

**National Oceanography Centre, Southampton**

**Cruise Report No. 10**

**RRS *Discovery* Cruise 298**

23 AUG – 25 SEP 2005

Cape Farewell and Eirik Ridge  
(CFER-I)

*Principal Scientist*  
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2006

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## DOCUMENT DATA SHEET

<b>AUTHOR</b> BACON, S et al	<b>PUBLICATION DATE</b> 2006
<b>TITLE</b> RRS <i>Discovery</i> Cruise 298, 23 Aug-25 Sep 2005. Cape Farewell and Eirik Ridge (CFER-1).	
<b>REFERENCE</b> Southampton, UK: National Oceanography Centre, Southampton, 113pp. (National Oceanography Centre Southampton Cruise Report, No. 10)	
<b>ABSTRACT</b> <p>This report describes scientific activities during RRS <i>Discovery</i> cruise 298 in the vicinity of Cape Farewell, southern Greenland, during early autumn 2005. A Deep Western Boundary Current array of seven moorings was deployed, and two IFREMER moorings were recovered, serviced and redeployed; also, a WHOI mooring was recovered. Hydrographic work comprised an area survey of 63 CTD/LADCP stations; up to 24 water samples were captured on each station for the measurement of salinity, dissolved oxygen, nutrients, CFCs (CFC-11, CFC-12, CFC-113 and CCl<sub>4</sub>), and oxygen isotope fraction (<math>\delta^{18}\text{O}</math>). Continuous underway measurements comprised: navigation; currents, using ship-mounted ADCPs (75 and 150 kHz); meteorology; sea surface temperature and salinity; 3.5 kHz sub-bottom sediment profiling; and bathymetry. Three sediment cores were obtained. Six floats / drifters were launched. D298 (CFER-1) is a part of the project “Cape Farewell and Eirik Ridge: Interannual to Millennial Thermohaline Circulation Variability”, funded by the UK Natural Environment Research Council as part of its “Rapid Climate Change” Directed Research Programme.</p>	
<b>KEYWORDS</b> ADCP, Atlantic Ocean, Cape Farewell, CFC, cruise D298 2005, CTD, deep western boundary current, <i>Discovery</i> , dissolved oxygen, Eirik Ridge, Lowered ADCP, meteorology, moorings, nutrients, oxygen isotopes, sediment cores, shipboard ADCP, sub-bottom profiler	
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## CONTENTS

<b>DOCUMENT DATA SHEET .....</b>	<b>3</b>
<b>CONTENTS.....</b>	<b>5</b>
<b>SCIENTIFIC PERSONNEL.....</b>	<b>8</b>
<b>SHIP'S PERSONNEL.....</b>	<b>9</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>10</b>
<b>1 INTRODUCTION .....</b>	<b>11</b>
<b>2 MOORING OPERATIONS.....</b>	<b>13</b>
2.1 NOC DWBC MOORINGS .....	13
2.1.1 <i>Mooring Design and Implementation</i> .....	13
2.1.2 <i>Current Meter Detail</i> .....	14
2.1.3 <i>Acoustic Release Detail</i> .....	15
2.1.4 <i>Setting up the IFREMER SBE16</i> .....	15
2.1.5 <i>Mooring G</i> .....	17
2.1.6 <i>Mooring E</i> .....	19
2.1.7 <i>Mooring D</i> .....	21
2.1.8 <i>Mooring C</i> .....	23
2.1.9 <i>Mooring B</i> .....	25
2.1.10 <i>Mooring H</i> .....	27
2.1.11 <i>Mooring A</i> .....	29
2.1.12 <i>Non-UKORS Moorings</i> .....	31
2.2 COMPTE-RENDU, MISSION OVIDE-05 .....	32
2.2.1 <i>OVIDE-2C</i> .....	32
2.2.2 <i>OVIDE-2E</i> .....	33
2.3 ULTRAMOOR RECOVERY .....	36
<b>3 CTD.....</b>	<b>38</b>
3.1 DATA PROCESSING USING THE SEABIRD SOFTWARE ON THE DATA-LOGGING PC .....	38
3.2 DATA PROCESSING ON THE UNIX SYSTEM .....	39
3.3 CTD CONDUCTIVITY CALIBRATION.....	40
3.3.1 <i>Processing path</i> .....	40
3.3.2 <i>CTD conductivity calibration results</i> .....	41
3.4 CTD OXYGEN SENSOR CALIBRATION.....	41
APPENDIX TO SECTION 3: SEABIRD SENSOR TYPES, SERIAL NUMBERS AND CALIBRATION DATES .....	51

<b>4</b>	<b>LOWERED ADCP .....</b>	<b>53</b>
4.1	SUMMARY .....	53
4.2	PROCESSING .....	54
4.2.1	<i>Firing Method</i> .....	54
4.2.2	<i>Procedures – Stage 1</i> .....	54
4.2.3	<i>Procedures – Stage 2</i> .....	55
4.2.4	<i>General Comments</i> .....	56
4.3	VISBECK PROCESSING ROUTE.....	56
4.3.1	<i>Results</i> .....	57
4.3.2	<i>Problems</i> .....	58
	APPENDIX I TO SECTION 4: COMMAND FILES.....	58
	APPENDIX II TO SECTION 4: VISBECK PROCESSING.....	59
<b>5</b>	<b>NAVIGATION .....</b>	<b>62</b>
5.1	GPS AND BESTNAV .....	62
5.2	SHIP’S GYROCOMPASS .....	62
5.3	ASHTECH 3DF GPS ATTITUDE DETERMINATION .....	63
<b>6</b>	<b>SHIPBOARD ACOUSTIC DOPPLER CURRENT PROFILERS .....</b>	<b>64</b>
6.1	RDI 150 KHz SHIPBOARD ACOUSTIC DOPPLER CURRENT PROFILER .....	64
6.1.1	<i>Configuration and Performance</i> .....	64
6.1.2	<i>Clock Correction</i> .....	64
6.1.3	<i>Processing</i> .....	64
6.1.4	<i>Calibration</i> .....	64
	APPENDIX I TO SECTION 6: WATER TRACK CONFIGURATION FILE FOR THE 150 KHz SADCP .....	65
6.2	OCEAN SURVEYOR 75 KHz SHIPBOARD ACOUSTIC DOPPLER CURRENT PROFILER .....	69
6.2.1	<i>Configuration and Performance</i> .....	69
6.2.2	<i>Processing</i> .....	69
6.2.3	<i>Calibration</i> .....	70
	APPENDIX II TO SECTION 6: CONFIGURATION FILES FOR THE 75 KHz SADCP .....	72
<b>7</b>	<b>WATER SAMPLES .....</b>	<b>80</b>
7.1	SALINITY .....	80
7.1.1	<i>Equipment</i> .....	80
7.1.2	<i>Sample Collection and Analysis</i> .....	80
7.1.3	<i>Data Processing</i> .....	81
7.2	DISSOLVED OXYGEN .....	83
7.3	NUTRIENTS.....	86
7.4	CFCs .....	87

7.5	OXYGEN ISOTOPE SAMPLES .....	89
<b>8</b>	<b>UNDERWAY SURFACE METEOROLOGY .....</b>	<b>92</b>
8.1	ROUTINE PROCESSING .....	92
8.2	TSG SALINITY CALIBRATION .....	93
	APPENDIX TO SECTION 8: SURFMET SENSOR INFORMATION .....	97
<b>9</b>	<b>ECHOSOUNDER .....</b>	<b>98</b>
<b>10</b>	<b>CORING .....</b>	<b>100</b>
10.1	D298 PISTON CORE P1 .....	100
10.2	D298 PISTON CORE P2 .....	101
10.3	D298 PISTON CORE P3 .....	102
<b>11</b>	<b>SUB-BOTTOM PROFILER .....</b>	<b>103</b>
11.1	INTRODUCTION .....	103
11.2	ACQUISITION SYSTEM .....	103
11.3	SETTINGS USED .....	103
11.4	OPERATION .....	105
11.5	INITIAL RESULTS .....	106
11.6	PROBLEMS .....	106
<b>12</b>	<b>DARTCOM AND COMPUTING .....</b>	<b>108</b>
<b>13</b>	<b>ENGINEERING .....</b>	<b>109</b>
<b>14</b>	<b>FLOATS AND DRIFTERS .....</b>	<b>110</b>
14.1	UK MET. OFFICE SURFACE DRIFTERS .....	110
14.2	IFREMER PROVOR FLOATS .....	110
14.3	ARGO FLOAT .....	111
	<b>REFERENCES .....</b>	<b>113</b>

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Jeffrey Orsborn	Steward

## ACKNOWLEDGEMENTS

We are most grateful to the Master (Roger Chamberlain), the officers and crew of RRS *Discovery*. D298 was a difficult cruise, carried out in rather foul weather, and with occasional mechanical problems.

Our senior scientific engineers deserve a large amount of credit for their hard and efficient work in trying conditions: particularly Ian Waddington (i/c Moorings), Steve Whittle (Technical Liaison Officer), and Dave Teare (electronics). We would have been in a pickle without such high-quality engineers.

Thanks to Helen Snaith and Louise Allen back at base for putting up our (near-) daily web diary.

I am personally very grateful to John Allen, as my “lieutenant”, and to Steve Alderson, for their help and support during the cruise.

Thanks to our friends and colleagues at IFREMER for the loan of three instruments with which to improve our westernmost mooring (A).

D298 was funded by the UK Natural Environment Research Council as part of a project under its “Rapid Climate Change” Directed Research Programme: “Cape Farewell and Eirik Ridge: Interannual to Millennial Thermohaline Circulation Variability”, grant no. NER/T/S/2002/00453.

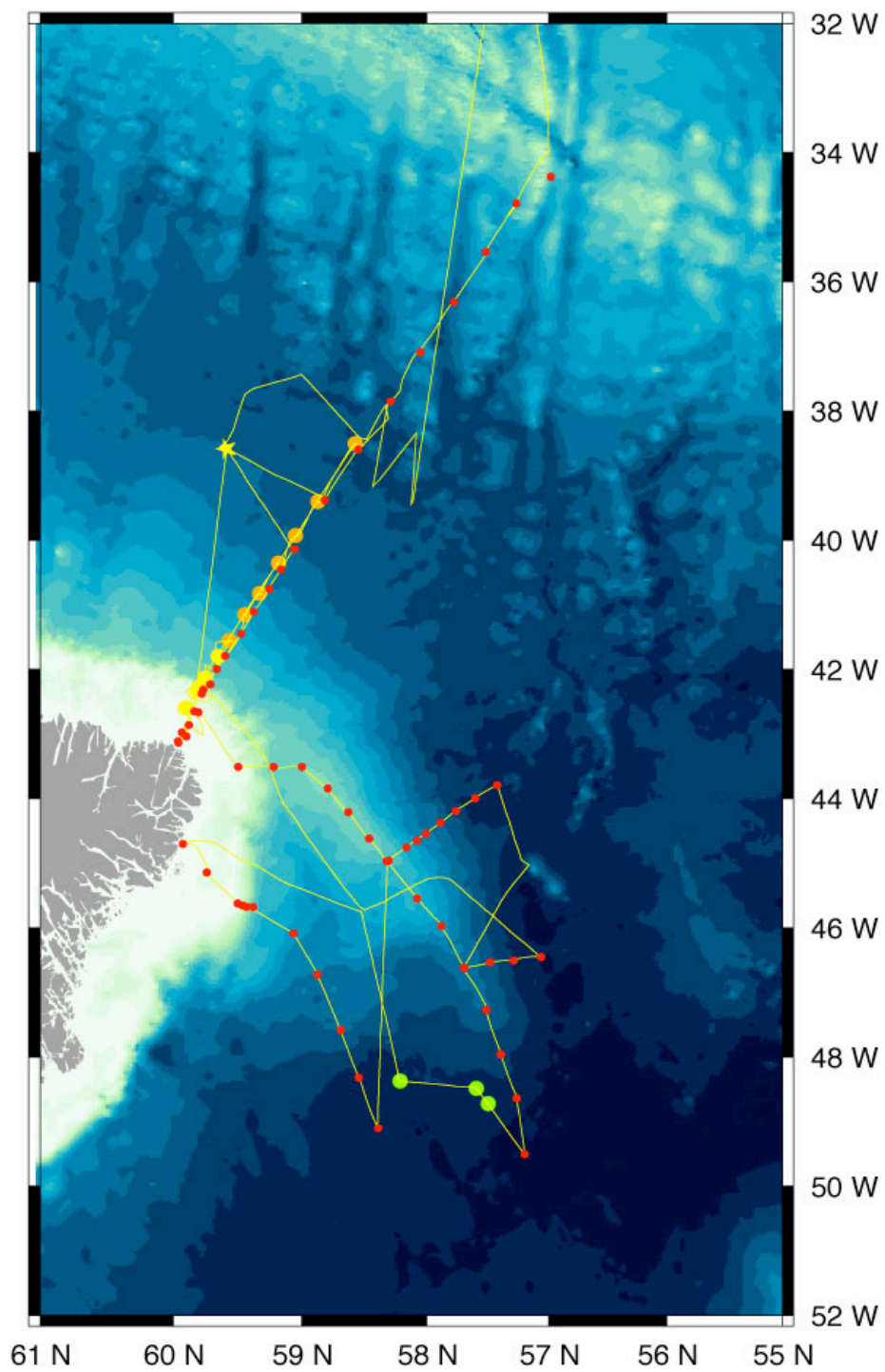
# **1 INTRODUCTION**

Sheldon Bacon

D298 was an interesting cruise to the environs of Cape Farewell, southern Greenland, combining hydrographic survey work with mooring operations, sediment coring and sub-bottom-profiling. The amount of work we were able to complete was restricted by foul weather, and since the mooring operations took top priority, this meant that the total number of hydrographic stations and sediment cores were reduced over the original intentions. Nevertheless, all the essentials were achieved. Figure 1.1 shows our track, with positions of stations, cores and moorings. Positions of all five IFREMER moorings are included for reference; we were directly concerned with two of them during the cruise.

For future reference, the names of the individual hydrographic sections were the Irminger Basin section (easternmost section), the Labrador Sea section (north-western-most section), the Eirik Ridge section (following the top of the ridge), the Spur (the eastern of the two short sections), and the Stub (the western short section).

The total of scientific activities completed during the cruise were as follows. 63 CTD/LADCP stations carried out, and water samples collected and either analysed on board or frozen for later analysis (see the relevant report section description of analyses); 7 NOC moorings deployed; 2 IFREMER moorings recovered, serviced and redeployed; 1 WHOI mooring recovered; 6 floats / drifters deployed; 3 sediment cores obtained; and lots of underway data (of various sorts) gathered. These are all described in the relevant sections below.



**Figure 1.1:** D298 track (yellow line), stations (red dots), cores (green dots), NOC moorings (orange dots), IFREMER moorings (yellow dots), and WHOI mooring (yellow star). Bathymetry is from Smith and Sandwell (1997), plotted in 200 m depth increments.



## **2 MOORING OPERATIONS**

### **2.1 NOC DWBC Moorings**

#### *2.1.1 Mooring Design and Implementation*

The mooring array hardware design was derived from the scientific outline diagrams. The instrumentation is each supported by its own buoyancy package. Thus if at any time a line should fail, each instrument is supported, either to rise to the surface or if moored to remain upright and in a position to continue logging data. Budget constraints precluded the use of ARGOS beacons, and with the experiences gained on similar deep RAPID moorings at 26.5N was deemed not required. Mooring designs were all run through the hydrodynamics mooring software to validate performance in the expected maximum current conditions. Mooring design and hardware detail can be found UKORS cruise file Moorings - D298 CapeFarewell\D298 LATEST.

All deep mooring lines are braid on braid polyester. Lines were purchased pre-measured and spliced from the manufacturer. Due to late changes within the array, lines were adjusted onboard and respliced. This use of polyester in deep arrays such as this allows late changes to be made given the competence of the person splicing the line ends. Mooring A was extended during the design of the array to include additional IFREMER instruments. Thus the line used throughout is 6mm galvanised steel wire coated to 8 mm diameter with polypropylene. This line is also provided with a titanium swivel at the steel buoy.

Shackles are all federal specification screw pin bow - 5/8 pin for in line applications, 1/2" pin for glass sphere attachment. Chain is predominantly 3/8" for buoyancy and 1/2" for anchor attachment, providing a robust assembly as used on all conventional UKORS wire moorings.

Buoyancy, other than mooring A, is 17 inch glass spheres, providing distributed buoyancy throughout the mooring with a pick glass sphere on recovery line for mooring recovery. Mooring A uses a 48 inch steel sphere with additional glass back up buoyancy.

Anchors are all steel chain bundled together with 5/8" galvanised long link chain , providing a good hold down force with improved resistance to drag on the sloping topography.

Moorings were deployed buoy first with freefall anchor last. Deployments were carried out with the UKORS DBC portable mooring traction winch system and ships cranes. Anchor release was using the SeaCatch hook. Stopping off and instrument handling using the UKORS mooring table.

Ship's speed was controlled throughout each operation to keep the drag loading within safe limits whilst maintaining line tension and ship's progression towards the mooring site. Short tows were undertaken on completion of streaming out the mooring to position at the correct depth for each

mooring prior to anchor drop. Only mooring A was monitored during descent by acoustic transponding. At all anchor drops, depth, time and ship's position were noted in the main lab.

### 2.1.2 Current Meter Detail

Two types of current meter are used in the mooring array – RCM 7/8, a rotor vane instrument and RCM 11 a Doppler current sensor. Each are self recording to a data storage device. The RCM 7/8 type is set to record at 1 hour intervals. The RCM 11 type is set to record at 30 minute intervals in Burst mode. Details of channel and sensor selections are given in the Instruments Folder. Scaling, set up and calibration of sensors was carried out at NOC.

Two RCM8 units brought as spares were incorporated into the moorings adjacent to RCM 11 current meters to provide sensor intercomparisons as Moorings H and B. Calibration and sensor detail is in UKORS cruise file Moorings – D298 CapeFarewell\Calibrations. Set up detail is in UKORS cruise file Moorings – D298 CapeFarewell\Instruments. D COMBEN – S WHITTLE

### SUMMARY

CURRENT METER SERIAL NO.	FIRST DATA	SAMPLE INT.	DATE / DAY
RCM8 7452	1900 gmt	60 mins	27- August - 2005 Day 239
RCM8 9681	1600 gmt	60 mins	30- August - 2005 Day 242
RCM8 12293	1900 gmt	60 mins	27- August - 2005 Day 239
RCM8 10277	1900 gmt	60 mins	27- August - 2005 Day 239
RCM8 12692	1400 gmt	60 mins	27- August - 2005 Day 239
RCM8 12691	1400 gmt	60 mins	27- August - 2005 Day 239
RCM8 12668	2100 gmt	60 mins	27- August - 2005 Day 239
RCM8 9450	1100 gmt	60 mins	28- August - 2005 Day 240
RCM8 10280	2100 gmt	60 mins	27- August - 2005 Day 239
RCM8 6750	1500 gmt	60 mins	27- August - 2005 Day 239
RCM7 11678	1400 gmt	60 mins	27- August - 2005 Day 239
RCM7 9598	1500 gmt	60 mins	27- August - 2005 Day 239
RCM8 9598	1500 gmt	60 mins	27- August - 2005 Day 239
RCM11 443	1100 gmt	30 mins	28- August - 2005 Day 240
RCM11 516	1630 gmt	30 mins	29- August - 2005 Day 241
RCM11 520	1100 gmt	30 mins	28- August - 2005 Day 240
RCM11 515	1100 gmt	30 mins	28- August - 2005 Day 240
RCM11 381	1100 gmt	30 mins	28- August - 2005 Day 240
RCM11 518	1700 gmt	30 mins	29- August - 2005 Day 241
RCM11 507	2100 gmt	30 mins	27-August - 2005 Day 239
RCM11 399	2100 gmt	30 mins	27-August - 2005 Day 239
RCM11 438	2100 gmt	30 mins	27-August - 2005 Day 239
RCM11 428	1900 gmt	30 mins	27-August - 2005 Day 239
RCM11 395	1900 gmt	30 mins	27-August - 2005 Day 239

RCM11 444	1900 gmt	30 mins	27-August - 2005 Day 239
RCM11 510	1900 gmt	30 mins	27-August - 2005 Day 239
RCM11 519	1500 gmt	30 mins	27-August - 2005 Day 239
RCM11 426	1500 gmt	30 mins	27-August - 2005 Day 239
RCM11 383	1400 gmt	30 mins	27-August - 2005 Day 239

### 2.1.3 Acoustic Release Detail

The acoustic releases used throughout the array are IXSEA AR861 units each having a unique ARM command but with common other commands throughout as:

RELEASE	1455
RELEASE WITH PINGER	1456
PINGER ON	1447
PINGER OFF	1448
DIAGNOSTIC	1449

All the units used in the Array were wire tested to operating depth requirements on CTD stations, to mooring depths required. Using TT801 deck unit and PES single element.

MOORING	SER.NO	ARM/RANGING
A	354	14EA
B	360	14F0
C	325	14D5
D	364	14F4
E	327	14D7
G	316	14CC
H	355	14EB

All Build Sheets were produced electronically on D298 and are contained in the folder UKORS cruise file Moorings - D298 CapeFarewell\AR861.

### 2.1.4 Setting up the IFREMER SBE16

D Childs

Before using the SBE 16, an interface cable needed to be made as the unit was supplied without one. Additionally, the instrument had the wrong manual, resulting in some confusion as to the correct configuration settings. Having identified the instrument as a SBE16 and not a SBE 16 Plus, the correct manual was printed from the SBE website and the correct settings were obtained.

Having located a spare SBE bulkhead connector and a 9 pin D type connector the lead was made. Having made the lead, the unit was tested by configuring the SBE 16 with SeaTerm to use the following settings:

Baud Rate:     **600**  
Data Bits:     **7**  
Stop Bits:     **1**  
Parity:        **Even**

Initial tests showed that the unit was still logging data, so once the unit had been halted, the internal batteries were removed, and replaced with new D type cells. This ensures that there is sufficient battery capacity to operate the instrument for the intended one year deployment.

Next, the date and time were set using the ships clock, to ensure the unit had the correct GMT time and date settings:

Date set to **28 August 05**; Time Set to **12:13:00**

After installing new batteries and setting the correct date and time, a memory check was performed to ensure that all memory in the unit was free from errors. To do this the **TE** command was issued. This runs through each of the SBE 16's memory modules ten times to check the reading and writing functions of the instrument. After a period of about five minutes, the test completed and showed no errors.

Next the instrument was set to log data for a short period, to test the instrument prior to deployment. These tests just involved running the instrument on the bench for a few hours to check that all the sensors were working correctly and logging data. The settings used for the test were also used for the actual deployment:

Sample Interval = **1800**     Sample Number = **0**     Free Samples = **173880**

To get the instrument to run the **GL** command was issued, followed by a secondary conformation. Once entered twice the **GL** command sets the unit up to log from that point onwards, at the set logging interval.

After the unit was set to log, the instrument was checked over prior to being fitted into its mooring attachment, as supplied by IFREMER. This required the instrument to be clamped into a bracket which would be fitted into the mooring line via shackles at each end fitted through eyelets. To keep the conductivity sensor clean and slightly damp, a hose was fitted with a small amount of water inside it to stop the sensor drying out. At deployment time, this hose was removed and kept ready for the recovery of the instrument.

### 2.1.5 Mooring G

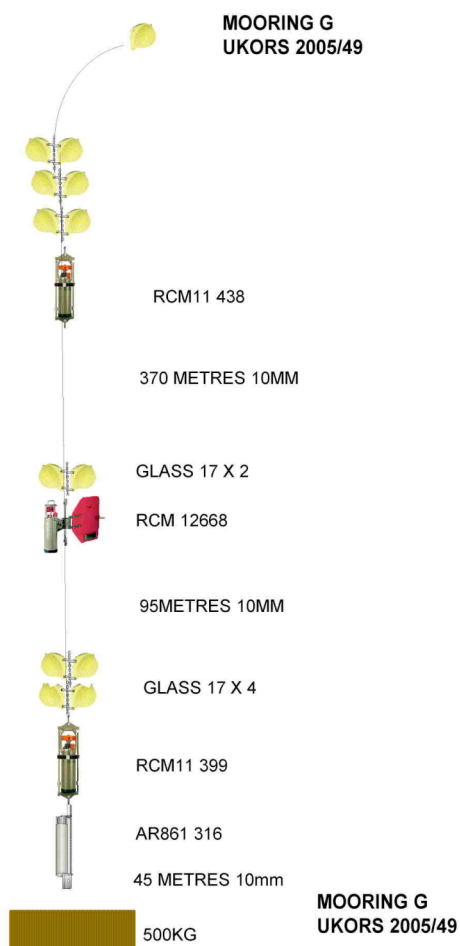
4th Sept 2005 - Day 247UKORS MRG 2005/49

Commence deploy in slight swell, deploy using DBC - prewound moorings using mooring table for stop off. Buoy first. Hove to increasing 1 kt with final tow speed 1.5 kts all mooring deployed - connected to anchor on deck on crane with SeaCatch for deploy. Anchor free fall. Note that time and positions shown are as logged in the main lab at the moment of anchor release from the ship.

Anchor away - 1233+38s GMT Depth 3208 ucm

58 34.758N 38 30.066W - observed in lab .

1235 + 49 GMT



FAIRLIE - GOVAN		DEPLOYMENT	UKORS ID	2005/49
LATITUDE	58 34.758N		DATE	4TH SEPT 05
LONGITUDE	39 24.043W		DAY	247
NOTE ALL TIMES RECORDED IN GMT				
COMMENCE TIME				
COMPLETION TIME	1235			

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	438	RCM 11	
POLYESTER 10MM		370 METRES	
GLASS 2 X 17			
RCM	12668	RCM 8	
POLYESTER 10MM		95 METRES	
GLASS 4 X 17			
RCM	399	RCM11	
AR861	316		
POLYESTER 10MM		45 METRES	
CHAIN 1/2"		1M	
ANCHOR		500 KG CHAIN CLUMP	1235 gmt

**MOORING METHOD** FREEFALL DEPLOYMENT

#### COMMENTS

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 45 metres - modification on cruise

#### UKORS PERSONNEL

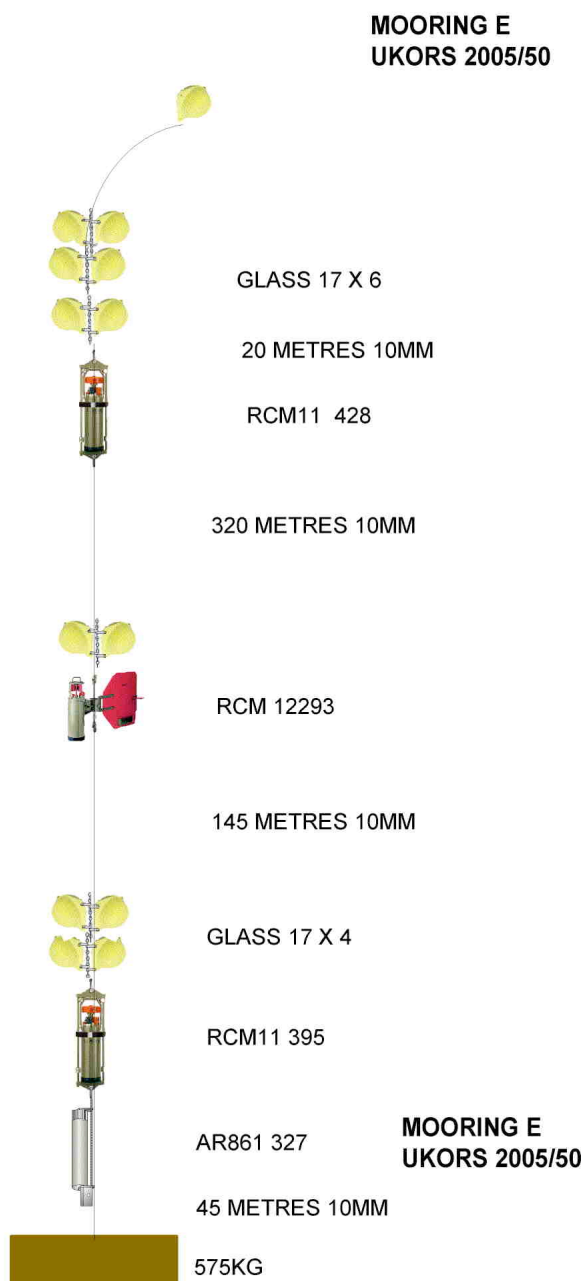
Waddington , Whittle , Comben , Childs

### 2.1.6 Mooring E

4th Sept 2005 - Day 247 UKORS MRG 2005/50

Deploy slight swell and sea mist, deploy as method G - start point 1.5 nm increase speed through deploy to 2.5 kts - final tow speed 3 kts. Anchor freefall.

