

# **National Oceanography Centre, Southampton**

## **Cruise Report No. 45**

*RRS James Clark Ross Cruise 195*

18 - 29 NOV 2009

Drake Passage repeat hydrography of  
WOCE section SR1b: a beginners' guide

*Principal Scientist*

M J Yelland

2009

National Oceanography Centre, Southampton  
University of Southampton, Waterfront Campus  
European Way  
Southampton  
Hants SO14 3ZH  
UK

Tel: +44 (0)23 8059 6406  
Email: [mjy@noc.soton.ac.uk](mailto:mjy@noc.soton.ac.uk)



## DOCUMENT DATA SHEET

<b>AUTHOR</b> YELLAND, M J et al	<b>PUBLICATION</b> DATE 2009
<b>TITLE</b> RRS <i>James Clark Ross</i> Cruise 195, 18-29 Nov 2009. Drake Passage repeat hydrography of WOCE section SR1b: a beginners' guide.	
<b>REFERENCE</b> Southampton, UK: National Oceanography Centre, Southampton, 123pp. (National Oceanography Centre Southampton Cruise Report, No. 45)	
<b>ABSTRACT</b> <p>This report describes the 16th occupation of the Drake Passage CTD section, established during the World Ocean Circulation Experiment as repeat section SR1b. It was first occupied by National Oceanography Centre (previously IOSDL and then SOC) in collaboration with the British Antarctic Survey in 1993, and has been re-occupied most years since then. Thirty one full depth stations were performed during JR195: two test stations, and 29 of the 30 nominal stations for the SR1b Drake Passage section. Two 500 m stations were added as part of POL's cruise JR198.</p> <p>The CTD was an underwater SBE 9 <i>plus</i> unit equipped with the following sensors: dual temperature and conductivity sensors, a pressure sensor encased in the SBE underwater unit, a SBE-43 oxygen probe, an Aquatracka MKIII fluorometer, a transmissometer, an upward-looking downwelling PAR sensor, and an altimeter. A downward-looking LADCP (RDI Workhorse Monitor 300 kHz) was deployed on all stations, except for the two 500 m stations when it was replaced by a 600 kHz LADCP from Bangor University.</p> <p>Various underway measurements were obtained, including navigation, VM-ADCP, sea surface temperature and salinity, water depth and various meteorological parameters.</p> <p>A practical aim during this cruise was to write detailed guides for each data stream, including how to set the systems up, operations while on station or underway, initial examination of data to ensure that the systems are working correctly, through to data analysis to the level required for a cruise report. Much of the data analysis was performed using "MSTAR", a suite of Matlab programs recently developed at NOCS by Brian King and used on the JCR for the first time during JR195. Some of these detailed guides are included in the main body of the report, whereas others are included as appendices.</p>	
<b>KEYWORDS</b> Antarctic Circumpolar Current, Antarctic Ocean, ADCP, Acoustic Doppler Current Profiler, Cruise 195 2009, CTD Observations, Drake Passage, <i>James Clark Ross</i> , Lowered ADCP, LADCP, Southern Ocean, SR1b, Vessel-Mounted ADCP, WOCE, World Ocean Circulation Experiment	
<b>ISSUING ORGANISATION</b> <b>National Oceanography Centre, Southampton</b> <b>University of Southampton, Waterfront Campus</b> <b>European Way</b> <b>Southampton SO14 3ZH</b> UK Tel: +44(0)23 80596116Email: <a href="mailto:nol@noc.soton.ac.uk">nol@noc.soton.ac.uk</a>	

*A pdf of this report is available for download at: <http://eprints.soton.ac.uk>*



## CONTENTS

<b>DOCUMENT DATA SHEET .....</b>	<b>3</b>
<b>CONTENTS.....</b>	<b>5</b>
<b>SCIENTIFIC/TECHNICAL PERSONNEL .....</b>	<b>9</b>
<b>SHIP'S PERSONNEL.....</b>	<b>9</b>
<b>LIST OF TABLES.....</b>	<b>10</b>
<b>LIST OF FIGURES.....</b>	<b>10</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>11</b>
<b>1. OVERVIEW.....</b>	<b>12</b>
1.1 INTRODUCTION AND BACKGROUND. ....	12
1.2 SCIENTIFIC OBJECTIVES.....	13
1.3 CRUISE NARRATIVE .....	14
<i>1.3.1 Mobilisation period, 12-16th November.....</i>	<i>14</i>
<i>1.3.2 Drake Passage section and Antarctic Peninsular, 18th-29th November. ....</i>	<i>15</i>
<b>2. CTD .....</b>	<b>17</b>
2.1 INTRODUCTION.....	17
2.2 CONFIGURATION .....	17
2.3 DEPLOYMENT .....	18
2.4 DATA ACQUISITION .....	21
2.5 SBE DATA PROCESSING .....	22
2.5 PROBLEMS .....	23
2.5.1 Problems during set-up.....	23
2.5.1.1 CTD configuration .....	23
2.5.1.2. SeaBird software .....	23
2.5.1.3. Sensor calibration issues.....	23
2.5.2 Problems or significant events during operations .....	24
2.6 MSTAR DATA PROCESSING .....	24
2.7 CALIBRATIONS .....	26
2.7.1 Pressure .....	26
2.7.2 Temperature.....	26
2.7.3 Salinity .....	26

