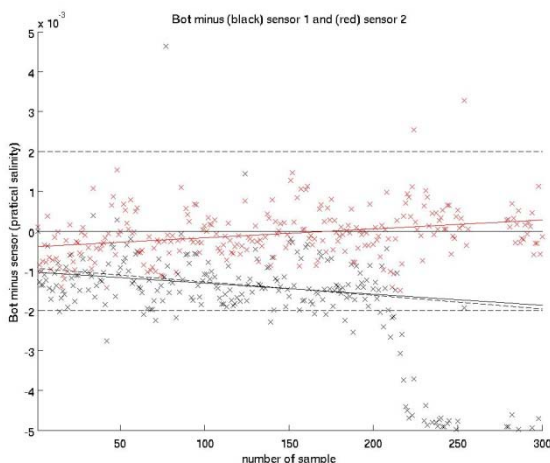
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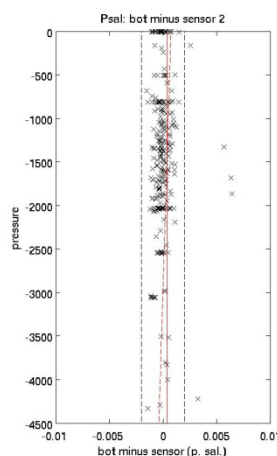
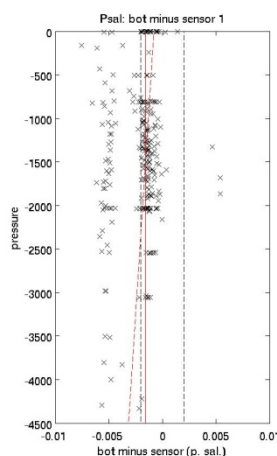
Figure 4.1.3: Temperature(blue), salinity (red) and pressure (black) versus time for cast CTD043. Example of spikes in salinity and temperature.

were sampling water in a narrow depth range, around the tracer depth. The salinity differences between bottle salinity and sensors 1 show a strong jump between station 38 and 41 (sample number 200-220). The reason for this sudden failure of sensor 1 is not known but should be investigated. In contrast, sensor 2 has behaved very well all along the 55 casts. The salinity differences between bottle salinity and sensor 2 fall within +/- 0.002 psu (See Figure 4.1.4). We looked for pressure dependence and/or time dependence, but no clear trend pattern emerged.

**We therefore chose to use data from sensor 2.**



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## Theta-S profiles

We used theta-S profiles as an additional test to detect possible drift of the sensor 2. Bottom water hydrologic characteristic are known to be very stable, so are a good test to detect drifts. All theta-S characteristics of bottom water sampled during the cruise were found to fall in the same narrow band. However, we found profiles from the latest part of the cruise to be slightly fresher than profiles at the start of the cruise (See Figure 4.1.5). The difference does not appear to be a constant shift in salinity, so appear to be a real change. The difference is also consistent with previous bottom water studies finding Atlantic bottom water slightly fresher than Pacific bottom water.

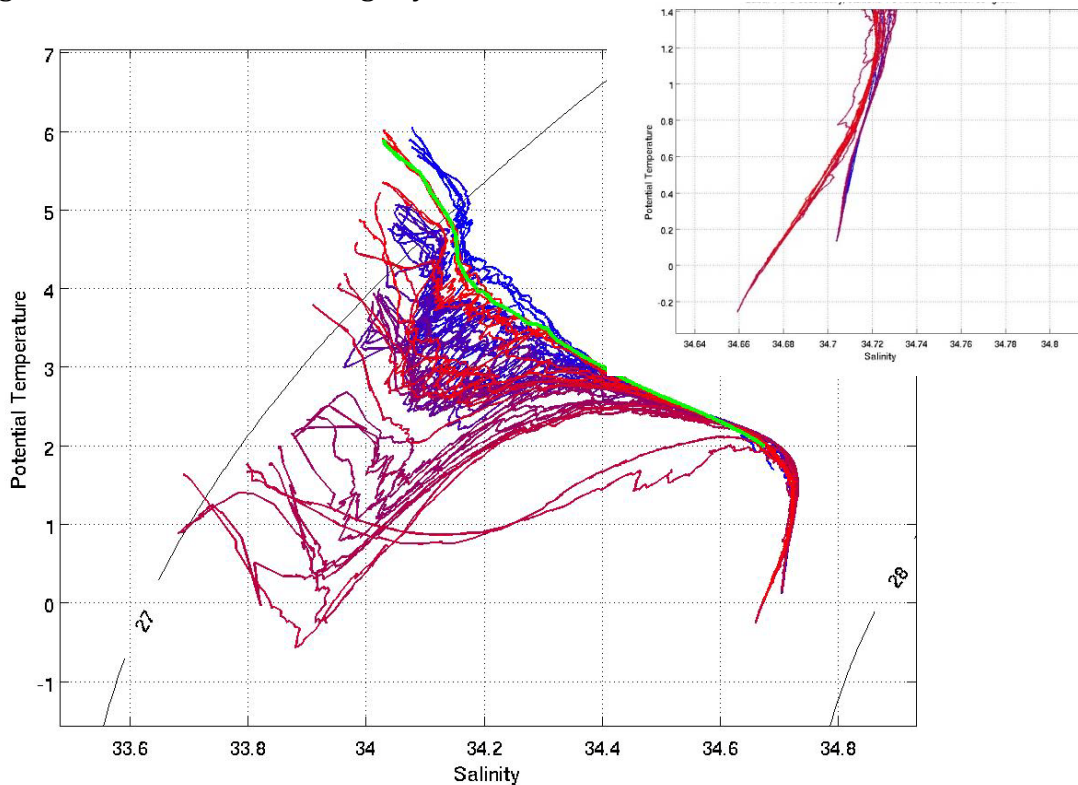


Figure 4.1.5: Theta-S profiles from the CTD sensor 2 of the cruise JR26. Color shows time, blue being early profile and red last profiles.

## Calibration

Based on the above analysis we decided to use data from sensor 2 without any calibration. If any calibrations would have been applied, it would have been less than 0.001 psu, less than the targeted accuracy.

## 4.1.5 Recommendations

We had repeated issue with spikes in data from CTD043 to the end of the cruise (see Figure 4.1.3 and 4.1.4). In addition, there has been a sudden jump in the quality of sensor 1 of the CTD around station 38. The reason for the deterioration of the quality of

the sensor is not yet known. We therefore highly recommend a routine maintenance of the CTD and termination to investigate these problems.



### 4.7.1.Sections

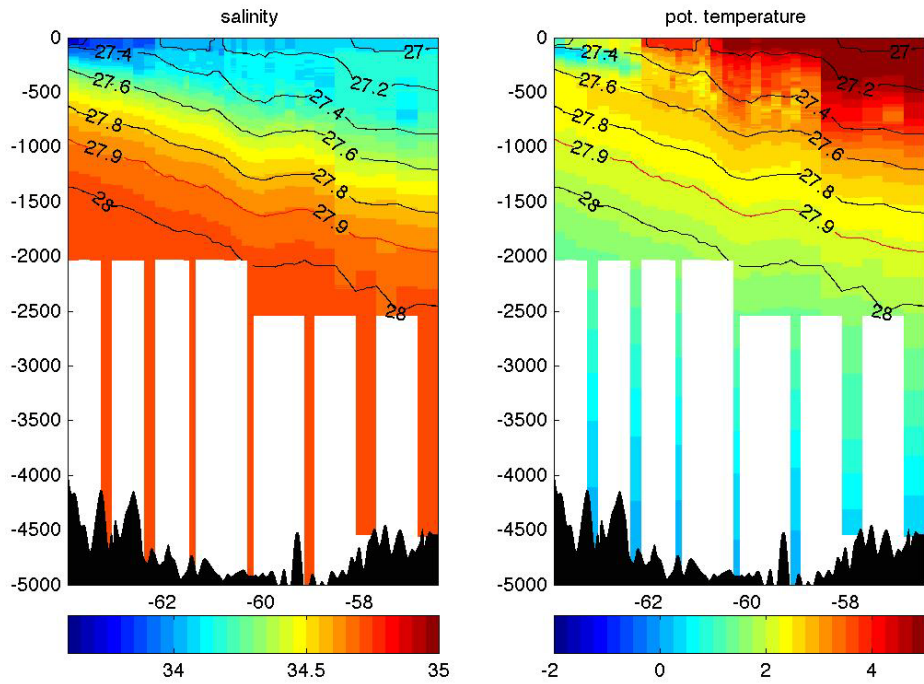


Figure 4.1.6: Temperature and salinity section at the S3 section

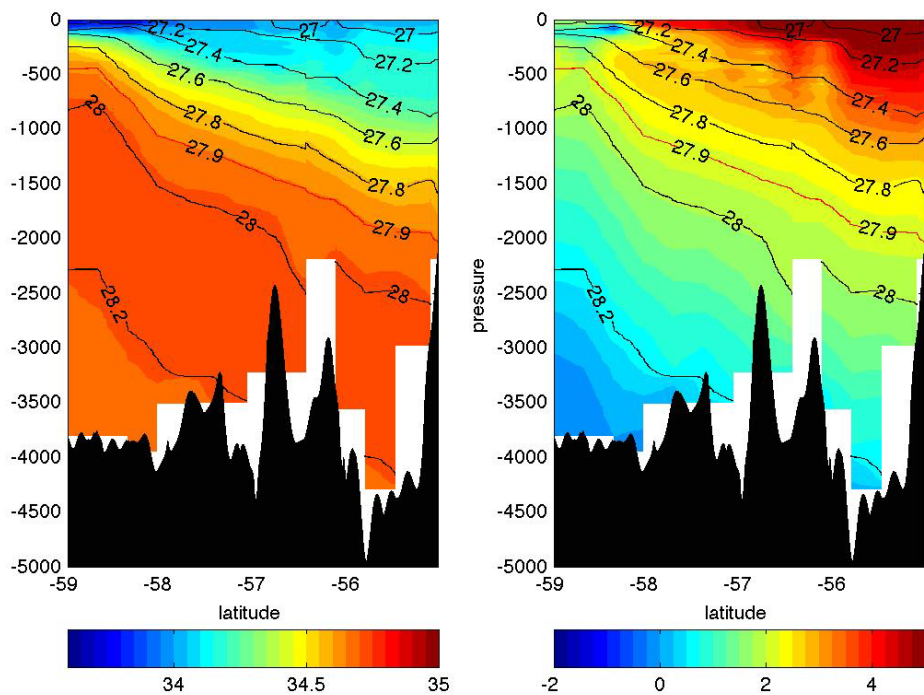


Figure 4.1.7: Temperature and salinity section at the Sr1 section.



## **4.2 Lowered Acoustic Doppler Current Profiler**

### **4.2.1 Introduction**

This section describes the operations of the Lowered Acoustic Doppler Current Profiler (LADCP) system used on JC54. The LADCP system consists of the CTD, two ADCPs (one up-looker and one down-looker), a battery and interconnection cables mounted on the main sampling rosette. LADCP profiles were collected at all CTD stations, except for station S3.9. Acquisition software and hardware was provided by Andreas Thunherr from LDEO and setup and onboard processing was by David Smeed (NOC).

### **4.2.2. LADCP System & Processing Method**

Two Teledyne/RDI Workhorse 300kHz ADCPs were mounted on the CTD rosette, one pointing downward (downlooker) and one upward (uplooker). A unique prototype high-power Workhorse ADCP (s/n 12736) from the LDEO stable was used as the downlooker throughout the entire cruise. The up-looker was one of two NOC standard Workhorse (s/n 1855 for casts 1 to 45 and s/n 12369 for casts 46 to 55). The LADCP was powered with a standard NOC battery/charger system.

Data acquisition was carried out using the LDEO "acquire" software, version 1.5.. The configuration of the instruments remained unchanged during the first section in particular 25 x 8m bins, were used.

The LDEO 'acquire' software was installed on a LDEO PowerPC Mac Mini running MacOSX 4.11. The computer was installed in the "chemistry lab" adjacent to the CTD hanger, a convenient location from which to connect the deck cables between the computer and the CTD frame. The computer was configured to synchronize with the onboard timeserver "jrla".

Communications between the acquisition computer and the ADCPs took place across two parallel RS-232 connections, via a KeySpan 4-port USB-to-serial adapter and a D-Link USB hub. Data backup was done automatically onto an external USB disk and, manually onto a laptop in the UCI.

Navigation and depth data was displayed on the Mac Mini using the JCR's web interface to SCS data providing data at one minute intervals. This data was used to fill the relevant entries on the LADCP logsheets.

Preliminary shipboard processing of the LADCP data was carried out with the LDEO IX\_6 LADCP-processing software.

### **4.2.3 Use of navigation, CTD and VMADCP data**

Navigation data is required to determine the absolute velocity from LADCP data, and CTD time series enables depth- and sound-speed correction. In addition VMADCP data can be used to verify the LADCP data or included as a constraint in the processing.

The computers logging the CTD and VMADCP were also synchronized with the JRLA timeserver. However, when processing the data there is an apparent 2 to 3 second time difference between the CTD and LADCP data streams. This is believed to be lag associated with the CTD computer and it is assumed that the LADCP time is correctly synchronized with the navigation data.

Navigation and CTD data were obtained from the mstar files on the Nosea1 processing computer. The CTD data was preliminary 1Hz data and navigation data was obtained from the Seatex system, except for cast 27 during which errors appeared in the Seatex Data. For cast 27 data from the Glonass datastream was used.

On station VMADCP data were extracted from the preliminary processed data on Nosea2. These data were averaged for all samples acquired during each CTD station and a file was created showing the mean currents standard deviation and number of samples in each depth bin. The number of good VMADCP samples decreased significantly as we progressed south along the section on 78°W.

#### **4.2.4 Data coverage and quality**

LADCP profiles were collected for all CTD casts, except as noted below. The raw LADCP profiles are numbered so as to correspond with the CTD cast numbers. In some cases it was necessary to renumber the casts after acquisition. Note that:

1. There were a couple of occasions where the acquisition software reported errors and had to be rerun but this did not result in any loss of data.
2. At station S2.2 two casts were made. The first (Cast 002) was aborted due to a problem with the CTD.
3. For casts 1 to 4 the configuration file incorrectly identified uplooker as downlooker and vice versa. Corrected in processing.
4. At station S3.9 (CTD cast 010) the LADCP was not started and so no data was obtained.
5. At station S2.15 two casts were made. The first (Cast 016) was aborted, however, the LADCP was not turned off between these two casts and so data from two casts is contained within one file (for each instrument).
6. Processing software indicated that beam 2 of the NOC uplooker s/n 1855 was weak with range typically 12% less than the other. This does not appear to have a significant impact on the data. On station 42 beam 4 became weak and on casts 43, 44 and 45 beam 4 was broken. The instrument was replaced on cast 46.
7. The tilt and rotation of the CTD package was generally stable. There were though some casts with significantly higher motion (35-38, 40, 47,48, 51,52). Rough weather at the time of casts 47 and 48 and strong mean flows that displaced the CTD package horizontally from the ship on some casts could explain most of the variability. It is possible that the vane on the CTD was not aligned correctly for some casts, however, there are no records to confirm this.
8. Comparison between the LADCP and VMADCP was generally good except when the amount of good VMADCP data was low (e.g. cast 33). On board processing of the LADCP data did not identify any major problems

## 4.2.5 Preliminary Results

In figure XXX the zonal transport is shown in the upper 2000m for the first section (S3) and for the full depth on the second section (S1).