Anchor away 1630 + 21s GMT Depth 3094 ucm, 58 52.471N, 39 24.043W



FAIRLIE - GOVAN		DEPLOYMENT	UKORS ID	2005/50
LATITUDE	58 52.471N		DATE	4TH SEPT 05
LONGITUDE	39 24.043W		DAY	247
NOTE ALL TIMES RECORDED IN GMT				
COMMENCE TIME				
COMPLETION TIME	1630			

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	428	RCM 11	
POLYESTER 10MM		320 METRES	
GLASS 2 X 17			
RCM	12293	RCM 8	
POLYESTER 10MM		145 METRES	
GLASS 4 X 17			
RCM	395	RCM11	
AR861	327		
POLYESTER 10MM		45 METRES	
CHAIN 1/2"		1M	
ANCHOR		575 KG CHAIN CLUMP	1630GMT

**MOORING METHOD** FREEFALL DEPLOYMENT

#### COMMENTS

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 45 metres - modification on cruise

#### UKORS PERSONNEL

Waddington , Whittle , Comben , Childs



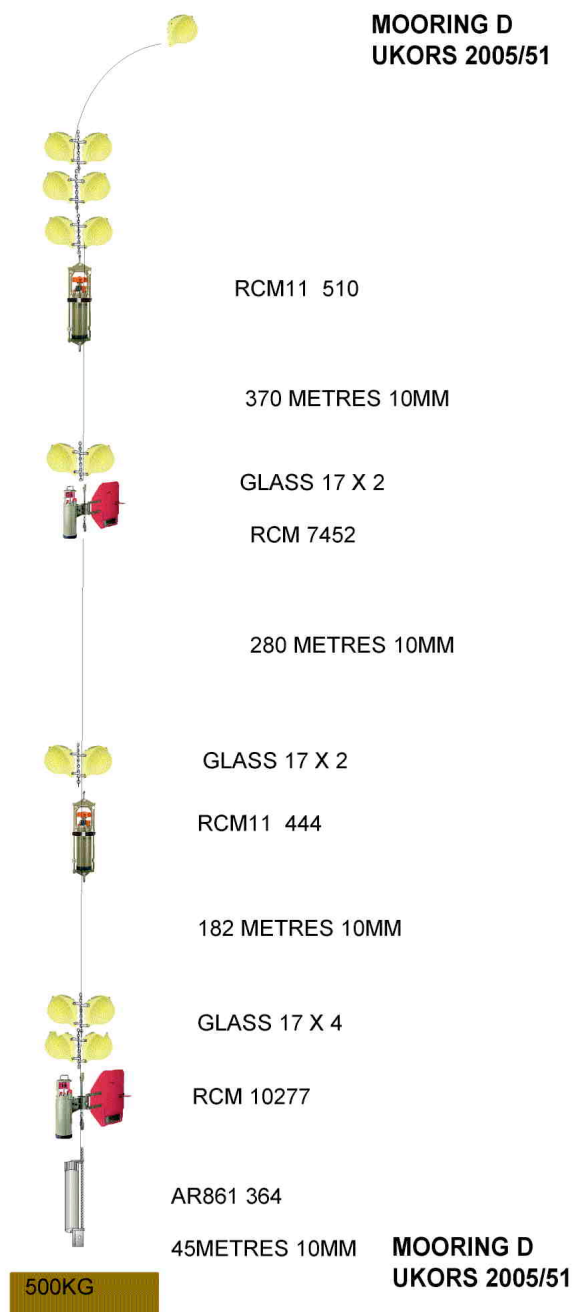
### 2.1.7 Mooring D

4th Sept 2005 - Day 247UKORS MRG 2005/51

As mooring E above - Increasing anchor by 75 kg with additional chain

Anchor away 1913 + 30s GMT Depth 3042 ucm

59 02.969 N 39 55 .249 W



FAIRLIE - GOVAN		DEPLOYMENT	UKORS ID	2005/51
LATITUDE	59 02.969N		DATE	4TH SEPT 05
LONGITUDE	39 55.249W		DAY	247
NOTE ALL TIMES RECORDED IN GMT				
COMMENCE TIME				
COMPLETION TIME	1913			

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	510	RCM 11	
POLYESTER 10MM		370 METRES	
GLASS 2 X 17			
RCM	7452	RCM 8	
POLYESTER 10MM		280 METRES	
GLASS 2 X 17			
RCM	444	RCM11	
POLYESTER 10MM		182 METRES	
GLASS 4 X 17			
RCM	10277	RCM8	
AR861	364		
POLYESTER 10MM		45 METRES	
CHAIN 1/2"		1M	
ANCHOR		575 KG CHAIN CLUMP	1630GMT

**MOORING METHOD** FREEFALL DEPLOYMENT

#### COMMENTS

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 45 metres - modification on cruise

#### UKORS PERSONNEL

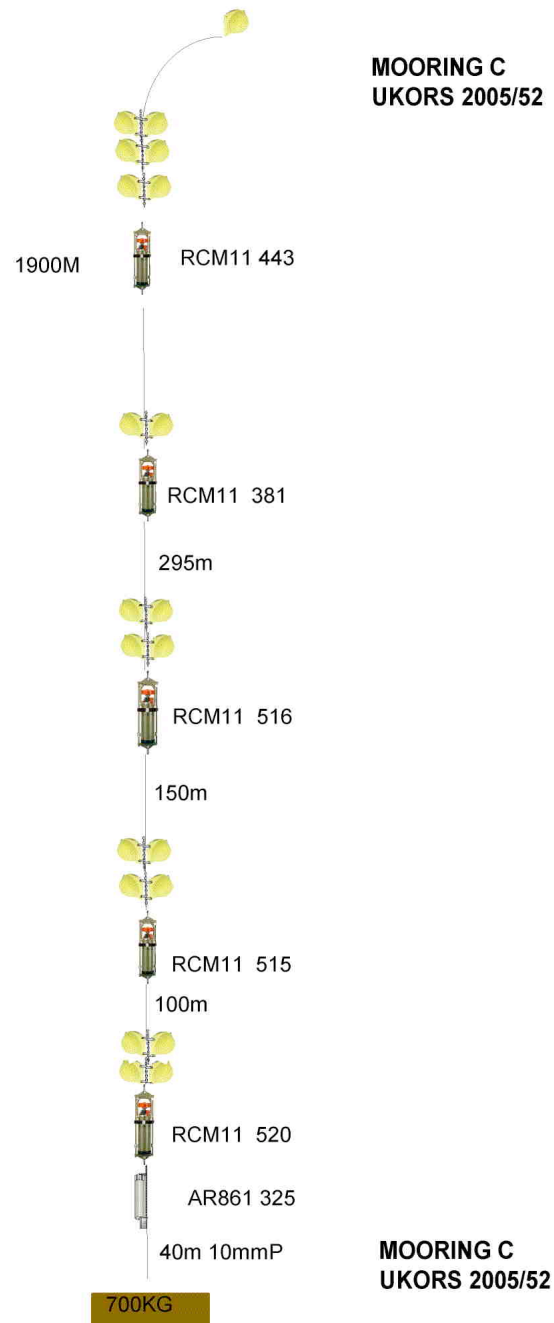
Waddington , Whittle , Comben , Childs

### 2.1.8 Mooring C

5th Sept 2005 - Day 248UKORS MRG 2005/52

Buoy first - 1/2 mile tow at 2 kts onto position. Raining steadily.

Anchor away 0917 + 36s GMT Depth 2914 ucm, 59 11.103 N, 40 21.011 W



FAIRLIE - GOVAN

DEPLOYMENT

UKORS ID

2005/52

<b>LATITUDE</b>	59 11.103N
-----------------	------------

<b>DATE</b>	5TH SEPT 05
-------------	-------------

<b>LONGITUDE</b>	40 21.011W
------------------	------------

<b>DAY</b>	248
------------	-----

NOTE ALL TIMES RECORDED IN GMT

<b>COMMENCE TIME</b>	
----------------------	--

<b>COMPLETION TIME</b>	0917Z
------------------------	-------

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	443	RCM 11	
POLYESTER 10MM		295 METRES	
GLASS 2 X 17			
RCM	381	RCM 11	
POLYESTER 10MM		295 METRES	
GLASS 4 X 17			
RCM	516	RCM11	
POLYESTER 10MM		150 METRES	
GLASS 4 X 17			
RCM	515	RCM11	
POLYESTER 10MM		100 METRES	
GLASS 4 X 17			
RCM	520		
AR861	325		
POLYESTER 10MM		40 METRES	
CHAIN 1/2"		1M	
ANCHOR		700 KG CHAIN CLUMP	0917GMT

<b>MOORING METHOD</b>	FREEFALL DEPLOYMENT
-----------------------	---------------------

**COMMENTS**

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 45 metres - modification on cruise

**UKORS PERSONNEL**

Waddington , Whittle , Comben , Childs

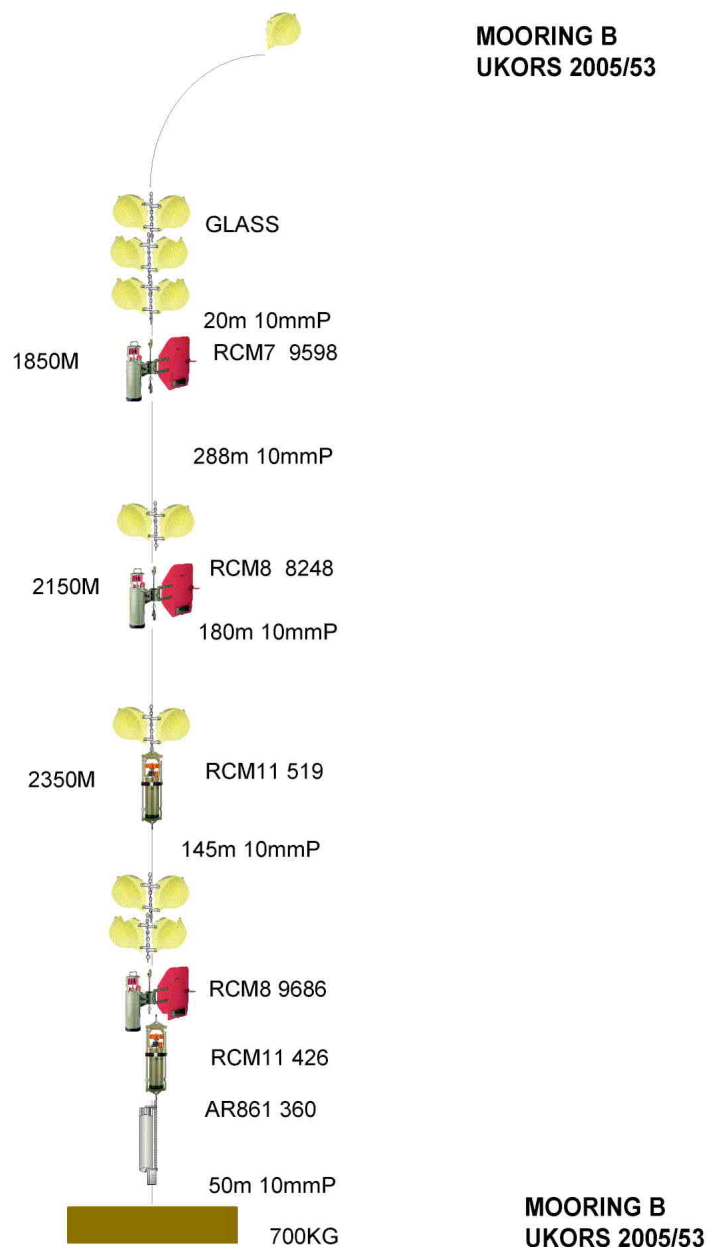
### 2.1.9 Mooring B

5th Sept 2005 - Day 248

UKORS MRG 2005/53

Buoy first - 3/4 mile tow at 2.5kts onto position. Raining steadily - poor visibility 1/2 to 1 mile.

Anchor away 12 02+07s GMT Depth 2681 ucm, 59 19.976 N, 40 49.259 W



FAIRLIE - GOVAN

DEPLOYMENT

UKORS ID 2005/53

LATITUDE 59 19.976N

DATE 5TH SEPT 05

LONGITUDE 40 49.259W

DAY 248

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

COMPLETION TIME 1202Z

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	9598	RCM7	
POLYESTER 10MM		288 METRES	
GLASS 2 X 17			
RCM	8248	RCM8	
POLYESTER 10MM		180 METRES	
GLASS 2 X 17			
RCM	519	RCM11	
POLYESTER 10MM		145 METRES	
GLASS 4 X 17			
RCM	9686	RCM8	
RCM	426	RCM11	
AR861	360		
POLYESTER 10MM		50 METRES	
CHAIN 1/2"		1M	
ANCHOR		700 KG CHAIN CLUMP	1202GMT

MOORING METHOD FREEFALL DEPLOYMENT

**COMMENTS**

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 50 metres - modification on cruise

**UKORS PERSONNEL**

Waddington , Whittle , Comben , Childs

### 2.1.10 Mooring H

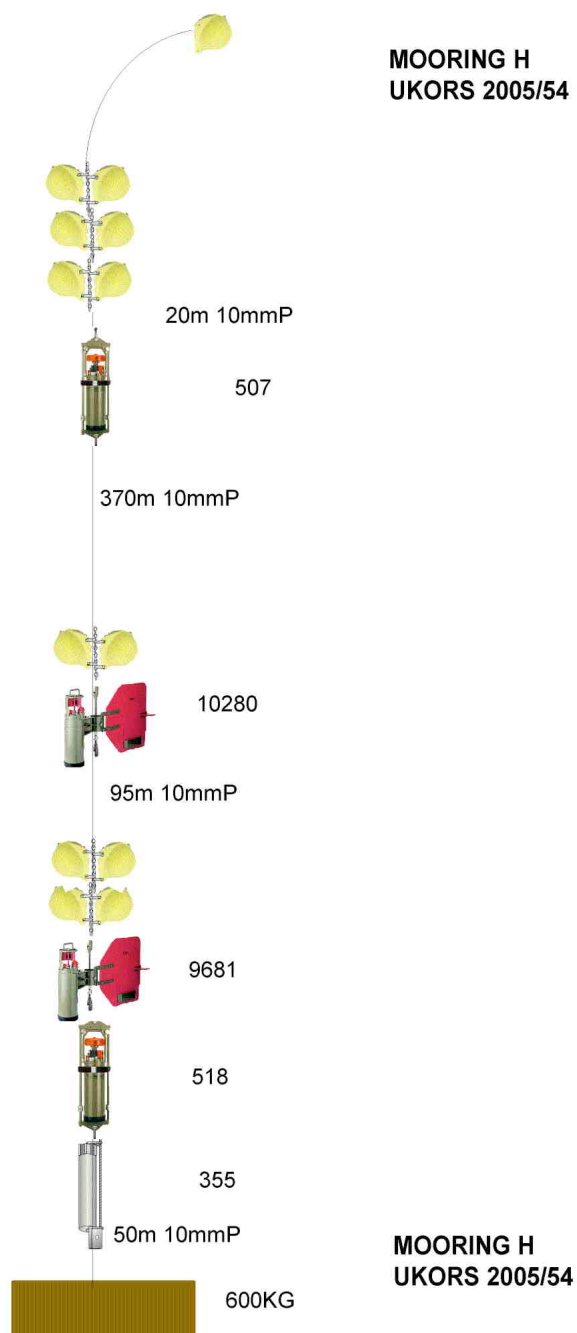
5th Sept 2005 - Day 248

UKORS MRG 2005/54

Buoy first - 1/2 mile tow at 2.5 kts onto position. Raining steadily - slight swell.

Anchor away 1355+20s GMT Depth 2443m ucm

59 26.966 N 41 09.0932 W



FAIRLIE - GOVAN		DEPLOYMENT	UKORS ID	2005/54
LATITUDE	59 19.976N		DATE	5TH SEPT 05
LONGITUDE	40 49.259W		DAY	248
NOTE ALL TIMES RECORDED IN GMT				
COMMENCE TIME				
COMPLETION TIME	1202Z			

ITEM	SER NO	COMMENT	TIME
GLASS 17 PICK UP		YELLOW	
REC LINE		15M 20MM POLYPROP GREEN	
GLASS 6 X 17			
RCM	507	RCM11	
POLYESTER 10MM		370 METRES	
GLASS 2 X 17			
RCM	10280	RCM8	
POLYESTER 10MM		95 METRES	
GLASS 4 X 17			
RCM	9681	RCM8	
RCM	518	RCM11	
AR861	355		
POLYESTER 10MM		50 METRES	
CHAIN 1/2"		1M	
ANCHOR		700 KG CHAIN CLUMP	1202GMT

**MOORING METHOD** FREEFALL DEPLOYMENT

#### COMMENTS

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Height reduction of bottom current meter to 50 metres - modification on cruise

#### UKORS PERSONNEL

Waddington , Whittle , Comben , Childs



### 2.1.11 Mooring A

6th Sept 2005 - Day 249

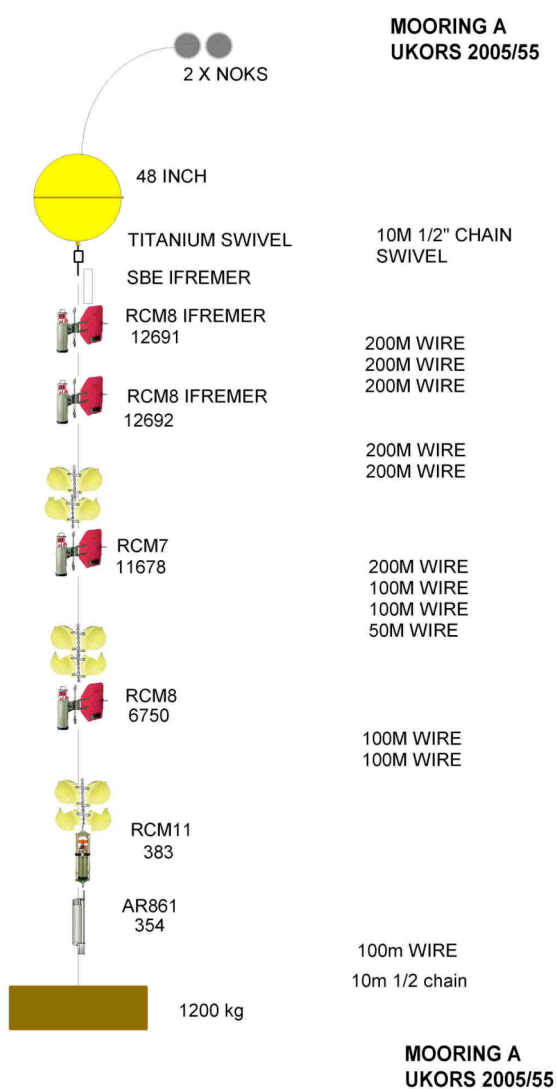
UKORS MRG 2005/55

Buoy first deployment - 1/2 mile tow at 2kts onto position. Swell running causing occasional heavy pitch aft. Mooring design adjusted to ease deployment of glass - anchor increased from 800 kg to 1200 kg .

Anchor away 1220 + 15s GMT Depth 2113 ucm

59 33.967N 41 33.038W

Mooring observed to seabed using acoustic release. Observed on seabed at 1231+30S gmt range 1975m. wd= 2113m , release height off bed = 110m. Interrogate vertical and 9.2V battery. Mooring indications OK departed site at 1240 gmt.



FAIRLIE - GOVAN		DEPLOYMENT	UKORS ID	2005/55
LATITUDE		59 33.967N	DATE	6TH SEPT 05
LONGITUDE		41 33.038W	DAY	249

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

COMPLETION TIME 1220

ITEM	SER NO	COMMENT	TIME
NOKALON 14 X 2		WHITE NOK FLOATS	
REC LINE		15M 20MM POLYPROP GREEN	
STEEL 48 WITH MAST		YELLOW	
CHAIN 1/2 INCH LONG L		10 METRES	
SWIVEL TITANIUM		ELKINS	
SBE 16		IFREMER ON IFREMER MOORING ROD	
RCM	12691	RCM8 IFREMER	
WIRE BLUE 6-8		200M	
WIRE BLUE 6-8		200M	
WIRE BLUE 6-8		200M	
RCM	12692	RCM8 IFREMER	
WIRE BLUE 6-8		200M	
WIRE BLUE 6-8		200M	
GLASS 17 X 4			
RCM	11678	RCM7	
WIRE BLUE 6-8		200M	
WIRE BLUE 6-8		100M	
WIRE BLUE 6-8		100M	
WIRE BLUE 6-8		50M	
GLASS 17 X 4			
RCM	6750	RCM8	
WIRE BLUE 6-8		100M	
WIRE BLUE 6-8		100M	
RCM	383	RCM11	
AR861	354		
WIRE BLUE 6-8		100M	
CHAIN 1/2 INCH LONG		10M	
ANCHOR 1200 KG		CHAIN	1220GMT

MOORING METHOD FREEFALL DEPLOYMENT

#### COMMENTS

Cape Farewell Mooring - for Sheldon Bacon - RAPID

Modifications to anchoring and buoyancy carried out during deploy increasing ea.

On seabed 1231 gmt ranging on descent - interrogate on seabed as vertical and 9.2v

#### UKORS PERSONNEL

Waddington , Whittle , Comben , Childs

### *2.1.12 Non-UKORS Moorings*

See sections 2.2 and 2.3 for more detail.

#### **7th September 2005 - Day 250**

Recover IFREMER OVIDE Mooring - tangled wires - all instruments recovered intact. Released using NOC 810 deck unit set to 8Khz recv.

Recover IFREMER ADCP Lander - OK - Released using IFREMER 300 deck unit and dunker - reception poor - possibly due to hole - adjusted position and determined location by closing on original mooring position.

#### **18th September 2005 - Day 261**

Deploy IFREMER OVIDE mooring 1100m water depth, steep slope, at 8khz setting the NOC 810C deck unit had severe problems receiving signals from IFREMER releases. On IFREMER TT300 with dunker - good comms established at ranges of 1200 m. Triangulated using dunker on TT300.

Deploy IFREMER ADCP lander. Triangulated using IFREMER TT300

#### **19th September 2005 - Day 262**

Recover WHOI Ultramooring. Long swell. Recovered large syntactic using deck auxiliary winch and then transfer to DBC. Increase number of turns on winch to 5 to increase traction as coated wire slipping on drums. Recovery went well using mooring table. Final back up buoyancy recovered using both aft cranes. Recovered tangled – releases on chain hand hauled onboard.

## 2.2 Compte-Rendu, Mission Ovide-05

Le but de la campagne OVIDE-05 à bord du RRS *Discovery* est de relever deux mouillages courantométriques (OVIDE-2C et OVIDE-2E) déployés en juin 2004 lors de la campagne OVIDE-04 à bord du N/O *Thalassa*, et de redéployer ces deux mouillages avec des configurations légèrement différentes.

### 2.2.1 OVIDE-2C

Le mouillage OVIDE-2C, qui comporte un ADCP 75 kHz (RDI) en tête de ligne est reconditionné et reprogrammé à bord, il peut alors être redéployé sur le mouillage.

OVIDE-2C bis. Il faut auparavant lui extraire toutes ces données. Les trois courantomètres (Aanderaa) RCM8 sont remplacés par de nouveaux courantomètres du même type, et le Seacat (Seabird) est remplacé par un Microcat (Seabird). Sur ce nouveau mouillage nous ajoutons deux courantomètres de nouvelle génération, pour une inter comparaison. A la profondeur de 890 mètres nous positionnons un courantomètre RCM 11 (Aanderaa) couplé avec un RCM 8 (Aanderaa), à la profondeur de 990 mètres nous positionnons un courantomètre Aquadopp (Nortek) couplé avec un RCM 8 (Aanderaa).

Pour ce mouillage, il faut trouver une position proche de celle de l'année dernière pour obtenir la même profondeur de déploiement, ceci nous assurera un jeu de données similaire. Après un bref relevé bathymétrique nous déterminons la position idéale, la profondeur est d'environ 1100 mètres.

#### ⇒ Relevage mouillage OVIDE-2C:

Latitude : N 59° 48'.092                      Profondeur : 1086 mètres  
Longitude : W 42° 16'.627

Seacat N° 4610 échantillonnage 10 minutes (CTD)

Courantomètres RCM 8 N° 10235 , 12288 , 12514 échantillonnage 1 heure (TPVCap)

ADCP 75 KHz N° 881 échantillonnage 30 minutes

Balise ARGOS N° 11263

Largueurs IXSEA N° 294 , 447

#### ⇒ Déploiement mouillage OVIDE-2C bis:

Latitude : N 59° 47'.620                      Profondeur : 1112 mètres  
Longitude : W 42° 15'.922

Microcat N° 4008 échantillonnage 10 minutes (CTD)

Courantomètres RCM 8 N° 10743 , 10233 , 10232 échantillonnage 1 heure ( TPVCap )  
Courantomètre RCM 11 N° 454 échantillonnage 1 heure ( TPVCap )  
Courantomètre Aquadopp N° 1337 échantillonnage 1 heure ( TPVCap )  
ADCP 75 KHz N° 881 échantillonnage 30 minutes  
Balise ARGOS N° 11259  
Largueur IXSEA N° 294 , 447

### 2.2.2 OVIDE-2E

Le mouillage OVIDE-2E est un châssis aluminium posé sur le fond avec un ADCP 300 kHz (RDI) monté sur cardan, et un Seacat pour la mesure de salinité. L'ADCP est reconditionné à bord après l'extraction des données. Pour cela il faut ouvrir l'appareil, lui changer son énergie et le reprogrammer pour sa nouvelle mission. Après avoir visualisé les données acquises, il semble indispensable de changer la programmation de l'ADCP. Sur la période hivernale, il y a une absence importante de données, dû probablement au manque de particules dans l'eau. Une configuration différente est choisie avec une cadence d'échantillonnage plus rapide et un fonctionnement en Broadband plutôt que Narrowband. Les différents appareils sont montés dans un nouveau châssis plus compact, le Seacat est remplacé par un Microcat et une intercomparaison sera effectuée par l'ajout d'un nouveau capteur de salinité (RBR). Le châssis est déployé plus près de la côte cette année, en l'absence de glace, pour mesurer la vitesse maximale du courant «EGCC» qui longe la côte du Groenland. Pour déterminer la position idéale de déploiement nous effectuons un relevé bathymétrique, car il faut trouver une petite fosse pour protéger le châssis, du passage des Icebergs vers le sud du Groenland.

#### ⇒ Relevage mouillage OVIDE-2E :

Latitude : N 59° 54'.332      Profondeur : 189 mètres  
Longitude : W 42° 35'.702

Seacat N° 4509 échantillonnage 10 minutes ( CTD )  
ADCP 300 KHz N° 3835 échantillonnage 30 minutes  
Balise ARGOS N° 11259  
Largueur IXSEA N° 234 , 240

#### ⇒ Déploiement mouillage OVIDE-2E bis :

Latitude : N 59° 55'.872      Profondeur : 183 mètres  
Longitude : W 42° 58'.162

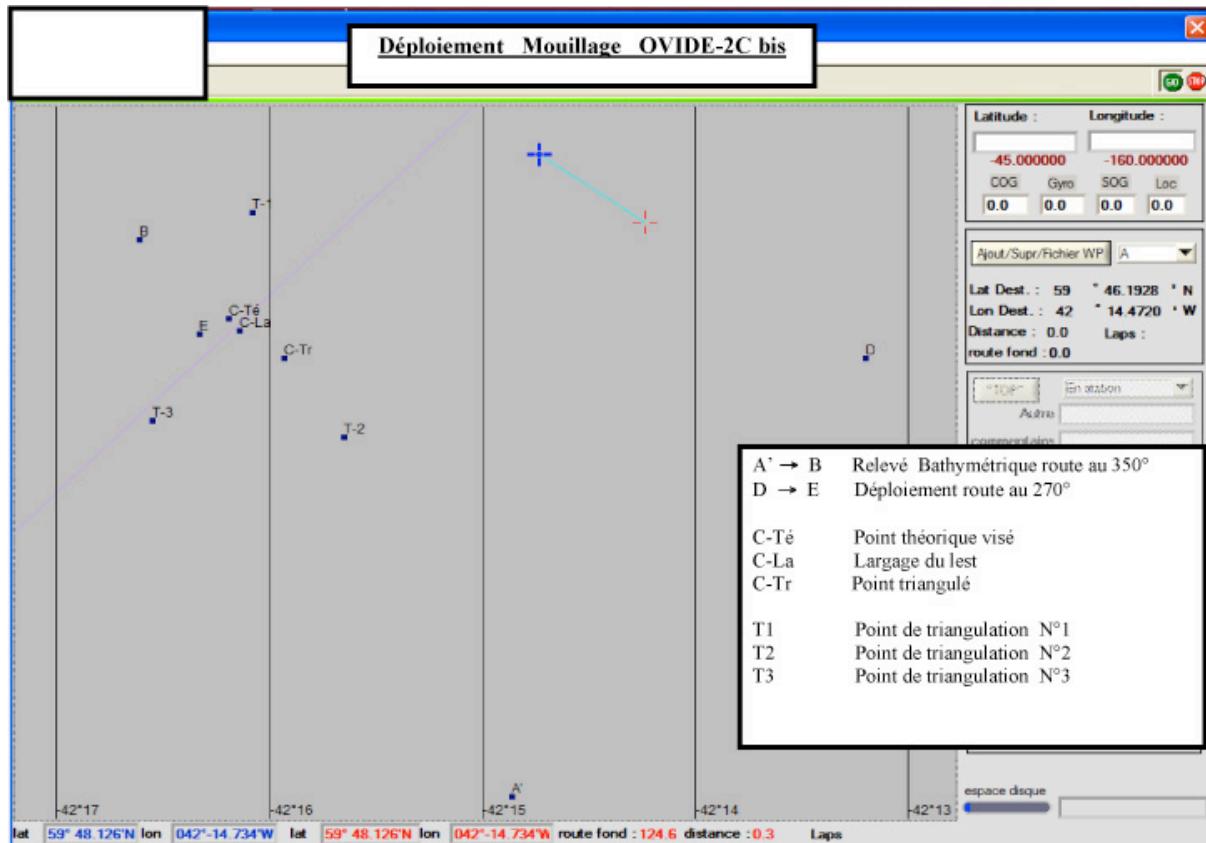
Microcat N° 3999 échantillonnage 10 minutes (CTD)

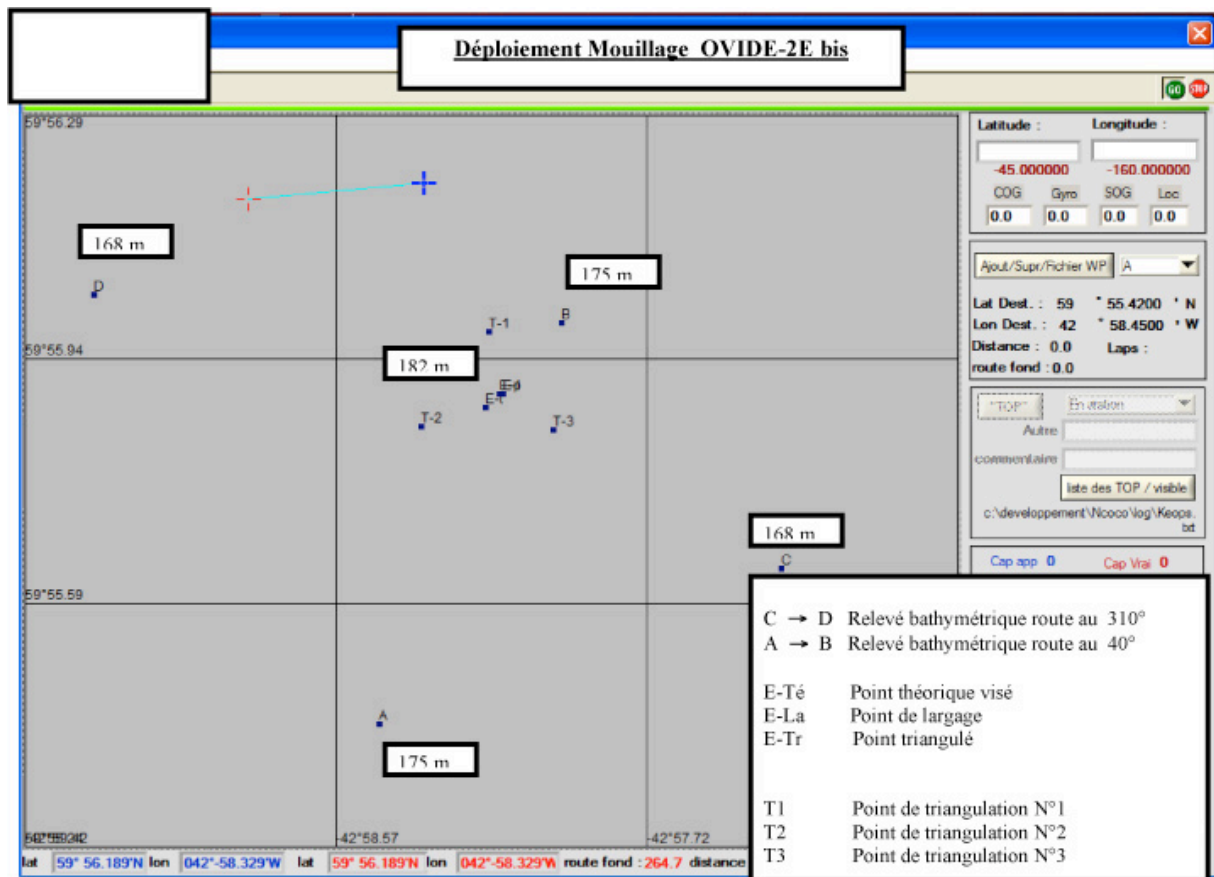
RBR XR-420 N° 10490 échantillonnage 10 minutes (CT)

ADCP 300 KHz N° 3835 échantillonnage 10 minutes

Balise ARGOS N° 11259

Largueur IXSEA N° 101 , 110





## **2.3 Ultramoor Recovery**

Peter A. Koski

### **Introduction**

This is the report for the WHOI mooring recovery operation. The Primary Investigators for this project at WHOI are Nelson Hogg and Dan Frye. Recovery and engineering personnel from WHOI are Brian Hogue and Peter Koski.