2.8 INITIAL RESULTS .....	27
<b>3. LOWERED ACOUSTIC DOPPLER CURRENT PROFILER (LADCP) .....</b>	<b>29</b>
3.1 INTRODUCTION .....	29
3.1.1 LADCP set-up.....	30
3.2 DEPLOYMENT .....	31
3.3 RECOVERY .....	32
3.3.1 Charging the battery pack .....	32
3.4 DATA PROCESSING .....	33
3.4.1 UHDAS processing .....	33
3.4.2 LDEO processing .....	35
3.5 LADCP PROBLEMS ON JR195 .....	36
3.6 PRELIMINARY RESULTS.....	37
<b>4. VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER .....</b>	<b>39</b>
4.1 INTRODUCTION .....	39
4.2 INSTRUMENTATION .....	39
4.3 CONFIGURATION .....	39
4.4 OUTPUTS.....	40
4.5 POST-PROCESSING OF DATA: IFM KIEL SOFTWARE .....	40
4.5.1 Output Files .....	41
4.5.2 JR195 Data .....	42
4.5.3 Calibration.....	43
4.6 VMADCP: CODAS/HAWAII PROCESSING. ....	47
4.6.1 Calibration results. ....	47
4.6.2 CODAS processing quick summary.....	48
<b>5. SCS UNDERWAY DATA AQUISITION .....</b>	<b>50</b>
5.1 UNDERWAY DATA ACQUISITION USING THE SCS SYSTEM .....	50
5.2 TAR FILE ARCHIVE ON NOSEA2 .....	51
5.3 BACKUP TO A MAC OR EXTERNAL DRIVE .....	51
<b>6. SURFACE METEOROLOGICAL SAMPLING SYSTEM .....</b>	<b>52</b>
6.1 INTRODUCTION .....	52
6.2 INSTRUMENTATION .....	52
6.3 ROUTINE PROCESSING .....	52

6.4 SENSOR PERFORMANCE .....	53
<b>7. UNDERWAY TEMPERATURE AND SALINITY.....</b>	<b>59</b>
7.1 INTRODUCTION.....	59
7.2 SELECTING SURFACE CTD DATA .....	59
7.3 CALIBRATION OF UNDERWAY SEA SURFACE TEMPERATURE.....	59
7.4 CALIBRATION OF UNDERWAY SALINITY DATA .....	60
7.4.1 Introduction .....	60
7.4.2 Underway salinity compared to surface CTD measurements and bottle samples.....	60
7.5 RESIDUALS .....	61
<b>8. NAVIGATION.....</b>	<b>62</b>
8.1 INSTRUMENTATION .....	62
8.1.1 Seapath system.....	62
8.1.2 Ashtech.....	62
8.1.3 Ship's Gyro .....	63
8.2. ROUTINE PROCESSING.....	63
8.2.1 SEAPATH .....	63
8.2.2 ASHTECH and GYRO.....	63
8.3 SUMMARY.....	64
<b>9. ECHO SOUNDER BATHYMETRY .....</b>	<b>64</b>
<b>10. SALINOMETER .....</b>	<b>65</b>
10.1 INTRODUCTION.....	65
10.2 RUNNING THE SALINOMETER (AUTOSAL) .....	66
10.2.1 Initial setup of the Salinometer. ....	66
10.2.2 Initial standardisation.....	67
10.2.3 Taking bottle samples .....	67
10.3 ANALYSING A CRATE OF SAMPLES ONCE THE SALINOMETER IS SET UP .....	68
10.4 POTENTIAL PROBLEMS:.....	69
<b>11. COMPUTING SETUP AND SUPPORT.....</b>	<b>69</b>
11.1 PERSONAL COMPUTERS .....	69
11.2 NETWARE .....	69
11.3 UNIX .....	69
11.4 SCS LOGGING SYSTEM / DATA LOGGING .....	70

11.5 NETWORK .....	70
<b>12. SUMMARY AND RECOMMENDATIONS:.....</b>	<b>71</b>
<b>13. REFERENCES .....</b>	<b>72</b>
<b>APPENDIX A. BRIDGE LOG OF SCIENTIFIC OPERATIONS. ....</b>	<b>73</b>
<b>APPENDIX B – JCR193 CTD INSTRUCTIONS .....</b>	<b>81</b>
B.1 CTD DECK UNIT SETUP, PROCESSING AND DATA TRANSFER.....	81
B.2 CTD DEPLOYMENT TASKS AND ROUTINES .....	82
B. 3 SEABIRD DATA PROCESSING .....	85
B.4 MSTAR DATA PROCESSING .....	89
B.5 DETAILS OF MSTAR PROCESSING .....	92
B.6 BOTTLE FILE FORMATS.....	96
B.7 INSTRUMENT CALIBRATION CONSTANTS .....	97
B.8 SEABIRD CTD CONFIGURATION FILE AS USED THROUGHOUT JR195. ....	98
<b>APPENDIX C - UNDERWAY DATA PROCESSING .....</b>	<b>101</b>
C.1 DAILY UNDERWAY DATA PROCESSING SCHEDULE.....	101
C.2 MPLXYED EDITING OF DATA.....	103
<b>APPENDIX D - LOG SHEETS.....</b>	<b>106</b>
<b>APPENDIX E. VM-ADCP SETUP.....</b>	<b>113</b>
<b>APPENDIX F. RRS JAMES CLARK ROSS CRUISE JR198.....</b>	<b>119</b>