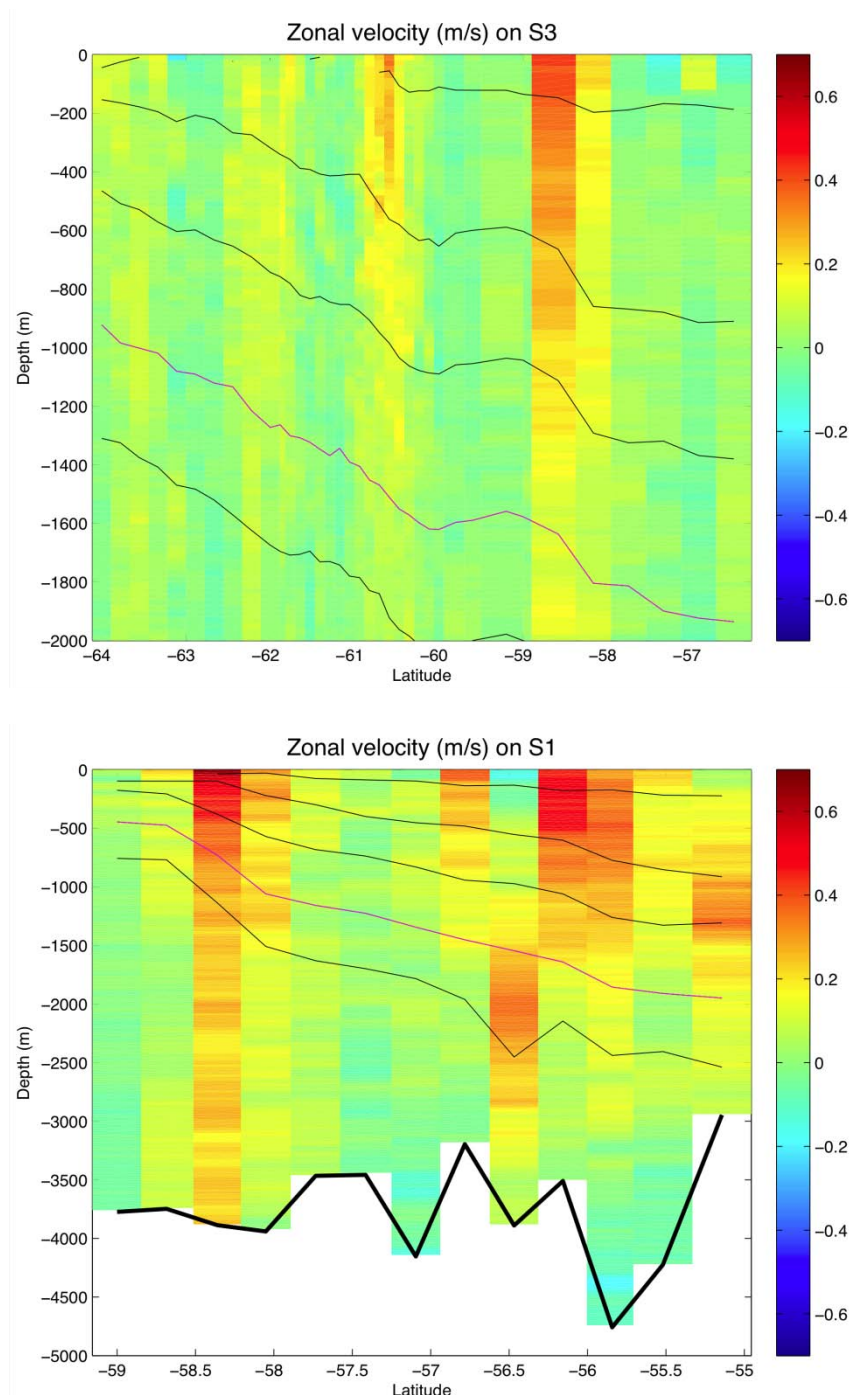


Figure XXX. Zonal velocity measured by LADCP. A) for section S1 upper 2000m only and B) for section S2 full depth. Thin black lines indicate potential density surfaces 27.00, 27.25, 27.50 and 27.75. The magenta line is the potential density 27.68. Thick black line in B indicates the bathymetry.

## 4.3 VMP-5500 Operations and Measurements

Alex Brearley, Katy Sheen, Chris Barnard, Peggy Courtois, Terry Edwards, Chris O'Donnell, David Smeed and Paul Woodroffe.

### 4.3.1 Cruise narrative

The Vertical Microstructure Profiler (VMP-5500, VMP for short thereafter) is a novel scientific instrument manufactured by Rockland Scientific International that measures profiles of temperature, conductivity and velocity microstructure (i.e. on the length scales of the dissipation of turbulent flows, typically a few millimetres to tens of centimetres) throughout the water column. The NOCS VMP was used during the JR276 / UK DIMES 2.5 recovery cruise. This represented the third installment of the DIMES microstructure programme (the first set of measurements having been conducted in the US DIMES 2 and UK DIMES 2 cruises in January – March 2010 and December – January 2010/11, respectively), the central goal of which is to obtain measurements of turbulent kinetic energy dissipation and mixing across a range of topographic and flow regimes in the Southeast Pacific and Southwest Atlantic sectors of the Antarctic Circumpolar Current.

We joined the ship in Punta Arenas, Chile, on 7 April 2011. The VMP was assembled during the steam to the first measurement site and a successful on deck weight release test performed. Over-the-side operations commenced on 12 April 2011 at 1500UTC, with a check for gross buoyancy (the instrument floated without weights). On 1825UTC on 12 April 2011, an untethered 200 m test cast was conducted to assess the performance of the weight release mechanism and the various sensors on the instruments. The tests were successful.

The general mode of microstructure operations consisted of a VMP deployment every four to eight CTD stations along section S3 and at alternate CTD stations on section SR1, to prevent excessive battery discharge. Full-depth CTDs were conducted at VMP stations, which meant that time was not wasted whilst waiting for the instrument to surface and accompanying full-depth LADCP data were available. If possible, it is useful to plan to recover the VMP during darkness, as this can save up from 30 mins to several hours in locating the VMP once it has surfaced, due to the ease of spotting the beacon at night. Altogether, 13 full or near full-depth VMP deployments were accomplished (11 were in the original schedule). Weather conditions and sea state were slightly better than expected for this location and season, only once becoming severe enough to prevent VMP operations (planned VMP casts at SR1.5 and SR1.7 were moved to SR1.6 and SR1.8 in response). One deployment was conducted with winds slightly in excess of the recommended limit of 30 knots. No VMP stations were missed because of technical problems with the instrument and no significant technical issues were encountered. However, there were some issues with the weights being released slightly early on VMP deployments 12 and 13. Furthermore, a bottom collision occurred on the final cast (VMP 14), most likely because only one weight was successfully released initially, with the other being caught in the lanyard. The VMP only started ascending when the magnesium burn wire dissolved. Generally, the new weight release mechanism and logic of the NOCS VMP led to a clear improvement in performance with respect to the JC029 / SOFINE cruise,

where battery and weight release problems led to multiple bottom crashes. The EM current meter, magnetometer and battery voltage trace were not present on the NOC VMP, as they were undergoing service and repair after flooding on JC054. Thus, the battery did not discharge as fully during casts as during JC054 and typically only took 4-5 hours to recharge. Communications with the instrument also seemed far more reliable and speedy than during JC054 (no terminal window hanging was observed).

### **4.3.2 Technical remarks on the NOCS VMP-5500**

#### Configuration

The NOCS VMP-5500 s/n 016 was deployed with 2 microshear probes, 2 microtemperature probes, one microconductivity probe, one Seabird 3F fast temperature sensor (s/n 4634) and one Seabird 4C conductivity sensor (s/n 3240). Internally there was also a 3-axis accelerometer. The Rockland Geo-ElectroMagnetic Current Meter and 3-axis magnetometer electronics board were not installed as they were under service and repair.

#### NOCS VMP

Base Instrument: VMP-5500 SN 016

#### Microstructure Probes

- 2 shear probes
- 2 microtemperature fp07 thermistors
- 1 microconductivity

#### Finestructure

- Seabird 3c conductivity cell
- Seabird 4f temperature cell

#### Flight data streams

- IC sensors 3-axis accelerometer
- Pressure sensor

#### Laptop Ethernet Settings

Configure IPv4: Using DHCP with manual address

IP Address: 192.168.2.x where x is any number between 3 and 254

Subnet Mask (if needed): 255.255.0.0

Make sure that the Ethernet is connected before you turn on the VMP (otherwise it goes into dive mode). Once you have issued the 'shutdown now' command you cannot communicate with the instrument again unless it is power cycled (this takes 2 minutes).

### **4.3.3 Deployment and Recovery**

#### General Comments

Thanks to the efforts of the NMF Technicians and the JCR Deck Crew, deployment and recovery of the VMP went smoothly, even during poor weather conditions. All deployments were made using the ship's rear aft Effer crane, with the instrument hoisted by a sling around the tail bale. It was released in the water using a 'sea catch'. The VMP was recovered using hooked poles fitted with releasing recovery lines and craned aboard by its bale using the starboard midships winch and gantry. Apart from the reduced vessel motion at midships, this

location also kept the profiler away from thruster wash and prevented it going out of sight under the stern flare. The NOCS VMP was stored in the ship's wet lab on an aluminium frame trolley, donated by WHOI, that supports a half section of plastic drain pipe fitted with foam. Deployments and recoveries were made from this cart. Further technical details of deployment and recovery are given on the attached BAS Guidance Notes (Section 4.3.13).

### On-Deck Handling

The method of deployment and recovery requires someone to steady the nose whilst the profiler is being picked up and set down on the trolley. This increases the risk of damaging the nose-mounted sensors, although no damage to sensors occurred during deployments. Picking up the profiler by the nose also puts significant bending load on the main joint between the nose and tail assembly. The consequences of this joint failing would be serious injury to personnel or loss of the nose section of the profiler. The trolley allowed the VMP to be easily moved into the CTD annex between casts. Deployment and recovery of the VMP seemed to be easier than during JC054, but this may simply be due the better weather and sea state. The cart system has proven to be a stable and reliable platform which allows pivoting on a foam block for the initial tilt from horizontal during launch and allows for the nose guard forks to be planted on plastic for recovery. The cart with instrument can be handled easily on deck by a single person, but two are usually needed to counteract ship motion safely.

### Determining the Instrument's Release Pressure

Successful VMP operation requires determining an accurate depth at which to release the weights. During JR276, we used the EM120 swath bathymetry once the ship was on station. This was kept regularly updated by Johnnie Edmonston with sound velocity profiles from recent CTD casts. The only difficulty encountered with the swath was that sometimes the VMP was projected to drift in a direction not covered by the swath beam. As the SR1 line is annually repeated by a team from NOCS, some existing bathymetry data were available, which was a useful complementary source of information. However, we recommend that a thorough search is done for all available multibeam data prior to UK DIMES 3 in the Scotia Sea during 2012.

### Acoustic Telemetry

Whilst submerged, the profiler was tracked using an LBL telemetry system consisting of: Ixsea TT801 deck unit s/n 175 (with firmware modification for pressure telemetry) Ixsea Model MT861S-R-P1 LBL Acoustic Transponder with Pressure Sensor S/N 314

This allowed the slant range to the beacon and also the pressure to be determined. A user interface developed by Chris Barnard was used to calculate the approximate horizontal range from the ship (more details in Section 5.1). The VMP was deployed and once it had accelerated to its profiling velocity and was clear of the vessel, the CTD was deployed. The 75 kHz VMADCP was used to estimate the VMP drift direction and magnitude. The bridge were given the horizontal range to the VMP every 30 min while the CTD was in the water and tried to keep within close range of the VMP. When the VMP was near the bottom it was 'pinged' more frequently to try and catch the turnaround. Once the CTD was on deck, the bridge was given more frequent updates (~10 mins). If the VMP had drifted to a range greater than ~700 m, the ship was moved 200 m in the current direction and the VMP 'pinged' again



to check whether the ship had moved closer or further away, with the position adjusted again as necessary. Later in the cruise during foggy weather, a more formal triangulation method was used in an attempt to pinpoint the location, with some success.

On one occasion, a simple Matlab script, written by David Smeed, was used to combine the Ixsea range and depth data with the GPS position of the ship. This script works well when the CTD is inboard and the ship can be moved more rapidly than the VMP drift. It aims to improve the estimation of the direction of the VMP from the ship.

More points about ranging the VMP are found in the JC054 cruise report.

In general, the VMP was within 700 m on surfacing and could be easily spotted, especially at night with the strobe beacon. A closer range would probably be required in foggy conditions. While this system is useful, caution must be taken when trying to reduce range below 300 m, so as not to risk the instrument surfacing too close to the ship. At station SR1.9 (CTD cast 49, VMP cast 12), the Ixsea system alerted users of an early abort of the VMP cast (~800 dbar before the target pressure). Subsequent investigation of the VMP deployment .txt file did not reveal any reason for the failure, though we suspect limited battery charging time since the previous deployment may have triggered the release. A similar issue happened on VMP cast 13 (CTD cast 52, station 1.11), when the weight release triggered 150 dbar before the target pressure for an undocumented reason. Subsequent timeout releases did occur on this cast.

A more significant problem occurred on VMP cast 14 (CTD cast 54, station 1.13), when the VMP exceeded its specified maximum pressure and crashed into the bottom. The instrument remained stuck there until the magnesium clip dissolved. Fortunately, we had chosen to keep the existing burn wire for this final cast (as opposed to replacing it with a new one, as was the norm), meaning that the instrument was only at the bottom for 4.5 hours. Inspection of the deployment .txt file after recovery revealed that the instrument weight release did fire successfully on pressure, then continually fired on both pressure and timeout. The plot of vertical velocity revealed that the instrument slowed down rapidly from 0.55 to 0.1 m/s before hitting the bottom, suggesting that one weight was successfully jettisoned at the initial release but that the second weight got caught in the lanyard, arresting the descent. The second weight was only lost when the burn wire corroded. There was no apparent damage to the nose or sensors, with only slight residue apparent. As a precaution, we recommend not reusing these sensors (Table 4.3.2).