### **Mooring System Overview**

The Ultramoor mooring is the 3<sup>rd</sup> prototype of a long term deep ocean instrument platform designed to supply updates of instrument data and system health on a predefined schedule over the endurance of the mooring. The system works by using acoustic modems to telemeter data from each instrument to a central data collection computer and then according to the schedule, data pods are deployed that are able to transfer the data via satellite telephone back to the office. The mooring is located at N59° 35.37', W38° 35.00' and is in 2990m depth.

The current prototype was set up for eight instruments (4 Seabird SB-37 CTDs, 3 Nortek Aquadopp ACMs, 1 RDI Workhorse ADCP). Each instrument is outfitted with an acoustic modem (MicroModems developed by the Acoustic Comms Group at WHOI). The central data collection component (termed the Data Capsule Magazine, or DCM) contains another acoustic modem (Utility Acoustic Modem or UAM, developed by the Acoustic Comms Group at WHOI) that also acts as a system controller. Also on the DCM is an array of data capsules that are linked to the UAM via an inductive loop. Each capsule contains an Iridium satellite telephone and 12MB of FLASH memory.

The mooring was designed for an endurance of five years. However, the data received from the first two capsules indicated that there was a problem with the acoustic modems and some of the instruments. The decision was taken to try to recover the mooring, repair the problems at sea and redeploy for the balance of the five year deployment.

### **First Recovery Attempt**

The first recovery attempt was made on 2 September 2005. Arriving on the site at 1100z we found the sea state to be marginal for a safe recovery effort so we attempted to obtain the status of the release equipment. During this time, the sea state worsened with winds building from about force 5 to force 8+. Due to the worsening sea state we were unable to satisfactorily determine the status of the release equipment. After consulting with the bridge, we decided to suspend this recovery effort without releasing the mooring pending further consideration of the weather situation. At about 1700Z, it was apparent that the weather would not subside and the decision was taken to return to CTD operations at best speed.



## **Second Recovery Attempt**

The second recovery attempt was made on 19 September 2005. Arriving on the site around 1200Z, we found the sea state to be sufficient for safe recovery operations. We were successful in determining the status of the release gear (“vertical and ready”) and after a quick consultation with the bridge, we released the mooring. The recovery operation went very smoothly, taking about 3 hours from mooring release. There did not appear to be any physical damage to the mooring (save for one glass ball was imploded, a common occurrence).

## **Post Recovery Actions**

The recovery was performed on the way back to Scotland at the end of the cruise, so redeployment is not an option. As such, we are not going to attempt to repair the mooring components aboard ship. Instead, we are simply observing the mooring systems in their deployed state for the next few days, until 36hrs before arrival in Scotland. The final actions will be to download status info and data from each instrument, the data capsules and the acoustic modems to preserve the information before preparing the mooring for the return shipment to WHOI.

### 3 CTD

Adam Williams, Jon Lauderdale and Sheldon Bacon

On D298, 63 full-depth stations were occupied. The CTD used was a UKORS SeaBird 911plus system with 24 10L Niskin bottles. Station positions and times are given in Table 3.1. Details of sensor types, serial numbers and calibration dates are given in Table 3.3.

Our CTD frame is stabilised against rotation with a fin. We mount our primary CTD sensor pair on the outer edge of the fin. The secondary sensor pair are adjacent to the CTD pressure case towards the bottom of the frame, as normal. During D298, cable problems adversely affected data quality on the primary sensor pair during stations 5, 28 and 60. The final CTD data therefore employ the primary sensor pair as the source of temperature and conductivity data for all stations except those three, where the secondary sensor pair is the source of temperature and conductivity data.

#### 3.1 Data Processing using the SeaBird Software on the data-logging PC

Following each cast the logging is stopped and the data is saved to the file `:/D298_data`. The logging software outputs four files per CTD cast in the form `D298nnn` with the following extensions: `.dat` (raw data file), `.con` (data configuration file), `.btl` (contains record of bottle firing locations), and `.hdr` (a header file).

Firstly, these files are backed up onto the UNIX station `sohydro6` via ftp to the file location `:/data61/ctd/RAW`. The raw data files are then processed using SeaBird's own CTD data processing software, `SBE.DataProcessing-Win32: v.5.30`. This package contains a whole suite of CTD processing routines but in this instance, only five of these were utilised.

**DatCnv** The Data Conversion routine `DatCnv` reads in the raw CTD data (`D298nnn.dat`) that contains the raw CTD data in engineering units output by the SeaBird hardware on the CTD rosette. `DatCnv` requires a configuration file that defines the calibrated CTD data output so that it is in the correct form to be read into the `pstar` format on the UNIX system. The output variables and order are shown in Table 3.2. The output file (`D298nnn.cnv`) was set to binary output and to include both up and down casts. A second output file (`D298nnn.ros`) contains bottle firing information, taking the output data at the instant of bottle firing.

**AlignCTD** This program reads in `D298nnn.cnv` and shifts the Oxygen sensor relative to the pressure data by 5 seconds compensating for lags in the sensor response times. The output is written over the input file.

**WildEdit** The variability of the data is scanned to remove large deviations from the mean by this routine. The input and output file is again `D298nnn.cnv`. The data are scanned twice calculating the standard deviation of a set number of scans, setting values that are outside

a set number of standard deviations (sd) of the mean to bad data values. On this cruise, the scan range was set to 500, with 2 sd's on the first pass and 10 sd's on the second.

**CellTM** The effect of the thermal mass on the conductivity cells was removed using the routine Celltm. It should be noted that this routine should be run after Wildedit or any other editing of bad data values due to the effect of this routine on the salinity in areas of high noise. The algorithm used was:

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

where  $\alpha$ , the thermal anomaly amplitude is set at 0.03 and  $\beta$ , the thermal anomaly time constant is set at 1/7 (the SeaBird recommended values for SBE911+ pumped system).  $\Delta$  is the sample interval (1/24 second),  $dt$  is the temperature (t) difference taken at a lag of 7 sample intervals.  $c_{cor,i}$  is the corrected conductivity at the current data cycle (i),  $c_{meas,i}$  the raw value as logged and  $ctm_i$  is the correction required at the current data cycle,  $\partial c \partial t$  is a correction factor that is a slowly varying function of temperature deviation from 20 °C.

**Translate** Finally, the D298nnn.cnv is converted from binary into ASCII format so that it can be read into the pstar format. The header information can be checked at this stage to ensure that all of the processes have been performed on each station.

The .cnv and .ros files were then sent via ftp:// to the sohydro6 UNIX workstation so that the data processing could be continued using the PEXEC programs.

### 3.2 Data Processing on the UNIX system

The following c-shell UNIX scripts were used to process the data on sohydro6.

**ctd0** This script reads in the raw ascii file (.cnv) and converts it into the pstar format, and setting the header information. The latitude and longitude when the CTD was at the bottom is required for each station to be added to the header. The output file contains the data averaged to 24hz. The output file is D298nnn.24hz.

**ctd1** This script inputs the .24hz file and uses the PEXEC program *pmdian* to remove residual spikes from all of the variables. The data is then averaged onto a 1hz file using *pavrge*. Absent data values in the pressure data are interpolated across using *pintrp*. Salinity, potential temperature, sigma0 and sigma2 are calculated using *peos83* and finally a 10

second averaged file is created. The output files are D298nnn.1hz and D298nnn.10s respectively.

- ctd2 This script uses the .1hz file to select the relevant data values that represent the up and down casts of the CTD. The .1hz file needs to be examined (i.e using *mlist*) to determine the data cycle when (i) the shallowest depth of the CTD rosette after the initial soaking at 10m, (ii) at the greatest depth, and (iii) when the CTD is removed from the water. These values need to be manually entered at the correct screen prompts. The data is then cut and a file D298nnn.ctu is created. Finally, the data is averaged into two decibar pressure bins creating a file D298nnn.2db.
- ctd3\_a The script ctd3 used to produce numerous plots of the data in the .ctu file was adapted to create three plots. *profilennn.ps* is a plot of the temperatures and the conductivity-derived salinities from the primary and secondary CTD sensors. *tsnnn.ps* is a Potential Temperature-Salinity plot for the station. The final plot is called *oxynnn.ps* and shows the measured oxygen concentration and the transmissivity of both up and down casts.
- fir0 For each cast, this script converts the .ros file into the pstar format. Retained variables are: time and nbf (number of bottles fired). This file is merged with the CTD .10s file, from which are obtained: pressure, temp (primary temperature), cond (primary conductivity), temp2 (secondary temperature), cond2 (secondary conductivity), alt (altimeter), oxygen, t2-t1 (secondary minus primary temperature sensor difference), c2-c1 (secondary minus primary conductivity difference), salin (salinity derived from pressure plus temp and cond), salin2 (salinity derived from pressure plus temp2 and cond2), potemp and potemp2 (primary and secondary potential temperatures). Output file is *fir298nnn*.

### 3.3 CTD Conductivity Calibration

This section describes the process for calibrating the CTD conductivity sensors against the sample salinity measurements.

#### 3.3.1 Processing path

- i. pexec file *sam.master* was created, with variable names and associated units appropriate to the cruise. All variables required in subsequent processing were included.
- iv. for each cast, a cshell script *samfir* was run. *samfir* checks for the existence of *sam.master*, the copies it to *sam298nnn*, header information for which is obtained from the CTD .24hz file. Variables are pasted into it from *fir298nnn*: pressure; temperature, conductivity and derived potential temperature and salinity for each sensor pair; oxygen and altimeter.

- v. for each cast, a cshell script *sal0* was run, to retrieve an ascii file *sal298nnn.txt* containing sample salinity data from the Mac Mini using ftp. The ascii file is converted into a pstar file *sal298nnn*. Note that the notorious “getexcel.exec” is dispensed with. The “-head” option on pascin is very useful.
- vi. for each cast, a cshell script *passal* was run, to paste sample salinity data from file *sal298nnn* into *sam298nnn*.
- vii. for each cast, a cshell script *botcond* was run, to calculate sample conductivity from bottle salinity, CTD pressure and (primary) temperature. Bottle minus CTD conductivity was calculated for each sample and for both CTD conductivity sensors. These operations all pertain to file *sam298nnn*.

### 3.3.2 CTD conductivity calibration results

According to the SeaBird manual, the CTD conductivity sensors should be calibrated with a simple scale factor –  $C_{new} = fac * C_{old}$ , where *fac* is determined using a least-squares fit of  $C_{old}$  (uncalibrated CTD conductivity) to derived water sample conductivity, which is taken to be the true conductivity and hence representative of  $C_{new}$ . The least-squares fit is given by:

$$fac = \frac{\sum_i^N C_{new,i} C_{old,i}}{\sum_i^N C_{old,i}^2}$$

where index *i* is sample number and N is the total number of samples. Note that the SeaBird conductivity sensors (prior to at-sea calibration with samples) were only very slightly different from “reality”: differences between sample and CTD salinities (excluding outliers) were generally less than 0.002, so we are making a very small adjustment.

For the primary conductivity with 425 good sample / CTD pairs, *fac* = 1.0000217. For the secondary conductivity with 439 sample / CTD pairs, *fac* = 0.9999466. These values were applied as appropriate to all CTD stations. Excluding outliers, post-calibration bottle minus CTD conductivity statistics were: primary sensor: mean difference 0.0000, sd 0.0010 mS/cm; secondary sensor: mean difference 0.0000, sd 0.0011 mS/cm. Figures 3.1 and 3.2 show post-calibration conductivity differences plotted versus pressure.

### 3.4 CTD Oxygen Sensor Calibration

Stage 1: to complete the station sample files (*sam298nnn*) containing the upcast CTD sensor data collected as each bottle was fired, by adding to the file the measured bottle oxygen concentration determined by chemical analysis from the separate data files. Bottle oxygen text files are converted to pstar files using exec *oxy0*. Fixing temperatures and oxygen concentrations for primary samples and duplicate samples (*tfixa*, *botoxya*, *tfixb*, *botoxyb*) are pasted into the station sample files using exec *pasoxy*. Oxygen concentrations in  $\mu\text{mol/l}$  are converted to concentrations in  $\mu\text{mol/kg}$

by calculating sample seawater density at the time of fixing using the relevant `tfix` temperature variable and CTD salinity in exec *botoxy*.

Stage 2: replacing the upcast CTD oxygen data with the “good” downcast values. The oxygen sensor suffers from a hysteresis effect that offsets upcast oxygen concentration from downcast (clear water) oxygen concentration. This was done by tracing water masses between the up and down casts along density, potential temperature (and/or pressure) surfaces using Pexec program *pbotle* within script *pbotle.exec*, which also calculates the (bottle minus downcast CTD) oxygen differences described below.

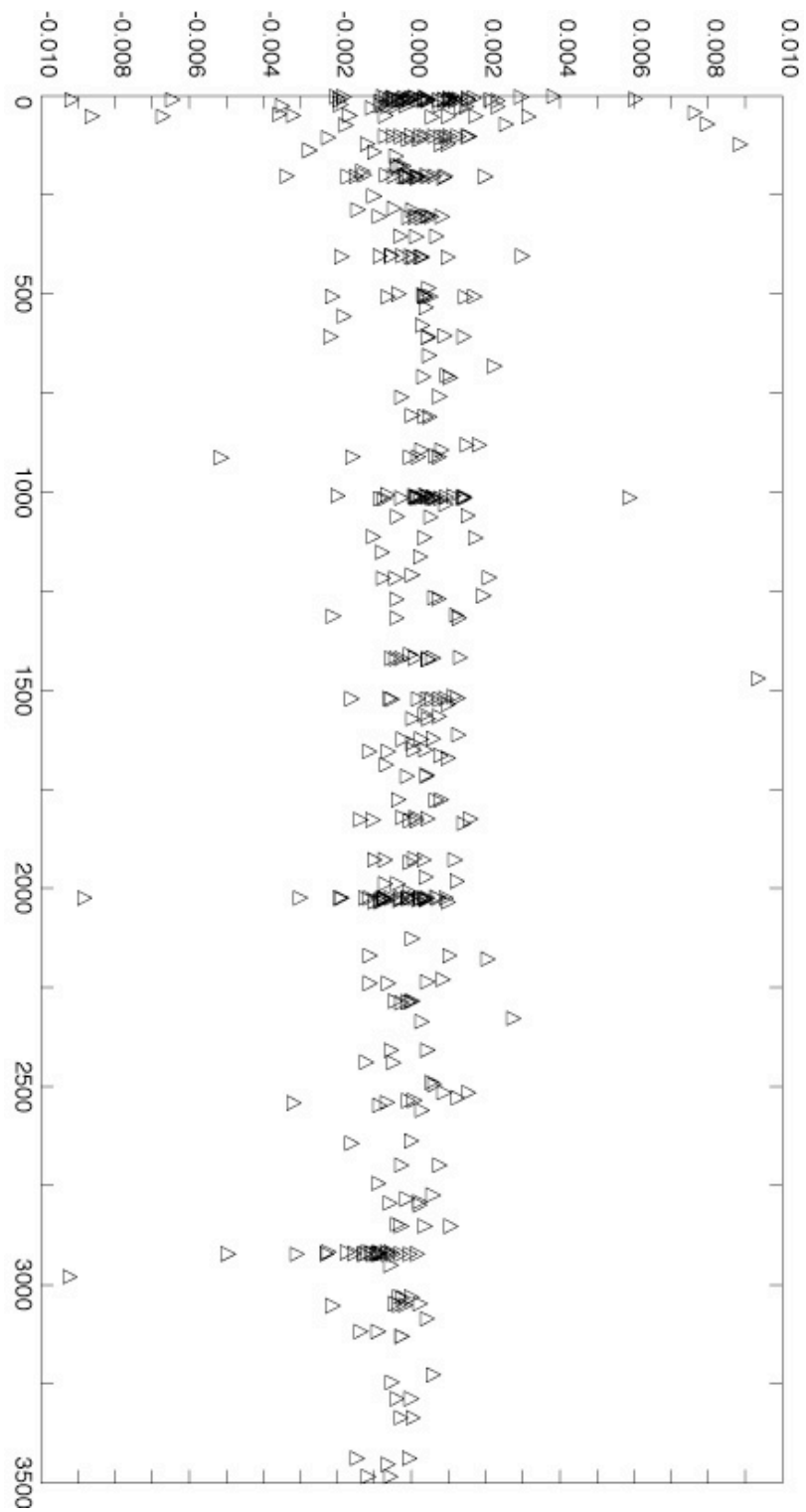
Stage 3: the differences between bottle oxygen concentration ( $O_{bot}$ ) and equivalent downcast CTD oxygen concentration ( $O_{dCTD}$ ) were calculated and, after the removal of outliers, regressed as a linear function of pressure (equation O1). Taking  $O_{bot}$  to represent the true value of seawater oxygen concentration and assuming this fit adequately explains the remainder of the data points, equation O1 can be employed to calibrate the downcast CTD oxygen profiles to “true” oxygen concentrations.

$$O_{bot} - O_{dCTD} = a + bP \quad (O1)$$

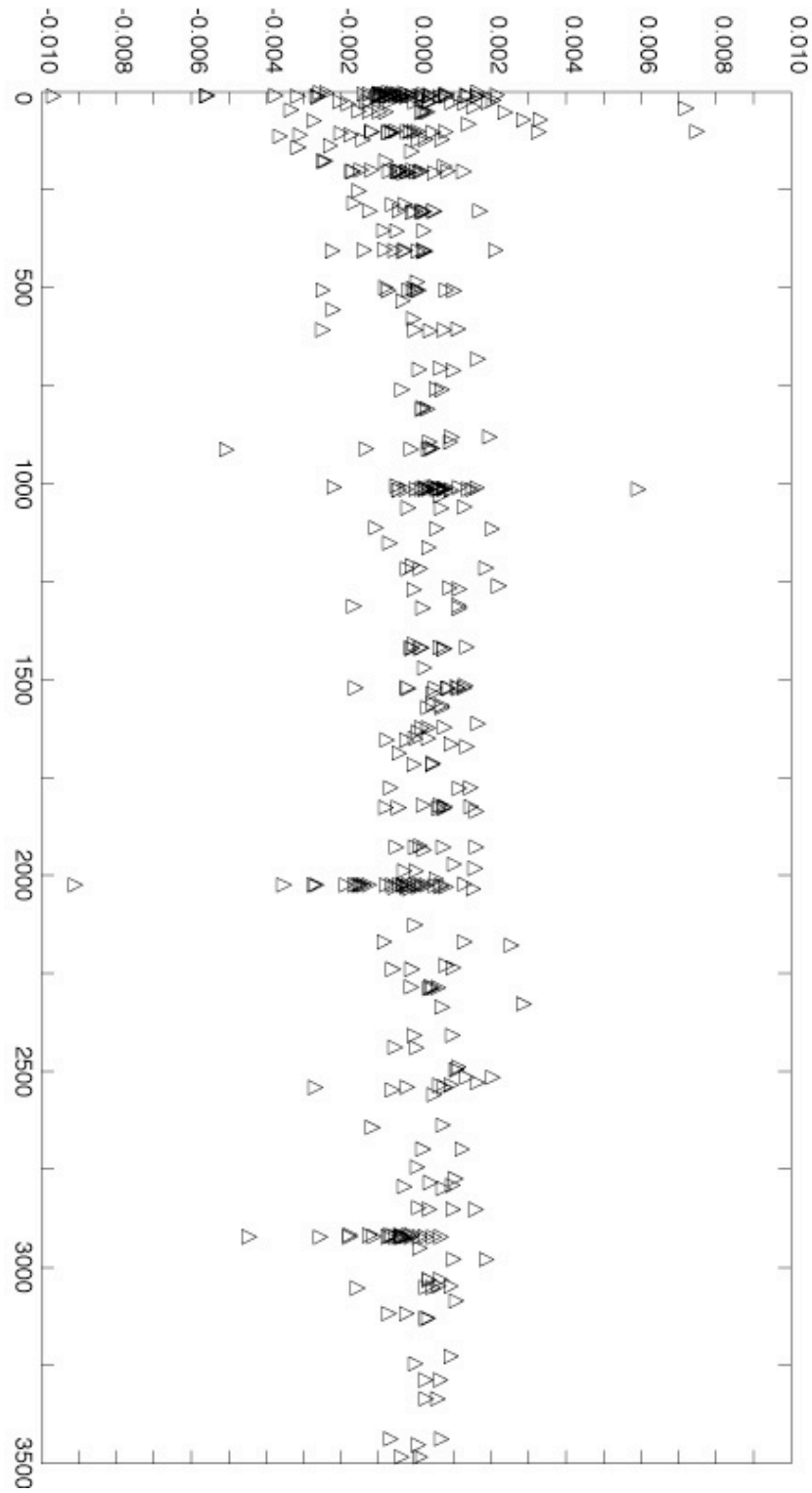
where  $a$  and  $b$  are offset and slope parameters of the linear fit. Note that various other functional forms were investigated, including (eg) higher-order pressure polynomials, and the incorporation of oxygen concentration as a parameter, but the simple form shown above proved to be the most efficient form of calibration.

To assess the suitability of O1, best-fit residuals were calculated for the whole data set. These are plotted in figure 3 against station number. There appeared to be four different regions: (i) stations 1-4; (ii) stations 5-12, (iii) stations 13-58, and (iv): stations 59-63. If treated separately, the residuals may be further reduced, therefore improving the quality of the CTD oxygen calibration. The results of this separate treatment are shown in figure 4, which demonstrates that the final residuals are indeed reduced compared to figure 3 – especially at the beginning and end of the cruise. These residuals do have a degree of scatter about zero, however much of this is within one standard deviation of the chemical measurements ( $\pm 3.2 \mu\text{mol/kg}$ ; see section 7.2) and the majority is within two standard deviations, therefore this fit was considered adequate to be applied to the downcast CTD oxygen profile data.

The fit parameters for the four groups of stations are listed in Table 3.4.



**Figure 3.1:** post-calibration conductivity differences (sample minus primary CTD conductivity, mS/cm, horizontal axis) versus pressure (dbar, vertical axis).



**Figure 3.2:** post-calibration conductivity differences (sample minus secondary CTD conductivity, mS/cm, horizontal axis) versus pressure (dbar, vertical axis).



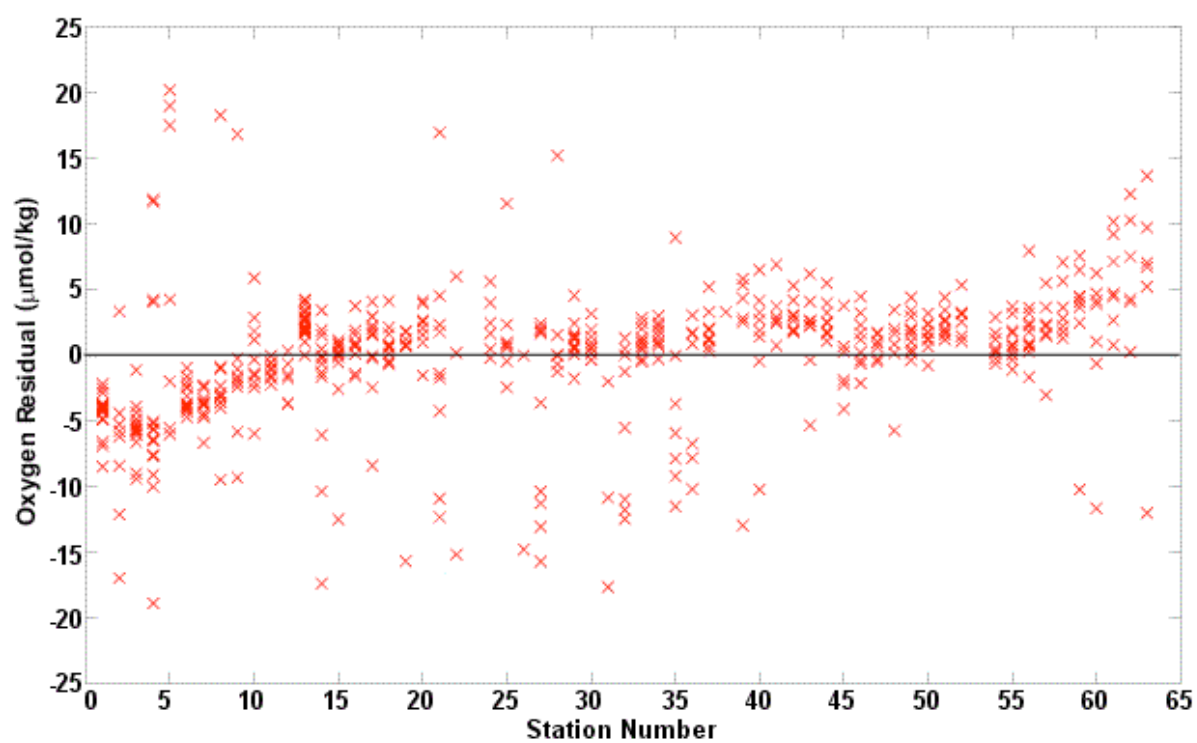


Figure 3.3: Oxygen residuals, all data

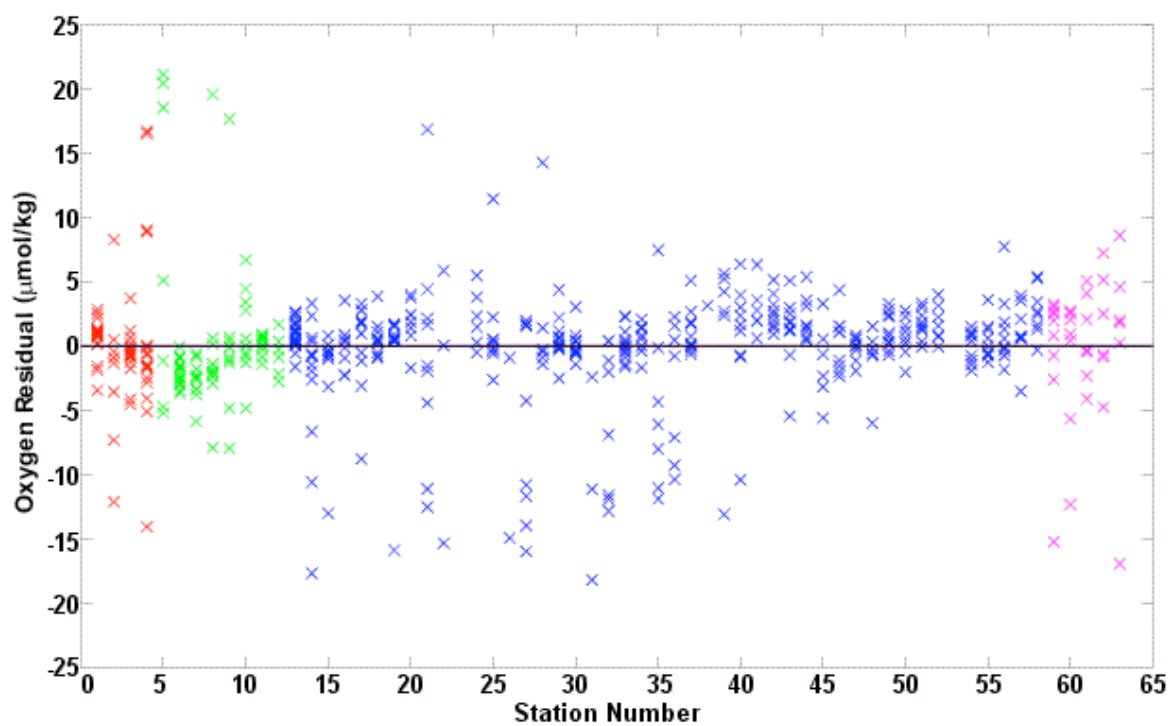


Figure 3.4: Oxygen residuals, four groups of stations.