## SCIENTIFIC/TECHNICAL PERSONNEL

### JR195

Margaret J Yelland (PSO)	NOCS
Yueng Djern Lenn	Bangor Uni.
Bengamin I Moat	NOCS
Gwenaelle Moncoiffe	BODC, POL
Jeff Polton	POL
Hugh J Venables	BAS

### JR198

Miguel A M Maqueda (PSO)	POL
Geoff Hargreaves	POL

### BAS technical support.

Vsevolod Afanasyev	BAS (AME)
Jeremy Robst	BAS (ITC)

## SHIP'S PERSONNEL

Graham P Chapman	Master
Robert C Paterson	Chief Officer
Kris Dalvi	2 <sup>nd</sup> Officer
Benjamin J Du Feu	3 <sup>rd</sup> Officer
Charles A Waddicor	ETO (Comms)
Derek M Forward	Chief Engineer
Glynn Collard	2 <sup>nd</sup> Engineer
James C Ditchfield	3 <sup>rd</sup> Engineer
Steven J Eadie	4 <sup>th</sup> Engineer
Jake Boswell	Cadet
Simon A Wright	Deck Engineer
Gareth Wale	Deck Engineer
Nicholas J Dunbar	ETO (Eng)
"Hamish" James Gibson	Purser
Joanna M Gregory	Doctor
George M Stewart	Bosun
Derek G Jenkins	Bosun's Mate
Andrew C Campbell	SG1
Clifford Mullaney	SG1
Colin J Leggett	SG1
John P O'Duffy	SG1
James F Mcilhatton	SG1
Mark A Robinshaw	MG1
Carl J Moore	MG1
Keith A Walker	Cook
Glen R Ballard	2nd Cook
Kenneth Weston	Steward
James Newall	Steward
Derek W Lee	Steward
Colin Motte	Steward

## LIST OF TABLES

Table 2.1: Nominal station positions for Drake Passage CTD section.....	19
Table 2.2: Actual CTD stations carried out during JR195.....	20
Table 2.3: CTD equipment information.....	21
Table 2.4: Transmissometer calibration data.....	24
Table 4.1: VMADCP files obtained during JR195.....	46
Table 4.2: VMADCP mean calibration results for JR195 and previous cruises.....	46
Table 4.3: VMADCP calibrations derived from the CODAS processing.....	47
Table 6.1: Meteorological instrument details.....	56
Table 7.1: Underway SST and salinity instrument details.....	62
Table 10.1: Standardisation history of the salinometer.....	66
Table 10.2: Data acquisition events.....	70

## LIST OF FIGURES

Figure 1.1: CTD station positions across Drake Passage.....	14
Figure 1.2: The science team at Rothera.....	15
Figure 2.1: The BAS CTD frame and equipment.....	18
Figure 2.2: Temperature (°C) across JR195 Drake Passage section.....	27
Figure 2.3: Salinity (PSU) across JR195 Drake Passage section.....	27
Figure 2.4: Density across JR195 Drake Passage section.....	28
Figure 2.5: Nominally calibrated dissolved oxygen concentration..	28
Figure 2.6: Nominally calibrated chlorophyll fluorescence.....	29
Figure 2.7: T-S plot for Drake Passage section of JR195 .....	29
Figure 3.1: Schematic of CTD frame.....	31
Figure 3.2: Schematic of star cable (for two LADCPs).....	30
Figure 3.3: Down-/up-cast and mean velocities. ....	35

Figure 3.4: Merged mean LADCP zonal and meridional velocities.....	35
Figure 3.5: This is produced as "Fig. 2" when 'lp' is run in matlab. T.....	36
Figure 3.6: This is produced as "Fig. 1" when 'lp' is run in matlab.....	36
Figure 3.7: LADCP profile data processed using the UH routines. ....	38
Figure 3.8: LADCP profile data processed using the LDEO routines.....	38
Figure 3.9: Geostrophic velocities across the SR1b track.....	38
Figure 4.1: Surface currents vs longitude along the ship track for JR195. ....	43
Figure 4.2: Northwards and eastwards velocity profiles.....	44
Figure 4.3: Calibration statistics from water-tracking files for JR195. ....	45
Figure 6.1: Schematic of the instrument positions on the foremast.....	52
Figure 6.2: The difference between the humidity sensors .....	54
Figure 6.3: Comparison of night time air temperatures. ....	54
Figure 6.4: The radiation sensors located on the bird table of the foremast platform. ....	55
Figure 6.5a: Meteorological data for days 322 to 327.....	57
Figure 6.5b: Meteorological data for days 327 to 331 .....	58
Figure 7.1: Difference between underway and surface CTD SST measurements .....	60
Figure 7.2: The salinity difference SBE45 - CTD or bottle sample. ....	61
Figure 7.3: The SBE45 residuals after correcting the salinity data. ....	61
Figure 7.4: The SST residuals after correcting the salinity data. ....	62
Figure 9.1: Carter corrected depth data for the section.....	65

## ACKNOWLEDGEMENTS

I am hugely indebted to the JR195 and JR198 science teams for their professionalism, enthusiasm and hard work, and to Graham Chapman, JCR Master, for his support and patience at all times during the cruise. The staff of the JCR are a real pleasure to sail with, and are always very efficient, friendly and helpful. Shore support from Richard Bridgeman (BAS, Cambridge) during mobilisation, and Brian King (NOCS) throughout the cruise is also very much appreciated.