### Recovery Aids

A red or hi-vis yellow flag on a mast was used with the following recovery aids:  
Seimac Ltd Novatech Model ST-400A Strobe S/N U03-042  
Seimac Ltd Novatech Model RF-700A1 RDF Beacon S/N U03-040  
Seimac Ltd Novatech Model AS-900A  
Argos Beacon S/N V01-053 ID 74853

Argos positions were not required during JR276 to locate the instrument, but continue to form a useful backup of final resort should the instrument be lost.

The VMPs was also fitted with a Novatech RDF beacons. The on-board RDF system on the RRS James Clark Ross alerted watchers when the VMP had surfaced and its direction. This worked well, although its use was minimal.

The Novatech strobes are by far the most immediately useful aids to recovery. Given the later time of year of this cruise and increased hours of darkness compared to JC054, the window of effectiveness of the strobes were greatly increased. Time was saved by attempting, where possible, to plan for VMP surfacing to occur during the night. It may be advisable for future austral summer cruises to change strobe behavior to deactivate the optic sensor, which turns the Novatech strobes off in daylight.

### Main System Battery

VMP stations were generally positioned to allow for at least 4-5 hours to recharge the batteries. One exception was at VMP12 (SR1.9), when weather issues meant that two consecutive deployments were required, giving only 2-3 hours charging time. Despite initially appearing to be fully charged after this time (by voltmeter measurement), we suspect that the early weight release firing on this cast may have been attributable to lack of battery power. We thus recommend that the user always allows at least 4 hours of charging with the instrument turned off (i.e. before the further 30 minutes of weight release charging).

The NOCS VMP seemed to encounter fewer problems charging and retaining power than during JC054. It is likely that the continual firing of the weight release after the pressure target had been released does not seriously impact the battery performance, as speculated during comparison of the WHOI and NOCS VMPs during JC054. It is more likely that the flooding of the EM bulkhead connection during JC054 was responsible for the early problems. The lack of EM sensor also significantly reduced the power consumption. The NOCS VMP was able to get a full charge and perform several casts without battery issues.

There is a strong recommendation to add the ability to actively monitor the temperature of the internal battery and provide some means of a thermal cutoff to prevent overcharging. As part of this, it would be advisable to provide a more direct or controllable means of charging the weight release cell.

### **4.3.4 Modifications Required by Absence of EM Current Meter**

The EM current meter and magnetometer board were sent, along with the sensors, to Rockland at the end of JC054 for repair. To account for this, we needed to modify the matrix in the setup.txt that controls data acquisition during deployment. Without this modification, issuing the odas4ir command resulted in a 'special character' error and no on-deck pressure readings. Moreover, on typing odas4ir -f setup.txt -c all -s 1024, channel 255 had a checksum error, with 37253 displayed as opposed to the 'correct' 37252. Instead of deleting the channels, which would have affected the sampling rate, we instead elected to replicate (slow) channels 4, 6 and 11 in place of the magnetometer channels 32, 33 and 34 and also in place of the EM channels 35, 36 and 37. Finally, the three lines in the setup.txt file referring to magnetometer calibration coefficients were commented out. Adjustments had to be made to the processing flows to account for these 'triplicated' channels (see Section 4.3.9).

Furthermore, an additional 3 kg of weights were added at the base of the bail to compensate for the loss of the EM collar, shroud and cable.

### **4.3.5 NOCS VMP-5500 logsheet**

VMP – 5500 Dive LOG

Cruise: JR276	Station Number:	Year and Day of Year:
---------------	-----------------	-----------------------

Sensor Information

Fine. Var.	Channel	Used	Micro. Var.	Channel	Used	Probe
GND1	0		Ax	1		
T1	4		Ay	2		
T2	6		Az	3		
P	10		T1_dT1	5		
SBT1E	16		T2_dT2	7		
SBT1O	17		Sh1	8		
SBC1E	18		Sh2	9		
SBC1O	19		P_dP	11		
Mz	32		C_dC	12		
My	33					
Mx	34					
EMvel1	35					
EMvel2	36					
Vbat	37					

Sensor Notes:

Deployment Name:

Time instrument turned on:	Deployment position:
Acoustic depth (m):	Bottom press. $P_{bot}$ (db):
On-deck press. $P_{deck}$ (db):	Assumed overshoot $P_{over}$ (db):
Safety allowance $P_{safe}$ (db, $\geq 50$ db recommended):	Specified max. press. (db, must not exceed $P_{bot} + P_{deck} - P_{over} - P_{safe}$ ):
Estimated dive time (s, at a dive rate of $\sim 0.55 \text{ s}^{-1}$ ):	Specified max. time (s):
Available memory (/root/data):	Enough (at ca. 50Mb /1000 m)?:
Memory cleared?:	If not, most recent data file in memory:
Main battery voltage (V, should be $\geq 12.8$ V)	Dive start time i.e. LED flashing (GMT):
Ship position when VMP released:	Time when VMP released (GMT):
	Expected surface time (GMT):

Comments:

Recovery

Name:

Station Number:		DOY / time VMP spotted:	
Range / bearing at which VMP spotted:		Ship position when VMP spotted:	
Date / time VMP on deck:		Recovery position:	
Acoustic depth (m) / corrected bottom pressure:			
Post-dive main battery voltage (V):		Time charging started (GMT):	
Estimated charging end time (GMT):		Time charging ended (GMT):	
Voltage after charging:			
Name of data file:		Size of data file:	
Method of dive end:		Max. pressure of dive:	

Comments:

#### 4.3.6 Example VMP setup file (for VMP cast 3)

```

*****
/root/data/jr276_ acquisition started Thu Apr 14 14:44:47 2011 UTC
using setup file: 'setup.txt'

# ODAS setup file for internally recording instruments
# Modified 2010-09-17 by DC

#####

prefix: jr276_003_
disk: /root/data
rate: 512
recsize: 1
no-fast: 8
no-slow: 1
profile: vertical
man_com_rate: 3
max_time: 17970
max_pressure: 4977

#####

channel: 16,S8T2E,4,34834858e-3,6,38778322e-4,2,09151115e-5,1,71827763e-6,1000,0,2
channel: 17,S8T2D,4,34834858e-3,6,38778322e-4,2,09151115e-5,1,71827763e-6,1000,0,2
# SN 4634, 2006-08-22

channel: 18,S8C2E,-1,03168270e1,0,1,424138250e,6,44015395e-4,1,20437887e-4,246e,1
channel: 19,S8C2D,-1,03168270e1,0,1,424138250e,6,44015395e-4,1,20437887e-4,246e,1
# SN3240, 2006-08-23

channel: 10,Pves,-11,1,0,29503,-2,19e-7,0,0,0,0,0
channel: 1,Ptch,1955,17154,0,0,0,0,0,0,0
channel: 3,az,343,12855,0,0,0,0,0,0,0
channel: 2,Roll,-338,13000,0,0,0,0,0,0,0
#channel: 0,GND1

#channel: 32,Mz,64,68,88,0,0,0,0,0,0,0
#channel: 33,My,41,5,72,57,0,0,0,0,0,0,0
#channel: 34,Mx,236,-70,43,0,0,0,0,0,0,0,0

#####

matrix: 255 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 16 1 2 3 5 7 8 9 12
matrix: 17 1 2 3 5 7 8 9 12
matrix: 18 1 2 3 5 7 8 9 12
matrix: 19 1 2 3 5 7 8 9 12
matrix: 10 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 0 1 2 3 5 7 8 9 12

/root/data/jr276_ acquisition stopped Thu Apr due to: user requested terminate request

*****
/root/data/jr276_ acquisition started Thu Apr 14 14:56:58 2011 UTC
using setup file: '/root/data/setup.txt'

# ODAS setup file for internally recording instruments
# Modified 2010-09-17 by DC

#####

prefix: jr276_003_
disk: /root/data
rate: 512
recsize: 1
no-fast: 8
no-slow: 1
profile: vertical
man_com_rate: 3
max_time: 17970
max_pressure: 4977

#####

channel: 16,S8T2E,4,34834858e-3,6,38778322e-4,2,09151115e-5,1,71827763e-6,1000,0,2
channel: 17,S8T2D,4,34834858e-3,6,38778322e-4,2,09151115e-5,1,71827763e-6,1000,0,2
# SN 4634, 2006-08-22

channel: 18,S8C2E,-1,03168270e1,0,1,424138250e,6,44015395e-4,1,20437887e-4,246e,1
channel: 19,S8C2D,-1,03168270e1,0,1,424138250e,6,44015395e-4,1,20437887e-4,246e,1
# SN3240, 2006-08-23

channel: 10,Pves,-11,1,0,29503,-2,19e-7,0,0,0,0,0
channel: 1,Ptch,1955,17154,0,0,0,0,0,0,0
channel: 3,az,343,12855,0,0,0,0,0,0,0
channel: 2,Roll,-338,13000,0,0,0,0,0,0,0
#channel: 0,GND1

#channel: 32,Mz,64,68,88,0,0,0,0,0,0,0
#channel: 33,My,41,5,72,57,0,0,0,0,0,0,0
#channel: 34,Mx,236,-70,43,0,0,0,0,0,0,0,0

#####

matrix: 255 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 16 1 2 3 5 7 8 9 12
matrix: 17 1 2 3 5 7 8 9 12
matrix: 18 1 2 3 5 7 8 9 12
matrix: 19 1 2 3 5 7 8 9 12
matrix: 10 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 4 1 2 3 5 7 8 9 12
matrix: 6 1 2 3 5 7 8 9 12
matrix: 11 1 2 3 5 7 8 9 12
matrix: 0 1 2 3 5 7 8 9 12

/root/data/jr276_ record number: 9! Thu Apr event type: pressure release

```

### 4.3.7 NOCS VMP-5500 instructions for launch and recovery

VMP Sequence for Launch  
UK DIMES JR276, April 2011

At the Laptop Station

At ~30 minutes prior to launch:

1. Start a new log sheet in the VMP dive log:  
enter cruise (JR276), station number, date

On Deck



<p>otherwise note most recent data file (.p) in memory on the log sheet</p>	
<p>6. Check channels and get the pressure on deck from the instrument:</p> <ul style="list-style-type: none"> <li>- type “odas4ir -f setup.txt -c all -s 1024” in the terminal window. This gives a list of channel numbers and the standard deviation and mean of the measurements over 1024 counts. Check these values look sensible.</li> <li>- type ‘odas4ir -f setup.txt’ in the terminal window.</li> </ul> <p>multiple readings of the on-deck pressure will be printed to the screen (should be close to 0)</p> <p>record to nearest first decimal point as “On-deck press <math>P_{deck}</math>” on log sheet</p> <p>exit with CTRL-C</p>	<p>5. Install the weights:</p> <ul style="list-style-type: none"> <li>check the magnetism of the weights</li> <li>demagnetize if greater than 2G</li> <li>check the state of the magnesium safety clip, replace if necessary and note on log sheet</li> <li>install the weights (2) and check the cable tension</li> </ul>
<p>7. Make the specified max. pressure and specified max. time calculations for this dive:</p> <p>when you have arrived on station, make a decision about the water depth and the safety factor for this dive</p> <p>run “calculate_max_press_and_time” in matlab on laptop</p> <p>record “Bottom press <math>P_{bot}</math>”, “Assumed overshoot <math>P_{over}</math>”, “Safety allowance <math>P_{safe}</math>”, “Specified max. press.”, “Estimated dive time” and “Specified max. time” from Matlab output on log sheet</p> <p>take a second and make sure it makes sense</p>	<p>6. Turn the instrument ON:</p> <ul style="list-style-type: none"> <li>turn the instrument on by replacing the dummy plug by the shorting plug</li> <li>watch for the LED on the tip of the probe to start flashing (~ 30s)</li> <li>record the time as the “Dive start time” on the log sheet (i.e. when flashing).</li> </ul>
<p>8. Enter this dive's information in the 'setup.txt' file on the instrument:</p> <p>open setup.txt file by typing “edit setup.txt” in terminal window</p> <p>update the prefix field with station number (prefix format='jc29_station#_')</p> <p>enter max_time and max_pressure as calculated above into the appropriate fields</p> <p>save and exit by hitting “ESC” and hitting enter once to select “Leave Editor” and enter again to select “Save Changes”</p>	<p>7. Throw it in the water</p> <ul style="list-style-type: none"> <li>note time and position when VMP is released and estimate expected surface time on log sheet</li> <li>make an offering to the VMP gods</li> </ul>

<p>9. Test the setup.txt file:  type “odas4ir -f setup.txt” at command line  in terminal window  check for any error messages  if all is well, exit with “CTRL-C”</p>	
<p>10. Turn off the instrument and disconnect  from the power supply:  type “shutdown now” in the terminal  window  close the Putty terminal window  wait 30 seconds  IF the weight release battery has been  charging for at least 20 minutes, turn  instrument off by disconnecting the white  plastic on-off switch  turn off the power supply</p>	
<p>11. Test the instrument battery voltage:  disconnect the instrument from the power  supply  using the voltmeter test the instrument  battery voltage by measuring the voltage at  the connector to the power supply (stick  voltage meter probes where wires enter the  plastic connector)  record the main battery voltage on the log  sheet  IF voltage &gt;~ 12.8 V OK to deploy; if less  charge more (with plastic on-off switch  disconnected)</p>	

VMP Sequence for Recovery  
V1, UK DIMES2, 2nd December 2010

At the Laptop Station	On Deck
	<p>1. ~ 10 minutes prior to expected surface  time:  send a look-out with the RAF to the top of  the bridge  all others to the bridge for look-out</p>
	<p>2. Find it!  record date, time, ship position and range</p>



	and bearing when spotted in the log sheet
	3. Get it on the deck: record the date, time and ship's position in the log sheet
1. Test the instrument battery voltage: connect the E/CRG cable to the instrument using the voltmeter test the instrument battery voltage by measuring the voltage at the instrument's connector to the power supply record the recovery battery voltage on the log sheet	4. Turn the 4 recovery aids off and replace.
2. Plug the instrument in and start it charging: connect the E/CRG charging cable to the power charger and turn on the power supply	5. Replace tube full of millipore water from the wet lab on SeaBird conductivity cell
3. Get the laptop talking to the instrument: IF it is not already connected, connect the ethernet cable on the E/CRG cable to the laptop turn the instrument on by connecting the plastic plug on the E/CRG cable	6. Replace tape over 5 EM current meter probes
4. FTP the data and log file from the instrument to the laptop: cd to /Users/mstar/JR276/VMP/raw create new directory with station number as name cd to the new directory. ftp to the instrument: root@ 192.168.2.2, password rglr0x type prompt type 'mget jr276_station#*' type 'get setup.txt' type 'quit'	7. Rinse with fresh water: be gentle with the flow rate over the shear probes!
5. Once the file transfer is complete, turn off the instrument: disconnect the white plastic on-off switch on the E/CRG cable so it is in the "off" position leave the instrument plugged in to charge	8. Turn the instrument off: remove the shorting plug and connect the E/CRG charging cable to the instrument