**Table 3.1:** Details of date, time, position and water depth for D298 CTD stations.

Station number	Code	Date YYYYMMDD	Time HHMMSS	Latitude			Longitude			Corrected depth (m)
001	1	20050826	145044	57	0.201	N	12	0.513	W	-999.0
001	2	20050826	161216	57	0.201	N	12	0.513	W	-999.0
001	3	20050826	165755	57	0.201	N	12	0.513	W	-999.0
002	1	20050830	220940	56	59.988	N	34	0.010	W	1318.2
002	2	20050830	224103	56	59.988	N	34	0.010	W	1318.2
002	3	20050830	232617	56	59.988	N	34	0.010	W	1318.2
003	1	20050831	122109	57	16.222	N	34	46.834	W	2218.3
003	2	20050831	130756	57	16.222	N	34	46.834	W	2218.3
003	3	20050831	144353	57	16.222	N	34	46.834	W	2218.3
004	1	20050831	183758	57	31.409	N	35	32.371	W	2394.6
004	2	20050831	193458	57	31.409	N	35	32.371	W	2394.6
004	3	20050831	210841	57	31.409	N	35	32.371	W	2394.6
005	1	20050901	004401	57	46.935	N	36	18.660	W	2932.5
005	2	20050901	014348	57	46.935	N	36	18.660	W	2932.5
005	3	20050901	032329	57	46.935	N	36	18.660	W	2932.5
006	1	20050901	072851	58	3.305	N	37	5.144	W	2525.1
006	2	20050901	082535	58	3.305	N	37	5.144	W	2525.1
006	3	20050901	100456	58	3.305	N	37	5.144	W	2525.1
007	1	20050901	143716	58	17.995	N	37	50.352	W	3186.0
007	2	20050901	154310	58	17.995	N	37	50.352	W	3186.0
007	3	20050901	173918	58	17.995	N	37	50.352	W	3186.0
008	1	20050901	215416	58	33.601	N	38	35.978	W	3201.4
008	2	20050901	225754	58	33.601	N	38	35.978	W	3201.4
008	3	20050902	010800	58	33.601	N	38	35.978	W	3201.4
009	1	20050902	042605	58	49.219	N	39	22.578	W	3085.6
009	2	20050902	052635	58	49.219	N	39	22.578	W	3085.6
009	3	20050902	070739	58	49.219	N	39	22.578	W	3085.6
010	1	20050903	022556	59	3.908	N	40	8.114	W	2987.8
010	2	20050903	032612	59	3.908	N	40	8.114	W	2987.8
010	3	20050903	050629	59	3.908	N	40	8.114	W	2987.8
011	1	20050903	072540	59	15.361	N	40	45.609	W	2735.7
011	2	20050903	081935	59	15.361	N	40	45.609	W	2735.7
011	3	20050903	095540	59	15.361	N	40	45.609	W	2735.7
012	1	20050903	112314	59	22.801	N	41	6.068	W	2502.8
012	2	20050903	121407	59	22.801	N	41	6.068	W	2502.8
012	3	20050903	135716	59	22.801	N	41	6.068	W	2502.8
013	1	20050905	011229	59	9.836	N	40	26.843	W	2880.5
013	2	20050905	021404	59	9.836	N	40	26.843	W	2880.5
013	3	20050905	031555	59	9.836	N	40	26.843	W	2880.5
014	1	20050905	152120	59	28.769	N	41	26.396	W	2229.6
014	2	20050905	160523	59	28.769	N	41	26.396	W	2229.6
014	3	20050905	172634	59	28.769	N	41	26.396	W	2229.6
015	1	20050906	015651	59	35.989	N	41	48.029	W	1912.3
015	2	20050906	023948	59	35.989	N	41	48.029	W	1912.3
015	3	20050906	034120	59	35.989	N	41	48.029	W	1912.3
016	1	20050906	051345	59	39.942	N	41	59.502	W	1813.5
016	2	20050906	055422	59	39.942	N	41	59.502	W	1813.5
016	3	20050906	070336	59	39.942	N	41	59.502	W	1813.5

017	1	20050906	193438	59	42.913	N	42	13.618	W	1640.4
017	2	20050906	201331	59	42.913	N	42	13.618	W	1640.4
017	3	20050906	213208	59	42.913	N	42	13.618	W	1640.4
018	1	20050906	234035	59	46.171	N	42	18.766	W	1031.1
018	2	20050907	001032	59	46.171	N	42	18.766	W	1031.1
018	3	20050907	011547	59	46.171	N	42	18.766	W	1031.1
019	1	20050907	025304	59	46.824	N	42	22.048	W	504.9
019	2	20050907	032042	59	46.824	N	42	22.048	W	504.9
019	3	20050907	035207	59	46.824	N	42	22.048	W	504.9
023	1	20050907	142656	59	57.721	N	43	6.666	W	160.5
023	2	20050907	143305	59	57.721	N	43	6.666	W	160.5
023	3	20050907	145637	59	57.721	N	43	6.666	W	160.5
022	1	20050907	155206	59	53.903	N	43	2.116	W	165.7
022	2	20050907	160141	59	53.903	N	43	2.116	W	165.7
022	3	20050907	162330	59	53.903	N	43	2.116	W	165.7
021	1	20050907	173527	59	52.809	N	42	51.327	W	184.8
021	2	20050907	174613	59	52.809	N	42	51.327	W	184.8
021	3	20050907	182301	59	52.809	N	42	51.327	W	184.8
020	1	20050907	211754	59	48.436	N	42	39.509	W	195.9
020	2	20050907	215045	59	48.436	N	42	39.509	W	195.9
020	3	20050907	222053	59	48.436	N	42	39.509	W	195.9
024	1	20050908	040142	59	30.010	N	43	30.131	W	277.7
024	2	20050908	041547	59	30.010	N	43	30.131	W	277.7
024	3	20050908	044312	59	30.010	N	43	30.131	W	277.7
025	1	20050908	063305	59	13.915	N	43	30.463	W	1653.2
025	2	20050908	071231	59	13.915	N	43	30.463	W	1653.2
025	3	20050908	082055	59	13.915	N	43	30.463	W	1653.2
026	1	20050908	100051	59	0.004	N	43	30.400	W	1611.2
026	2	20050908	103718	59	0.004	N	43	30.400	W	1611.2
026	3	20050908	113945	59	0.004	N	43	30.400	W	1611.2
027	1	20050908	131933	58	47.843	N	43	50.420	W	1519.4
027	2	20050908	140143	58	47.843	N	43	50.420	W	1519.4
027	3	20050908	150412	58	47.843	N	43	50.420	W	1519.4
028	1	20050908	190840	58	38.087	N	44	12.345	W	1584.9
028	2	20050908	194351	58	38.087	N	44	12.345	W	1584.9
028	3	20050908	205201	58	38.087	N	44	12.345	W	1584.9
029	1	20050908	225821	58	27.996	N	44	36.961	W	1680.0
029	2	20050908	233913	58	27.996	N	44	36.961	W	1680.0
029	3	20050909	010327	58	27.996	N	44	36.961	W	1680.0
030	1	20050909	041057	58	19.481	N	44	57.794	W	1939.5
030	2	20050909	045403	58	19.481	N	44	57.794	W	1939.5
030	3	20050909	060024	58	19.481	N	44	57.794	W	1939.5
031	1	20050909	084315	58	4.944	N	45	32.370	W	2124.1
031	2	20050909	092747	58	4.944	N	45	32.370	W	2124.1
031	3	20050909	105511	58	4.944	N	45	32.370	W	2124.1
032	1	20050909	141437	57	53.012	N	45	58.157	W	2463.5
032	2	20050909	150801	57	53.012	N	45	58.157	W	2463.5
032	3	20050909	162620	57	53.012	N	45	58.157	W	2463.5
033	1	20050909	211444	57	41.760	N	46	37.161	W	2791.0
033	2	20050909	221554	57	41.760	N	46	37.161	W	2791.0
033	3	20050910	000444	57	41.760	N	46	37.161	W	2791.0
034	1	20050910	035847	57	31.009	N	47	16.012	W	2963.5
034	2	20050910	045553	57	31.009	N	47	16.012	W	2963.5

034	3	20050910	062217	57	31.009	N	47	16.012	W	2963.5
035	1	20050910	090004	57	23.857	N	47	57.214	W	3260.4
035	2	20050910	100356	57	23.857	N	47	57.214	W	3260.4
035	3	20050910	115145	57	23.857	N	47	57.214	W	3260.4
036	1	20050910	141335	57	15.984	N	48	38.247	W	3494.4
036	2	20050910	151858	57	15.984	N	48	38.247	W	3494.4
036	3	20050910	170037	57	15.984	N	48	38.247	W	3494.4
037	1	20050910	201009	57	12.034	N	49	30.398	W	3580.2
037	2	20050910	211827	57	12.034	N	49	30.398	W	3580.2
037	3	20050910	232032	57	12.034	N	49	30.398	W	3580.2
038	1	20050912	145556	59	55.650	N	44	41.984	W	118.5
038	2	20050912	150145	59	55.650	N	44	41.984	W	118.5
038	3	20050912	152138	59	55.650	N	44	41.984	W	118.5
039	1	20050912	175842	59	44.376	N	45	8.916	W	-999.0
039	2	20050912	180454	59	44.376	N	45	8.916	W	-999.0
039	3	20050912	183529	59	44.376	N	45	8.916	W	-999.0
040	1	20050912	212457	59	30.121	N	45	37.166	W	477.1
040	2	20050912	214222	59	30.121	N	45	37.166	W	477.1
040	3	20050912	223140	59	30.121	N	45	37.166	W	477.1
041	1	20050913	001846	59	27.800	N	45	38.807	W	1007.9
041	2	20050913	004242	59	27.800	N	45	38.807	W	1007.9
041	3	20050913	013018	59	27.800	N	45	38.807	W	1007.9
042	1	20050913	030014	59	26.055	N	45	39.947	W	1567.6
042	2	20050913	035941	59	26.055	N	45	39.947	W	1567.6
042	3	20050913	045442	59	26.055	N	45	39.947	W	1567.6
043	1	20050913	060553	59	23.087	N	45	40.095	W	1948.2
043	2	20050913	064834	59	23.087	N	45	40.095	W	1948.2
043	3	20050913	075055	59	23.087	N	45	40.095	W	1948.2
044	1	20050913	101119	59	4.035	N	46	4.970	W	2445.6
044	2	20050913	105904	59	4.035	N	46	4.970	W	2445.6
044	3	20050913	122149	59	4.035	N	46	4.970	W	2445.6
045	1	20050913	143742	58	52.673	N	46	43.386	W	2650.9
045	2	20050913	152933	58	52.673	N	46	43.386	W	2650.9
045	3	20050913	164125	58	52.673	N	46	43.386	W	2650.9
046	1	20050913	193310	58	41.570	N	47	34.809	W	3025.3
046	2	20050913	203144	58	41.570	N	47	34.809	W	3025.3
046	3	20050913	221506	58	41.570	N	47	34.809	W	3025.3
047	1	20050914	003158	58	33.019	N	48	18.972	W	3440.2
047	2	20050914	013721	58	33.019	N	48	18.972	W	3440.2
047	3	20050914	031606	58	33.019	N	48	18.972	W	3440.2
048	1	20050914	060223	58	23.826	N	49	6.251	W	3464.8
048	2	20050914	071056	58	23.826	N	49	6.251	W	3464.8
048	3	20050914	084328	58	23.826	N	49	6.251	W	3464.8
049	1	20050914	202115	58	18.615	N	44	57.328	W	1928.5
049	2	20050914	210158	58	18.615	N	44	57.328	W	1928.5
049	3	20050914	223210	58	18.615	N	44	57.328	W	1928.5
050	1	20050915	000302	58	10.013	N	44	45.036	W	2195.3
050	2	20050915	004600	58	10.013	N	44	45.036	W	2195.3
050	3	20050915	020130	58	10.013	N	44	45.036	W	2195.3
051	1	20050915	031925	58	5.293	N	44	38.824	W	2477.9
051	2	20050915	040223	58	5.293	N	44	38.824	W	2477.9
051	3	20050915	050849	58	5.293	N	44	38.824	W	2477.9
052	1	20050915	062229	58	0.236	N	44	32.265	W	2719.7

052	2	20050915	071555	58	0.236	N	44	32.265	W	2719.7
052	3	20050915	084120	58	0.236	N	44	32.265	W	2719.7
053	1	20050915	095902	57	53.554	N	44	22.480	W	2988.3
053	2	20050915	105827	57	53.554	N	44	22.480	W	2988.3
053	3	20050915	123616	57	53.554	N	44	22.480	W	2988.3
054	1	20050915	135937	57	45.935	N	44	11.107	W	3220.5
054	2	20050915	145751	57	45.935	N	44	11.107	W	3220.5
054	3	20050915	162745	57	45.935	N	44	11.107	W	3220.5
055	1	20050915	175721	57	36.483	N	43	59.405	W	3369.8
055	2	20050915	190041	57	36.483	N	43	59.405	W	3369.8
055	3	20050915	205952	57	36.483	N	43	59.405	W	3369.8
056	1	20050915	224401	57	25.575	N	43	47.027	W	3401.3
056	2	20050915	234908	57	25.575	N	43	47.027	W	3401.3
056	3	20050916	013429	57	25.575	N	43	47.027	W	3401.3
057	1	20050916	115113	57	41.969	N	46	37.073	W	2792.6
057	2	20050916	124545	57	41.969	N	46	37.073	W	2792.6
057	3	20050916	141832	57	41.969	N	46	37.073	W	2792.6
058	1	20050916	155929	57	29.070	N	46	31.969	W	3046.1
058	2	20050916	165751	57	29.070	N	46	31.969	W	3046.1
058	3	20050916	183332	57	29.070	N	46	31.969	W	3046.1
059	1	20050916	201938	57	17.568	N	46	29.858	W	3358.7
059	2	20050916	212122	57	17.568	N	46	29.858	W	3358.7
059	3	20050916	231618	57	17.568	N	46	29.858	W	3358.7
060	1	20050917	012134	57	4.019	N	46	26.816	W	3527.9
060	2	20050917	022815	57	4.019	N	46	26.816	W	3527.9
060	3	20050917	041907	57	4.019	N	46	26.816	W	3527.9
061	1	20050918	184349	59	57.673	N	43	7.754	W	192.2
061	2	20050918	185046	59	57.673	N	43	7.754	W	192.2
061	3	20050918	192047	59	57.673	N	43	7.754	W	192.2
062	1	20050918	221525	59	55.901	N	42	58.131	W	183.5
062	2	20050918	222422	59	55.901	N	42	58.131	W	183.5
062	3	20050918	231532	59	55.901	N	42	58.131	W	183.5
063	1	20050919	014658	59	50.245	N	42	38.810	W	191.6
063	2	20050919	015609	59	50.245	N	42	38.810	W	191.6
063	3	20050919	022108	59	50.245	N	42	38.810	W	191.6

**Table 3.2:** DatCnv Configuration file

1. Pressure, Digiquartz (db)
2. Temperature (ITS-90, deg C)
3. Conductivity (mS/cm)
4. Temperature 2 (ITS-90, deg C)
5. Conductivity 2 (mS/cm)
6. Altimeter (m)
7. Oxygen, SBE43 ( $\mu\text{mol/kg}$ )
8. Temperature Difference, 2-1 (ITS-90, deg C)
9. Conductivity Difference, 2-1 (mS/cm)
10. Beam Attenuation, Chelsea/SeaTech/Wetlab CStar (1/m)
11. Beam Transmission, Chelsea/SeaTech/Wetlab CStar (%)
12. Time, Elapsed (seconds)
13. Julian days
14. Latitude (deg)
15. Longitude (deg)
16. Scan Count
17. Bottles fired

**Table 3.3:** Oxygen fit parameters

Stations	a	b
1-4	5.307	-2.493D-03
5-12	9.319	-2.649D-03
13-58	10.236	-1.873D-03
59-63	15.258	-3.635D-03

### Appendix to Section 3: SeaBird sensor types, serial numbers and calibration dates

Date: 19/09/2005

ASCII file: C:\Program Files\Sea-Bird\Seasave-Win32\D298\_data\0528.con

Configuration report for SBE 911

-----  
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 : Yes  
Scan time added : No

#### 1) Frequency, Temperature

Serial number : 4116  
Calibrated on : 22-july-05  
G : 4.42609733e-003  
H : 6.84617808e-004  
I : 2.45784420e-005  
J : 2.04124847e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

#### 2) Frequency, Conductivity

Serial number : 2571  
Calibrated on : 04 Aug 05  
G : -1.01174031e+001  
H : 1.41048808e+000  
I : 1.57467464e-004  
J : 6.06764952e-005  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

#### 3) Frequency, Pressure, Digiquartz with TC

Serial number : 73299  
Calibrated on : 10-june-05  
C1 : -5.087539e+004  
C2 : 2.199664e-002  
C3 : 1.589010e-002  
D1 : 3.721700e-002  
D2 : 0.000000e+000  
T1 : 3.011152e+001  
T2 : -2.857091e-004  
T3 : 4.528990e-006  
T4 : -5.484500e-011  
T5 : 0.000000e+000  
Slope : 0.99990000  
Offset : -1.07980  
AD590M : 1.282870e-002  
AD590B : -9.075590e+000

4) Frequency, Temperature, 2

Serial number : 2919  
Calibrated on : 22-july-05  
G : 4.31707130e-003  
H : 6.44653929e-004  
I : 2.29759700e-005  
J : 2.17550684e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

5) Frequency, Conductivity, 2

Serial number : 2571  
Calibrated on : 04-aug-05  
G : -1.02764778e+001  
H : 1.59465359e+000  
I : -4.85215854e-005  
J : 1.08283886e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

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

Serial number : 0621  
Calibrated on : 22-may-05  
Soc : 4.1440e-001  
Boc : 0.0000  
Offset : -0.4774  
Tcor : 0.0018  
Pcor : 1.35e-004  
Tau : 0.0

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

Serial number : 1040  
Calibrated on : n/a  
Scale factor : 15.000  
Offset : 0.000

9) A/D voltage 3, Free

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, Free

13) A/D voltage 7, Transmissometer, Chelsea Alphatracka Mk2

Serial number : 161045  
Calibrated on : 28/4/01  
M : 21.1680  
B : -0.3810  
Path length : 0.250



## 4 LOWERED ADCP

David Wilkinson, John Allen, Sara de la Rosa, Dave Teare, Alan Davies and Dave Childs

### 4.1 Summary

Two RD Instruments 300 kHz Workhorse (WH) Lowered Acoustic Doppler Current Profilers (LADCP) were attached to a modified frame for simultaneous deployment throughout the cruise. One of the instruments (ser. no. 4275) was mounted near the centre of the bottom of the frame as the down-looking or master WH. The second was mounted level with the top of the frame on a special external hoop extension to the otherwise round frame, on the opposite side to the anti-rotation fin. This second, and upward, WH was denoted the slave instrument (ser. no. 1881). The battery pack for both instruments was mounted in the frame at the level of the CTD. The slave was programmed to ping synchronously with the master to prevent interference. Both instruments functioned well to begin with. However, during the 'Visbeck' data analysis route it was noted that the master, downward looking, WH instrument occasionally suffered from weak backscatter amplitude at beams 3 or 4. Eventually this became a common problem on beam 4 and so this WH was replaced with a spare from station 49 onwards. On station 43 only header files and no data were on either the slave or master WH units; the reason for this remains unknown.

Before each cast the instruments were set up with the following steps:

- test the battery voltage;
- check on board data storage space remaining, and delete old casts if necessary;
- check current time against GMT and adjust if more than a few seconds adrift;
- run a diagnostic check in each instrument;
- download configuration file to each instrument starting with the slave - this configuration requires the slave to listen for the master pinging before it can begin;
- save the diagnostic checks and configuration information to a station-related text file (example files are given in Appendix I to Section 4);
- note the time of deployment of the master (i.e. the start of pinging);
- disconnect leads (it's embarrassing otherwise!).

The instruments record to their own internal memory. On recovery the last data file in the memory of each instrument was downloaded to a PC before ftp transfer to a UNIX workstation for processing. Occasionally the cast resulted in more than one file in memory. The correct file was usually significantly larger than the others and has the station time associated with it. The download procedure also involved checking the number of bytes and frames in the file as well as the time of the first frame: information which could be used to pin down the correct data file.

## 4.2 Processing

The LADCP provides a profile of ocean current relative to the CTD package as it descends. Software is required to convert this to an absolute current relative to the ground. Codes by both Eric Firing and Martin Visbeck were used on this cruise and these will be dealt with separately here.

### 4.2.1 Firing Method

The LADCP provides a full-depth profile of ocean current. However, to obtain the ocean current the unknown package motion must be removed during processing. In the Eric Firing method overlapping profiles of the vertical shear of horizontal velocity are averaged and gridded to form a full depth shear profile. By differentiating individual profiles the constant velocity of the package drops out. The full depth shear profile is then integrated vertically to obtain the baroclinic ocean velocity. This is performed in stage one of the processing using the ADCP data alone. The unknown integration constant is the barotropic velocity which is computed as the sum of the time averaged measured velocity and the ship drift. This is calculated in stage 2 of the processing when the navigation data is combined with the ADCP data. During this processing phase the ADCP data is also matched with the CTD data to provide a more accurate determination of depth.

During cruise D298 the Firing method was used as a backup to the Visbeck method for later comparison. The method was only successfully applied to the master (downward facing) LADCP unit.

### 4.2.2 Procedures – Stage 1

The phase 1 processing requires only the raw LADCP data and the latitude and longitude of the cast. However the nature of the software requires significant manual intervention in the process. The steps involved are as follows:

- 1 Transfer the raw LADCP data files to the /data62/ladcp/raw/d298/ladcp directory.
- 2 Enter the “source LADall” command in the directory /data62/ladcp directory to set the appropriate paths for Matlab.
- 3 Rename the raw data files to the standard form dNNN\_01.000 (where NNN is the cast number and will be referred to as such in all subsequent stages).
- 4 Check the depths range and timing of the cast data using the “perl -S scan.prl NNN\_01” command run from the /data62/ladcp/pro/d298/ladcp/proc directory.
- 5 Calculate the magnetic deviation at the location of the cast in a 2 step process starting in the same directory as step 4:
  - a) Enter the position of the cast using the command putpos NNN 01 “degrees latitude” “decimal minutes latitude” “degrees longitude (-ve west)” “ decimal mintutes longitude”.The terms in apostrophes represent the coordinates to be input.

b) The magnetic deviation is then calculated by launching matlab from the same directory and typing the command “magvarsm(NNN.01)”.

6 The CODAS database is then loaded from the same Unix directory using the command “perl -S load.prl NNN\_01”. This is followed by a second Unix command to merge the ping files and create a shear profile “perl -S domerge.prl -c0 NNN\_01”.

7 For the final step of stage 1 matlab is again launched from the current Unix directory and the following commands entered:

```
plist=NNN.01
```

```
do_abs
```

The do\_abs command generates five plots showing the various velocity components and information about the sensor such as heading, tilt and angle. The graphs were only successfully produced with the addition of a pause command between each plot in the Matlab function.

#### 4.2.3 Procedures – Stage 2

Stage 2 of the processing introduces the navigation and CTD data. The raw data files containing the two sets of data must first be converted to the appropriate format for the Firing software.

1 Navigation file preparation

a) A copy of the latest navigation file abnv2981 is taken from /data61/nav and placed in /data62/ladcp/raw/d298/gps

b) The time field in the raw data file is converted from seconds to J-date using the PSTAR programme *pxtime* and following the prompts.

c) The file is reduced to the fields decimal date, longitude, latitude (in that order) using the PSTAR *mlist* Programme. Within the *mlist* function the command vars is used to select the required fields, the command “fmt time 9.5” to set the appropriate form of the date and the command “ascii” followed by “l” to output the data in ascii format.

d) The resultant file “MLIST.ASCII” is renamed as “gps.asc”.

e) The formatted navigation data is loaded in matlab having launched from the gps directory in part a). The file is opened with the command “sm=load(‘gps.asc’)” and then the first column (mlist index) is removed using “sm(:,1)=[]”. Finally the workspace is saved in the gps directory as “sm.mat”.

2 CTD file preparation

a) Reformat the raw 1hz ctd file ctd298NNN.1hz found in the directory /data61/ctd using the PSTAR *mlist* programme. The variables selected using the vars command are time, pressure, temperature and salinity (in that order). The time is kept in seconds but is formatted using “fmt time 10.1”. The data is then output in ascii format using the “ascii” command followed by the “l” command.

- b) The reformatted MLIST.ASCII file is renamed ctd.NNN.01 and moved to the directory data62/ladcp/raw/d298/ctd. The header lines must be removed prior to further processing using, for example, nedit.
- 3 The CTD data is added to the matlab LADCP profile by launching matlab from the directory data62/ladcp/pro/d298/ladcp/proc/Pctd and entering the command “ctd\_in(NNN,01).
- 4 The CTD data is fitted to the LADCP profile by launching matlab from the directory data62/ladcp/pro/d298/ladcp/proc/Fitd and entering the command “plist=NNN.01” followed by the command “fd”.
- 5 The CTD data is added to the CODAS database and the ping files merged to create the shear profile using two Unix commands run from the directory data62/ladcp/pro/d298/ladcp/proc. The commands are “perl -S add\_ctd.prl NNN\_01” followed by “perl -S domerge.prl -c1 NNN\_01”.
- 6 Finally the output plots created at the end of the stage 1 processing are reproduced with the barotropic velocity component included. Matlab is launched from the directory used in step 5 and the same Matlab command entered. “plist=NNN.01” followed by “do\_abs”.

#### 4.2.4 General Comments

The only requirements of the processing are the 3 raw data files (LADCP, navigation and CTD) plus the latitude and longitude of the cast. However the procedure is very time consuming due to the large number of manual steps. The process was dramatically sped up using a series of Unix scripts to run chunks of the process for batches of casts. However if the Firing software is to be used regularly it would benefit from the writing of a new front end that runs the process with the minimum user involvement and good informative error and warning messages.

### 4.3 Visbeck processing route

The code of Martin Visbeck (Visbeck, 2002) solves a large inverse problem for the water velocities. It allows for the use of other velocity information to act as constraints on the LADCP data. Although shipboard ADCP data can be used in this regard, on this cruise bottom track velocities alone were used, with default weightings. Two scripts used on previous cruises (specifically D285-8) were used to construct input ascii data files for the processing:

- |                   |   |
|-------------------|---|
| <i>doctdasc.m</i> | copy time, pressure, temperature and salinity data from pstar CTD files (.1hz files) to ascii format in columnar form |
| <i>donavpro.m</i> | extract time, latitude and longitude data from the pstar version of the bestnav navigation file (abnv2981)            |

The Visbeck code was run through a top level matlab script, a separate script was copied for each cast and modified to access the relevant input files, and provide the approximate start and end times and positions. Each script was named accordingly 'lad298nnn.m' and was of the form given in Appendix II to Section 4. In our case, to avoid duplication, raw LADCP files were accessed through the Eric Firing directory structure. At this point the operator or basic data analyst needs to know little more, and a full description of the Visbeck processing method is given in the cruise report for RRS *Discovery* D285/6. However, we will here give an operators discussion of the processing route because this may provide operational cues.

The top level Matlab script calls the script *laproc.m*. Within this a number of further scripts and routines are called as follows:

<i>loadrdi.m</i>	loads the raw LADCP files and edits for bad data etc.
<i>loadctdsoc.m</i>	loads the ascii CTD file produced by <i>doctdasc.m</i>
<i>getdpthi.m</i>	Produces a depth profile from all given information, vertical velocity inverse, bottom, and surface tracking, for instance.
<i>loadnavsoc.m</i>	loads the ascii navigation files produced by <i>donavpro.m</i>
<i>presolve.m</i>	This calls the main processing routines .....
<i>prepinv.m</i>	The bulk of the analysis happens here, the data matrix and operator is prepared.
<i>resolve.m</i>	calculate least squares inverse solution matrix, also calculate Eric Firing style shear based solution, and produce postscript files as required.

#### 4.3.1 Results

Results are encouraging. Figure 4.1 shows contoured northward current strength for the initial section into the Greenland coast from the Reykjanes Ridge. There is a clear southward flowing East Greenland Current in excess of 40 cm/s. Furthermore, a signal of southward flowing overflow waters at 2500 m on the Greenland shelf edge is also indicated. The strong northward surface flow on the western side of the Reykjanes Ridge agrees with that found during the Marine Productivity cruises (D258, 262, 264, and 267), however at the time of writing a close comparison with the Vessel Mounted ADCP data had not been possible. Such a comparison should be carried out at the earliest opportunity following the cruise.