## 1. OVERVIEW

*Margaret Yelland*

### 1.1 Introduction and background.

The research cruise JR195 began from Port Stanley on the morning of the 18<sup>th</sup> November 2009 and finished at Rothera on the evening of the 29<sup>th</sup> November 2009. The objective of the cruise was to perform a CTD section across Drake Passage (Figure 1.1), repeating the measurements made during previous research cruises for the purpose of long-term monitoring. A second cruise, JR198, ran concurrently with JR195. JR198 was run by staff from Proudman Oceanographic Laboratory (POL), with the aim of servicing, recovering and deploying various Bottom Pressure Recorders which have been deployed across Drake Passage and elsewhere on the Antarctic Peninsula for more than 20 years. POL also aimed to perform a 24 hour station near elephant Island, making repeated full depth profiles using a Vertical Microstructure Profiler (VMP). JR198 is described in detail in a separate cruise report (Hargreaves et al., 2010) and is discussed here briefly in Appendix F.

As described by Bacon and Cunningham (2005), the World Ocean Circulation Experiment established a repeat hydrographic section across Drake Passage and designated it SR1. This section was first occupied by the R/V Meteor in 1990 (Roether et al., 1993). Subsequently, the section was moved eastwards to lie on a satellite ground track with the northern end on the south side of Burdwood Bank, south of the Falkland Islands, and the southern end off Elephant Island at the tip of the Antarctic Peninsula. This revised section location was designated SR1b and was first occupied by the R/V Polarstern in 1992 (Gersonde, 1993). The first UK occupation of SR1b took place on RRS Discovery later the same year using SeaSoar (a profiler which undulates between the surface and ~400 m) (Turner, 1993; Read et al., 1993) only i.e. no CTD profiles.

year	start date	end date	designator	LADCP	cruise report
1992	11/11/1992	17/12/1992	D198 - SeaSoar only	N	Turner, 1993
1993	20/11/1993	18/12/1993	JR0a or JR00_1	N	Bacon and Cunningham 2005
1994	13/11/1994	12/12/1994	JR0b or JR00_2	N	Bacon and Cunningham 2005
1996	13/11/1996	07/12/1996	JR16	Y	Bacon and Cunningham 2005
1997	17/12/1997	08/01/1998	JR27	Y	Bacon and Cunningham 2005
1999	12/02/2000	16/02/2000	JR47	N	Bacon and Cunningham 2005
2000	21/11/2000	14/12/2000	JR55	Y	Cunningham, 2001
2001	19/11/2001	17/12/2001	JR67	Y	Bacon et al., 2002
2002	18/12/2002	02/01/2003	JR81	Y	Bacon et al., 2003
2003	27/11/2003	17/12/2003	JR94	Y	Hawker et al., 2005
2004	01/12/2004	19/12/2004	JR115	Y	Sparrow et al., 2005
2005	5/12/2005	12/12/2005	JR139	Y	Stansfield et al., 2008
2006	7/12/2006	15/12/2006	JR163	Y	Williams et al., 2008
2007	29/11/2007	8/12/2007	JR193	Y	Quartly <i>in prep</i>
2008	Dec 2009	Dec 2009	JR194	Y	Quartly <i>in prep</i>
2009	3/2/2009	3/3/2009	JC031	Y	McDonagh et al., 2009
2009	18/11/2009	29/11/2009	JR195	Y	Yelland et al., 2010

*Table 1.1: List of UK occupations of Drake Passage section, WOCE designation SR1b (adapted from Bacon and Cunningham, 2005). Notes: “Year” is the year of the start of the relevant southern season. “LADCP” shows which cruises carried that instrument (JR115 experienced some technical difficulties with the LADCP). All occupations aimed to occupy the standard station positions (see Section 2) shown in Figure 1.1. D198 was occupied with an undulating profiling instrument, SeaSoar, with no full-depth CTDs.*

Between that time and the present there have been 15 UK (NOCS/BAS) occupations of SR1b at nearly one section per year, all with full-depth CTDs and, since 1996, with full depth LADCP also. See Table 1.1 for a list of cruises, dates and references. The scheduling of the cruises usually makes use of the BAS logistical requirement to re-supply the base at Rothera at the start of the austral summer, hence all but two have taken place on the RRS James Clark Ross (JCR).

This report will describe each major data stream in turn. Each data stream was the primary responsibility of one science team member: CTD, Gwen Moncoiffe; LADCP, Yueng Lenn; VMADCP, Hugh Venables; underway data (meteorology, navigation, echosounder etc), Ben Moat; salinometer operations, Margaret Yelland and Jeff Polton.

A major practical aim during this cruise was to write detailed guides for each data stream, including how to set the systems up, operations while on station or underway, initial examination of data to ensure that the systems are working correctly, through to data analysis to the level required for a cruise report. Much of the data analysis was performed using "MSTAR", a suite of Matlab programs recently developed at NOCS by Brian King and used on the JCR for the first time during JR195. Some of these detailed guides are included in the main body of the report, whereas others are included as appendices.

Unless stated otherwise, times are given in GMT. Jday of 1.5 represents 1200 GMT on 1<sup>st</sup> January: the same date and time is given by a decimal day of 0.5. Jday is used in this report, but some data outputs include a decimal day time stamp.