<p>for the next dive note on log sheet when charging started and estimated completion time. Assign someone to turn it off and note who on log sheet.</p>	
<p>6. Do a quick look of the data in Matlab on laptop: in station directory on matlab run “firstlook_jr276” inspect output and check for broken microstructure probes – IF microstructure probe needs replacing record on log sheet record max pressure of dive on log sheet (outputted at command line of matlab window) IF a probe needs to be replaced, note failed probe number, cause of failure, new probe number, channel on instrument, and calibration info for new probe if required on the log sheet and VMP probe log book. Update shear probe coefficients in template setup_calibration.txt file (in VMPdata dir). Copy template setup_calibration.txt to station directory (.../raw/station_no)</p>	<p>9. Inspect the magnesium safety pin on the weight release IF needed, replace and record on the log sheet. (Replace about every 2nd time)</p>
<p>7. Record remaining recovery details in the log sheet: record name and size of data files (.p) on log sheet open station .txt file and note method of dive end (pressure release? time release? other?) record on log sheet</p>	
<p>8. Archive: As soon as there is time: backup new station directory (raw data, .mat files and firstlook figs) to jrlb, legdata/work/VMP_raw print output figures from “firstlook_jr276” and put in red VMP binder with log sheet</p>	

### 4.3.8 VMP Channel Information

“odas4if -f setup.txt -c all -s 1024”

Look out for mean=32768 and st.dev = 0 for channels other than 17,19,255)

The following channel pairs should show similar values: (4,5) (6,7) (8,9) and (10,11)

### 4.3.9 NOCS VMP-5500 processing instructions

#### Summary

If it is the first cast of the cruise, ensure you have the right coefficients for the Seabird variables, pressure variables, accelerometer variables, magnetometer variables and microtemperature variables. The EM variables were commented out during JR276 as the EM current meter was absent.

First, we need to create a directory structure to deal with the data. Under a parent cruise directory (e.g., 'JR276'), make a 'VMP' directory. Under 'VMP', create a 'raw' data directory, a 'programs' directory, a 'processing' directory, and a 'final' directory.

When you finish a cast, create a subdirectory called 'nnn' below 'raw' and take the raw data file (e.g., 'jr276\_nnn\_ccc.p', where nnn is the VMP cast number and ccc is a data file number), the cast's log file (e.g., 'jr276\_nnn.txt') and the cast's setup file ('setup.txt') there. Change to the 'raw/nnn' directory and run 'firstlook\_jr276' or equivalent. If this is the first cast of the cruise, you'll need to make sure all the pathnames are correct in 'firstlook\_jr276'. This stage will allow you to have a quick look at the (largely uncalibrated) data to check data quality, fall rate, maximum pressure, etc., and will write a file called 'jr276\_nnn\_ccc\_firstlooked' in the 'processing' directory, and create a folder of firstlooked figures called 'processing/nnn/firstlook\_figures'. At this stage, back up the raw and processing directories.

Create a 'setup\_calibrated.txt' file in the 'raw/nnn' directory, and update calibration coefficients for sh1, sh2, and write down the name of the probes used in the header of the file. If it is the first cast of the cruise, make sure you have the right calibration coefficients for all the accelerometer, T\*, pressure, conductivity, Seabird, magnetometer and EM variables.

Check that you are in the 'processing/nnn' directory. Run 'fine\_structure\_processing\_routine'. This creates a 'VMP\_CTD.mat' file that contains, amongst other variables, T, C and S data (t\_ave, c\_ave and s\_ave) averaged in a regular 0.5 dbar pressure grid (P\_grid) starting at 0.25 dbar. It also creates a folder of finestructure processing figures under 'processing/nnn/finestructure\_figures'.

Check that you are in the 'processing/nnn' directory. If this is the first cast in the cruise, check that the right pressure and shear variables differentiator gains are set in 'process\_micro\_jr276\_v2.m'. Then run that script to process the microstructure data. This will produce locally a 'micro\_nnn.mat' file containing the processed microstructure data in an approximately 0.5 dbar (1 s) grid, and a 'final\_grid\_nnn.mat' file under the final directory with processed fine- and microstructure data in a 0.5 dbar grid.

In the end, you'll need to produce a final file with all the processed cruise data by running 'make\_cruise\_data\_set\_jr276' in the 'VMP' directory, after entering all the relevant time and location information and selecting which of the microshear or microtemperature channels are of superior quality.

#### Details

First, an initial check of the data of each cast was performed using the 'firstlook\_jr276' matlab routine. This routine reads in the raw data from the cast, converts it to a matlab file and produces a series of diagnostic plots useful for checking the probes and instrument before

the next cast. These plots include: the velocity of the profiler with the extracted downcast used for further processing indicated, the battery voltage, the pressure and ‘ground’, raw data from the microtemperature, microconductivity and shear probes, the profile’s acceleration and rotation and the seabird temperature and conductivity.

The `read_odas.m` routine used by ‘firstlook’ had to be modified to account for the triplication of slow channels 4, 6 and 11 (T1, T2 and P\_dP) in the setup matrix. (These channels were sampled in place of the EM current meter and magnetometer channels). A simple fix was incorporated such that variables T1, T2 and P\_dP were resampled e.g. `T1=T1(1:3:end)`. The new routine was named ‘`read_odas_jr276.m`’. Note: Do not remove lines from the setup matrix as this will affect the sampling rate of all the slow channels!

Secondly, the seabird finestructure data was processed using ‘`finestructure_processing_routine.m`’. The end product is temperature and salinity that are:

1. truncated to include data only below 10 dB;
2. adjusted to account for the spatial displacement between the pressure sensor (at the VMP nose) and the CTD sensors (on the VMP body);
3. despiked;
4. corrected for short-term (sensor response) and long-term (thermal inertia) mismatch errors in T and C;
5. corrected to account for the thermal expansion and pressure contraction of the conductivity cell;
6. low-pass filtered to remove high-frequency noise;
7. block-averaged in 0.5 dB pressure bins.

Thirdly, the microstructure data was processed using the routine ‘`process_micro_jr276_v2.m`’. Data is converted to real units and calibrated to the seabird data. The epsilon and chi values are estimated by integrating the power spectra of the shear and the microtemperature gradient, respectively. The data are averaged into regular 0.5 dbar bins. Note that this program used various microstructure parameters, which should be checked before each cruise. The shear probe sensitivities are read from the file ‘`setup_calibration.txt`’ which should be updated for each cast.

The `process_micro` routine was modified from that used on JC054, such that the pressure value at which to start the extracted downcast was increased from 5.25 dB to 6.25 dB. The change was required to account for the different deployment procedures. On this cruise the VMP was released when deeper in the water than on JC054, such that the profiler did not reach the previous criteria of a drop speed (`W_32`) of 0.4 m/s at 5.25 dB.

There is also a diagnostics program which plots computed epsilon and chi values. Measured shear spectra are binned into TKE dissipation rates and compared to the corresponding Naysmyth spectrum. Calculated microT and microC data are compared with the Batchelor spectra corresponding to the estimated chi values.

Finally, the data was averaged into 1 dbar bins and saved as a matlab structure file using the program ‘`make_cruise_data_set_jr276.m`’. The average results from the two shear or microtemperature probes were used, unless a probe was noisy, in which case the noisy probe data was discarded. Deployment location, time, station number and corresponding CTD cast

numbers were added to the dataset. Data was plotted using ‘average\_ep\_plot.m’, ‘chi\_ep\_plot\_\*.m’ and ‘cross\_section\_plot\_inpstruc\*’.

### 4.3.10 Initial Results for Sections S3 and SR1

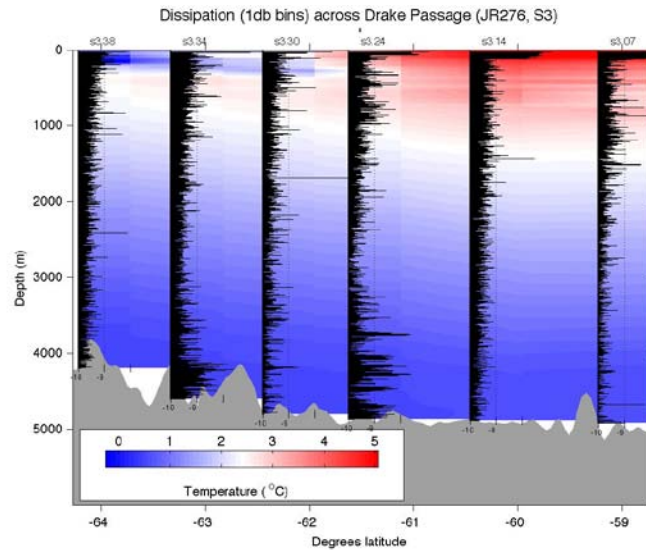


Figure 4.3.1: Vertical section of S3. Black lines show log plots of estimated TKE dissipation from VMP casts in W/kg. Corresponding station numbers are indicated on top axis. Background colour is temperature from calibrated Seabird temperature cell.

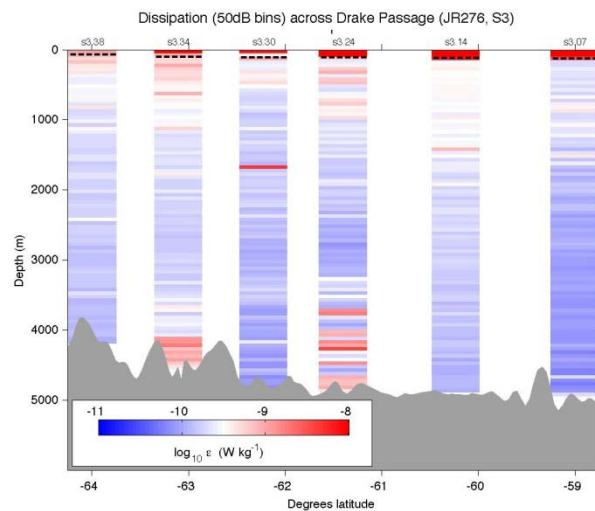


Figure 4.3.2: Vertical section of S3 showing estimated TKE dissipation for VMP casts. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

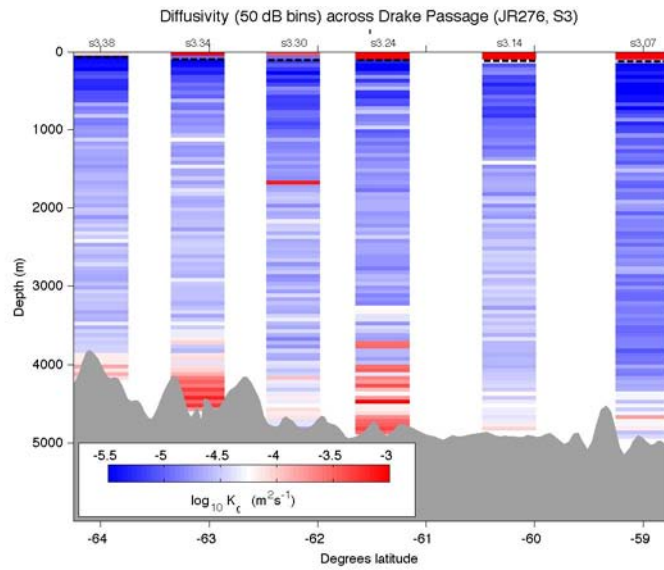


Figure 4.3.3: Diapycnal diffusivity,  $K_c$ , across section S3 from VMP deployments. Stratification computed from Seabird conductivity and temperature cells. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

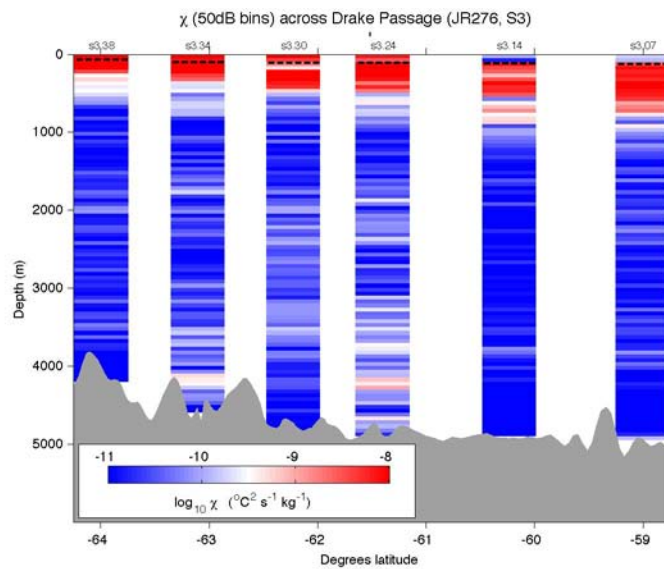


Figure 4.3.4: Vertical section of  $\chi$ , computed from temperature microstructure across section S3. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

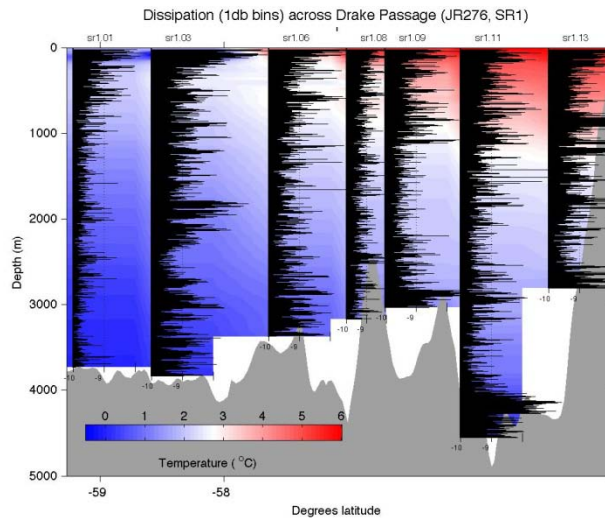


Figure 4.3.5: Dissipation across section SR1. Black lines show log plots of estimated TKE dissipation from VMP casts in W/kg. Corresponding station numbers are indicated on top axis. Background colour is temperature from calibrated Seabird temperature cell.