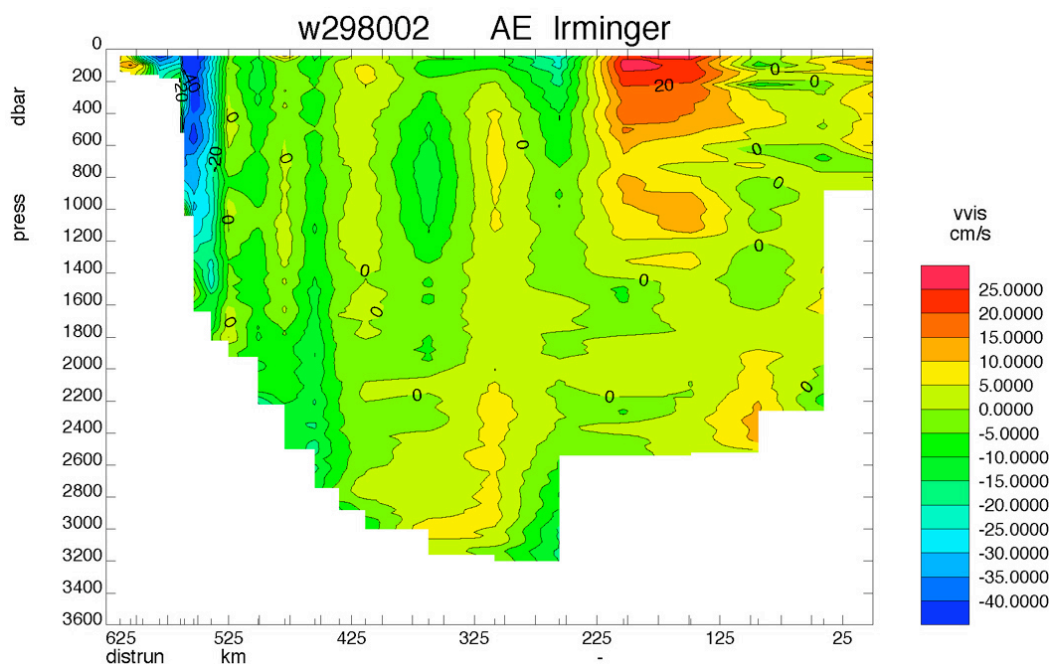


Figure x: Northward currents determined by the LADCP for the Irminger Basin CTD section

#### 4.3.2 Problems

Station 43 returned no data from either the master or the slave instrument. Perfectly normal header records were produced and it has not been possible to determine an explanation for this.

Incorporating the CTD data into the processing route for stations 298003 and 298009, produced ridiculous bottom depth estimates and a failure to constrain the LADCP profiles with bottom tracking data. We could find nothing unusual about the CTD files for these stations, whose maximum depths were as expected. By ignoring the CTD data the integration of  $w$  produced bottom depth estimates that were almost identical to those that would have been provided by the CTD profiles, and a plausible looking velocity profile constrained properly by the bottom tracking data.

#### Appendix I to Section 4: Command files

Master command file - WHM\_D298.CMD

Slave command file - WHS\_D298.CMD

(where different)

CR1	retrieve factory parameters
CF11101	flow control
EA00000	heading alignment
EB00000	heading bias
ED00000	transducer depth
ES35	salinity assumed for sound speed
EX11111	coordinate transform
EZ0111111	sensor source
TE00:00:01.00	time per ensemble
TP00:01.00	time between pings
LD111100000	data out
LF0500	blank after transmit (5 m)

```

LN016          number of depth bins (16)
LP00001        pings per ensemble (1)
LS1000         depth bin length (10 m)
LV250          ambiguity velocity (250 cm/s)
LJ1
LW1
LZ30,220
SM1            = Master                SM2            = Slave
SA001          send a synchronizing pulse before ping
SW05000        wait 5 milliseconds      ST0            wait zero
CK
CS

```

## Appendix II to Section 4: Visbeck Processing

```

% LADCP PROCESSING SOFTWARE    6.0h
% Martin Visbeck, LDEO, 2002
% master file for cast 298002, copy and edit for each station
% master for all freq ladcp for SOC use with pstar - by rtp July 2002
% NB NB testing simplified directory structure
% note too that nav and ctd files are now both ascii, and the full time
% is stored in two words as YYYYMMDD HHMMSS in each
tic
clear

% set path
%f.directory = '/working/gdd/wdht1/marprod/ladcp/';
f.directory = '/data62/ladcp/';
% file names
% ctd file to read depth from SEABIRD CTD file
% where 298002 is the Discovery station number
% ctd298002.asc is created by doctdasc in m directory
f.ctd='/data62/ladcpVIS/ctd/ctd298002.asc';
% f.nav is created by doctdnav from pstar - see script in m directory
f.nav='/data62/ladcpVIS/nav/nav298002.asc'; % continous navigation data
%f.sadcp='.../sur/sur298002.asc'; %single sadcp profile
%ps.sadcpfac = 5; %set sadcp weight multiplier
% RDI raw data files
% use prefix d for 150, w for 300 and b for 600khz. Use these because
% d and w seem to be existing conventions, and b = backscatter inst
% get inst info from user in f.freq
% assume 150khz if input is not w or b
%p.freq = input('Enter d (150kHz), w (300kHz) or b (600kHz):','s');
p.freq='w';
if p.freq ~= 'w' & p.freq ~= 'b'
p.freq = 'd';
f.inst = '150';
end
if p.freq == 'w'
f.inst = '300';
elseif p.freq == 'b'
f.inst = '600';
end

%eval( ['f.ladcpdo=' f.directory f.inst 'khz/raw/' p.freq
'298002.000';']);
%eval( ['f.ladcpdo=' f.directory 'raw/' p.freq '298002.000';']);
eval( ['f.ladcpdo=' f.directory 'raw/d298/ladcp/d002_01.000';']);
disp ('input files are;')

```

```

disp (f.ctd)
disp (f.nav)
disp (f.ladcpdo)
%f.ladcpdo='../300khz/raw/w298002.000'; % downward looking ladcp data
% RDI raw data files empty means use only down looking instrument
%f.ladcpup=' ';
eval( ['f.ladcpup='' f.directory 'raw/d298/ladcp/d002_10.000'';']);
disp (f.ladcpup)
% set to f.ladcpup=' '; if only down looking instrument is used
% results should be written to this base filename (without extension)
f.res='../pro/w298002result';
%f.%f.res='w298002result';

% parameter

% station name
p.name='298002';
% why is next line = 4?? rtp
p.ladcp_station= 4;

% start and end time
% these are replaced later, but need to be roughly right - rtp
% [year, month, day, hour, minute, second]
p.time_start=[2005 08 30 21 50 00];
p.time_end=[2005 08 30 23 27 00];

% start and end GPS position (needs to be accurate enough for the
% calculation of p.drot which is used in loadrdi
% these are replaced by accurate values later - rtp
% [degrees N, minutes N, degrees E, minutes E]
% for west and south derees use minus sign on BOTH degree and minute
p.poss=[56 59.00 -33 -59.00];
p.pose=[56 59.00 -33 -59.00];

% magnetic deviation angle in degree (as given on chart)
% overwritten later, but not before being used to rotate all current
% vectors by p.drot
% p.drot=-60;
p.drot=magdev(p.poss(1)+p.poss(2)/60, p.poss(3)+p.poss(4)/60);

% start, deepest and end depth if W is used to find depth
% p.zpar [startdepth, maxdepth (from CTD), enddepth]
% are these obtained from ctd? rtp
p.zpar=[0 NaN 0];
p.zpar=[10 NaN 10];
% set approx depth from CTD
p.zpar=[0 870 0];
% we should use the altimeter to get the bottom depth whenever possible
% set p.altr_ht to 0 or leave empty if no good altr data for the cast
%p.altr_ht=[]
p.altr_ht = 0;
disp(['approx depth = ',int2str(p.zpar(2)),' and altr = ',int2str(p.altr_ht)])

% try to get bottom track out of water bins (for old RDI systems)
% p.btrk_ts is in dB to detect bottom above bin1 level (for own btm track)
% but this is overridden when there exists a valid altr ht off bottom
% p.btrk_range gives maximum distance for bottom track
% mode = 1 : use only RDI bottom track
%         2 : use only own bottom track

```



```

%          3 :   use RDI, if existent, own else (default)
%          0 :   use not bottom track at all
p.btrk_mode = 1;
%p.btrk_ts=10;
%p.btrk_range=200;

% minimum % good
p.pglim=25.0;
% maximum error velocity [m/s]
p.elim=0.2;
% maximum difference between W per profile [m/s]
p.wlim=0.08;

% inverse solve parameter
% solve down and up individually
ps.down_up=1;
% resulting velocity profile vertical resolution (here 20m)
ps.dz=20;

% pre average the data to dz of p.dz
p.avdz=ps.dz;

% process the data, plot some results and save ascii files
pause off
laproc

```

## 5 NAVIGATION

Steven Alderson and Amelie Meyer

RRS *Discovery* has two hull mounted ADCP's: the old 150kHz and the Ocean Surveyor 75kHz. The 150kHz ADCP is mounted 1.75m to port of the keel, 33m aft of the bow and at a depth of ~5m. The 75kHz ADCP is 4.15m forward and 2.5m to starboard of the 150kHz instrument. The positioning of the 75kHz ADCP that much further forward means that it is more prone to bubble contamination when the ship is pitching, therefore depth coverage and quality deteriorates noticeably in rough seas. To avoid echoes between the two instruments, it would be preferable to synchronise pinging between the two instruments. However this was not possible on the cruise because of the low specification of the PC running the 150kHz logging.

High quality navigation data is crucial for obtaining accurate measurements of ocean currents using both vessel mounted and lowered ADCPs. The following sections describe the operation and data processing paths for both ADCPs as well as the navigation data, crucial for obtaining accurate ADCP current measurements.

There are four GPS receivers on RRS *Discovery*: the Trimble 4000 (gps\_4000) which is a differential GPS; the Glonass (gps\_glos) which uses a combination of Russian and American satellite networks; the Ashtech (gps\_ash); and the GPS G12 (gps\_g12). Data from all instruments were logged to the RVS Level A system before being transferred to RVS Level C system. A major problem was encountered with the master clock signal used by all navigation streams. This was corrected before the work region was entered, but problems may still be present for data before 242 XXXX (See section Y.Y for more details).

### 5.1 GPS and Bestnav

A standard PSTAR best navigation file was updated regularly throughout each cruise from datastream bestnav, using the script navexec0. The preferred input for bestnav is the Trimble 4000, as it has been found on previous cruises to give higher positional accuracy. If there were gaps in the Trimble 4000 data, the bestnav process uses Glonass instead.

The gps\_4000 coverage was extremely good during D298, with only one time-gap bigger than two minutes:

time gap : 05 242 09:02:17 to 05 242 09:20:26

### 5.2 Ship's Gyrocompass

The ship's gyrocompass provides a reliable (i.e. not dependent on transmissions external to the ship) estimate of the ship's heading. However, the instrument is subject to latitudinally dependent error, heading dependent error, and has an inherent oscillation following a change in heading.

Ship heading from the gyro was logged every second to the RVS level C. Processing consisted of regular acquisition of the gyro heading using PEXEC script gyroexec0. Data were edited for headings outside the 0-360 degree range.

### 5.3 ASHTECH 3DF GPS Attitude Determination

The Ashtech ADU2 (Attitude Detection Unit 2) GPS is a system comprising four satellite receiving antennae mounted on the bridge top. Every second, the Ashtech calculates ship attitude (heading, pitch and roll) by comparing phase differences between the four incoming signals. These data are used in post-processing to correct ADCP current measurements for 'heading error'. This post-processing is necessary because in real-time the ADCP uses the less accurate but more continuous ship's gyro heading to resolve east and north components of current. In processing, small drifts and biases in the gyro headings are corrected using the Ashtech heading measurements.

Processing the Ashtech data was broken down into a number of execs and manual steps as follows:

ashexec0	acquisition of raw data.	
ashexec1	merge Ashtech and gyro data. The difference between the Ashtech and gyro headings are calculated (a-ghdg) and set in the range between -180 and 180.	
ashexec2	quality control the data (ashexec2). This exec removes data outside the limits for the following variables:	

hdg	0	360
pitch	-5	5
roll	-7	7
attf	-0.5	0.5
a-ghdg	-7	7
mrms	0.00001	0.01
brms	0.00001	0.1

- Manually edit out any remaining outliers in a-ghdg using plxyed with ash.pdf.
- Append data to a master file for each cruise.

Data coverage for all three cruises was good, with only two gaps longer than two minutes after the point in time that the master clock problem had been corrected:

time gap : 05 243 00:37:57 to 05 243 00:44:09

time gap : 05 248 18:00:23 to 05 248 18:08:24

## 6 SHIPBOARD ACOUSTIC DOPPLER CURRENT PROFILERS

### 6.1 RDI 150 kHz shipboard acoustic Doppler current profiler

#### 6.1.1 Configuration and Performance

The 150kHz ADCP data was logged using the IBM DAS. It was configured to sample for 120 second intervals, with 64 bins of 8 m thickness, and a blank beyond transmit of 4 m. Where shallow water was encountered, the ADCP was operated in bottom track (BT) mode, otherwise it was operated in water track (noBT) mode.

The ADCP performed without malfunction for the entire cruise.

It should be emphasised that the 75kHz instrument is not a perfect replacement for the 150kHz since the 75kHz performs less well when the ship is underway, and has lower resolution in order to improve the statistics of measurements in each bin.

#### 6.1.2 Clock Correction

The ADCP uses its own internal clock that drifts by a few seconds per day. To correct this to match the ship's master clock, careful track was kept of the deviations between the two clocks. On this cruise, data were processed in daily chunks and the clock corrections applied by linear interpolation from selected values spanning the day.

#### 6.1.3 Processing

adpexec0:	read raw data into PSTAR format from the RVS level C; split into gridded depth dependent and non-gridded depth independent files; scale velocities to cm/s and amplitudes by 0.45 into dB; perform nominal edits and adjust bin depths to correct levels.
adpexec1:	correct data timebase.
adpexec2_clock:	merge data with Ashtech-gyro difference data and correct headings.
adpexec3:	apply calibration values to the velocities, scaling speed by A and rotating directions by phi.
adpexec4:	calculate absolute velocities by merging with bestnav navigation data and removing ship's speed over the ground.

#### 6.1.4 Calibration

Calibration of the 75kHz ADCP was undertaken using the following procedure:

- run through the normal processing steps as described above, with A=1 and phi=0 in surexec3.
- convert ADCP velocity of ground relative to the ship (bottomew/bottomns) and velocity of ship relative to the ground (ve/vn) into speed and direction ((botspd, botdirn, shipspd, shipdirn using pcmca2)

- calculate A (=shpspeed/adpspeed) and phi (=shpdirec-adpdirec)
- select a valid subset of data and calculate mean A and phi.

Calculation of the mean A and phi from spot values was undertaken by choosing good input data by visual inspection of the values. Records of data were included in the averaging if they occurred in a consecutive sequence of records, which involved stable heading, Ashtech correction and ship's speed. All available bottom track data from days 241 and 242 on the Greenland Shelf were used. The resulting three good estimates were averaged to give final A and phi values. The resulting calibration values were: A=1.002, phi=0.41.

### Appendix I to Section 6: Water track configuration file for the 150 kHz SADC

AD, SI, HUNDREDTHS	120.00	Sampling interval
AD, NB, WHOLE	64	Number of Depth Bins
AD, BL, WHOLE	3	Bin Length
AD, PL, WHOLE	8	Pulse Length
AD, BK, TENTHS	4.0	Blank Beyond Transmit
AD, PE, WHOLE	1	Pings Per Ensemble
AD, PC, HUNDREDTHS	1.00	Pulse Cycle Time
AD, PG, WHOLE	25	Percent Pings Good Threshold
XX, OD2, WHOLE	5	[SYSTEM DEFAULT, OD2]
XX, TE, HUNDREDTHS	0.00	[SYSTEM DEFAULT, TE]
AD, US, BOOLE	NO	Use Direct Commands on StartUp
DP, TR, BOOLE	NO	Toggle roll compensation
DP, TP, BOOLE	NO	Toggle Pitch compensation
DP, TH, BOOLE	YES	Toggle Heading compensation
DP, VS, BOOLE	YES	Calculate Sound Velocity from TEMP/Salinity
DP, UR, BOOLE	NO	Use Reference Layer
DP, FR, WHOLE	6	First Bin for reference Layer
DP, LR, WHOLE	15	Last Bin for reference Layer
DP, BT, BOOLE	NO	Use Bottom Track
DP, B3, BOOLE	NO	Use 3 Beam Solutions
DP, EV, BOOLE	YES	Use Error Velocity as Percent Good Criterion
DP, ME, TENTHS	150.0	Max. Error Velocity for Valid Data (cm/sec)
DR, RD, BOOLE	YES	Recording on disk
DR, RX, BOOLE	YES	Record N/S (FORE/AFT) Vel.
DR, RY, BOOLE	YES	Record E/W (FORT/STBD) Vel.
DR, RZ, BOOLE	YES	Record vertical vel.
DR, RE, BOOLE	YES	Record error Good
DR, RB, BOOLE	NO	Bytes of user prog. buffer

DR, RP, BOOLE	YES	Record Percent good
DR, RA, BOOLE	YES	Record average AGC/Bin
DR, RN, BOOLE	YES	Record Ancillary data
DR, AP, BOOLE	YES	Auto-ping on start-up
XX, LDR, TRI	3	[SYSTEM DEFAULT, LDR]
XX, RB2, WHOLE	192	[SYSTEM DEFAULT, RB2]
DR, RC, BOOLE	NO	Record CTD data
XX, FB, WHOLE	1	[SYSTEM DEFAULT, FB]
XX, PU, BOOLE	NO	[SYSTEM DEFAULT, PU]
GC, TG, TRI	1	DISPLAY (NO/GRAPH/TAB)
GC, ZV, WHOLE	2	ZERO VELOCITY REFERENCE (S/B/M/L)
GC, VL, WHOLE	-100	LOWEST VELOCITY ON GRAPH
CG, VH, WHOLE	100	HIGHEST VELOCITY ON GRAPH
GC, DL, WHOLE	0	LOWEST DEPTHS ON GRAPH
GC, DH, WHOLE	500	HIGHEST DEPTHS ON GRAPH
GC, SW, BOOLE	NO	SET DEPTHS WINDOW TO INCLUDE ALL BINS
GC, MP, WHOLE	25	MINIMUM PERCENT GOOD TO PLOT
SG, PNS, BOOLE	YES	PLOT NORTH/SOUTH VEL.
SG, PEW, BOOLE	YES	PLOT EAST/WEST VEL.
SG, PVT, BOOLE	YES	PLOT VERTICAL VEL.
SG, PEV, BOOLE	YES	PLOT ERROR VEL.
SG, PPE, BOOLE	NO	PLOT PERCENT ERROR
SG, PMD, BOOLE	NO	PLOT MAG AND DIR
SG, PSW, BOOLE	NO	PLOT AVERAGE SP. W.
SG, PAV, BOOLE	YES	PLOT AVERAGE AGC.
SG, PPG, BOOLE	YES	PLOT PERCENT GOOD
SG, PD1, BOOLE	NO	PLOT DOPPLER 1
SG, PD2, BOOLE	NO	PLOT DOPPLER 2
SG, PD3, BOOLE	NO	PLOT DOPPLER 3
SG, PD4, BOOLE	NO	PLOT DOPPLER 4
SG, PW1, BOOLE	NO	PLOT SP. W. 1
SG, PW2, BOOLE	NO	PLOT SP. W. 2
SG, PW3, BOOLE	NO	PLOT SP. W. 3
SG, PW4, BOOLE	NO	PLOT SP. W. 4
SG, PA1, BOOLE	NO	PLOT AGC 1
SG, PA2, BOOLE	NO	PLOT AGC 2
SG, PA3, BOOLE	NO	PLOT AGC 3
SG, PA4, BOOLE	NO	PLOT AGC 4
SG, PP3, BOOLE	NO	PLOT 3-BEAM SOLUTION
SS, OD, WHOLE	5	OffSet for Depth

SS,OH,TENTHS	45.0	OffSet for Heading
SS,OP,TENTHS	0.0	OffSet for Pitch
SS,ZR,TENTHS	0.0	OffSet for Roll
SS,OT,HUNDREDTHS	45.00	OffSet FOR temp
SS,ST,HUNDREDTHS	50.00	Scale for Temp
SS,SL,HUNDREDTHS	35.00	Salinity (PPT)
SS,UD,BOOLE	YES	Toggle UP/DOWN
SS,CV,BOOLE	NO	Toggle concave/Convex transducerhead
SS,MA,TENTHS	30.0	Mounting angle for transducers.
SS,SS,HUNDREDTHS	1500.00	Speed of Sound (m/sec)
XX,GP,BOOLE	YES	[SYSTEM DEFAULT, GP]
XX,DD,TENTHS	1.0	[SYSTEM DEFAULT, DD]
XX,PT,BOOLE	NO	[SYSTEM DEFAULT, PT]
XX,TU,TRI	2	[SYSTEM DEFAULT, TU]
TB,FP,WHOLE	1	FIRST BINS TO PRINT
TB,LP,WHOLE	64	LAST BIN TO PRINT
TB,SK,WHOLE	6	SKIP INTERVAL BETWEEN BINS
TB,DT,BOOLE	YES	DIAGNOSTIC TAB MODE
DU,TD,BOOLE	NO	TOGGLE USE OF DUMMY DATA
XX,PN,WHOLE	0	[SYSTEM DEFAULT, PN]
DR,SD,WHOLE	3	Second recording drive
DR,PD,WHOLE	3	First recording drive (1=A:,2=B: ... )
DP,PX,BOOLE	NO	Profiler does XYZE transform
SS,LC,TENTHS	5.0	Limit of Knots change
SS,NW,TENTHS	0.5	Weight of new knots of value
GC,GM,TRI	2	GRAPHICS CONTROL 0=LO RES, 1=HI RES, 2=ENHANCED
AD,PS,BOOLE	YES	YES=SERIAL/NO=PARALLEL Profiler Link
XX,LNN,BOOLE	YES	[SYSTEM DEFAULT, LNN]
XX,BM,BOOLE	YES	[SYSTEM DEFAULT, BM]
XX,RSD,BOOLE	NO	RECORD STANDARD DEVIATION OF VELOCITIES PER BIN
XX,DRV,WHOLE	0	[SYSTEM DEFAULT, DRV]
XX,PBD,WHOLE	3	[SYSTEM DEFAULT, PBD]
TB,RS,BOOLE	NO	SHOW RHPT STATISTIC
UX,EE,BOOLE	YES	ENABLE EXIT TO EXTERNAL PROGRAM
SS,VSC,TRI	0	Velocity scale adjustment
AD,DM,BOOLE	NO	USE DMA
TB,SC,BOOLE	NO	SHOW CTD DATA
AD,CW,BOOLE	NO	Collect spectral width
DR,RW,BOOLE	NO	Record average SP.W./Bin
DR,RRD,BOOLE	NO	Record last raw dopplers

DR,RRA,BOOLE	YES	Record last raw AGC
DR,RRW,BOOLE	NO	Record last SP.W.
DR,R3,BOOLE	NO	Record average 3-Beam solutions
DR,RBS,BOOLE	YES	Record beam statistic
XX,STD,BOOLE	NO	[SYSTEM DEFAULT, STD]
LR,HB,HUNDREDTHS	0.00	Heading Bias
SL,1,ARRAY5	1	1 8 NONE 19200 PROFILER
SL,2,ARRAY5	0	1 8 NONE 1200 LORAN RECEIVER
SL,3,ARRAY5	0	1 8 NONE 1200 REMOTE DISPLAY
SL,4,ARRAY5	2	1 8 NONE 9600 ENSEMBLE OUTPUT
SL,5,ARRAY5	0	1 8 NONE 1200 AUX 1
SL,6,ARRAY5	0	1 8 NONE 1200 AUX 2
DU,1,ARRAY6	100.00	100.00 60.00 0.00 0.00 YES D1
DU,2,ARRAY6	-100.00	-100.00 60.00 0.00 0.00 YES D2
DU,3,ARRAY6	200.00	200.00 60.00 0.00 0.00 YES D3
DU,4,ARRAY6	-200.00	-200.00 60.00 0.00 0.00 YES D4
DU,5,ARRAY6	200.00	19.00 60.00 0.00 0.00 YES AGC
DU,6,ARRAY6	0.00	0.00 60.00 0.00 0.00 NO SP. W.
DU,7,ARRAY6	0.00	0.00 60.00 0.00 0.00 NO ROLL
DU,8,ARRAY6	0.00	0.00 60.00 0.00 0.00 NO PITCH
DU,9,ARRAY6	0.00	0.00 60.00 0.00 0.00 NO HEADING
DU,10,ARRAY6	0.00	0.00 60.00 0.00 0.00 NO
TEMPERATURE		
DC,1,SPECIAL	"FH00001"	MACRO 1
CI,1,SPECIAL	"D298"	CRUISE ID GOES HERE
LR,1,SPECIAL	" "	LORAN FILE NAME GOES HERE

The bottom track configuration file for the 150kHz SADCP is identical to the above except for the line:

DP,BT,BOOLE	YES	Use Bottom Track
-------------	-----	------------------



## 6.2 Ocean Surveyor 75 kHz shipboard acoustic Doppler current profiler

### 6.2.1 Configuration and Performance

The 75kHz ADCP is a narrow band phased array with a 30 degree beam angle. Data was logged on a PC, using RDI data acquisition software (version 1.3). The instrument was configured with 60 bins of 16m thickness, and a blank beyond transmit of 8 m. Data were written by the software into a collection of output files on disk, which were then transferred by FTP to a UNIX workstation for further processing. The files transferred included:

#### File Extension Contents

ENR	Raw ADCP data file
ENX	Single ping data after all transforms and editing has been applied; ready for averaging.
STA	Short term averaged data (120 seconds)
LTA	Long term averaged data (600 seconds)
N1R	Raw NMEA data files, including ADCP time stamp messages

The STA files were initially used for all the initial steps of data processing. The software normally logs the PC clock time and its offset from GPS time. This offset is then applied to the data during standard processing, before merging with navigation. Gyro heading and GPS Ashtech heading, location and time are fed as NMEA messages into the software, and the gyro heading normally used for coordinate transformation. On day 252 after a sequence of bottom track data (see later section), it was noticed that the heading and clock correction in the output files were identically zero. On examination it was apparent that neither the heading nor the clock correction were available in the STA, LTA or ENX files. The data were available however in the N1R raw NMEA file. A new data processing path had to be created to produce new averaged data from the N1R and ENX files, before further processing with standard scripts. This is described in more detail later.

The method for calibration of this instrument (and of the 150kHz SADCP) relies on the collection of bottom track data, where the velocity of the bottom relative to the ship can be measured in water depths less than 1000m. This reduces the amount of data collected in the rest of the water column and therefore increases the noise in the measurements. Consequently, the instrument is swapped into bottom track mode only when appropriate.

Configuration files for this are listed in Appendix II to Section 6.

### 6.2.2 Processing

#### Standard processing scripts

surexec0: read data into PSTAR format from RDI binary file; write water track data into files of the form sur279nn.raw and equivalent, where nn is a two character code; write bottom

track data where present into files of the form sbt279mm; scale velocities to cm/s and amplitude by 0.45 to dB; correct time variable by combining GPS and the PC times; set the depth of each bin.

surexec0b: take a sequence of files created by surexec0, append them together and extract data spanning a complete day.

This was intended to create files for the 75kHz instrument with similar names and data ranges as the corresponding 150kHz data files and each of the navigation files. Output files from surexec0 were given two character letter codes ('aa', 'ab', etc.) and those from surexec0b were assigned two digit numbers as usual.

surexec1: edit data (status flag equal to 1 is bad data); edit on percent good variable; move ensemble time to the end of its interval.

surexec2: merge data with Ashtech-gyro difference file (created by ashexec2) and correct heading.

surexec3: calibrate velocities by scaling by factor A and rotating by angle phi.

surexec4: calculate absolute velocities by merging with navigation data (bestnav) and removing the ship's velocity over the ground from the ADCP data.

#### **Additional raw data processing scripts**

enxexec0: read N1R files, parse NMEA messages; when an adcp message is found (\$PADCP), the next GPS message is used to calculate clock correction (accurate to ~1 second), the GYRO messages up till the next ADCP one are averaged together to give heading estimates. Comparison of the resulting heading and time streams with the gyro data processed independently shows good agreement between the datasets, confirming the validity of this process.

enxexec0b: read ENX single ping data into PSTAR format; create heading and clock correction variables by merging with parsed data from enxexec0; average to 2 minutes; edit out averages with less than 10 constituents. The resulting files are given two letter identifiers and then processed with surexec0b.

#### **6.2.3 Calibration**

Calibration of this instrument proceeded exactly as for the 150kHz instrument using the same time range of data, and will not be described further. Three good estimates of the calibration were obtained and the final values used in the processing were:  $A = 1.002$ ,  $\phi = 0.59$ .

A comparison of the relative velocities from the two instruments is shown in Figure X.2. Velocities have been extracted and averaged into a single row of values from the data for day 261 from a layer of thickness 48m centred at 109m for both instruments. These are both converted to speed and direction

and plotted in the two panels as scatter plots, using only data where speed is greater than 100cm/s. A regression line has been drawn in both cases. Excellent agreement is obtained. This demonstrates the validity of the recovery procedure adopted for the 75kHz instrument.

## Appendix II to Section 6: Configuration Files for the 75 kHz SADC

The OS75 SADC uses two configuration files. The first (extension ".txt") occupies the same function as the configuration file for the 150kHz file and represents the parameters sent directly to the instrument. The second (extension ".ini") represents the settings used by the software on the PC which reads data from the instrument and performs further processing. The name of the first configuration file is stored in the second. A lot of significant parameters are hidden in this second file which are not visible through the GUI interface provided by the PC. This was the source of the error in parameter selection which resulted in the absence of heading and clock correction. Below is the corrected file in which "HeadingSource" is set to "0" and not "1" as used on the cruise.