## 1.2 Scientific Objectives

Drake Passage is the narrowest passage through which the Antarctic Circumpolar Current (ACC) flows, and thus is a convenient location for making measurements across the entire ACC. The objective of this section is to look at changes on interannual to decadal scales. The key objectives for the JR195 CTD section across Drake Passage are:-

- (i) to determine the interannual variability of the position, structure and transport of the Antarctic Circumpolar Current (ACC) in Drake Passage;
- (ii) to examine the fronts associated with the ACC, and to determine their positions and strengths;
- (iii) by comparing geostrophic velocities with those measured directly (by the lowered ADCP), to determine the size of ageostrophic motions, and to attempt to estimate the barotropic components;
- (iv) to examine the temperature and salinity structure of the water flowing through Drake Passage, and thus identify the significant water masses;
- (v) to calculate the total flux of water through Drake Passage by combining all available measurements.

The scientific objective of JR198 is described fully in a separate cruise report (Hargreaves et al., 2010) and briefly in Appendix F.



- b) A member of the science team (Gwen Moncoiffe from BODC) had some experience of CTD configuration and a willingness to delve into manuals, read wiring diagrams and chase up instrument calibrations. Gwen was helped by the notes left on the ship by Mark for the incoming AME support staff.
- c) Support via email from staff at BAS HQ in Cambridge (Richard Bridgeman, AME).
- d) Help from the ship's officers and crew.
- e) Sailing was delayed one day to the morning of the 18<sup>th</sup>, since the weather forecasts for the intervening periods predicted Force 8 winds and very rough seas with significant wave heights of 5 to 6 m. Wind and wave directions were from the west, i.e. across the direction of the ship's passage, which may have caused problems for the cargo on deck and would have made CTD deployments difficult if not impossible.

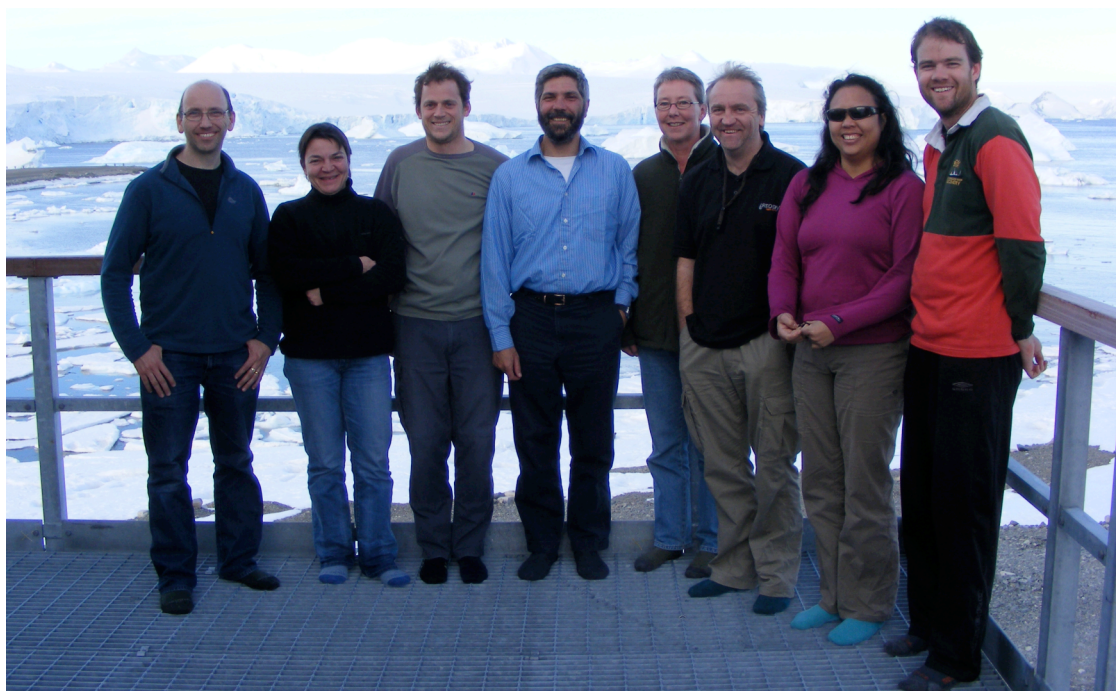


Figure 1.2. The science team at Rothera: Geoff, Gwen, Jeff, Miguel, Mags, Ben, Yueng, Hugh.

### 1.3.2 Drake Passage section and Antarctic Peninsular, 18th-29th November.

During the Drake Passage section the JR195 science team worked 12 hour watches (8 til 8 local time), with Venables, Moat and Yelland taking the night shift and Moat, Lenn and Polton taking the day shift. This worked well, since the deck crew and winch drivers worked the same watches.

Below is a short day-by-day account of scientific operations and weather conditions. All times stated in this cruise report are GMT unless specified otherwise. Notes on wind speed, sea state and ice conditions are courtesy of the bridge scientific log (*times in the log are local, i.e. GMT - 3 hours*) - see Appendix A. Section 2 gives details of the nominal, and actual, positions and depths of the CTD stations.