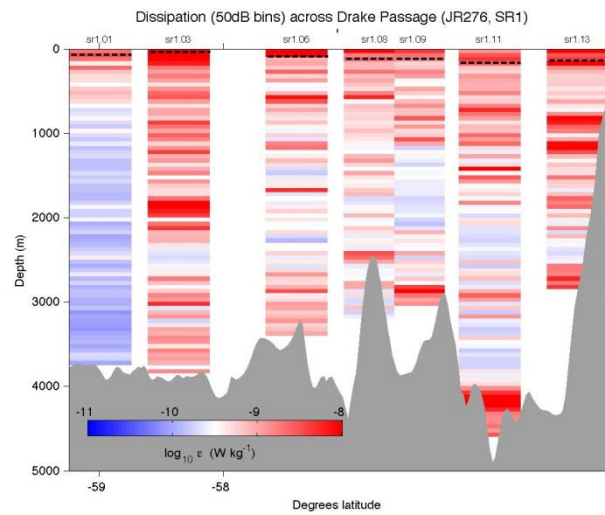


Figure 4.3.6: Vertical section of SR1 showing estimated TKE dissipation computed from VMP shear sensors. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

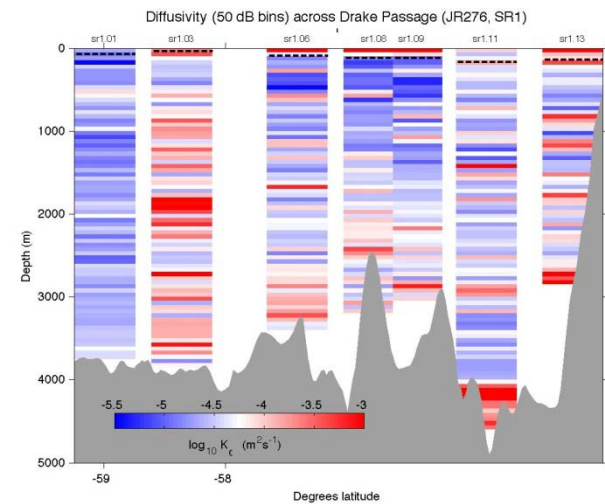


Figure 4.3.7: Diapycnal diffusivity,  $K_z$ , across section SR1 from VMP deployments. Stratification computed from Seabird conductivity and temperature cells. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

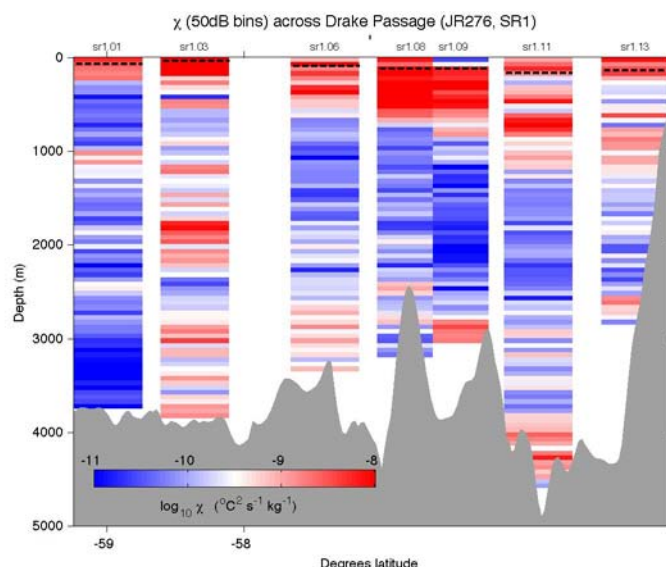


Figure 4.3.8: Vertical section of  $\chi$ , computed from temperature microstructure across section SR1. Black dashed lines show base of mixed layer, defined by a potential density of  $0.03 \text{ kg/m}^3$  below the surface.

### 4.3.11 Operations Summary

A summary of the deployments is given in Table 4.3.1, with the probes used for each cast in Table 4.3.2.

STATION	CTD#	INSTRUMENT	DIVE	DATE (Julian Day and year)	DEPLOYMENT			RECOVERY			DIVE MAX DEPTH (dB)	REAL TIME COMMENTS
					NUMBER	TIME (GMT)	LAT	LON	TIME (GMT)	LAT		
S3.5	6	NOC	1	102 2011	18:34	-58.1636	-77.9895	18:37	-58.1627	-77.9872	204	Shallow depth test. T2 dead!
S3.7	8	NOC	2	103 2011	6:09	-59.0000	-78.0000	12:08	-59.0070	-78.0027	5031	
S3.14	15	NOC	3	104 2011	15:01	-60.2350	-77.9997	20:47	-60.2378	-77.9907	4997	
S3.24	26	NOC	4	106 2011	3:37	-61.4118	-77.9995	9:30	-61.3912	-78.0000	4975	Shear probe may have been knocked on deployment
S3.30	32	NOC	5	107 2011	1:07	-62.2222	-78.0000	6:45	-62.2313	-77.9787	4911	Shear 2 improved now, so swap shear 1 with one from the new M7xx box
S3.34	36	NOC	6	107 2011	18:19	-63.110333	-77.998833	23:38	-63.104667	-78.0025	4697	
S3.38	40	NOC	7	108 2011	11:05	-63.998333	-77.9995	15:55	-63.99455	-77.99801	4697	
SR1.1	41	NOC	8	111 2011	09:47	-58.999447	-55.854342	14:09	-58.98678	-55.852245	3805	Microconductivity went bad half way down profile
SR1.3	43	NOC	9	111 2011	21:59	-58.366	-56.248833	02:46	-58.35142	-56.157058	3908	Very high mixing (esp at 2000m). Surface current 2 knots to NE. ridge
SR1.6	46	NOC	10	112 2011	17:26	-57.415833	-56.840667	21:34	-57.405833	-56.844667	3436	Rough weather, but recovery and deployment good.
SR1.8	48	NOC	11	113 2011	19:06	-56.783333	-57.2295	23:09	-56.776383	-57.219583	3227	
SR 1.9	49	NOC	12	114 2011	03:06	-56.468	-57.424833	06:50	-56.468167	-57.423833	3083	Weight release triggered early (low battery?) meaning it did not reach max pressure of 3798 dbar
SR1.11	52	NOC	13	114 2011	16:52	-55.833833	-57.736667	22:12	-55.879197	-57.78365	4648	Did not reach max pressure - weights fell off before. Timeout release recorded at the correct time in the text file.
SR1.13	54	NOC	14	115 2011	06:02	-55.140667	-57.999333	13:48	-55.148333	-57.961967	3023	Weight release occurred (pressure release) but suspect that only one weight fell off. VMP remained at bottom until mag clip corroded.

Station	CTD#	MC	T1	T2	SH1	SH1-stated response	SH1-measured capc.,in	SH1-measured capc.,out	SH2	SH2-stated response	SH2-measured capc.,in	SH2-measured capc.,out
S3.5	6	10 1	T280	T347	M400	0.0927	1.0670		M422	0.0961	1.0700	0.1950
S3.7	8	10 1	T280	T355	M400	0.0927	1.0670		M541	0.1216	1.1820	0.7277
S3.14	15	10 1	T280	T355	M400	0.0927	1.0670		M544	0.1195	1.1840	1.1790
S3.24	26	10 1	T280	T355	M400	0.0927	1.0670		M543	0.1120	1.1800	
S3.30	32	10 1	T280	T355	M543	0.1120	1.1810	1.1520	M400	0.0927	1.0490	
S3.34	36	10 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
S3.38	38	10 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
SR1.1	41	7 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
SR1.3	43	7 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
SR1.6	46	7 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
SR1.8	48	7 1	T280	T382	M730	0.0629	1.0360		M400	0.0927	1.0490	
SR1.9	49	7 1	T280	T382	M730	0.0629	1.0360	no value - probe dead	M400	0.0927	1.0490	1.0540
SR1.11	52	7 1	T280	T382	M731	0.0757	1.0870		M734	0.0658	1.0840	
SR1.13	54	7 1	T280	T382	M729	0.0655	1.0680		M734	0.0658	1.0840	



Table 4.3.2: Summary of microstructure probes used

### 4.3.12 Recommendations

1. Consult with Rockland about the failure of the weight release mechanism on VMP cast 14. Ken Decoteau at WHOI agrees with our assessment that the lanyard failed to clear fully the weight trays and believes that our use of a cable tie as opposed to a large o-ring to connect the two lanyards may have contributed to this problem.
2. Investigate further the possibility of installing some kind of transmitting GPS device as a further recovery aid. This would assist in speedy recovery of the instrument, especially in adverse, and particularly foggy, weather conditions.
3. Establish what can be done with the batch of M5xx shear probes from Rockland that appeared to be giving consistently noisy data. Chris Barnard and Terry Edwards are going to investigate.
4. Consult with Ken Decoteau, Rockland and other DIMES VMP participants about the cause of the early weight firing on casts 12 and 13. Whilst low battery charge appears to be the cause on cast 12, we do not know as it appears that battery release does not get noted in the deployment text file. The cause of early firing on cast 13 has not been resolved.
5. Arrange for spares of various VMP parts to be acquired before UK DIMES 3 (Terry Edwards and Chris Barnard).

### 4.3.13 BAS Deployment Sheet

BRITISH ANTARCTIC SURVEY

Form MS.AQ

**SCIENTIFIC or CHARTERERS OVERSIDE EQUIPMENT GUIDANCE NOTES**

<b>Ship:</b> R.R.S. James Clark Ross	
<b>Sheet Number:</b> 056	<b>Issue Status:</b> A
<b>Issue Date:</b> 25/04/11	
<b>Item:</b> VMP (Vertical Microstructure Profiler)	<b>Type:</b> 5500
<b>Owner:</b> NMF	
<b>Brief Description:</b> Freefalling Profiler	
<b>Deployment Location:</b> Starboard After Effer	
<b>Weight:</b> 200 Kg (In Air)	<b>Approx Dimensions:</b> 3m Long, Up to 0.6m $\varnothing$
<b>Winch:</b> N/A	<b>Wire:</b> N/A
<b>Max. Cable Veer Rate:</b> N/A	<b>Max. Cable Haul Rate:</b> N/A
<b>Vessel Deployment Speed:</b> On Station	<b>Vessel Recovery Speed:</b> Move vessel as required
<b>Persons required on deck</b>	<b>Duty</b>

Person in charge with radio NMF Technician Two Science Staff. Two Seamen	Oversee / assist with deployment & comms to bridge.  To co-ordinate/control operations and assist in deployment/recovery  Final checks and to assist in deployment/recovery.  To assist in deployment/recovery
<b>Safety / Protective Clothing and Gear required:</b>	
<ul style="list-style-type: none"> <li>• Hard Hats: Safety Footwear: Work Gloves: Warm. Foul weather gear as required.</li> </ul>	
<b>Operation Control Room Support equipment :</b>	
<ul style="list-style-type: none"> <li>• Echo Sounder to monitor bottom depth (SWATH/EA600)</li> <li>• Hydrophone unit if using ship's transducer rather than dunker hydrophone.</li> </ul>	
<b>Notes :</b>	
<ul style="list-style-type: none"> <li>• There is a slight delay after coming on station as depth is checked and profiler mission is finalized before moving it out onto deck.</li> <li>• Ensure everyone is clear which parts of the profiler that can be touched during deployment and recovery to prevent damage to sensors.</li> </ul>	
<b>Refer to Risk Assessment Number:</b> MRA/GEN/11/JR	

BRITISH ANTARCTIC SURVEY  
Form MS.AQ (cont)

**SCIENTIFIC or CHARTERERS OVERSIDE EQUIPMENT GUIDANCE NOTES**

<b>Pre Deployment Checks:</b>
<ul style="list-style-type: none"> <li>• All persons involved understand what is required.</li> <li>• Working area safe and adequately lit.</li> <li>• Communication between Deck / Bridge established.</li> <li>• On station - Permission from the bridge to proceed.</li> </ul>
<b>Deployment Technique:</b>
<ol style="list-style-type: none"> <li>1. Before starting extend Effer to maximum extent to reduce time in deploying profiler and secure "sea catch" to hook to prevent its loss.</li> <li>2. Attach profiler to "sea catch" via strop and fit safety pin. Attach additional steadying line to maintain orientation of profiler during deployment.</li> <li>3. Confirm with bridge permission to launch and that DF beacon is working.</li> <li>4. Lift profiler on crane and then remove weight safety strap.</li> <li>5. Slew profiler over the side to the launch position.</li> <li>6. Remove the "sea catch" safety pin.</li> </ol>

7. Lower the profiler and clear the steadying line.
8. When ready release the profiler.
9. Monitor VMP during the deployment via the hydrophone and keep bridge updated on progress.

**Recovery Technique:**

1. Monitor the VMP during its ascent and keep the bridge updated on its expected surface time and ranges.
2. Move the vessel and range to locate vessel close to expected surfacing position.
3. Once sighted manoeuvre vessel to bring profiler to starboard side under the Midships gantry.
4. Meanwhile prepare two poles fitted with releasing recovery lines and move the Midships gantry over the side with auxiliary winch wire run to deck.
5. Hook recovery line to profile using long pole.
6. Shackle recovery line to auxiliary winch wire and recover using winch and gantry.
7. Lower profiler into trolley.
8. Secure the deck and inform the bridge.



#### 4. 4 EM-APEX FLOATS

At the request of Dr James Gerton of the University of Washington, 2 EM-APEX floats were deployed from the RRS James Clark Ross UK 1.5 cruise as part of the DIMES project. EM-APEX floats are neutrally buoyant drifters that contain sensors to measure depth, temperature, conductivity, fluorescence and are equipped with electromagnetic sensors that measure motionally induced electric fields generated by the ocean currents moving through the vertical component of the Earth's magnetic field. The EM-APEX can change its buoyancy by inflating a bladder which allows it to rise to the surface. Once at the surface, it will gather its position via GPS and send back the data it has collected via Iridium transceiver. This cycle is repeated over the life of the instrument

The table shows the launch information for each instrument.

Instrument S/N	Date	Time GMT	Latitude	Longitude
4594	13/04/2011	1100 z	59 00.02 S	77 59.92 W
4595	15/04/2011	2049 z	61 03.54 S	78 00.17 W

Once the instruments had been deployed, an email was sent to UW to confirm their deployment. Dr. Gerton replied that float 4594 was operating as expected and float 4595 was operating but appears to have been ballasted about 50 grams light so it was taking long for it to complete each cycle but was otherwise operating normally.