### Txt Configuration file

```
-----
---\
; ADCP Command File for use with VmDas software.
;
; ADCP type:      75 Khz Ocean Surveyor
; Setup name:     default
; Setup type:     Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
;       column is treated as a comment and is ignored by
;       the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (eg. courier).
-----
--/

; Restore factory default settings in the ADCP
crl

; set the data collection baud rate to 115200 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb811

; Set for narrowband profile mode, single-ping ensembles,
; sixty 16m bins, 8m blanking distance, 390 mm/s ambiguity vel
NP001
NF800
NS1600
NN60
```

```

WP000

WF0800
WS1600
WN040

WV390

; Disable single-ping bottom track,
; Set maximum bottom search depth to 1200 meters
BP000
BX12000

; output velocity, correlation, echo intensity, percent good
WD111100000

; Two seconds between bottom and water pings
TP000200

; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor,
; external synchro heading sensor, use internal
; transducer temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer depth to 5.3m
ED00053
; No synchro
CX0,0
; save this setup to non-volatile memory in the ADCP
CK

```

### **Ini Configuration file**

```

[Expert only options]
TurnedOffBeam=0

```

```

[ADCP Port Setup]

```

```
AdcpComPortName=COM1
AdcpComBaudRate=9600
AdcpComParity=NOPARITY
AdcpComStopBits=1
AdcpComDataBits=8
AdcpConfigFilename=C:\RDI\Configuration\OS75 NB NoBT 16m bin Nosync.txt
```

```
[NMEA Port Setup]
NMEANavComEnable=TRUE
NmeaNavComPortName=COM5
NmeaNavComBaudRate=4800
NmeaNavComParity=NOPARITY
NmeaNavComStopBits=1
NmeaNavComDataBits=8
NMEARPHComEnable=TRUE
NmeaRPHComPortName=COM6
NmeaRPHComBaudRate=4800
NmeaRPHComParity=NOPARITY
NmeaRPHComStopBits=1
NmeaRPHComDataBits=8
```

```
[Serial Port for Binary Ensemble Data Output]
BinaryEnsembleOutputComEnable=FALSE
BinaryEnsembleOutputComPortName=None
BinaryEnsembleOutputComBaudRate=9600
BinaryEnsembleOutputComParity=NOPARITY
BinaryEnsembleOutputComStopBits=1
BinaryEnsembleOutputComDataBits=8
BinaryEnsembleOutputDataType(0:none;1:enr;2:enx;3:sta;4:lta)=0
BinaryEnsembleOutputRefVelType(0:none;1:Bottom;2:Mean)=0
BinaryEnsembleOutputStartBin=1
BinaryEnsembleOutputEndBin=4
BinaryEnsembleOutputMeanStartBin=1
BinaryEnsembleOutputMeanEndBin=4
BinaryEnsembleOutputLeader(0:no;1:yes)=FALSE
BinaryEnsembleOutputBottomTrack(0:no;1:yes)=FALSE
BinaryEnsembleOutputNavigation(0:no;1:yes)=FALSE
BinaryEnsembleOutputVelocity(0:no;1:yes)=FALSE
BinaryEnsembleOutputIntensity(0:no;1:yes)=FALSE
BinaryEnsembleOutputCorrelation(0:no;1:yes)=FALSE
BinaryEnsembleOutputPercentGood(0:no;1:yes)=FALSE
BinaryEnsembleOutputStatus(0:no;1:yes)=FALSE
```

```
[Serial Port for ASCII Ensemble Data Output]
AsciiEnsembleOutputComEnable=FALSE
```

```

AsciiEnsembleOutputComPortName=None
AsciiEnsembleOutputComBaudRate=9600
AsciiEnsembleOutputComParity=NOPARITY
AsciiEnsembleOutputComStopBits=1
AsciiEnsembleOutputComDataBits=8
AsciiEnsembleOutputDataType(0:none;1:enr;2:enx;3:sta;4:lta)=0
AsciiEnsembleOutputRefVelType(0:none;1:Bottom;2:Mean)=0
AsciiEnsembleOutputStartBin=1
AsciiEnsembleOutputEndBin=4
AsciiEnsembleOutputStoreToDisk(0:no;1:yes)=FALSE
AsciiEnsembleOutMeanStartBin=1
AsciiEnsembleOutputMeanEndBin=4
AsciiEnsembleOutputLeader(0:no;1:yes)=TRUE
AsciiEnsembleOutputBottomTrack(0:no;1:yes)=TRUE
AsciiEnsembleOutputNavigation(0:no;1:yes)=TRUE
AsciiEnsembleOutputVelocity(0:no;1:yes)=TRUE
AsciiEnsembleOutputIntensity(0:no;1:yes)=TRUE
AsciiEnsembleOutputCorrelation(0:no,1:yes)=TRUE
AsciiEnsembleOutputPercentGood(0:no;1:yes)=TRUE
AsciiEnsembleOutputStatus(0:no;1:yes)=TRUE

```

[Serial Port for Speed Log Output]

```

SpeedLogComEnable=FALSE
Speed Log ComPortName=None
Speed Log ComBaudRate=9600
Speed Log ComParity=NOPARITY
Speed Log ComStopBits=1
Speed Log ComDataBits=8

```

[IP Port for Binary Ensemble Data Output]

```

BinaryEnsembleOutputNetEnable=FALSE
BinaryEnsembleOutputIPPortNumber=5433

```

[IP Port for ASCII Ensemble Data Output]

```

AsciiEnsembleOutputNetEnable=FALSE
AsciiEnsembleOutputIPPortNumber=5433

```

[IP Port for Speed Log Output]

```

SpeedLogNetEnable=FALSE
SpeedLogHostName/IPAddress=5434

```

[Fake Data Options]

```

AdcpFakeDataEnable=FALSE
AdcpFakeDataFilename=SimAdcp.enr
FakeDataTimeBetweenEnsembles=2

```

NMEAFakeDataEnable=FALSE  
NMEAFakeDataFilename=SimNav.nmr

[File Name Components]  
EnableDualRecordDir=FALSE  
FileRecordPath=C:\RDI\DATA\D298\  
FileRecordBackupPath=C:\RDI\ADCP\  
DeploymentName=D298  
DeploymentNumber=7  
MaximumFileSize=2

[Bottom Track Data Screening Options]  
BTampScreenEnable=FALSE  
BTCorScreenEnable=FALSE  
BTErrScreenEnable=FALSE  
BTVertScreenEnable=FALSE  
BTFishScreenEnable=FALSE  
BTPctGoodScreenEnable=FALSE  
BTAmplitudeThreshold=30  
BTCorrelationThreshold=220  
BTErrVelThreshold=1000  
BTVerticalVelThreshold=1000  
BTFishThreshold=50  
BTPctGoodThreshold=50

[Water Track Data Screening Options]  
WTampScreenEnable=FALSE  
WTCorScreenEnable=FALSE  
WTErrScreenEnable=FALSE  
WTVertScreenEnable=FALSE  
WTFishScreenEnable=FALSE  
WTPctGoodScreenEnable=FALSE  
WTAmplitudeThreshold=30  
WTCorrelationThreshold=180  
WTErrVelThreshold=1000  
WTVerticalVelThreshold=1000  
WTFishThreshold=50  
WTPctGoodThreshold=50

[Profile Data Screening Options]  
PRampScreenEnable=FALSE  
PRCorScreenEnable=FALSE  
PRErrScreenEnable=FALSE  
PRVertScreenEnable=FALSE  
PRFishScreenEnable=FALSE



```

PRPctGoodScreenEnable=FALSE
PRMarkBadBelowBottom=FALSE
PRAmplitudeThreshold=30
PRCorrelationThreshold=180
PRErrorVelThreshold=1000
PRVerticalVelThreshold=1000
PRFishThreshold=50
PRPctGoodThreshold=50

[Transformation Options]
XformToEarth=TRUE
Allow3Beam=TRUE
BinMap=TRUE
BeamAngleSrc(0:auto,1:man)=0
ManualBeamAngle=30
HeadingSource(0:adcp,1:navHDT,2:navHDG,3:navPRDID,4>manual)=0
ManualHeading=0
TiltSource(0:adcp,1:nav,2:man)=1
ManualPitch=0
ManualRoll=0
SensorConfigSrc(0:PRfixed,1:Pfixed,2:auto)=2
ConcavitySource(0:convex,1:concave,2:auto)=2
UpDownSource(0:dn,1:up,2:auto)=2
EnableHeadingCorrections=TRUE
SinCorrectionAmplitudeCoefficient=0
SinCorrectionPhaseCoefficient=0
MagneticOffsetEV=0
AlignmentOffsetEA=60
EnableVelocityScaling=FALSE
VelocityScaleFactorForBTVelocities(unitless)=1
VelocityScaleFactorForProfileAndWTVelocities(unitless)=1
EnableTiltAlignmentErrorCorrection=FALSE
TiltAlignmentHeadingCorr(deg)=0
TiltAlignmentPitchCorr(deg)=0
TiltAlignmentRollCorr(deg)=0

[Averaging Options]
AvgMethod(0:time,1:dist)=0
FirstAvgTime=120
SecondAvgTime=600
FirstAvgDistance=500
SecondAvgDistance=5000
EnableRefLayerAvg=TRUE
RefLayerStartBin=3
RefLayerEndBin=10

```

```

[Reference Velocity Options]
RefVelSelect(0:none,1:BT,2:WT,3:LYR,4:NDP,5:NAP,6:NSPD)=6
VelRefLayerStartBin=30
VelRefLayerEndBin=35
RefVelUnitVel(0:mm/s,1:m/s,2:knots,3:ft/s)=1
RefVelUnitDepth(0:m,1:cm,2:ft)=0

[User Exit Options]
UserWinAdcpEnable=FALSE
UserWinAdcpPath=C:\Program Files\RD Instruments\WinAdcp\WinAdcp.exe
UserWinAdcpUpdateInterval(sec)=10
UserWinAdcpFileType(0:enr,1:enx,2:sta,3:lta)=3
UserAdcpScreening=FALSE
UserNavScreening=FALSE
UserTransform=FALSE

[Shiptrack Options]
ShipTrack1Source(0:Nav;1:BT;2:WT;3:Layer)=3
ShipTrack2Source(0:Nav;1:BT;2:WT;3:Layer)=0
ShipTrack1RedStickEnable=TRUE
ShipTrack1GreenStickEnable=TRUE
ShipTrack1BlueStickEnable=TRUE
ShipTrack2RedStickEnable=TRUE
ShipTrack2GreenStickEnable=TRUE
ShipTrack2BlueStickEnable=TRUE
ShipTrack1RedBin=2
ShipTrack1GreenBin=3
ShipTrack1BlueBin=4
ShipTrack2RedBin=2
ShipTrack2GreenBin=3
ShipTrack2BlueBin=4
ShipTrack1DisplaySelect(0:Lat/Lon;1:Distance)=0
ShipTrack2DisplaySelect(0:Lat/Lon;1:Distance)=0
ShipTrack1WaterLayerStartBin=30
ShipTrack1WaterLayerEndBin=35
ShipTrack2WaterLayerStartBin=3
ShipTrack2WaterLayerEndBin=5
ShipTrackDistanceUnit=0

[ADCP Setup Options]
SetProfileParameters=FALSE
NumberOfBins=100
BinSize(meters)=8
BlankDistance(meters)=8

```

```
TransducerDepth(meters)=5
SetBTEnable(0:SendBPCmd,1:Don'tSendBPCmd)=TRUE
ADCPSetupMethod(0:Options,1:CommandFile)=1
BtmTrkEnable(0:SendBP0,1:SendBP1)=1
MaxRange(meters)=1000
SetHdgSensorType=TRUE
HdgSensorType(0:internal,1:external)=1
SetTiltSensorType=TRUE
TiltSensorType(0:internal,1:external)=1
SetProcessingMode=TRUE
BandwidthType(0:Wide,1:Narrow)=0
ADCPTimeBetweenEnsemblesSel=1
ADCPTimeBetweenEnsembles=1
```

## 7 WATER SAMPLES

### 7.1 Salinity

Igor Shkvorets, Sara De La Rosa

#### 7.1.1 Equipment

During the Cruise salinity sample analyses were performed on the UKORS Guildline Autosol 8400B #65764 and RBR Micro-salinometer MS-310 #12051 in the Constant Temperature (CT) laboratory. The temperature in the CT lab was maintained between 21.5 and 22.2 deg.C. The Autosol bath was set at 24 deg.C, and stability of the Autosol bath temperature with NORMAL, T1 and T2 positions is shown in Figure 7.1. At the beginning of cruise a broken heating lamp was replaced. In addition, peristaltic pump was changed and adjusted for appropriate flow speed.

The RBR Micro-salinometer MS-310 was taken on the cruise for the seagoing trial and was used to measure in parallel with the Autosol for approximately one quarter of all salinity samples. Newly developed in RBR (Canada) with collaboration with the Marine Hydrophysical Institute (Ukraine), this instrument compares the conductance of the sample of seawater directly with that of a standard. A dual inductive cell system removes the need for a highly stable bath temperature and gives a direct reading of the conductivity ratio of the sample against standard seawater. The overall instrument is very compact, with a bench footprint of less than 310 by 210 mm, and a weight of under 5kg.

#### 7.1.2 Sample Collection and Analysis

On each CTD cast 8-12 samples were taken for salinity from Niskin bottles. A quarter of the samples were duplicated. Samples were taken in 200ml glass sample bottles, rinsed 3-5 times and sealed with disposable plastic stoppers and screw on caps after drying the neck. Samples were stored in the CT laboratory for a minimum of 24 hours before analysis to allow equilibration to laboratory conditions. Analysis followed the standard Autosol procedure and Micro-salinometer manual. A sample of IAPSO Standard Seawater was run every 24 samples for salinometer calibration and drift checking. Only one batch P146 ( $K_{15}=0.99979$ ) of Standard Seawater was used. The standardization dial was set to 4.30 and not changed during the cruise. Igor Shkvorets carried out the majority of analysis with Sara de la Rosa helping.

Stability of the Autosol readings during the measurement of one crate of samples (24 bottles) is indicated in Figure 7.2. Autosol readings always drifted during the measurements to high values (up to 0.003 in the practical salinity units). For the correction of this drift it, a linear correction of the measured  $2R_t$  was applied for each sample. After overnight soaking of the conductivity cell with distilled water readings returned back close to the expected value of the standard seawater  $K_{15}$ .

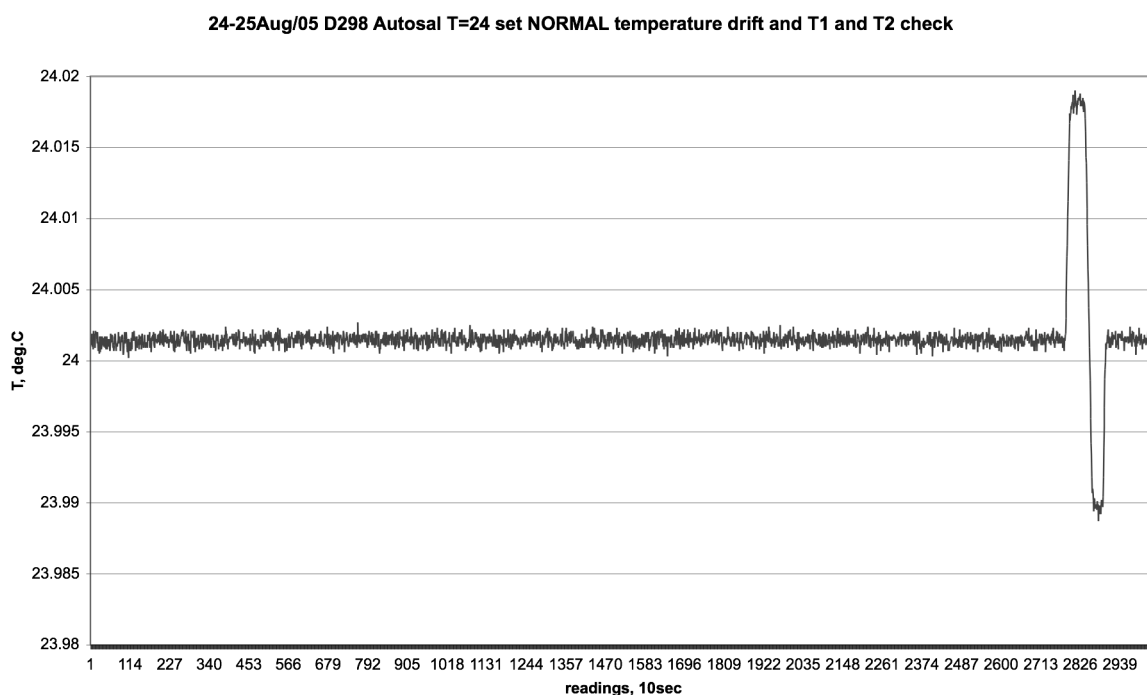
The Micro-salinometer showed a drift less than 0.001 in practical salinity and all data were accepted without correction. Comparison of the salinity measurements of 170 samples (20 of them are

duplicated) performed by the Micro-salinometer MS-310 and the Autosol during the cruise is shown in Figure 7.3. Mean value of salinity differences is -0.0004 with standard deviation 0.0011. This result shows very good accuracy of the sample salinity measurements in ocean conditions for the MS-310. With additional improvement of the ready-to-read time (now it is required to be about 10 min for a sample), that MS-310 is a sophisticated instrument for mass salinity sample measurements at sea without having a constant temperature laboratory.

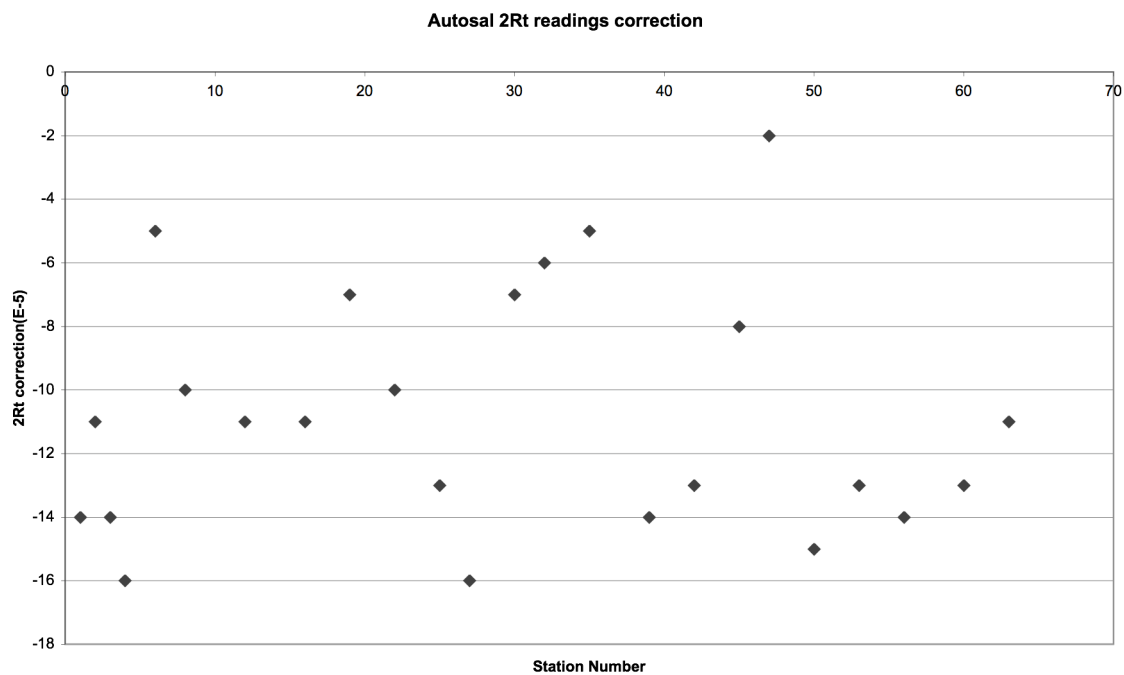
### 7.1.3 Data Processing

Raw conductivities from the Autosol were corrected by applying a linear regression correction for each sample, according to the calibration results. After correction, practical salinity was calculated using Guildline AutoSalCal1.1 software. Results were saved in a tab delimited text file with name *sal298{num}.txt*.

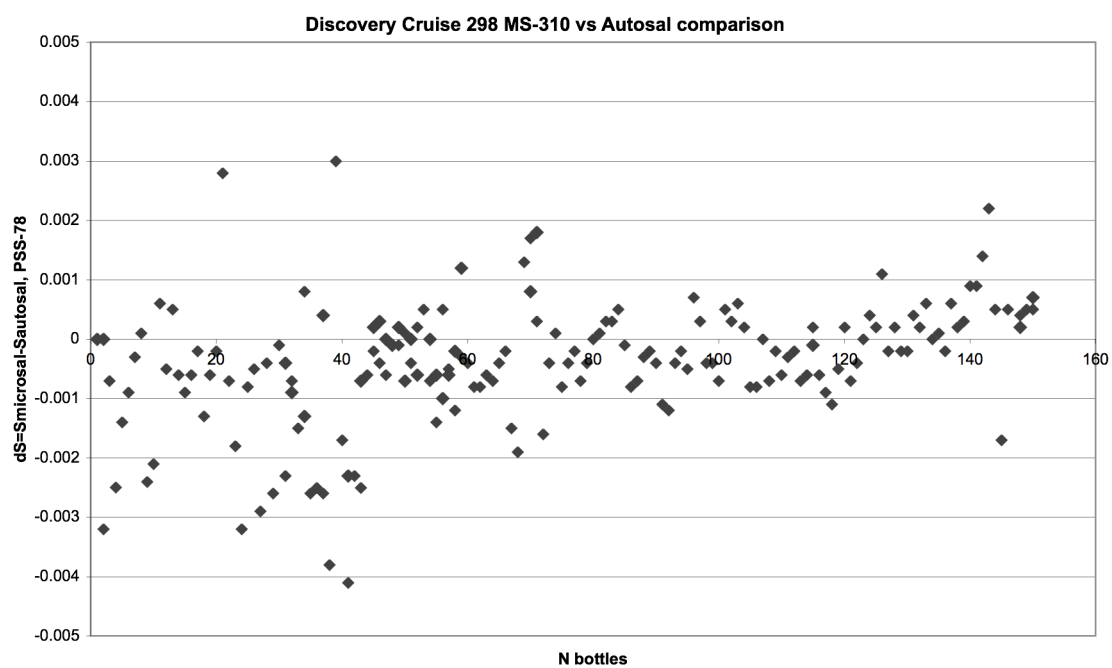
Raw conductivity ratio and temperature data from the Micro-salinometer MS-310 were automatically converted to the practical salinity using RBR Windows Software. Salinity and temperature were stored in the output files together with additional information about each sample (station number, bottle number, sample number). Variable names for sample salinity were *botsala* and *botsalb* for Guildline Autosol primary and duplicate samples, and *micsala* and *micsalb* for RBR Microsalinometer samples similarly.



**Figure 7.1:** Stability of Autosol bath temperature.



**Figure 7.2:** Stability of Autosal readings during measurement of one crate of (24) samples.



**Figure 7.3:** Comparison of Microsalinometer and Autosal measurements.

## 7.2 Dissolved Oxygen

Jonathan Lauderdale, Alistair McVicar and Sara de la Rosa

Dissolved oxygen samples were drawn from 10L Niskin Bottles from 63 CTD stations following collection of samples for CFC analysis and then fixed on deck. Analysis of the samples was by the Winkler whole bottle titration method in the chemistry laboratory. A series of duplicates from the same Niskin bottle and two Niskin bottles fired at the same depth were collected on most casts.

### Method:

Samples were drawn through short pieces of silicone tubing into clear, pre-calibrated, wide necked glass bottles (100ml nominal volume). The temperature of each sample was taken using a handheld digital temperature probe in order to calculate temperature dependant volume changes of the samples. Samples were then fixed with 1ml Manganous Chloride solution followed by 1ml Alkali Iodate solution (NaOH/NaI), prepared after Dickson (1994) and dispensed using Fortuna “Optifix” dispensers. The bottle specific lid was then inserted taking care not to introduce any air bubbles, and the bottles shaken thoroughly. The samples were then transferred to the chemistry laboratory and shaken again before being stored in a cool, dark cupboard for later analysis.

Analysis was conducted approximately 8 hours after sample collection using the Winkler whole bottle titration method with spectrophotometric end-point determination (photometer manufactured by SIS). Samples were acidified with 1ml of Sulphuric acid (using a dispenser) in order to dissolve the precipitate and release the Iodate ions. They were then mixed using a magnetic stirrer that was set to a constant spin during the titration. Ship movement sometimes disturbed the spin of the stirring bar which may have reduced stirring effectiveness, however, it is unlikely that this would have affected the accuracy of the end-point determination.

The following user variable parameters in the SIS supplied software [Options menu, Parameters] that was run on a Dell Dimension P166v Windows '98 PC were set at NOC from recommendations in previous cruise reports and applied throughout the cruise, giving titration times of less than five minutes.

Stepsize: 5 (x1/10000<sup>th</sup> cylinder volume)

Wait Time: 3s

Fast Delay: 2s

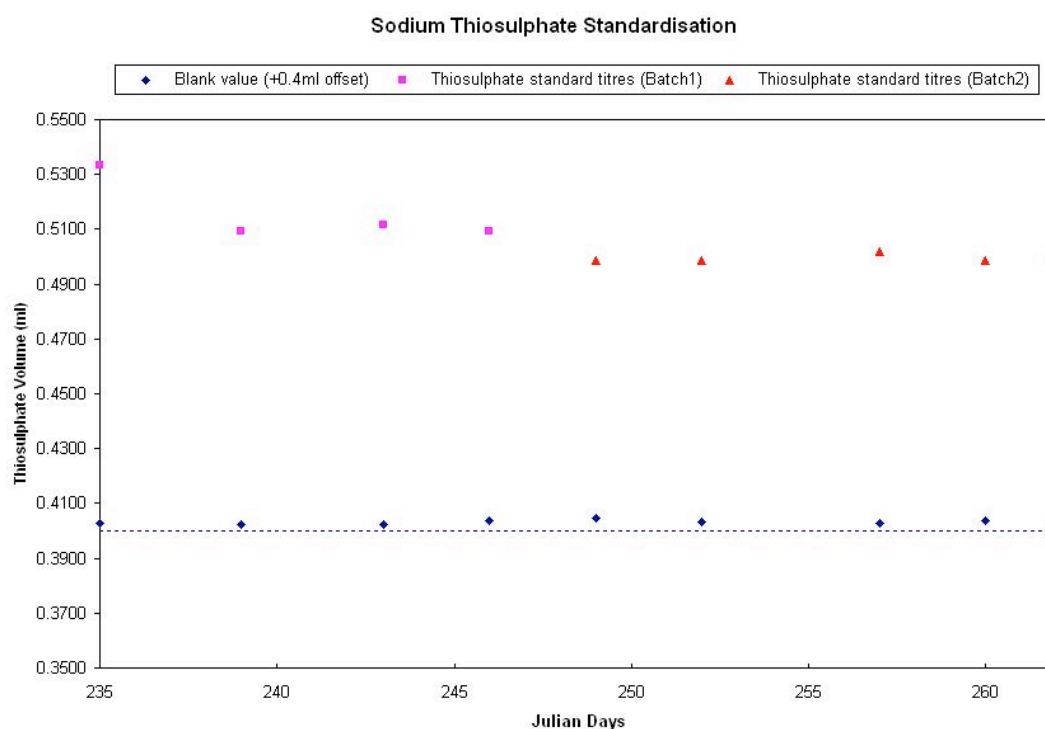
Slow Delay: 2s

Fast Factor: 0.5

Seawater samples were titrated against Sodium Thiosulphate solution (25gL<sup>-1</sup>) which was made up as necessary during the cruise to the by dissolving pre-weighed crystals in 1L Milli-Q water. As this reagent degrades with time it was standardised against 5ml of an OSIL certified 0.01N Potassium

Iodate solution every three or four days. The volume of Sodium Thiosulphate required in these titrations was then input into a *MS Excel* spreadsheet and used to calculate dissolved oxygen concentration following the equations of Dickson (1994).

Two thiosulphate solutions were used and both appeared relatively stable (figure 7.4). The reagent blank was evaluated at the same time as the standards and also remained relatively stable.