**18<sup>th</sup> November.** *Winds S/E force 5/4 decreasing to 3. Ship rolling moderately in rough seas and heavy cross-swell, decreasing to slight seas with moderate swell.* JCR departed Port Stanley at 0600 GMT. CTD test dip A was carried out to a depth of 100 m, in 200m of water depth in order to test the scale factor in the altimeter mounted on the frame: scale factor of 1 is correct. Salinity samples were taken from all 24 Niskin bottles in order to practise sampling procedure and Autosol operation. CTD test B carried out in depth of about 2500m, all worked well.

**19<sup>th</sup> November.** Winds ENE 3/4, increasing NNE 7/8. Moderate sea and swell increasing to very rough seas and moderate swell. CTD stations **1 to 4** were carried out, then two POL BPR were recovered and one deployed in depths of about 1000m. CTDs **5 to 7** carried out in increasing wind and wave conditions.

**20<sup>th</sup> November.** Winds NNE 7/8 decreasing NW 6. Very rough seas and heavy swell, decreasing to moderate sea and swell. No CTD station were performed due to strong winds combined with very rough seas, a heavy cross-swell and strong currents.

**21<sup>st</sup> November.** Winds N 5, decreasing ENE 4/4, increasing W 5/6. Moderate sea and swell becoming slight sea and moderate swell. JCR was between CTD stations 8 and 9 when conditions had eased sufficiently to deploy the CTD. Rather than return north to the nominal station position, station **8** was carried out about 10 nm south of the nominal position and station 9 was omitted. CTD stations **10 to 13** were carried out as planned.

**22<sup>nd</sup> November.** Winds W 5/6 decreasing 4, then increasing WSW 6/7. Moderate sea and swell with occasional heavy swell later. CTD station **14 to 16** were carried out. Recovery of a BPR located between stations 16 and 17 was hampered by bad visibility. In order to allow time for visibility to improve, CTD station **17** was carried out at the BPR site, i.e. about 10 nm further north than scheduled. Once the CTD was recovered visibility had improved and the BPR was recovered successfully.

**23<sup>rd</sup> November.** Winds SW 5/6, increasing SWS 6/7 later. Moderate sea and swell, seas becoming rough later. CTD stations **18 to 23** were carried out.

**24<sup>th</sup> November.** Winds SW 4/5 decreasing 4, then increasing NW 5. Slight sea and swell. CTD stations **24 and 25** were carried out (*the latter amongst some berg debris*) before moving about 30 miles west to the POL MRYTLE position (*bergs visible throughout*). The buoy failed to respond to the release signal, so the decision was made to recover the entire frame. The MYTRLE frame was believed to have responded to the release signal but did not release from seabed. MRYTLE recovery abandoned. After steaming east back to the section, CTD station **26** was carried out (*bergs, debris and a few growlers*) followed by a BPR deployment in about 2000 m water depth and then CTD station **27** (*snow showers*).

**25<sup>th</sup> November.** Winds N 3/4 increasing 5/6 then decreasing NW 4/5. Slight sea and swell increasing to moderate sea and heavy swell. BPR successfully recovered from water depth of about 1000m and a replacement BPR deployed. CTD stations **28** (*bergs on radar. Debris, brash and growlers*), **29** (*bergs on radar. Debris of bergs, new year ice and brash at times*) and **30** (*bergs on radar. Debris of bergs, new year ice and brash at times*) were carried out, completing the NOCS CTD section by about 0700 GMT. The JCR then headed northwest into deeper water and the rest of the day was spent on the POL "24 hour" station, performing repeated full depth (1000 m) profiles using the Vertical Microstructure Profiler (VMP). Two test profiles and 14 other profiles were carried out over a period of 13.5 hours, amongst *strips and pools of pack ice, berg debris and bergie bits, with bergs visible to the west*. The VMP data are described in Appendix F.

**26<sup>th</sup> November.** Winds NW 4/5. Moderate seas and heavy swell. The VMP station was immediately followed by two 500 m CTD casts using the Bangor 600 KHz LADCP (which replaced the NOCS 300 KHz LADCP used throughout the previous 7 days) amongst *1/10 berg debris with pack ice and berg debris to the south*.

**27-29<sup>th</sup> November.** From the end of Drake Passage, the JCR steamed south along the west of the peninsular to avoid bad ice conditions to the east of it, and arrived at Lockroy on the morning of the 27<sup>th</sup>. Most of that day was spent unloading stores and building materials for a new Nissan hut to accommodate base staff. Almost all the JCR personnel were involved in this operation. The JCR then called in at Vernadsky base on the morning of the 28<sup>th</sup>, for POL to service a tide gauge and BAS meteorologist to service their systems. The JCR then steamed

through the Lemaire channel under clear skies on the way to Rothera. The ship docked at Rothera on the evening of the 29<sup>th</sup>, and the science teams moved to base accommodation on shore the next day to wait for their Dash-7 flight north on the 4<sup>th</sup> December.

## 2. CTD

*Gwen Moncoiffé, Jeff Polton*

### 2.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to record vertical profiles of the temperature and salinity of the water column. Two test stations, one shallow (test A, later processed as station 990) and one deep (test B later processed as station 991) were carried out before starting the Drake Passage transect. They allowed us to test the equipment and sensors' configuration. Twenty nine stations were occupied across the Drake Passage SR1b transect and two ADCP turbulence test casts were carried out at the end of POL's "24 hour" VPM station. The locations of the nominal stations across Drake Passage are listed in Table 2.1. The actual locations of the stations occupied during JR195, alongside the water depth and other information, are listed in Table 2.2. Bad weather prevented us from occupying nominal Station 8 from Bacon et al (2003). The station eventually occupied was located half way between nominal Stations 8 and 9. Nominal Station 9 was not occupied. Station 17 was moved about 10 nm further north than the nominal position in order to facilitate recovery of a POL BPR during bad visibility.