### 4.5 AARDVARK

*J.B. Sallée and Emily Shuckburgh*

#### 4.5.1 Introduction and aim

Six Rafos floats and thirteen surface drifters 93rogue at 15 m have been deployed in targeted locations using satellite altimetry information and a novel deployment configuration based on ideas from dynamical systems research. The main goal of these deployments is to test this new deployment configuration, which is designed to provide a more robust quantification of mixing. Near-real time satellite altimetry is used to identify the release location based on the identification of target structures. The target structures are unstable manifolds of hyperbolic points (also called Lagrangian coherent structures). The altimetry data is used to calculate geostrophic surface velocity fields, from which backward-time finite-size Lyapunov exponents (FSLEs) are calculated to identify the unstable manifolds. Fixed-velocity forward-time integrations are also performed to give an indication of the location of the stable manifolds and hence the hyperbolic points.

The manifolds provide a dispersion and a mixing mechanism by folding the fronts of advected tracers in thin filaments, enhancing small-scale diffusion. By studying relative dispersion of floats up to the mesoscale (typically reached in a few weeks), precise measurements of manifold properties can be obtained and these can be used to provide a quantitative validation of the corresponding measurements of the altimetry-based calculation.

Near real-time satellite altimetry maps were downloaded every day and the finite-size Lyapunov exponents were calculated for the Drake Passage region. These maps were examined to identify suitable target structures close to the ship track. Surface drifters and

sub-surface RAFOS floats were then deployed on lines at low angle to the predicted unstable manifolds, intersecting the predicted hyperbolic point, with a spacing between drifters/floats of 10 km. Two structures were targeted, one with 5 drifters and a second with 8 drifters (3 in a triplet at the same location) and 6 RAFOS floats at the same locations as the drifters.

## 4.5.2 Instruments and system specification

### 4.5.2.1 RAFOS float

Sound Fixing and Ranging (RAFOS) floats manufactured by SeaScan are used to track the velocity of the ocean at a particular density over a wide spatial area. The float provides temperature and salinity data plus high-resolution trajectories. The float will listen for and record sound signals from the twelve moored sound sources in the area. Six shallow level (isopycnal surface 27.21) Iridium RAFOS floats were deployed on this cruise; refer to Table below. At the end of the mission the float will drop the ballast weight and rise to the surface to transmit all mission data. The 2m glass tube floats were lowered into the water by crane using a protective launch tube or by hand off the stern.

#### **Mission configuration for AARDVARK RAFOS floats:**

##### SCHEDULER TASK TABLE

Number of windows to acquire (<1000) = 210

Open window at = 00 00:00:00

Offset 00 00:55:00 GetParam

Offset 00 01:00:00 Listen Rcvr 0 Duration 60

Offset 00 02:05:00 GetCorr from Rcvr 0

Offset 00 02:10:00 End of Window

R0 Sweep Length= 261 (Samples) Corr Sampling period= 30750 (x10 microS)

R1 Sweep Length= -1 (Samples) Corr Sampling period= -1 (x10 microS)

Number of correlations to retain= 6

Press Launch Threshold in dBars= 5

Surface assumed if T > 25000 mDegC and P < 100 dBars

Max\_Depth= 2500 dbars

Forced\_Start= 1920

### 4.5.2.2 Surface drifter

Drifting buoys provide sea surface temperature data and surface velocity measurements for climate prediction models. The Global Drifter Program is a branch of the National Oceanic and Atmospheric Administration (NOAA). The NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) coordinates deployment and processes/archives the data. Thirteen drifters were deployed during this cruise; refer to the deployment table below. The surface float houses the alkaline D-cell batteries, a transmitter, a thermistor, and a tether strain sensor to verify the presence of the drogue. The drogue is centered at 15m beneath the surface to measure mixed layer currents in the upper ocean. The drogue is made of nylon cloth in 7 sections, for a total length of 6.44m. Throughout the drogue, rigid rings with spokes support the drogue's cylindrical shape. Each drogue section contains two opposing holes, which are rotated 90 degrees from one section to the next. These holes disrupt the formation of organized lee vortices. The batteries of a deployed drifter last an average of 400 days before ceasing transmission. In addition to position the drifter collects sea surface

temperature, which is averaged over a window of about 90 seconds and transmits the data at 401.65 MHz. Each drifter transmitter is assigned a Platform Terminal Transmitter (PTT) code, often referred to as the drifter ID for the Argos tracking satellite system. To track a drifter log on to [http://www.aoml.noaa.gov/phod/dac/gdp\\_track.php](http://www.aoml.noaa.gov/phod/dac/gdp_track.php)

### 4.5.3 Data processing and problems

Drifter's ids have been registered with NOAA, who process their trajectory and temperature. Data are made available by NOAA. RAFOS floats transmit their data at the end of their mission. The data will be processed and calibrated by Nicolas Wienders and Kevin Speer (Florida State University).

One the six RAFOS deployed failed, returning to the surface 4 hours after its deployment (Iridium ID number 300034013329180 ). The exact reason of the failure is not known yet and is being investigated by Seascan (RAFOS manufacturer). However, several other floats deployed as part as the DIMES project in previous cruises had similar problems. Figure 1 shows the pressure chart of one float that failed previously (blue curve). The pressure shows a change of slope at around 500m and the float heading down faster than before. It went over the max pressure (2500 dbars) and then came back up. After investigation the problem was attributed to a compressee failure (e.g. loss of the oil or piston seal failure). Although not clear yet, the failure of float 300034013329180 might be due to a similar problem.

One of the thirteen drifters deployed has never sent data (ID number 100964). The reason of the failure is not known. The drifter was deployed has part of a triplet deployment.

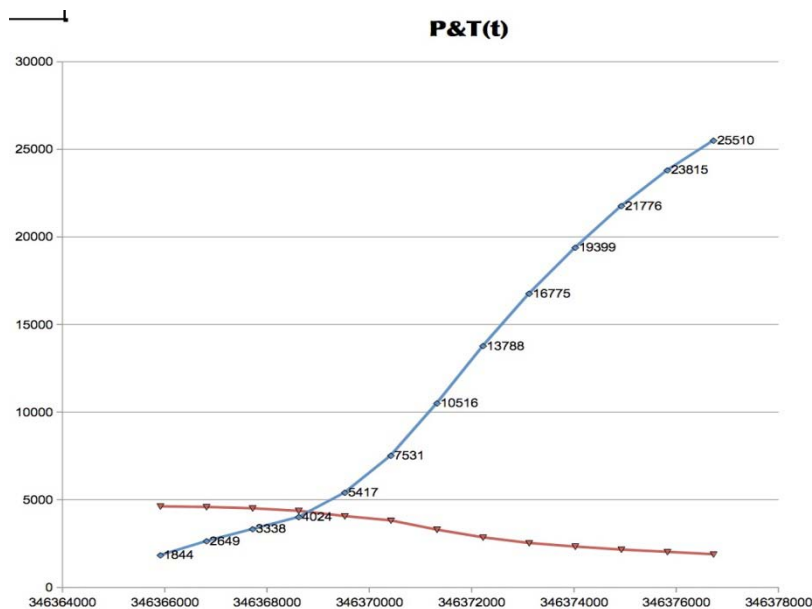
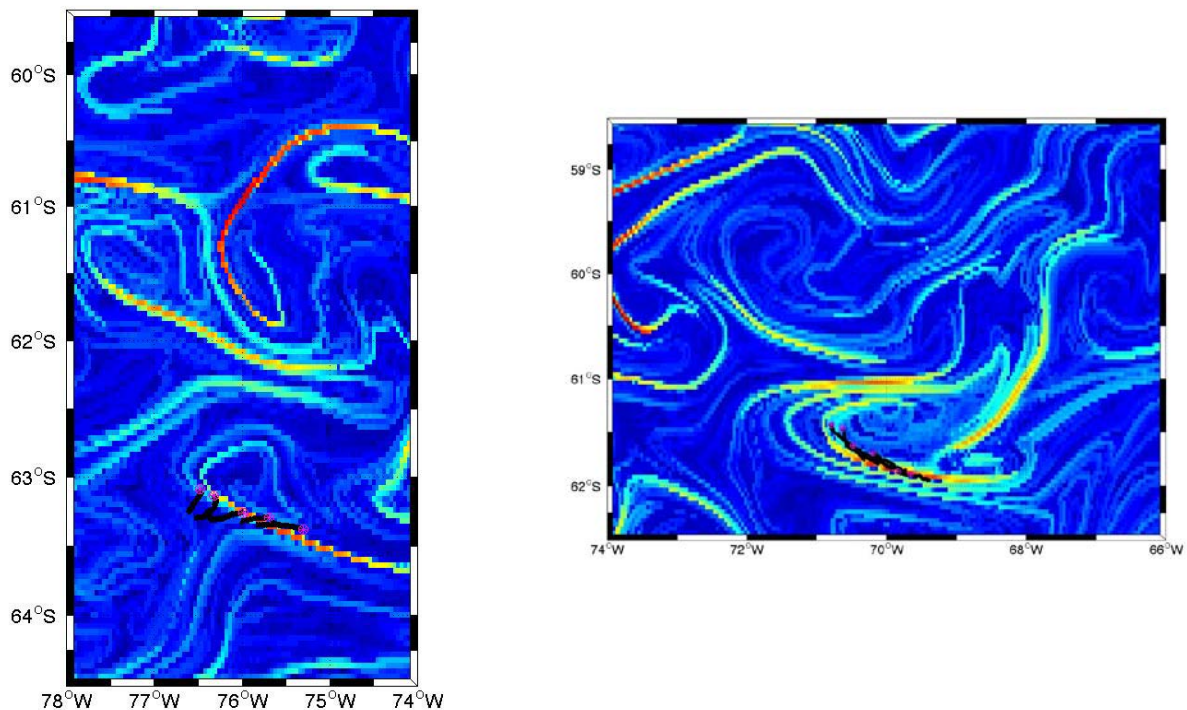


Figure 4.7.3: Pressure versus time (blue) for the RAFOS float

### 4.5.4 Deployment

We targeted an unstable manifold with a hyperbolic point located around 63 S, 76 W on the 18th April 2011. The first few days of trajectories show very good agreement with unstable manifold deduced from altimetry field (Figure 4.7.2). The first days of trajectories suggest

that the drifters have been release on both side of a hyperbolic point (repulsion point), which is very interesting for the project. In a second experiment we released 8 drifters along with six isopycnal RAFOS floats to target an unstable manifold with a hyperbolic point located at 61.5 S, 69.5 W on the 19 April 2011. Once again the first days of trajectories nicely follow the structure predicted from altimetry (Figure 4.7.2). Despite the failure of one drifter and one RAFOS float, the two releases have been a success. According to the recommendations and experience from the first part of the experiment (2 deployments in December 2010 aboard the James Cook), we have taken particular care to try to predict the location of the hyperbolic point. The prediction of the hyperbolic point worked very well for the first deployment of this cruise.



**Figure 4.7.4:** First days of drifter trajectories (black lines) and corresponding Finite Size Lyapunov Exponent (FSLE) map (colour): (a) first release of 5 drifters; and (b) second release of 7 drifters (one of which failed). Pink circle show their position after 1.5 days. Unstable manifolds are indicated by yellow-red lines in the FSLE map.

## 4.5.5 Further analysis

Further analysis will now be undertaken to calculate the FSLEs from the drifter/float trajectories, to compare the trajectories and FSLEs to the altimetry-based prediction, and to combine drifter/float and altimetry-based predictions to obtain a quantification of local eddy diffusivities.

## 4.5.6 Recommendations

Thorough investigation of the failures of RAFOS floats should be undertaken by Seascan to try decreasing the number of failure of RAFOS floats. Two floats surfaced straight after



deployment, over the 9 RAFOS floats deployed as part of AARDVARK in December 2010 and April 2011.

	Drifter	WMO#	Date	Time	Latitude	Longitude	
1	36914	71566	18/4/2011	20:47	63° 15.66	76° 36.84	AARDVARK
2	39267	71576	18/4/2011	21:15	63° 16.98	76° 25.14	AARDVARK
3	100970	71633	18/4/2011	21:43	63° 18.30	76° 13.44	AARDVARK
4	100963	71635	18/4/2011	22:09	63° 19.56	76° 01.80	AARDVARK
5	36413	71693	18/4/2011	22:36	63° 20.88	75° 50.10	AARDVARK
6	100968	71695	19/4/2011	15:39	61° 45.61	70° 15.18	AARDVARK
7	100966	71696	19/4/2011	16:23	61° 47.72	70° 04.59	AARDVARK
8	100969	71698	19/4/2011	17:07	61° 49.80	69° 54.04	AARDVARK
9	100962	71701	19/4/2011	17:50	61° 51.90	69° 43.48	AARDVARK
10	100965	71709	19/4/2011	17:50	61° 51.90	69° 43.48	AARDVARK
11	100964	Not Trans.	19/4/2011	17:50	61° 51.90	69° 43.48	AARDVARK
12	100971	71703	19/4/2011	18:34	61° 54.01	69° 32.88	AARDVARK
13	100967	71704	19/4/2011	19:17	61° 56.09	69° 22.43	AARDVARK

**Table 1: UK2.5 DIMES Cruise Drifter Deployment Log**

	Float s/n	Date	Time	Latitude	Longitude	Iridium ID #	
1	997	19/4/2011	15:37	61° 45.60	70° 15.21	30003401332 <b>3170</b>	AARDVARK
2	979	19/4/2011	16:23	61° 47.72	70° 04.59	30003401332 <b>1250</b>	AARDVARK
3	998	19/4/2011	17:07	61° 49.80	69° 54.04	30003401332 <b>7230</b>	AARDVARK
4	987	19/4/2011	17:50	61° 51.90	69° 43.48	30003401332 <b>6230</b>	AARDVARK
5	980	19/4/2011	18:34	61° 54.01	69° 32.88	30003401332 <b>5230</b>	AARDVARK
6	988	19/4/2011	19:17	61° 56.09	69° 22.43	30003401332 <b>9180</b>	AARDVARK

**Table 2: UK2.5 DIMES Cruise RAFOS Deployment Log**

## **5. NMF-SS Sensors & Moorings Cruise Report**

### **5.1 CTD system configuration**

1) The CTD systems consisted of an IOS 24 way Stainless Steel Frame with SBE32 24 Way Carousel with sensors configured as follows.