**Figure 7.4:** Thiosulphate standardisation and reagent blank values (+0.4ml offset)

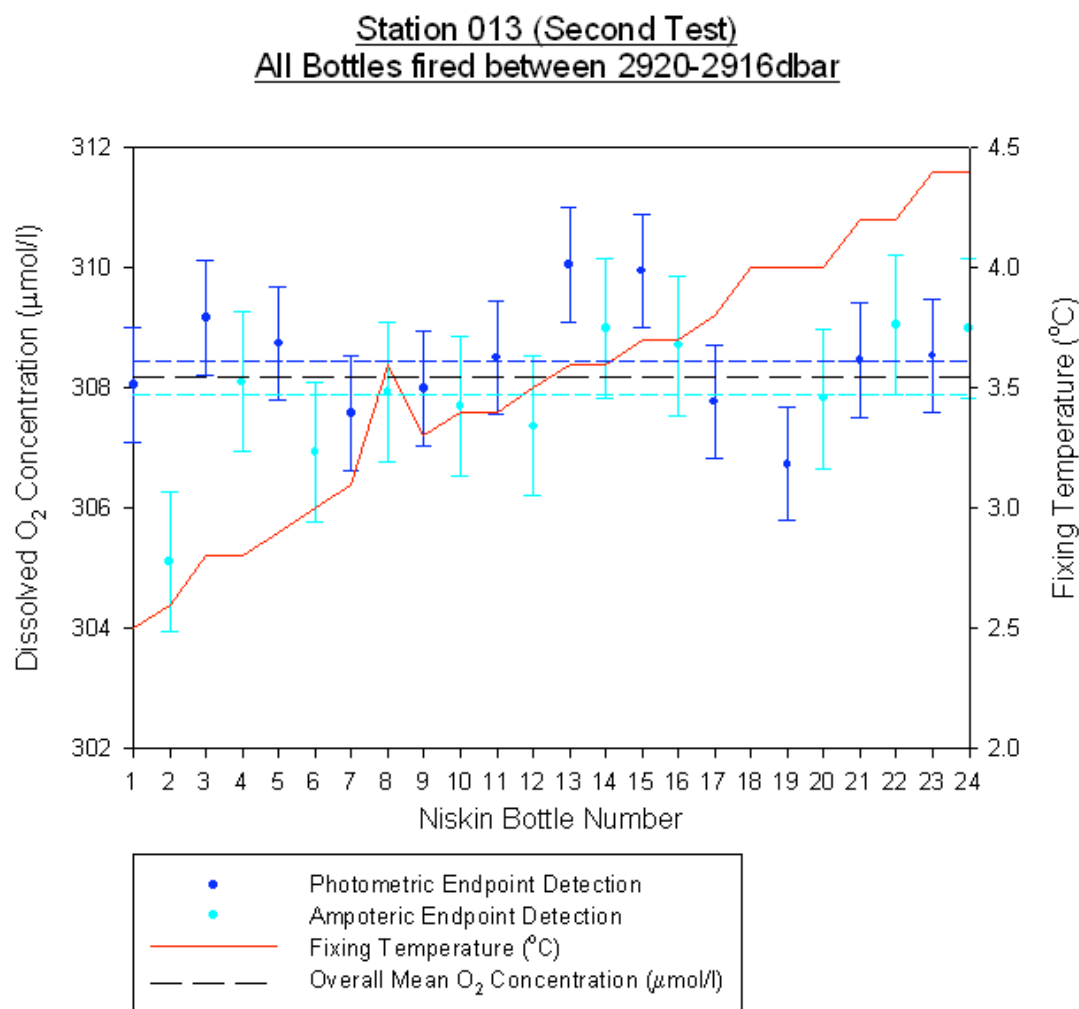
The duplicate samples drawn from the same Niskin bottle at each station were compared and the differences between them calculated. There were 42 pairs of duplicates. After conversion from  $\mu\text{mol/l}$  (final concentration from analysis) to  $\mu\text{mol/kg}$  (standard oceanographic oxygen concentration) they had a mean difference of  $-1.6 \mu\text{mol/kg}$  (standard deviation =  $5.8 \mu\text{mol/kg}$ ), however when obvious outliers were removed this fell to  $-0.9 \mu\text{mol/kg}$  (standard deviation =  $3.2 \mu\text{mol/kg}$  for 36 pairs).

#### **Intercalibration Exercise:**

Although not used for the main analysis, a MetrOhm DMS 716 Titrino with amphoteric end-point detection was carried as “back-up” equipment should the SIS system fail. CTD station 13 was used as a second test station with all bottles fired at approximately the same depth and sampled for dissolved oxygen as briefly described above. Alternately, half of the 24 samples were then titrated using the SIS package while the remaining samples were titrated using the MetrOhm system allowing direct comparison of the two methods. Figure 7.5 shows that the mean dissolved oxygen concentration obtained using the spectrophotometric end-point detection method was higher than the overall mean,



whereas the amphoteric end-point detection method gave a lower individual mean. An F-Test was used to assess the significance of this and gave a probability of 0.522 that there was no significant difference between the two method's mean values. This was found to be true where  $p=0.02$  and suggests that the results obtained by both methods are directly comparable.



**Figure 7.5:** Results of the intercalibration exercise for CTD station 13. Error bars are 1 sdu.

#### Problems/Errors:

In the time taken to sample the CTD rosette the later bottles to be sampled may have warmed whilst on deck, however the effect of this is likely to be small due to the low atmospheric temperatures in this region; Deeper bottles were sampled first in order to further reduce both this effect and the effect of equilibration with atmospheric oxygen.

Handheld temperature probes of the type used are subject to a certain amount of variability and in several cases at the start of the cruise it was difficult to obtain stable temperature readings. In most

cases the same temperature probe was used to reduce the errors introduced as a result of this variability.

Total number of samples taken: 716

E4010 “Titration Failed” errors: 25

W0071 “Approximation Failed” errors: 53

2.7% of the samples had to be discarded as they contained bubbles that were not noticed on deck and therefore could not be re-sampled.

### **7.3 Nutrients**

Les sels nutritifs ont été prélevés sur une grande partie des 60 premières stations de la campagne D298. Les analyses sont conduites au Laboratoire de Chimie Marine (UMR CNRS 7144, Roscoff) à la Station Biologique de Roscoff. Les sels nutritifs (nitrites, nitrates, phosphates et silicates) seront déterminés en analyse automatique sur des chaînes Auto Analyser II Bran et Luebbe selon les méthodes décrites en détail par Tréguer and Le Corre, (1975).

Les échantillons ont été prélevés sur des bouteilles Niskin de 10L. Les flacons de 125 mL utilisés, ainsi que leur bouchon, ont été nettoyés trois par l’eau de mer contenue dans la bouteille d’où l’eau est prélevée. Seul 100 mL d’eau de mer ont été prélevés par flacon. Ainsi, ceux-ci ont pu être, dès la fin du prélèvement, stockés dans un congélateur à -18°C. Quand ils sont congelés, ils sont rapidement transférés vers un réfrigérateur à -4°C afin de les conserver congelés jusqu’à la fin de la campagne. Ils sont ensuite transférés dans un camion frigorifique.

A partir de la station 40, l’ensemble des flacons de 125 mL fut utilisé. Ils furent remplacés par des flacons stériles de 25 mL. De la même façon, ces flacons ont été remplis aux deux tiers dans le but de les conserver congelés.

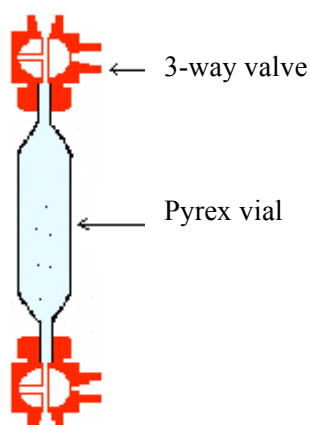
## 7.4 CFCs

Essyllt Louarn and Boris Cocquempot

The CFC analytical equipment was set up in the seagoing laboratory container of the Laboratory of Marine Chemistry (UMR CNRS 7144, Roscoff). The equipment was set to analyze CFC 12, CFC 11, CFC 113 and  $\text{CCl}_4$ .

### Sample collection:

Samples were collected from 10L Niskin bottles attached to a 24 bottle rosette. The Niskin bottles were refitted with o-rings specially made without grease or solvents to avoid any chance of halocarbon contamination.



The sampler (illustrated above) is composed of a ~30 mL pyrex vial. At both ends were adapted a PTFE-CFC-free 3-way valve. The samplers were connected to the Niskin bottle by a 1/8" Stainless Steel tube connected himself to a flexible tube.

The connection tubes were flushed 30 seconds before connection to the samplers. Then the samplers were flushed three times with the seawater; it then takes around three minutes to sample one bottle. The samples were stored in seawater, and had to be analyzed within 16 hours after collection.

### Analysis:

Halocarbon analyses were performed on a gas chromatograph (GC) equipped with an electron capture detector (ECD). The pre-concentration step is performed by a purge-and-trap system. The samplers are directly introduced into the purge-and-trap. The connection lines are purged with vacuum and pure nitrogen. The sample is then introduced into the purge-and-trap-system via the stripper which purges the water sample of the halocarbons gases by the mean of pure nitrogen. The gas stream is stripped of any water vapour via a cooler at  $-4^{\circ}\text{C}$  (using ethanol as cooling fluid) and a magnesium perchlorate trap prior transfer to the main trap.

The gases are trapped into a 1/16" SS trap filled of Porasil C held at -80°C with a silicone oil bath. The trapped compounds desorbed at 100°C in a boiling water bath. During the desorption time the compounds of interest are released onto the analytical pre-column. The analytical pre-column (Restek 502, 30cm) is held in-line with the main analytical column (DB624, 75m) for one minute. After that time, all compounds of interest are on the main column and the pre-column is switched out of line and backflushed with a relatively high flow of nitrogen gas. This prevents eluting compounds from building up on the analytical column, eventually eluting and causing the detector baseline signal to increase.

The flux flushing the main column is programmed to 10 mL.min<sup>-1</sup> during 3 min after the end of desorption, then to 25 mL.min<sup>-1</sup> during 2 min and finally to 55 mL.min<sup>-1</sup>. An analysis lasts around 15 minutes, which comprises the stabilisation time at the end of the analysis. The acquisition, the GC-ECD as well as the two valves connected to the pre-column are controlled by the computer software Chromquest®.

### Results:

During the D298 cruise, 50 stations were sampled for CFCS, ie 708 samples. Most of the stations measured had a duplicate chosen randomly. A calibration was run at least every two days. The calibration was performed using 10 different sample volumes flushed with a NOAA (2003) air standard. The precision for CFC 11 and CCl<sub>4</sub> was less than 1%, 2% for CFC 113 and 4-6% for CFC 12.

For electronic problems that occurred two times, we had to skip two stations (9 and 43). A calibration was conducted during the station 27. We also had to change the pre-column because of a water contamination (station 43). Usual and preventive reparations were managed during transit and coring times.

## 7.5 Oxygen Isotope Samples

Alistair McVicar and Eelco Rohling

Water samples for  $\delta^{18}\text{O}$  were collected from 61 stations (all the CTD stations excluding the test stations 1 and 13) at specific depths that were determined on the basis of the CTD's temperature / salinity profile as generated on the downward cast. In order to achieve consistency in the surface water measurements a series of standard depths were sampled (Surface, 10m, 25m, 50m, 100m and 200m). A maximum of 20 water samples were taken per station in small (28ml) glass vials and these were individually labelled (D298 - 'Station number'- 'bottle number'). They were collected immediately after the samples for analysis of CFC and oxygen concentrations.

The sampling procedure was:

- *Flush* the bottles and lids with water to remove impurities and contaminants.
- *Fill* each vial leaving an air gap of a few millimetres from the top, to allow for expansion when warmed. Care was taken to ensure the flow was sufficiently slow to reduce bubbles and oxygenating the water.
- *Seal* with a high density rubber cap and then tape (using electrical tape) around the neck and cap.
- *Store* in the cold store at 4°C, to keep near sampling temperature and avoid expansion that might break the seal, for later analysis back in the lab.

No chemical agents were added to the samples due to the minimal effect photosynthesis by organisms in the sample will have on the isotopic composition due to the enormous amount of oxygen in  $\text{H}_2\text{O}$ . The total number of samples taken on the cruise was in the region of 1100.

In addition to sampling from the Niskin bottles surface samples were taken from the non-toxic flow, with an intake of approximately 4-5m below the sea surface, when we were sufficiently close to Greenland. This was to ensure we sampled water with low salinity values in order to improve the later determination of the fresh water end members. For these samples the bottles were labelled with the code: D298 – NT – 'bottle number'. These samples had their salinities determined on board by Igor Shkvorets using a Guildline Autosol 8400B salinometer. The lowest salinity value we achieved was 29.97 (2DP).

**Table 7.1:** Data for non-toxic samples.

Date	Time (GMT)	Station	Position		Bottle Number		Calculated Salinity
			Lat	Long	Delta O	Salinity	
7/9/2005	14:55	23	59 57.70	43 06.63	D298-NT-01	A17	29.9595
	15:50	22	59 54.05	43 02.11	D298-NT-02	A18	29.9724
	17:35	21	59 52.72	42 51.25	D298-NT-03	A20	31.3928
	21:10	20	59 48.41	42 39.51	D298-NT-04	A19	30.2068
	23:33		59 44.536	42 48.006	D298-NT-05	A21	31.0533
8/9/2005	00:01		59 42.643	42 54.104	D298-NT-06	A22	31.1474
	00:28		59 40.989	42 58.998	D298-NT-07	A23	32.2499
	01:01		59 39.414	43 04.425	D298-NT-08	A24	34.0139
	01:32		59 37.795	43 09.685	D298-NT-10	601	33.1501
	01:59		59 36.095	43 14.808	D298-NT-11	602	33.2748
	02:31		59 33.827	43 20.847	D298-NT-12	603	34.1670
	03:04		59 31.173	43 20.910	D298-NT-13	604	33.9545
	04:15	24	59 30.008	43 30.127	D298-NT-14	605	33.9275
	05:19		59 25.340	43 30.004	D298-NT-15	606	34.4243
12/9/2005	12:58	38	59 55.648	44 41.982	D298-NT-16	A1	30.4280
	14:55		59 47.618	44 49.998	D298-NT-17	A2	30.6499
	15:26		59 44.527	45 00.053	D298-NT-18	A3	31.9850
	16:10	39	59 44.45	45 09.041	D298-NT-19	A4	32.1299
	17:58		59 34.862	45 28.074	D298-NT-20	A5	31.4451
	20:36	40	59 29.525	45 38.110	D298-NT-21	A6	33.8578
18/9/2005	16:40		59 50.051	42 29.108	D298-NT-22	A24	32.1617
	17:19		59 52.749	42 42.867	D298-NT-23	A23	31.0291
	17:55		59 55.432	42 56.306	D298-NT-24	A22	30.6267
	18:38	61	59 57.690	43 07.690	D298-NT-25	A21	30.0622
	21:25		59 54.007	42 57.173	D298-NT-26	A19	30.1314
	23:23	62	59 55.952	42 58.049	D298-NT-27	A20	30.0305

We also netted a growler (mini ice-berg) that was cut up on deck to enable samples to be removed from the interior where there should be less contamination from salt water. Two bottles were filled with ice that was then allowed to melt in the cold store. These then filled eight 28ml vials (4 from each bottle) following the procedure above. The bottles were labelled with the code: D298 – GI – ‘bottle number’ – B1 (or B2; to signify which main bottle they were sourced from). One sample from each main bottle was analysed on board to determine its salinity. The bottles were found to have a conductivity of 0.00044 and 0.00208 equating to salinities of 0.0154 and 0.0728, respectively. Hence the ice consisted of fresh water derived from land. The  $\delta^{18}\text{O}$  values will therefore be of great use in determining the freshwater end member of glacial melt water. This can then be related to the freshwater end member of the East Greenland Coastal Current (EGCC) to determine both its source and the proportion of the fresh water flux from land-ice melt.

These water samples were transported to the NOC using a refrigerated lorry for later analysis. The analytical plan is to use a dual inlet GV Instrument Isoprime mass spectrometer to determine the  $\delta^{18}\text{O}$  values. Secondary analysis of the samples will be to find the  $\delta^2\text{H}$  values. The objectives are firstly to

identify sources of freshwater admixture to various water masses in the region and secondly to use  $\delta^{18}\text{O}$  as an independent conservative tracer in order to help evaluate water mass transport and mixing.

## 8 UNDERWAY SURFACE METEOROLOGY

Alan Condron, Dave Teare and Sheldon Bacon

### 8.1 Routine processing

Standard meteorological variables were automatically logged by the ships underway Surface Meteorological (Surfmet) measurement system. Temperature, humidity, pressure, and wind velocity were measured using a thermistor, hygrometer, barometer, and propeller anemometer located on the foremast approximately 20 metres above the sea surface. Ocean variables salinity, sea surface temperature, fluorescence, conductivity, and transmissivity were logged from water gathered from the ships non-toxic pumped sea water supply.

The data was collected without interruption during the cruise from Julian day 237- 263 and processed into 24 hour segments. The processing takes place by running four unix command scripts in sequence: `smtexec0`, `smtexec1a`, `smtexec1b`, and `smtexec2`, which are found in the directory `/data61/shipexec`. The process transfers raw RVS format to PSTAR format, compiles the data into 2 minute averages, and then corrects the winds speed and direction to account for the ships motion. At each stage a file is written to the directory `/data61/tsg` with the name structure *\$name\$scruise\$nn.\$sct*. *\$name* is a three letter instrument identifier set as `smt` (i.e surfmet), *\$scruise* is the three digit cruise identifier (298), *\$nn* is a two digit file sequence number and *\$sct* is the stage of the processing. An example of a completed filename will have the name structure `smt29801.met`. A fuller explanation of each of the four processing stages is now given below.

**smtexec0:** This executive transfers the underway SurfMet data from the raw RVS format to PSTAR format, reading in the data using the routine `datapup`. File lengths were set as 24 hours periods starting 00:00:01 and ending the following 00:00:00 time period. The one second offset from midnight is used to avoid any overlap in subsequent files. If an existing filename occurs then the data is appended, otherwise a new file is created. The file has the following name structure *\$name\$scruise\$nn.raw*

**smtexec1a:** Absent Surfmet data values of 99999 are replaced with -999 and the ships position is read in. Spikes in air pressure are removed from the raw data and all the variables are converted into 2 minute average values for further processing in `smtexec2`. The file output name has the structure *\$name\$scruise\$nn.av*

**smtexec1b:** This script merges in the gyrocompass heading of the ship from the master `ashtech` edited and interpolated file from the ADCP processor. Data files will have the name structure *\$name\$scruise\$nn.hdg*

**smtexec2:** The ship's speed is calculated from the ships position (read in using `smtexec1a`) and used with the ships heading to correct the relative wind speed and direction for the movement of the

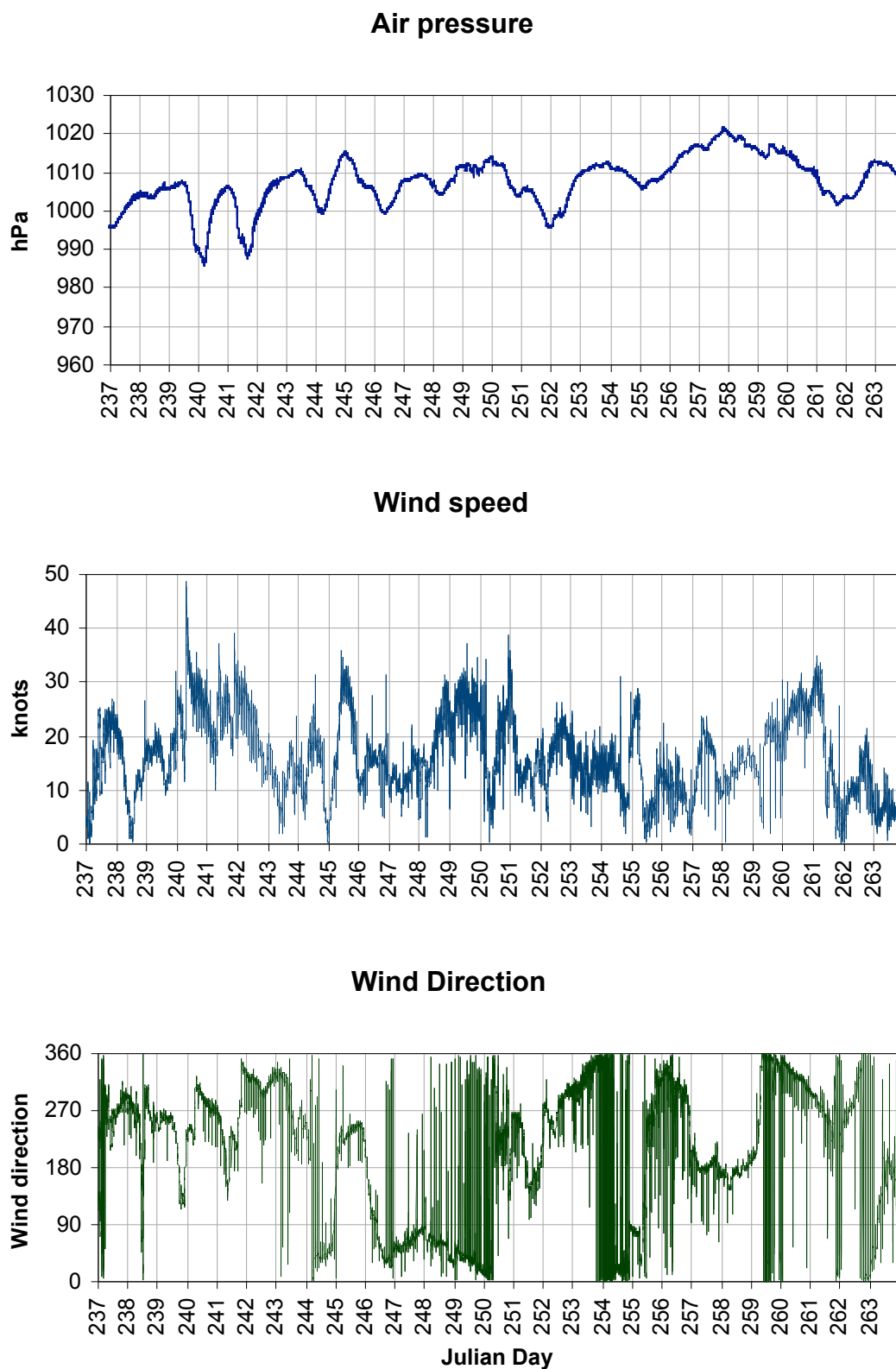


ship. Finally, 180° is subtracted from the wind direction to give the direction the wind is blowing from. The final file name has the structure *\$name\$cruise\$nn.met*. Data can then be examined using a series of PSTAR routines or exported to ascii format if necessary.

## 8.2 TSG Salinity Calibration

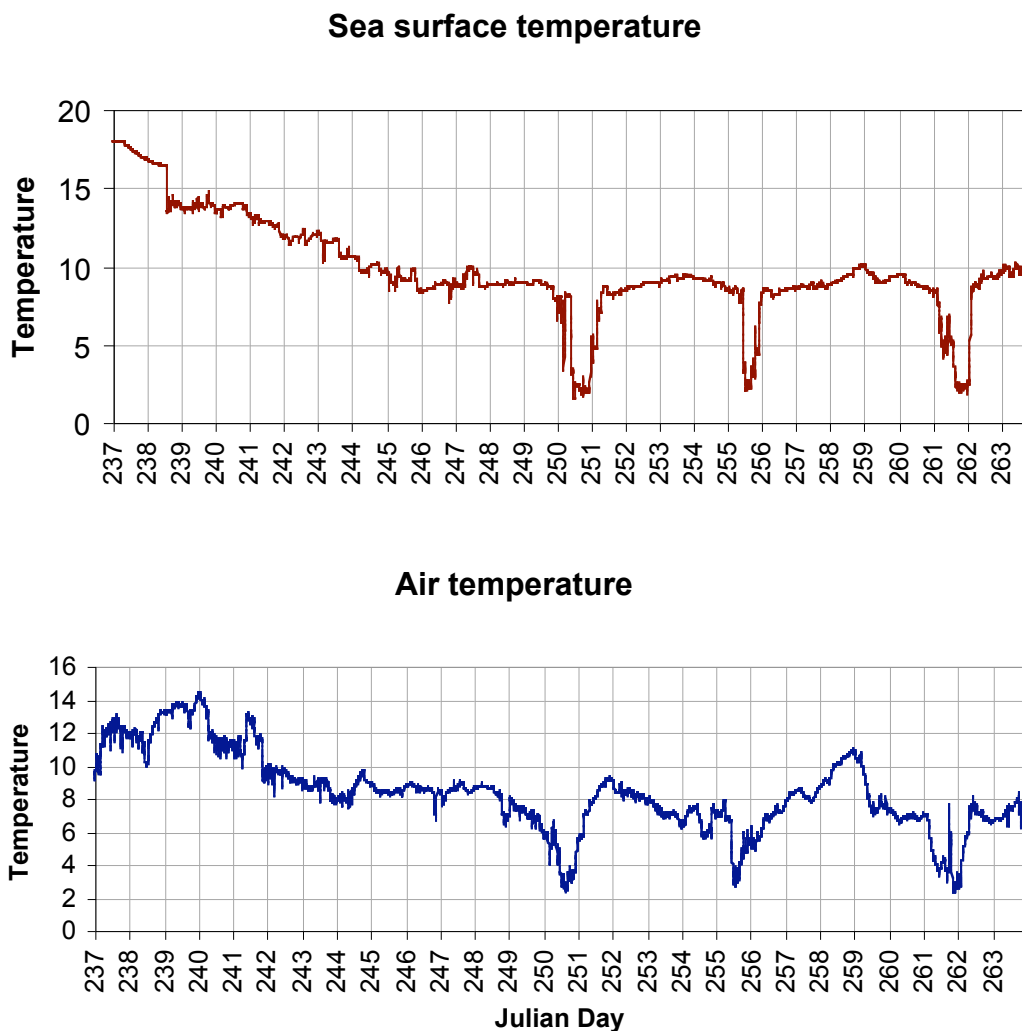
Post-cruise calibration of thermosalinograph (TSG) salinity ( $S_{TSG}$ ) was carried out by comparison of TSG with (calibrated) CTD salinity ( $S_{CTD}$ ). For 51 sample pairs, and taking CTD salinity data from 8 m water depth, we fitted ( $S_{CTD}-S_{TSG}$ ) to  $S_{CTD}$ . The slope of the fit was -2.094E-2, the intercept 0.5892, and the mean residual variance 8.02E-5, equivalent to a scatter of 0.009 in salinity. Taking  $S_{CTD}$  as representing true salinity, the necessary conversion to be applied to  $S_{TSG}$  is:

$$S_{CTD} = 0.5771 + (0.9795 * S_{TSG})$$

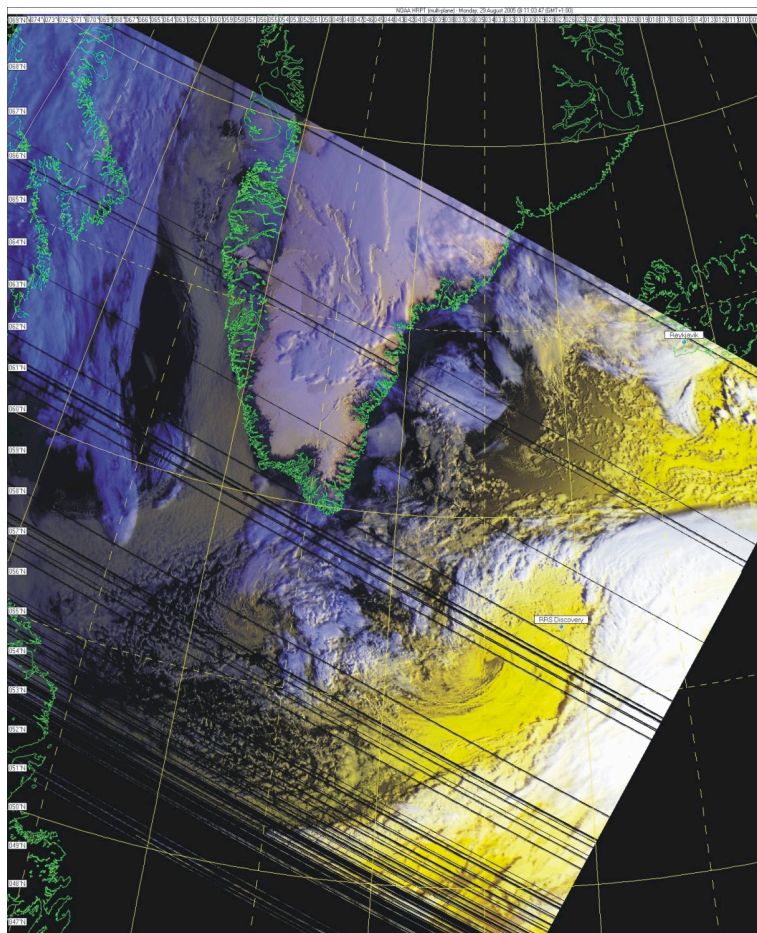


**Figure 8.1:** The graphs above show air pressure, wind speed and wind direction as logged by the ships underway Surface Meteorological (Surfmet) measurement system from Julian day 237-264. The passage of two significant mid-latitude cyclones can be observed on the outward steam on Julian days 240 and 242, the first of which had wind speeds close to 50 knots. Once in the vicinity of Greenland

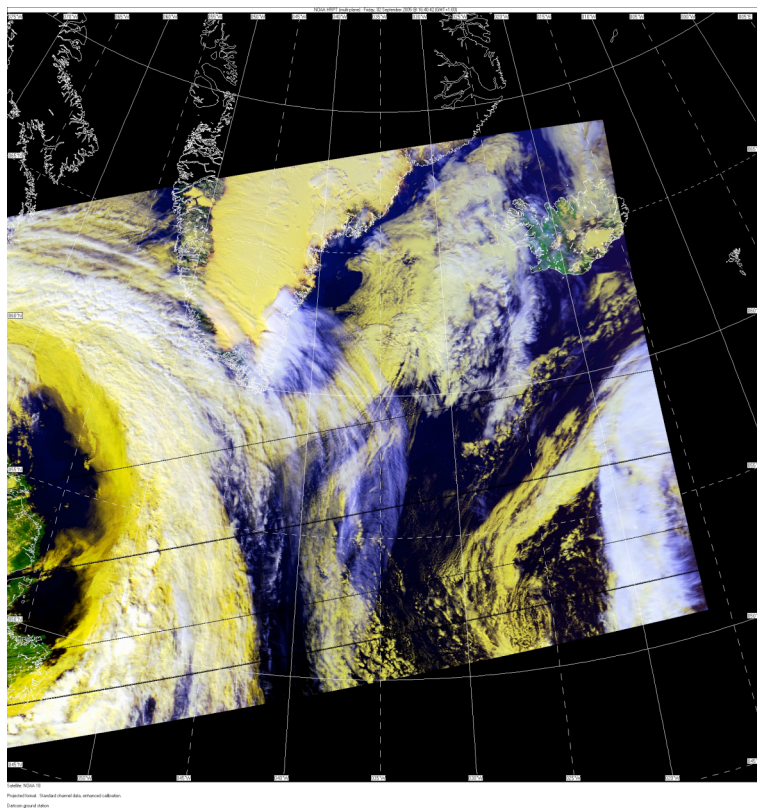
the ship was positioned to the west of the main storm track and frequently came under the influence of the semi-permanent Greenland high pressure. Average air pressure, wind speed and wind direction for the cruise was 1007 hPa, 16 knots and 205° (i.e. south south-west), respectively.