Additional details are given in Appendix B: B.1 gives details on pre-sailing setup and mobilisation; B.2 CTD deployment procedure and immediate post-cast operations; B.3 SeaBird initial data processing; B.4 overview of MSAT data processing procedure; B.5 details of MSTAR programs; B.6 bottle file formats; B.7 SeaBird instrument calibration; B.8 calibration details contained in the SeaBird Configuration file.

### 2.2 Configuration

The newly configured 24-bottle BAS CTD frame was used throughout the cruise with no change of sensors. The CTD frame was equipped with a SBE 32 Carousel Water Sampler, configured with 24 12-litre Ocean Test Equipment ("Niskin") bottles, connected to an SBE 9 *plus* CTD, controlled and powered by an SBE 11 *plus* deck unit. The Niskin bottles (98.5 cm high) were mounted vertically 15 to 20 cm above the sensors. The distance measured between the pressure sensor and the top / bottom of the bottles was 114 cm / 15.5 cm.

An SBE-35 high precision temperature sensor (SN 0024 last calibrated on 24/03/2009) was attached vertically on one of the side bar of the frame approximately level with the water bottles. This provided independent 8-second average temperature measurements each time a bottle was fired.

The underwater SBE 9 *plus* unit (SN 09P20391-0441) was equipped with the following sensors: dual temperature and conductivity sensors, a pressure sensor encased in the SBE underwater unit, a SBE-43 oxygen probe, an Aquatracka MKIII fluorometer, a transmissometer, an upward-looking downwelling PAR sensor, and an altimeter.

Table 2.3 gives details of sensors, serial number and calibration date.

There was no sensor change during the cruise and the mapping between sensors and voltage or frequency channels remained the same throughout. A report of the CON file settings used for JR195 is listed in Appendix B.8

For all stations a self-logging downward-looking LADCP was attached to the main CTD frame (see LADCP section of this report for detail of operations). The frame was equipped with a fin to reduce rotation of the package underwater.

On cast 013, the POL's MicroCAT CTD was attached to the frame for calibration.



*Figure 2.1. The BAS CTD frame and equipment, pictured with some of the Niskin bottles removed. The red instrument is the Bangor LADCP, which replaced the NOCS LADCP for the final two CTD stations (31 and 32).*

## 2.3 Deployment

The CTD was deployed from the mid-ship's gantry. The deployment procedure was to start data-logging on deck, then deploy and lower the CTD to 10 m cable out. The pumps are water activated and should come on 60 seconds after the CTD is in the water. After a 3 minute soak, the package was raised to just below the surface and then continuously lowered at a speed of about 60 m/min to a nominal 10 m above the seabed.

Three bottles were fired 10-15 seconds after reaching the bottom of the downcast, with a 10 second wait between each bottle firing to allow for power recharge of the firing mechanism and the 8-second reading from the SBE-35 temperature probe. Subsequent Niskin bottles were fired during the upcast, with identical waiting times. The detailed procedure for CTD casts used during this cruise is given in Appendix B. At all stations all 24 bottles were fired with three bottles being fired at 8 selected depths. Water was only sampled for salinity analysis to calibrate the conductivity sensors, so sampling depths were therefore selected according to the shape of the salinity profile, avoiding strong gradients.

Log sheets for CTD deployments and salt sampling operations are given in Appendix D.

The salinity sample collection and analysis is discussed in the calibration section below. Operation of the Autosol salinometer is discussed in Section 11.