Sea-Bird 9plus underwater unit, s/n 09P

Sea-Bird 3P temperature sensor, s/n 03P-4302, Frequency 0 (primary)

Sea-Bird 4C conductivity sensor, s/n 04C-2248, Frequency 1 (primary)

Digiquartz temperature compensated pressure sensor, s/n 89973, Frequency 2

Sea-Bird 3P temperature sensor, s/n 03P-4235, Frequency 3 (secondary)

Sea-Bird 4C conductivity sensor, s/n 04C-2813, Frequency 4 (secondary)

Sea-Bird 5T submersible pump, s/n 05T-2371, (primary)

Sea-Bird 5T submersible pump, s/n 05T-2395, (secondary)

Sea-Bird 32 Carousel 24 position pylon

Sea-Bird 11plus deck unit, s/n 11P-20391-0502

Sea-Bird 35 Standards Thermometer S/N 35-051

2) The auxiliary input initial sensor configuration was as follows:

Biospherical PAR Irradiance Sensor S/N 7274 (V0)

Sea-Bird 43 dissolved oxygen sensor, s/n 43-1624 (V2)

Benthos altimeter, s/n 2130.27001 (V3)

Chelsea MKIII Aquatracka fluorometer, s/n 88-216 (V4)

Wetlabs CStar 25cm path transmissometer, s/n CST-396DR (V6)

3) Additional instruments:

Ocean Test Equipment 10L BES-110L water samplers, s/n's 1b through 24b

TRDI WorkHorse 300kHz LADCP, s/n 12736 (downward-looking Master)

TRDI WorkHorse 300kHz LADCP, s/n 1855 (Cast 1-45 ) 12369 Cast ( 46-54 ) (upward-looking Slave)

NOC WorkHorse LADCP battery pack, s/n WH005

#### **5.1.2 Technical Difficulties**

##### **Terminations and CTD Cable Issue's**

The CTD was re terminated several times during the cruise due to leakage at the termination and also due to faults in the cable that occurred around 30M from the cable termination itself. In these cases the inner core of the wire had managed to come out of the insulation and make contact with the outer core, causing the deck unit to blow fuses.

Cast 2 CTD Termination Failed on Deployment

Cast 3 CTD Termination failed on recovery

Cast 12 CTD Wire fault (50M Cable removed)

Cast 16 Aborted at 1700M due to CTD Wire Fault. (50M Cable Removed)

Cast 47 CTD Re terminated to attempt to alleviate Modulo Errors between SBE9 and SBE11.

### **Winch Spooling Issues**

At around 3200M and 3500M when the CTD Wire was being hauled there were issues with the wire spooling correctly onto the drum at the cheek's. During these deeper cast's the Deck Engineer was always on hand to attempt to correct the issue and to ensure the cast could proceed with as little lost time as possible. However some reduction in speed was necessary at these points. Otherwise the winch system worked well.

### **Oxygen Sensor Issues**

During cast 41 the Oxygen sensor that had been installed from the start of the cruise had failed (SBE 43-0676). This was replaced by another BAS Supplied SBE 43-0620 oxygen sensor however this then had issues too. The cable was replaced (Cast 51) as part of fault finding and found not to help the matter. The NMF Supplied SBE43-1624 eventually replaced the sensor (Cast 52). The Oxygen Sensor issues then appeared to be fixed.

### **Data Spikes**

During several casts near the end of the cruise there were a lot of Module Errors. Modulo Errors are frame errors between the Seabird 9 underwater unit and Seabird 11 Deck Unit. They normally occur when the Deck unit and underwater unit do not agree with each other, ie a checksum.

### **ADCP 1855**

During Cast 45 ADCP 1855 was noted to have a very weak beam 4. The ADCP was removed and replaced with NMF ADCP 12369. On inspection the ADCP did not respond to the test commands. Slight moisture was found on one board near TP14. The moisture was removed and the unit was then able to communicate. It is unknown why the moisture was there and whether this was the cause of the communication issue. This unit will now be returned to RDI for repair of Beam 4 and repotting of the transducer, which has caused a large number of failures in the ADCP's over the last 2 years.

### **SBE35 Standards Thermometer Data**

Following Cast 10 the SBE35 clock was adjusted to remove a 20 second offset from the clock. However, this then caused the clock to go out of sync.

### **Salinity Offset**

During Cast 43 an offset between the primary and secondary conductivity and temperature sensors was noticed in the salinity samples ran through the salinometer. The cause of this is unknown at present.

### **Bottle 14 Lost**

During Cast 52 bottle 14 was lost. Cause Unknown.

Date: 04/27/2011

Instrument configuration file: D:\data\jr276\config\jr276-c.CON

Configuration report for SBE 911plus/917plus CTD

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Frequency channels suppressed : 0

Voltage words suppressed : 0

Computer interface : RS-232C  
Scans to average : 1  
Surface PAR voltage added : No  
NMEA position data added : No  
Scan time added : No

1) Frequency 0, Temperature

Serial number : 4302  
Calibrated on : 2010-07-16  
G : 4.37249350e-003  
H : 6.41896265e-004  
I : 2.18227300e-005  
J : 1.79692907e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 2248  
Calibrated on : 25-Jun-10  
G : -1.04905512e+001  
H : 1.43303057e+000  
I : -1.98073050e-003  
J : 2.29775344e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 0707-89973  
Calibrated on : 2007-06-13  
C1 : -4.925971e+004  
C2 : -2.136250e-001  
C3 : 9.435710e-003  
D1 : 3.900400e-002  
D2 : 0.000000e+000  
T1 : 2.983458e+001  
T2 : -3.883229e-004  
T3 : 3.262440e-006  
T4 : 3.429810e-009  
T5 : 0.000000e+000  
Slope : 1.00005000  
Offset : -0.81450  
AD590M : 1.277500e-002  
AD590B : -9.391460e+000

4) Frequency 3, Temperature, 2

Serial number : 4235  
Calibrated on : 25-Jun-10

G : 4.34551644e-003  
H : 6.45163175e-004  
I : 2.20850100e-005  
J : 1.73830524e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 2813  
Calibrated on : 20-Jul-10  
G : -9.66436718e+000  
H : 1.43654726e+000  
I : -9.34934811e-004  
J : 1.48931687e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor

Serial number : 7274  
Calibrated on : 12/1/2009  
M : 1.00000000  
B : 0.00000000  
Calibration constant : 55248618784.50000000  
Multiplier : 1.00000000  
Offset : -0.02596740

7) A/D voltage 1, Free

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

Serial number : 1624  
Calibrated on : 26 Aug 2010  
Equation : Murphy-Larson  
Coefficients for Owens-Millard:  
Soc : 0.0000e+000  
Boc : 0.0000  
Offset : 0.0000  
Tcor : 0.0000  
Pcor : 0.00e+000  
Tau : 0.0  
Coefficients for Murphy-Larson:  
Soc : 5.26100e-001  
Offset : -5.12600e-001  
A : -3.17690e-003  
B : 1.90660e-004  
C : -2.91600e-006  
E : 3.60000e-002  
Tau : 1.82000e+000

9) A/D voltage 3, Altimeter  
Serial number : 2130.27001  
Calibrated on : no calibration available  
Scale factor : 15.000  
Offset : 0.000

10) A/D voltage 4, Fluorometer, Chelsea Aqua 3  
Serial number : 088-216  
Calibrated on : 2009-08-27  
VB : 0.238400  
V1 : 2.079900  
Vacetone : 0.349600  
Scale factor : 1.000000  
Slope : 1.000000  
Offset : 0.000000

11) A/D voltage 5, Free

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

Serial number : CST-396DR  
Calibrated on : 23/08/2007  
M : 22.2100  
B : -1.3104  
Path length : 0.250

13) A/D voltage 7, Free

## 5. ICT Cruise Report (J. Edmonston).

### Netware system

Netware presented no problems during the cruise

### Unix Systems

All unix systems on board presented no problems during the cruise.

Nosea2, on board for the purpose of the cruise, and administered by Brian King, had the cruise data area mounted for pstar processing.

I believe the machine was rebooted once during the cruise, and besides having to have the mount point reinstated, presented no problems.

### Linux Systems

Linux Systems, including AMS3, jrla, jrlb presented no problems during the cruise.

AMS syncing on schedule but from time to time individual users would wait several hours at a time as the system presumably struggled with large quantities of mail, and / or large attachments.

### SCS

04/08/2011,13:13:58 Continuous acq started.

Acq still running at the time of writing this report. Anticipate closing this leg down and starting a new leg for the journey home on the 29<sup>th</sup> at the latest.

All back end processes, scs to levc, raw2compress, and web displays presented no problems.

### Em120

Em120 was used throughout the cruise and rebooted twice after losing the bottom.

Change in sea state and rapid slope were present at the time, might have confused it.

Shut down and restarted the transducers and workstation got it back in line.

On both occasions merely restarting the workstation, or operator software had no effect, with the EM120 failing the BIST test.

EM120 was rebooted one other time, after the seapath was rebooted on 16/4/11.

1320 16/4/11 em120 stopped. Transducers power cycled.

1340 16/4/11 em120 successfully restarted and gathering data.

### Seapath

The seapath unit dropped data quality to reduced on all channels, interfering with the echosounders, bridge and em120. At 1308 16/4/11 it was rebooted, which brought the data quality back up to good.

EM120 had to be restarted as mentioned above, ADCP had to be have the pings manually restarted to reacquire data.







## Event Log

Date (dayofyear)	Time (GMT)	Decimal day	latitude (decimal degrees)	Longitude (decimal degrees)	Station Number	Action/data file number
11/04/11 (101)	15:30					TSG Switched on
		101.64583	-56.49978	-78.00080		
	15:04	101.62778	-56.44852	-77.95827		VM-ADCP switched on
	15:38	101.65139	-56.49985	-78.00048	<b>S3.1</b>	CTD001 (Full depth).
	16:00	101.66667	-56.49996	-78.00013		Swath bathymetry (EM120) switched on
	17:04	101.71111	-56.49996	-78.00002		CTD001 at bottom
	19:04	101.79444	-56.50000	-78.00004		CTD001 inboard
	21:40	101.90278	-56.91652	-77.99996	<b>S3.2</b>	CTD002 (2500 m) in the water
						CTD002 aborted - problem with seabird data
12/04/11(102)	22:20	101.93056	-56.91668	-77.99994		
	2:10	102.09028	-56.91665	-77.99998	<b>S3.2</b>	CTD003 (2500 m) in the water
	4:28	102.18611	-56.91665	-77.99991		CTD003 inboard
	7:34	102.31528	-57.33332	-77.99996	<b>S3.3</b>	CTD004 (2500 m) in water
	9:51	102.41042	-57.33328	-77.99995		CTD004 inboard
	12:28	102.51944	-57.74999	-77.99982	<b>S3.4</b>	CTD005 (4531m) in water.
	15:00	102.62500	-57.74994	-77.99985		VMP floatation test
	15:52	102.66111	-57.74995	-77.99979		CTD005 inboard
	18:25	102.76736	-58.16346	-77.98960		VMP01 in water (shallow test)
	18:40	102.77778	-58.16368	-77.98984		VMP01 sighted
	18:58	102.79028	-58.16290	-77.97937		VMP01 recovered
	19:20	102.80556	-58.16668	-78.00013	<b>S3.5</b>	CTD006 in the water
	21:30	102.89583	-58.16664	-78.00015		CTD006 on deck
13/04/2011(103)	0:27	103.01875	-58.58336	-77.99987	<b>S3.6</b>	CTD007 in the water (2500)
	2:40	103.11111	-58.58196	-77.99510		CTD007 on deck

14/4/2011 (104)

6:05	103.25347	-58.99952	-77.99933	<b>S3.7</b>	VMP02 in the water
6:28	103.26944	-59.00002	-77.99957		CTD008 in water (4940m)
8:35	103.35764	-59.00004	-77.99949		Swath bathymetry switched off (for VMP)
8:40	103.36111	-58.99999	-77.99947		No signal from VMP; swath on
9:40	103.40278	-58.99998	-77.99951		Swath bathymetry switched off (for VMP)
9:47	103.40764	-58.99999	-77.99962		Response detected from VMP
10:10	103.42361	-59.00003	-77.99955		CTD008 on deck
10:59	103.45764	-59.00011	-77.99945		EM-APEX Float 4594 deployed
11:46	103.49028	-59.00122	-77.99927		VMP02 sighted
12:08	103.50556	-59.00698	-78.00268		VMP02 recovered
12:10	103.50694	-59.00699	-78.00267		Swath bathymetry switched on
13:43	103.57153	-59.20008	-78.00011	<b>S3.8</b>	CTD009 in water (2500)
13:57	103.58125	-59.20007	-78.00013		Change sound velocity profile on EM120 to that from cast 008
15:52	103.66111	-59.20004	-78.00006		CTD009 on deck
16:33	103.68958	-59.29244	-77.99609		Change sound velocity profile on EM120 to that from cast 009
17:24	103.72500	-59.39993	-77.99998	<b>S3.9</b>	CTD010 in water
19:34	103.81528	-59.39993	-78.00000		CTD010 inboard
21:08	103.88056	-59.60010	-77.99973	<b>S3.10</b>	CTD011 in water
23:26	103.97639	-59.60009	-77.99977		CTD011 on deck
1:00	104.04167	-59.79895	-77.99982		delay for CTD wire problem
2:00	104.08333	-59.80000	-78.00010		Cut 50m from wire and re-terminate
4:31	104.18819	-59.80001	-78.00011	<b>S3.11</b>	CTD012 in water
6:50	104.28472	-59.80088	-78.00082		CTD012 on deck
8:25	104.35069	-59.99977	-78.00045	<b>S3.12</b>	CTD013 in water
10:31	104.43819	-59.99995	-78.00006		CTD013 on deck
11:34	104.48194	-60.11753	-78.00014	<b>S3.13</b>	CTD014 in water
13:41	104.57014	-60.11758	-78.00012		CTD014 on deck
15:02	104.62639	-60.23494	-77.99969	<b>S3.14</b>	VMP03 in water
15:18	104.63750	-60.23519	-78.00025		CTD015 in water