**Figure 8.3:** The above graphs show sea surface and air temperature from Julian day 237-264. The sharp reduction in both sea surface and air temperature on days 250, 255 and 261 were recorded close to the Greenland coast. The cold sea surface temperatures are strong evidence for the existence of East Greenland coastal current, while the cold air temperatures are probably a result of in-situ cooling from the sea due to the very low wind speeds recorded at this time.



**Figure 8.4:** A satellite image received on 29 August, 2005 by the Dartcomm satellite system, showing RRS *Discovery* en route to the Irminger Basin and also heading for a mid-latitude synoptic cyclone.



**Figure 8.5:** A satellite image received at 15:40:42 on 2 September 2005 by the Dartcomm satellite system showing a possible tip jet feature blowing north-easterly around Cape Farewell towards Iceland. Localized mesoscale wind events, such as tip jets, have become of increasing interest in recent years due to their potential influence on rates of deepwater convection in the Irminger Sea.

## Appendix to Section 8: Surfmet Sensor Information

Manufacturer	Sensor	Serial #	Comments
FSI	OTM temperature	1370	HOUSING, calibration held internally in sensor
FSI	OTM temperature	1360	REMOTE, calibration held internally in sensor
Wetlabs	fluorometer	246	
Seatech	transmissometer	112R	
Vaisala	Barometer PTB100A	Z4740021	
Vaisala	Temp/humidity HMP44L	U1420016	
SKYE	PAR	28558	port
SKYE	PAR	28557	stb
Kipp and Zonen	TIR CMB6	07462	port
Kipp and Zonen	TIR CMB6	07463	stb
Sensors without cal			
FSI	OCM conductivity	1376	Original manufactures calibration. Surface salinity is produced from computed PRO_TSG then corrected with wet samples if taken.
Vaisala	Sensor collector QLI		
Vaisala	Anemometer WAA		
Vaisala	Wind vane WAV		
Rhopoint	+/- 5v		
Rhopoint	+/- 5v		

## 9 ECHOSOUNDER

Adam Williams and Robert Lloyd

During this cruise, RRS *Discovery* was equipped with a SIMRAD EA500 Echosounder. Measurements were made using a hull-mounted transducer and, for the majority of the cruise, a second transducer ‘fish’ suspended over the port side of the ship. The fish was used as it gives more accurate readings in bad weather. It was deployed on day 238 and was removed from the water around midday of day 263. The output from the echosounder was displayed on two SIMRAD VDU’s located in the main lab. The ship-mounted hull transducer was used to determine the depth of the seafloor for the periods when the EA500 fish was not deployed. The speed of sound in the water was set to 1500m/s for the initial output.

The raw data was logged into the *ea500d1* datastream containing values of uncorrected depth and time. At this stage the *ea500d1* data-stream was processed on the UKORS PC’s by Robert Lloyd. A correction taking into account the variability of sound speed in water was made and errors in the data-stream were visually identified and removed. A new data-stream was created named *prodep* containing uncorrected depth, corrected depth and measurement time.

These data-streams were then processed on the sohydro6 workstation using a series of UNIX shell scripts utilising PEXEC routines.

*simexec0*: This script takes the raw data from the two data streams creating daily files of raw data (*sim298??*) and corrected data (*sim298??.cal*).

*simexec1*: This script uses the corrected daily depths in *sim298??.cal* and merges it with the daily navigation data located in the bestnav navigation file: *abnv2981*. This creates a file *sim298??.nav*, which is then averaged into 5 minute bins using the pstar routine, *pavрге*. The final output is a file of depths, times and positions in 5 minute bins named *sim298??.5min*.

*simexec2*: This final routine appends the daily files into single files for the cruise. The output files are *dep2981.5min*, *dep2981.nav* and a file that removes any data where the ship speed is less than 2 knots (i.e. when the ship is on station) named *dep2981.track*.

There were few problems with the echosounder during the cruise. The bad weather experienced in the first week of the cruise caused long periods of bad data values that were removed in the processing for the *prodep* datastream. On the first section the 3.5khz sub-bottom profiler was apparently interfering with the SIMRAD EA500, so after a few days in was switched off to enable an accurate cruise track bathymetry to be determined to aid the mooring deployment. A modified set of UNIX scripts were written to obtain corrected depths without the remote processing of the *prodep* datastream so that data could be processed on the same day. These new files *simexec0\_*, *simexec1\_c*, and *simexec2\_c* utilise

the routine *pcarter* to calculate corrected depths. The output files are the same as for the first set of routines with a 'c' added to the file extension. These routines were only used to help determine the locations of the mooring array. Some additional removal of bad data values was done using the pstar routine *plxied*. The output file *dep2981.nav* was corrected thoroughly using *plxied* and *pavrgc* was used to create a file averaged in two minute bins to aid the ADCP processing (*dep2981.2min*).

## 10 CORING

### 10.1 D298 Piston Core P1

(on deck Sunday 11-9-2005, ~04:00)

This core was taken to recover Holocene (?) drupe of about 8ms thickness on 3.5 kHz (roughly  $0.008 \times 1500/2 = 6\text{m}$  thickness). Below the drupe, three sharp reflectors can be discerned. These could be turbidites or IRD layers. We were not overly concerned with the exact origin, as these layers seem to be present everywhere in the general coring target area, and our main focus here is recovery of a detailed Holocene section, for which the 6m transparent drupe looks promising.

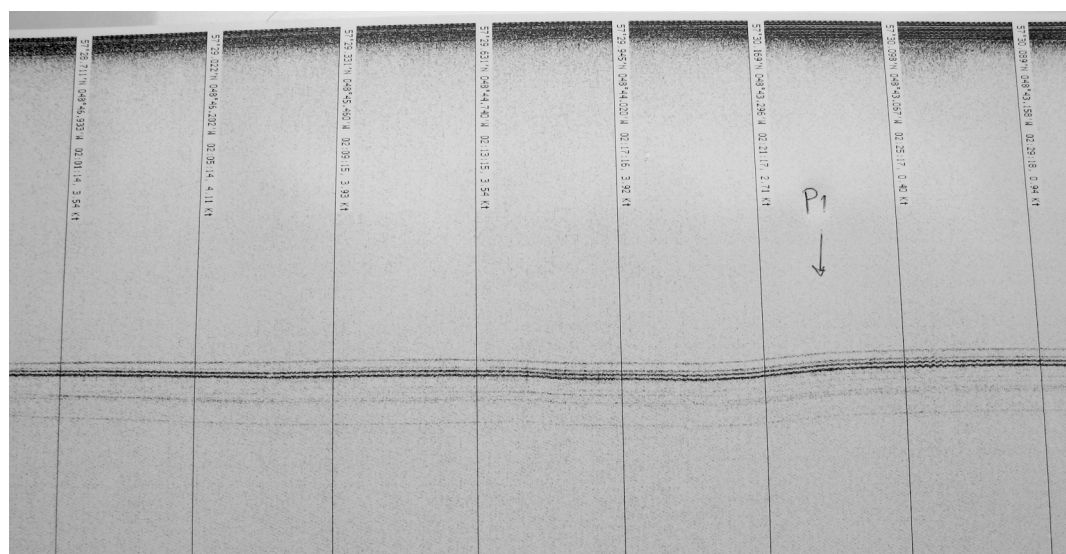
We used the modified NIOZ piston corer with its minimum 1000 kg load and 1 m freefall. This light set-up is used to try and avoid overpenetration, which was successful. After recovery, the extruded liner was cut in 1.5 m length, labelled, capped, and stored in the walk-in cold store at 4°C.

Recovery:

Trigger core: 0.75 m (full, but top in tact)

Main core: 9.80 m approx (liner-joint loose, so one short section in middle)

Barrel: 12 m Diameter: 110 mm Weight: 1000 kg Freefall: 1 m	Location into the water: 57 deg 30.228'N 48 deg. 43.152'W	Location when triggered: 57 deg 30.227'N 48 deg. 43.369'W
Waterdepth 3452 m (Simrad 10kHz Echosounder) Cable out when triggered: 3512 m Pullout tension: 3.9 T (tension before triggering ~3.5 T) – 400kg difference		



**Figure 10.1:** P1 core location on sub-bottom profiler trace.



## 10.2 D298 Piston Core P2

(on deck Sunday 11-09-2005, ~12:00h)

This core was taken to recover Holocene (?) drupe of about 5ms thickness on 3.5 kHz (roughly  $0.005 \times 1500 / 2 = 3.7\text{m}$  thickness). Below the drupe, two sharp reflectors can be discerned. These could be turbidites or IRD layers. Our main focus here is recovery of a detailed Holocene section from a small sheltered basin in between two gentle highs.

We used the modified NIOZ piston corer with its minimum 1000 kg load and 1 m freefall. This light set-up is used to try and avoid overpenetration, which was successful. After recovery, the extruded liner was cut in 1.48 m lengths, labelled, capped, and stored in the walk-in cold store at 4°C.

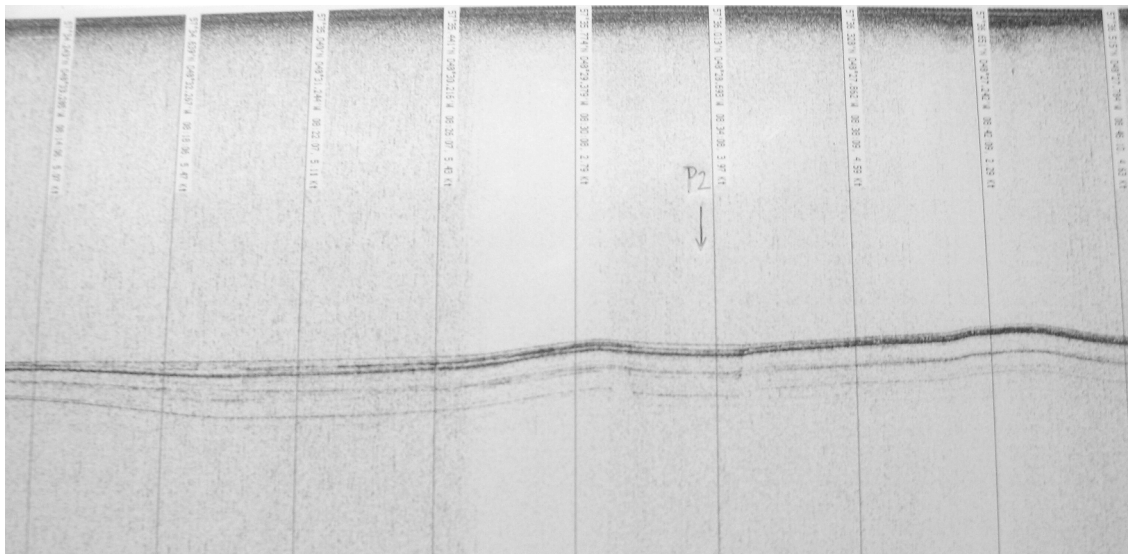
Recovery:

Trigger core: 0.25 m

Main core: 9.80 m approx (liner-joint loose, so one short section in middle)

Main core has lost top ~20 cm

Barrel: 12 m Diameter: 110 mm Weight: 1000 kg Freefall: 1 m	Location into the water: 57 deg 35.89'N 48 deg. 28.98'W	Location when triggered: 57 deg 35.938'N 48 deg. 28.835'W
Waterdepth 3456 m (Simrad 10kHz Echosounder) Cable out when triggered: 3518 m Pullout tension: 4.0 T (tension before triggering ~3.6 T) – 400kg difference		



**Figure 10.2:** P2 core location on sub-bottom profiler trace.

### 10.3 D298 Piston Core P3

(on deck Sunday 11-09-2005, ~19:00h)

This core was taken to recover Holocene (?) drape of about 4ms thickness on 3.5 kHz (roughly  $0.004 \times 1500 / 2 = 3$  m thickness) in an area where we expect relatively low bottom-water flow speeds. This is the approximate site of ODP Site 676. The core is taken on a gentle high. Sediment thicknesses did not change across this high, but downslope transports ought to be minimised by the selection of the site on top of the slight elevation. Below the drape, several distinct reflectors can be discerned.

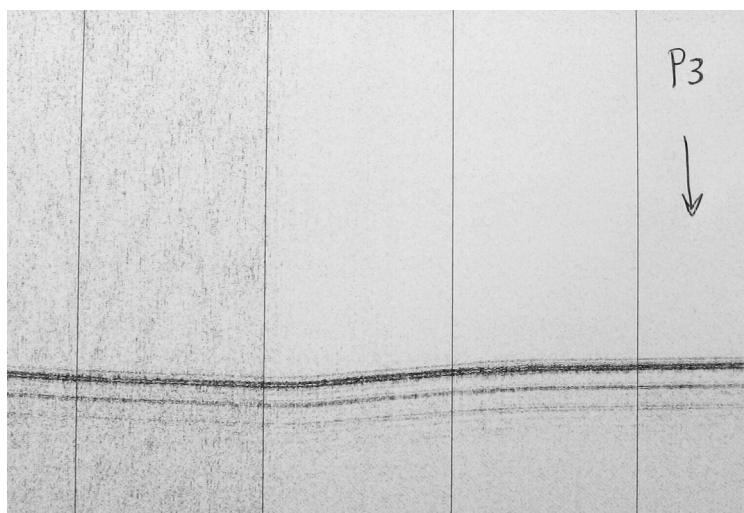
We used the modified NIOZ piston corer with its minimum 1000 kg load and 1 m freefall. This light set-up is used to try and avoid overpenetration, which was successful. After recovery, the extruded liner was cut in 1.48 m lengths, labelled, capped, and stored in the walk-in cold store at 4°C.

Recovery:

Trigger core: 0 m

Main core: 10.0 m approx (liner-joint loose, so one short section in middle)

Barrel: 12 m Diameter: 110 mm Weight: 1000 kg Freefall: 1 m	Location into the water: 58 deg 13.111'N 48 deg. 21.930'W	Location when triggered: 58 deg 13.025'N 48 deg. 21.765'W
Waterdepth 3430 m (Simrad 10kHz Echosounder) Cable out when triggered: 3492 m Pullout tension: ~4.0 T (tension before triggering ~3.2 T) – 800kg difference		



**Figure 10.3:** P3 core location on sub-bottom profiler trace.

## **11 SUB-BOTTOM PROFILER**

### **11.1 Introduction**

3.5 kHz sub-bottom profiling was used to help choose core sites and to examine variations in sedimentation style across the Eirik Drift, which in turn help to determine the detailed pathways of the DWBC across the drift. A short survey of the Imarssuak Mid-Ocean Channel in the central Irminger Basin was also carried out.

### **11.2 Acquisition System**

Raytheon PTR

Octopus 360+ Geophysical Acquisition System

Raytheon TDU-850 printer

Networked PC (TENISON)

Programs – Octopus 760 Remote Configuration and Octopus 361 SBP

### **11.3 Settings used**

Raytheon PTR

Detector              Output level - 3.5

Recorder signal – ac

Pulse width – 2.5

x10

Gain - 2.5-3.5 (depending on signal strength)

Power output - -6

Octopus 360+

Sub-bottom configuration page

Annotation

Text width – 12ms/char

Text height – 2 triggers

Text offset – 0 ms

Direction – L/R

Update – On

Polarity – Pos

Trigger Setup

Ext. i/p Level – High

Ext. i/p Edge – Rising

Output Edge – Rising

Printer Setup

Printer type – Raytheon 850

Printer port – LPT 1

#### External Heave

Input voltage – 1000 mV/m

Polarity – Pos

#### SB Miscellaneous

Input coupling – AC

Nav. source – COM1

#### Serial Port Setup

	COM1	COM2
Baud rate	4800	9600
Data bits	8	8
Parity	None	None
Stop bits	1	1
Usage	RMC	FIX, ANN, GMM

#### Event Setup

Type – Closure

Start – 0

Direction - +

#### Navigation display

Format – Date/Time & Nav

Lat/Long Disp. – Deg, Decimal Mins

Update Rate – 240 secs

#### Additional Miscellaneous

New auto file size 200

### Acquisition page

#### Multi-ping Acquisition

Trigger mode – Internal

Sample Frequency – 24 kHz

Sweep length – 700-1000 ms dependant on zoom required

Sweep delay – dependant on depth

Sweep view – dependant on zoom required

#### Gain control

Input range -  $\pm 5V$

TVG1, 2 and 3 Rate – 0 gain/s

#### Signal Processing

Low pass start – 9990 Hz  
Low pass rate – 0 Hz/ms  
High pass start – 0 Hz  
High pass rate – 0 Hz/ms  
Miscellaneous controls  
Print mode – Printer on  
View mode – Processed  
Rectification – Full wave  
Speed – Real time & analogue out  
Levels – White – 0 Black – 20  
File Control  
Sub-bottom mode – Analogue Multi-ping  
Folder – e.g. D298Archive on 'TENISON\Octopus' (Y:)  
Format – 360 SEG Y  
Media – Disk

#### **11.4 Operation**

At start of survey, a folder was created on TENISON (in My Computer\Shared Documents\Octopus) to archive the data files. The Octopus 360+ machine was then connected to this folder using the Octopus 760 Remote Configuration software on TENISON (SB0704017 IP Address 192.171.133.40 selected in Connected Devices box. Click connect; map new drive; select a drive; Folder – Browse – select Octopus on TENISON then created folder). This folder was then selected in the File Control; Folder box on the Acquisition page on the Octopus 360+ machine. Data were acquired continuously between all CTD and core stations. Files were recorded via the network to TENISON and were backed up to DVD from this machine. The system records approximately 4GB of data per day when recording continuously. The Raytheon thermal printer was on continuously during data acquisition.

The system was powered up gradually to prevent any damage to the hardware. The power knob on the Raytheon PTR was switched to standby with the power output to -24. Power was then switched on and left on for a few seconds. The power was then switched to standby and the power output increased -18 and then the power switched back on. This process was repeated until the power output reached -6. If the load mismatch light started to flash, the power was turned off and the process was repeated. The power was turned to standby while on station.

Octopus 361 SBP (sub-bottom processing toolkit) software installed on TENISON can be used to digitise reflectors and to produce bitmap images from SEG Y files. This software was not used extensively because of numerous errors encountered (see below).

## **11.5 Initial results**

### **Eirik Drift survey**

This survey added to an existing dataset collected over the last two years and revealed further details of bathymetric features and sedimentation style across the drift. A seamount was discovered on the northern flank of the drift that does not appear on any bathymetric chart of the area (Figure 11.1). A zone of thick Holocene sediments occurs on the northern flank of the drift below around 3300m. This formed the main coring target of this cruise. This survey revealed considerable local variability within this zone, including an apparent band of large sediment waves lying approximately parallel with the contours. In the more shallow water, a 'notch' in the ridge crest was identified at around 2100m. The sub-bottom characteristics of this feature suggest it may form a significant conduit for the DWBC across the drift crest.

### **Imarssuak Mid-Ocean Channel survey**

The IMOC was crossed in the central Irminger Basin by 5 transects. The channel is approximately 4 to 8km wide and around 100m deep (Figure 11.2). The position of the channel in the central part of the basin corresponds approximately to that shown on regional bathymetric charts. In several references (e.g. Hesse et al. 1990) the channel is shown to closely approach the southern flank of the Eirik Drift. Of the three transects of the southern Eirik Drift, only one shows a feature resembling the IMOC. Based on the observed location of this feature, it is suggested that it is not the IMOC, but is more likely a downslope channel/slump.

## **11.6 Problems**

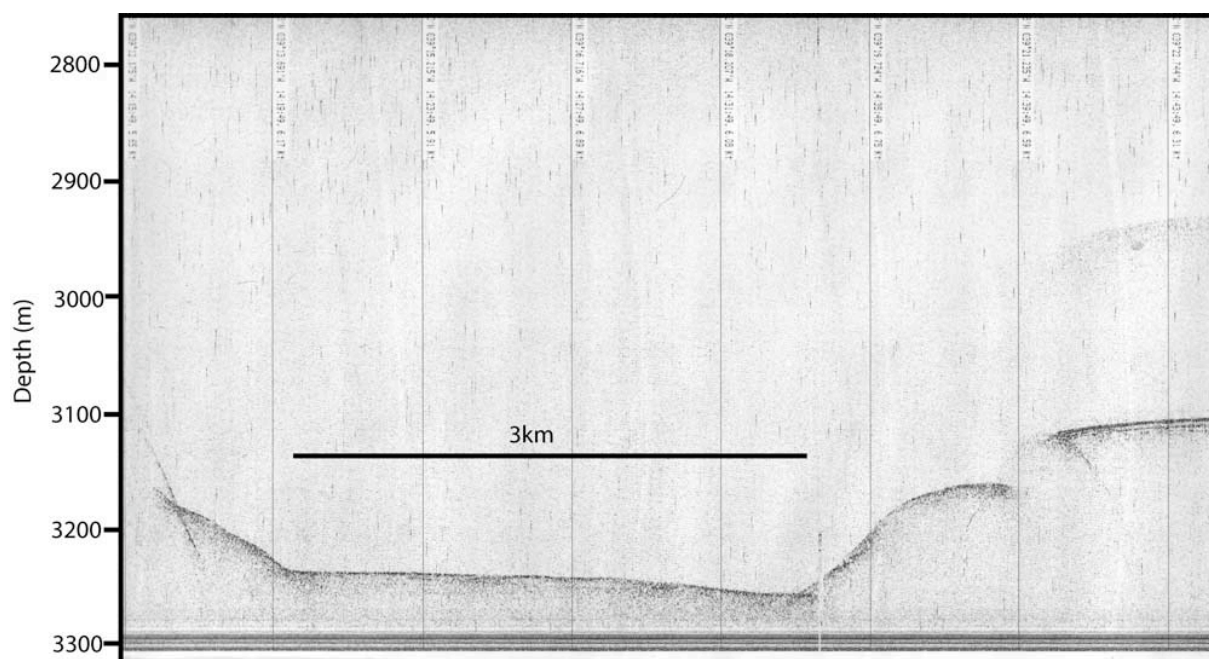
Octopus 360+ - the system frequently stopped recording with no identifiable pattern and therefore required careful observation to ensure a significant volume of data was not lost. The systems also crashed occasionally. After this, the power was turned off and on, all settings re-set and the network connection with TENISON checked (using the remote configuration program on TENISON).

TENISON – lost network connection occasionally (when this happens, the Octopus system will not record because it can't find the folder that has been set). TENISON was re-started and the network connection checked.

Octopus 361 SBP software on TENISON – frequent errors were encountered when trying use both the Digitise and Image utilities. Individual files would run sometimes but not others suggesting that these errors relate to the software or hardware on TENISON and are not due to file corruption during recording. It was therefore decided to carry out the majority of data analysis using systems at the NOC.



**Figure 11.1:** Seamount discovered on the northern flank of the Eirik Drift



**Figure 11.2:** The Imarssuak Mid-Ocean Channel in the central Irminger Basin

## 12 DARTCOM AND COMPUTING

The satellite pass archive was edited daily to select those passes that covered the cruise area. Those of interest were sampled to produce a false colour ‘visual’ image. The naming convention used was:

DDMMYY[NC][sst][T]

Where:

DDMMYY is the date.

[NC] is the source designator – NOAA or Chinese

[T] indicates a transformation onto a Mercator grid.

Infrequently the source designator is qualified by a number when more than one daily pass was available.

All usable data was archived under /rvs/raw\_data/satellite.

Those images thought useful for Website or other purposes were exported as JPEGs using the conventions above.

The system failed on day 251, only limited spares were available and we were unable to repair it.

### **Ashtech ADU**

The attitude detection system failed on day 239 and was eventually corrected on day 240. It is thought that an aging onboard memory protection battery has failed.

### **Computer Clock System**

On day 241 it became clear that the times logged by the system were 47 seconds slow compared to the GPS. The initial diagnosis proved incorrect and on day 242 it was discovered that there was a mismatch between the master and sub-master clocks. The sub-master was corrected manually as an interim measure. The master clock was power cycled and eventually synchronised to UTC and updated the sub-master. Controversy exists over the cause and duration of the problem.



## 13      ENGINEERING

This cruise relied a lot on the CTD winch system and portable deck winches for the recovery and deployment of moorings.

Firstly the ships CTD winch system performed ok but there are some minor issues that have to be addressed such as wire keep rollers fitted to a high tolerance and one of the sheaves has been machined on its outside diameter and this has made a very shallow groove for the wire to travel in.

There were also problems with the Standard CTD cable that had a trial drop before the main CTD line started and at the start of the station developed slack wire at the sheave situated at the top of the spurling pipe and jumped off the sheave with no damage to the wire.

This happened again at the end of a CTD station when slack wire developed in the winch room and caused a cats-paw, the wire had to be chopped and the decision to stream the cable overnight to try and get any torque out of the wire, the cable was then re-terminated and load tested and CTD station continued.

At the end of station 12 the cable again developed slack wire on the top of the hanger where it then jumped out of the sheave and broke all outer strands and most of the inner strands were so tightly twisted that the coaxial core was visible. The CTD was safely got onboard by excellent work by ships' crew and technicians.

The decision was then made to transfer to the F/O wire as the standard wire was thought to placing us in danger of losing the CTD.

This wire provided 50 CTD stations with no problems at all.

The primary role of this cruise was the recovery and deployment of moorings, all deck winches performed exceptionally well: there were 9 mooring deployments, 2 mooring recoveries, and a French lander was recovered and a new one deployed in its place.

The NIOZ Core system was used for three core stations and this time a variable weight bomb is a new addition to this system. It provided three excellent core stations with approx 10m of core in a 12m rig. The ships coring winch had no problems with its scroll gear, but only three stations were fitted in due to bad weather and the need for other science.

## 14 FLOATS AND DRIFTERS

In the course of D298, we launched 3 UK Met. Office surface drifters, 2 IFREMER Provor floats and a partridge in a pear tree. Sorry, that should read “an *Argo* float”.

### 14.1 UK Met. Office surface drifters

The drifters are easy to deploy. A small magnet is removed to start the buoy. The whole package – buoy and drogue, cardboard box and soluble tape – is thrown overboard. The tape dissolves, the box falls away and the buoy begins its mission.

*First Met. Office drifter:*

ARGOS number 52249; position 57° 00.0' N, 19° 58' W; time 1852 UTC, 27 Aug 2005 (day 239).  
Deployed by S. Bacon.

*Second Met. Office drifter:*

ARGOS number 52250; position 56° 47.5' N, 30° 02.9' W; time 2245 UTC, 29 Aug 2005 (day 241).  
Deployed by S. Bacon.

*Third Met. Office drifter:*

ARGOS number 52251; position 57° 20.88' N, 35° 00.38' W; time 1559 UTC, 31 Aug 2005 (day 243). Deployed by A. Williams.

### 14.2 IFREMER Provor floats

The Provor floats were deployed by Olivier Peden with the assistance of the ship's crew. As they floats are quite heavy (about 50 kg), they were deployed using one of the ship's cranes with a snap-hook.

*First Provor float:*

FICHE DE MISE A L'EAU PROVOR CTS3

CAMPAGNE : CFER – D298

NAVIRE : DISCOVERY

Flotteur : OIN-05-S3                      Proto CTS3 N° : 001

Immersion : 2000 m

Date du lancement de la mission : 28/08/2005

Heure du lancement de la mission ( TU ) : 3h15'20 s

Date du Largage : 28/08/2005

Heure du largage : 3h26'

Position du largage : Latitude : N 56°59'.992; Longitude : W 22°29'.250

Etat de la mer :

Hauteur de houle : 3 mètres

Moyen de mise a l'eau : Grue + Croc largable    Hauteur du largage : 1 mètre  
Niveau d'émergence du flotteur après mise a l'eau : Tape supérieur hors de l'eau  
OBSERVATIONS :

Ballast : Tendu

Audition pompe : 3h16'20s pour 2s OK

Vent : 45 nœuds au 270°

Vitesse Navire : 2,3 nœuds au 270°

Sonde : 2932 m

*Second Provor float:*

FICHE DE MISE A L'EAU PROVOR CTS3

CAMPAGNE : CFER – D298

NAVIRE : DISCOVERY

Flotteur : OIN-05-S3                      Proto CTS3 N° : 002

Immersion : 2000 m

Date du lancement de la mission : 29/08/2005

Heure du lancement de la mission ( TU ) : 4 h 06' 30s

Date du Largage : 29/08/2005

Heure du largage : 4 h 11'

Position du largage : Latitude : N 57° 00'.065; Longitude : W 26° 19'.995

Etat de la mer :

Hauteur de houle : 3 mètres

Moyen de mise a l'eau : Grue + Croc largable    Hauteur du largage : 1 mètre

Niveau d'émergence du flotteur après mise a l'eau : Capteurs hors de l'eau

OBSERVATIONS :

Ballast : Tendu

Audition pompe : 4 h 07' 08s

Vent : 35 nœuds au 270°

Vitesse Navire : 2 nœuds au 270°

Sonde : 2650 mètres

### **14.3    *Argo float***

APEX float deployment logsheet

APEX float number:    1881

Float activate time (T1): 1941 BST = 1841 UTC on 24 Sep 2005 (JDAY 267)

Expected dive time (T1+6 hours):            0041 UTC day 268

ARGOS check OK?    Y

Bladder inflating OK? Y

Rubber bung replaced? Not removed

Actual deployment time (T2): 2105 BST = 2005 UTC on 24 Sep 2005

Deployment Lat: 55° 56.55' N

Deployment Lon: 12° 08.08' W

Was a CTD station completed nearby? N

Name of person responsible for deployment: Sheldon Bacon

Comments / notes:

Took about 15 minutes to readiness. 5 minutes after deployment, xmit confirmed with gonio.

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