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16:02	104.66806	-60.23516	-78.00025		Changed sound velocity profile on EM120 to that from cast 013
19:00	104.79167	-60.23532	-78.00018		CTD015 on deck
20:28	104.85278	-60.23692	-78.00029		VMP03 spotted at surface
20:45	104.86458	-60.23783	-77.99054		VMP03 on deck
20:53	104.87014	-60.23861	-77.99124		Swath turned on
21:43	104.90486	-60.35299	-77.99960	<b>S3.15</b>	CTD016 in the water (2000m)
22:22	104.93194	-60.35301	-77.99992		CTD failed at 1700m
23:00	104.95833	-60.35299	-77.99995		CTD016 on deck
1:45	105.07292	-60.35303	-77.99995		CTD017 in the water (S3.15 still)
3:40	105.15278	-60.35298	-77.99993		CTD017 inboard
4:45	105.19792	-60.47141	-77.99901	<b>S3.16</b>	CTD018 in the water (2000m)
6:35	105.27431	-60.47061	-77.99927		CTD018 inboard
7:35	105.31597	-60.58809	-77.99914	<b>S3.17</b>	CTD019 in the water (2000m)
9:30	105.39583	-60.58817	-77.99662		CTD019 inboard
10:30	105.43750	-60.70595	-78.00222	<b>S3.18</b>	CTD020 in the water (2000m)
12:22	105.51528	-60.70599	-78.00041		CTD020 on deck
13:07	105.54653	-60.82010	-77.99999	<b>S3.19</b>	CTD021 in water (2000m)
14:23	105.59931	-60.82350	-78.00015		Change sound velocity profile on EM120 to that from cast 020
15:08	105.63056	-60.82351	-78.00016		CTD021 on deck
16:04	105.66944	-60.94085	-77.99977	<b>S3.20</b>	CTD022 in the water (2000 m)
17:59	105.74931	-60.94105	-77.99981		CTD022 on deck
18:51	105.78542	-61.05851	-77.99937	<b>S3.21</b>	CTD023 in water
20:40	105.86111	-61.05860	-77.99970		CTD023 on deck
20:49	105.86736	-61.05863	-78.00012		EM-APEX Float 4595 deployed
21:37	105.90069	-61.17616	-78.00032	<b>S3.22</b>	CTD024 in the water
23:20	105.97222	-61.17647	-78.00003		CTD024 on deck
0:22	106.01528	-61.29393	-78.00021	<b>S3.23</b>	CTD025 in the water
2:17	106.09514	-61.29396	-78.00014		CTD025 on deck
3:36	106.15000	-61.41177	-77.99948	<b>S3.24</b>	VMP04 in water
3:50	106.15972	-61.41181	-78.00009		CTD026 in the water
7:25	106.30903	-61.41176	-78.00001		CTD026 on deck
9:05	106.37847	-61.40056	-78.00001		VMP04 spotted at surface (light)
9:30	106.39583	-61.39108	-77.99996		VMP04 on deck

**16/4/2011 (106)**

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10:35	106.44097	-61.52982	-78.00036	<b>S3.25</b>	CTD027 in water
12:27	106.51875	-61.52945	-78.00005		CTD027 on deck
13:23	106.55764	-61.64701	-78.00045	<b>S3.26</b>	CTD028 in water
13:14	106.55139	-61.64593	-77.99955		Seapath (navigation data) failed, affecting EM120 and VM-ADCP
13:30	106.56250	-61.64702	-78.00042		VM-ADCP restarted
13:40	106.56944	-61.64700	-78.00045		Change sound velocity profile on EM120 to that from cast 020 after re-starting it
15:14	106.63472	-61.64705	-77.99998		CTD028 on deck
16:08	106.67222	-61.76461	-77.99871	<b>S3.27</b>	CTD029 in water
18:05	106.75347	-61.76464	-77.99954		CTD029 on deck
19:00	106.79167	-61.88227	-77.99985	<b>S3.28</b>	CTD030 in water
20:50	106.86806	-61.88387	-77.99695		CTD030 on deck
21:30	106.89583	-62.00032	-78.00056	<b>S3.29</b>	CTD031 in the water
23:25	106.97569	-62.00000	-77.99999		CTD031 on deck
23:50	106.99306	-62.04509	-77.99871		Crossing Polar Front! SST decreases 2C in 10 min
1:12	107.05000	-62.22250	-78.00029	<b>S3.30</b>	VMP05 in the water
1:28	107.06111	-62.22226	-78.00005		CTD032 in the water
4:56	107.20556	-62.22225	-77.99996		CTD032 on deck
6:27	107.26875	-62.23130	-77.97852		VMP05 spotted at surface
6:45	107.28125	-62.23894	-77.97754		VMP05 on deck
8:09	107.33958	-62.44423	-77.99984	<b>S3.31</b>	CTD033 in the water
10:00	107.41667	-62.44438	-77.99992		CTD033 on deck
11:24	107.47500	-62.66668	-78.00010	<b>S3.32</b>	CTD034 in the water
13:15	107.55208	-62.66664	-78.00014		CTD034 on deck
14:47	107.61597	-62.88883	-77.99977	<b>S3.33</b>	CTD035 in water
14:47	107.61597	-62.88883	-77.99977		Change sound velocity profile on EM120 to that from cast 034
16:36	107.69167	-62.88882	-77.99980		CTD035 on deck
18:20	107.76389	-63.11026	-77.99888	<b>S3.34</b>	VMP06 in the water
18:35	107.77431	-63.11144	-77.99893		CTD036 in the water (full depth 4742m)
	107.00000	-62.07950	-77.99908		New CTD salinity sampling protocol implemented to improve quality

**18/04/2011(108)**

21:55	107.91319	-63.11120	-78.00008		CTD036 on deck
23:38	107.98472	-63.10461	-78.00260		VMP06 on deck
1:06	108.04583	-63.33334	-78.00005	<b>S3.35</b>	CTD037 in water
2:48	108.11667	-63.33337	-78.00011		CTD037 inboard
4:19	108.17986	-63.55547	-78.00050	<b>S3.36</b>	CTD038 in water
6:02	108.25139	-63.55565	-77.99998		CTD038 inboard
7:26	108.30972	-63.77764	-77.99986	<b>S3.37</b>	CTD039 in water
9:07	108.37986	-63.77764	-77.99997		CTD039 in board
11:05	108.46181	-63.99837	-77.99949	<b>S3.38</b>	VMP07 in water
11:23	108.47431	-63.99915	-77.99968		CTD040 in water (Full depth 4313m)
11:44	108.48889	-63.99954	-77.99975		EM120 turned off
	108.00000	-63.14290	-77.99917		CTD040 inboard

**19/4/2011 (109)**

15:29	108.64514	-63.99991	-77.99993		Change sound velocity profile on EM120 to that from cast 040
15:34	108.64861	-63.99989	-77.99996		VMP07 spotted
15:37	108.65069	-63.99966	-77.99797		EM120 restarted
15:55	108.66319	-63.99463	-77.99803		VMP07 on deck
20:50	108.86806	-63.25741	-76.59286		Deployment of Drifter 36914 (Alberto)
21:15	108.88542	-63.28277	-76.42061		Deployment of Drifter 39267 (Mike)
21:45	108.90625	-63.30697	-76.20558		Deployment of Drifter 100970 (Sarati)
22:15	108.92708	-63.33062	-75.98846		Deployment of Drifter 100963 (Kevin)
22:37	108.94236	-63.34886	-75.82700		Deployment of Drifter 36413 (Andy W)
15:37	109.65069	-61.76012	-70.25370		Deployment of RAFOS 997
15:39	109.65208	-61.76020	-70.25326		Deployment of Drifter 100968 (Nico)
16:23	109.68264	-61.79511	-70.07689		Deployment of RAFOS 979
16:23	109.68264	-61.79511	-70.07689		Deployment of Drifter 100966 (Jim)
17:07	109.71319	-61.82995	-69.90108		Deployment of RAFOS 998
17:07	109.71319	-61.82995	-69.90108		Deployment of Drifter 100969 (Karen)
17:50	109.74306	-61.86494	-69.72488		Deployment of RAFOS 987
					Deployment of 3 Drifters, 100962 (Emily), 100965 (JB), 100964 (Francesco)
17:50	109.74306	-61.86494	-69.72488		
18:34	109.77361	-61.90011	-69.54928		Deployment of RAFOS 980
18:34	109.77361	-61.90011	-69.54928		Deployment of Drifter 100971 (Raf)

	19:17	109.80347	-61.93498	-69.37403		Deployment of RAFOS 988
	19:17	109.80347	-61.93498	-69.37403		Deployment of Drifter 100967
<b>20/4/2011 (110)</b>	11:20	110.47222	-60.72578	-63.65289		Overnight the temperature in the BioLab (salinometer room) fell very low. Engineers fixed re-heaters.
<b>21/4/2011 (111)</b>	8:30	111.35417	-59.06396	-56.13769		Flowrate to TSG has dropped overnight. Adjusted by opening further the outflow tap from the TSG.
	9:47	111.40764	-58.99933	-55.85406	<b>SR1.1</b>	VMP08 in water
	9:59	111.41597	-58.99956	-55.85463		CTD041 in water
	10:00	111.41667	-58.99956	-55.85467		TSG flow rate low again (0.35)
	12:11	111.50764	-59.00023	-55.85595		TSG flow rate normal
	10:55	111.45486	-59.00023	-55.85602		EM120 turned off
	12:52	111.53611	-59.00019	-55.85591		CTD041 on deck
	13:50	111.57639	-58.99819	-55.84992		VMP08 spotted
	14:09	111.58958	-58.98680	-55.85222		VMP08 on deck
	14:15	111.59375	-58.98630	-55.85302		EM120 turned on
	16:10	111.67361	-58.68449	-56.05505	<b>SR1.2</b>	CTD042 in water
	16:37	111.69236	-58.68446	-56.05498		Change sound velocity profile on EM120 to that from cast 041
	19:00	111.79167	-58.68447	-56.05496		CTD042 on deck
	19:12	111.80000	-58.67468	-56.06077		Change sound velocity profile on EM120 to that from cast 042
	22:00	111.91667	-58.36605	-56.24791	<b>SR1.3</b>	VMP09 in the water
	22:15	111.92708	-58.36588	-56.24443		CTD043 in water
<b>22 Apr 11(112)</b>	1:20	112.05556	-58.35177	-56.20353		CTD043 on deck
	2:02	112.08472	-58.35368	-56.19655		VMP09 spotted at surface
	2:42	112.11250	-58.35131	-56.15779		VMP09 recovered
	5:39	112.23542	-58.05035	-56.44589	<b>SR1.4</b>	CTD044 in water
	8:35	112.35764	-58.05308	-56.44152		CTD044 on deck
	11:38	112.48472	-57.73360	-56.64031	<b>SR1.5</b>	CTD045 in water. Visibility too poor to deploy VMP
	14:19	112.59653	-57.73342	-56.64024		CTD045 on deck



	14:27	112.60208	-57.73317	-56.64046		Change sound velocity profile on EM120 to that from cast 045
	17:26	112.72639	-57.41602	-56.84066	<b>SR1.6</b>	VMP10 deployed
	17:37	112.73403	-57.41569	-56.83997		CTD046 in water
	20:20	112.84722	-57.41559	-56.83977		CTD046 on deck
	21:06	112.87917	-57.41104	-56.84184		VMP10 spotted at surface
	21:30	112.89583	-57.40565	-56.84272		VMP10 on deck
	22:25	112.93403	-57.34636	-56.88245		Change sound velocity profile on EM120 to that from cast 046
	23:00	112.95833	-57.30086	-56.91143		Weather too poor for further deployments
<b>23 Apr 11(113)</b>	6:15	113.26042	-57.24750	-56.99635		No flow through non-toxic
	6:45	113.28125	-57.22468	-57.00450		Non-toxic flow restored
	12:30	113.52083	-57.10001	-57.03653	<b>SR1.7</b>	CTD047 in water
	12:32	113.52222	-57.10001	-57.03666		EM120 restarted
	15:49	113.65903	-57.08892	-57.02896		CTD047 on deck
		113.00000	-57.22541	-56.95935	<b>SR1.8</b>	Electrical re-termination on CTD due to spiking on previous cast
	19:10	113.79861	-56.78341	-57.22938		VMP11 in the water
	19:18	113.80417	-56.78304	-57.23005		CTD048 in the water
	21:51	113.91042	-56.78125	-57.22732		EM120 sound velocity profile changed to CTD048
	21:58	113.91528	-56.77853	-57.22486		CTD048 on deck
	22:42	113.94583	-56.77441	-57.21745		VMP11 spotted at surface
	23:09	113.96458	-56.76691	-57.18908		VMP11 on deck
<b>24 Apr 11 (114)</b>	3:08	114.13056	-56.46793	-57.42494	<b>SR1.9</b>	VMP12 in water
	3:18	114.13750	-56.46755	-57.42505		CTD049 in the water
	4:36	114.19167	-56.46789	-57.42477		VMP12 prematurely returned to surface (~2900db)
	5:57	114.24792	-56.46785	-57.42501		CTD049 on deck (aborted to catch VMP)
	6:41	114.27847	-56.48676	-57.39045		VMP12 on deck
	7:06	114.29583	-56.46717	-57.42491		CTD050 in water
	9:08	114.38056	-56.46830	-57.42420		CTD050 on deck
	11:31	114.47986	-56.14923	-57.62392	<b>SR1.10</b>	CTD051 in water

	14:19	114.59653	-56.16518	-57.58333		CTD051 on deck
	16:52	114.70278	-55.83386	-57.81982	<b>SR1.11</b>	VMP13 in water
	17:03	114.71042	-55.83327	-57.82072		CTD052 in water
	20:45	114.86458	-55.85263	-57.79202		CTD052 on deck - Bottle 14 missing
	21:44	114.90556	-55.86302	-57.78393		VMP13 spotted
	22:15	114.92708	-55.87929	-57.76607		VMP13 on deck
<b>25 Apr 11 (115)</b>	0:45	115.03125	-55.51918	-58.01500	<b>SR1.12</b>	CTD053 in the water. Bottle 1 moved to position 14, new bottle at position 1
	3:43	115.15486	-55.51919	-58.01500		CTD053 on deck
	6:05	115.25347	-55.14049	-57.99925	<b>SR1.13</b>	VMP14 in water
	6:17	115.26181	-55.14152	-58.00002		CTD054 in water
	6:20	115.26389	-55.14168	-58.00007		EM120 turned off
	8:05	115.33681	-55.14263	-57.99880		VMP14 stuck on bottom :(
	8:38	115.35972	-55.14446	-57.99616		CTD054 on deck
	11:54	115.49583	-55.14526	-57.97676		VMP14 is coming up :)
	12:32	115.52222	-55.14497	-57.97529		EM120 on again
	13:30	115.56250	-55.14377	-57.96941		VMP14 spotted
	13:48	115.57500	-55.14834	-57.96193		VMP14 on deck
	13:55	115.57986	-55.14812	-57.96210		Change sound velocity profile on EM120 to that from cast 053
	14:37	115.60903	-55.06714	-57.97373	<b>SR1.14</b>	CTD055 in water
	16:26	115.68472	-55.06713	-57.97367		CTD055 on deck
	17:27	115.72708	-54.89014	-57.98154		VM-ADCP set to Bottom Track
<b>26 Apr 11 (116)</b>	11:15	116.46875	-51.90096	-58.44867		Alongside Mare Harbour