Station	Lat, °S	Lat, min	Long, °W	Long, min	Nominal depth (m)	Distance to next station (nm)	Estimated time on station (hh:mm)	Estimated time to next station (hh:mm)
Test A					200		<b>0:30</b>	
Test B	53	~30.4	58	~11.0	2300	70.9	<b>2:00</b>	<b>6:30</b>
1	54	40.00	58	32.61	350	16.3	<b>0:30</b>	<b>1:30</b>
2	54	55.34	58	23.10	600	1.4	<b>0:30</b>	<b>0:15</b>
3	54	56.62	58	22.31	1000	1.1	<b>1:00</b>	<b>0:15</b>
4	54	57.66	58	21.67	1500	6.9	<b>1:30</b>	<b>0:45</b>
5	55	04.18	58	17.62	2000	3.3	<b>2:00</b>	<b>0:30</b>
6	55	07.27	58	15.71	2500	3.2	<b>2:00</b>	<b>0:30</b>
7	55	10.25	58	13.86	3000	2.8	<b>3:00</b>	<b>0:30</b>
8	55	12.86	58	12.24	3700	19.3	<b>3:00</b>	<b>2:00</b>
9	55	31.00	58	01.00	4200	20.2	<b>3:00</b>	<b>2:00</b>
10	55	50.00	57	49.23	4800	20.2	<b>3:30</b>	<b>2:00</b>
11	56	09.00	57	37.45	3400	20.1	<b>2:30</b>	<b>2:00</b>
12	56	28.00	57	25.67	3800	20.1	<b>3:30</b>	<b>2:00</b>
13	56	47.00	57	13.90	3200	20.1	<b>2:30</b>	<b>2:00</b>
14	57	06.00	57	02.12	3700	20.1	<b>3:00</b>	<b>2:00</b>
15	57	25.00	56	50.35	3700	20.1	<b>3:00</b>	<b>2:00</b>
16	57	44.00	56	38.57	3400	20.1	<b>2:30</b>	<b>2:00</b>
17	58	03.00	56	26.79	3900	20	<b>3:00</b>	<b>2:00</b>
18	58	22.00	56	15.02	3800	20	<b>3:00</b>	<b>2:00</b>
19	58	41.00	56	03.24	3800	20	<b>3:00</b>	<b>2:00</b>
20	59	00.00	55	51.47	3800	21	<b>3:00</b>	<b>2:00</b>
21	59	20.00	55	39.07	3800	21	<b>3:00</b>	<b>2:00</b>
22	59	40.00	55	26.67	3600	21	<b>2:30</b>	<b>2:00</b>
23	60	00.00	55	14.28	3500	21	<b>2:30</b>	<b>2:00</b>
24	60	20.00	55	01.88	3400	21	<b>2:30</b>	<b>2:00</b>
25	60	40.00	54	49.49	3100	8.4	<b>2:15</b>	<b>1:00</b>
26	60	47.97	54	44.55	2500	2.1	<b>2:00</b>	<b>0:30</b>
27	60	49.99	54	43.30	1500	1.1	<b>1:30</b>	<b>0:15</b>
28	60	51.02	54	42.66	1000	8.2	<b>1:00</b>	<b>1:00</b>
29	60	58.86	54	37.80	600	4.3	<b>0:45</b>	<b>0:30</b>
30	61	03.00	54	35.23	400	-	<b>0:30</b>	-

*Table 2.1: Nominal station positions for Drake Passage CTD section (adapted from Bacon et al., 2003 - depth of station 3 changed, and times and distance columns added. These additional columns show the figures used by the bridge). Instructions given to the bridge stated that **for the shelf edge stations, i.e. 1 - 8 and 25 - 30 inclusive, the station should be at a position where the depth is within 100 m of the nominal depth. For stations 9 - 24 inclusive, the position should be within 0.5 nm of the nominal position.***

CTD stn	Date	Time hh:mm GMT	JDAY	Lat. °S	Lat. (min)	Lon. °W	Lon. (min)	Corr depth (m)	CTD max pressure (db)	True wind (m/s)	Ice obs ****
990	18/11/2009	13:47	322.57430	52	14.823	57	49.163	n/a	125	10.0	
991	18/11/2009	21:20	322.88888	53	30.425	58	10.882	n/a	2315	5.0	
1	19/11/2009	05:34	323.23194	54	40	58	32.67	386	381	4.5	
2	19/11/2009	08:01	323.33402	54	55.4	58	22.95	582	567	6.6	
3	19/11/2009	09:27	323.39375	54	56.68	58	22.31	1188	1179	6.3	
4	19/11/2009	11:05	323.46180	54	57.7	58	21.62	1598	1592	8.6	
5	19/11/2009	17:18	323.72083	55	4.36	58	16.59	2070	2059	13.2	
6	19/11/2009	19:36	323.81666	55	7.54	58	14.52	2545	2537	13.6	
7	19/11/2009	22:39	323.94375	55	10.74	58	11.82	3117	3108	16.0	
*8	21/11/2009	03:35	325.14930	55	22.09	58	5.94	4216	4202	8.8	
10	21/11/2009	09:42	325.40416	55	50.01	57	49.24	4732	4721	9.5	
11	21/11/2009	14:48	325.61666	56	9.01	57	37.47	3395	3386	9.8	
12	21/11/2009	19:16	325.80277	56	28	57	25.68	3854	3839	9.2	
13	21/11/2009	23:37	325.98402	56	46.98	57	13.99	3082	3072	3.7	
14	22/11/2009	04:33	326.18958	57	6.01	57	2.02	4140	4122	7.8	
15	22/11/2009	09:14	326.38472	57	24.97	56	49.97	3480	3469	10.7	
16	22/11/2009	13:43	326.57152	57	43.88	56	38.23	3492	3488	5.6	
**17	22/11/2009	17:29	326.72847	57	53.76	56	32.69	3985	3975	6.1	
18	23/11/2009	01:15	327.05208	58	22	56	15.01	3885	3876	10.4	
19	23/11/2009	05:59	327.24930	58	41	56	3.23	3752	3743	12.5	
20	23/11/2009	10:36	327.44166	58	59.97	55	51.39	3776	3765	10.8	
21	23/11/2009	15:13	327.63402	59	19.97	55	39.02	3755	3746	10.7	
22	23/11/2009	19:48	327.82500	59	40	55	26.66	3675	3666	10.0	
23	24/11/2009	00:20	328.01388	59	59.98	55	14.28	3500	3491	11.3	
24	24/11/2009	05:01	328.20902	60	20	55	1.87	3437	3428	9.3	
***25	24/11/2009	09:15	328.38541	60	39.95	54	49.48	3090	3082	8.3	<i>d</i>
26	24/11/2009	19:41	328.82013	60	47.99	54	44.53	2577	2567	9.5	<i>B, d, g</i>
27	24/11/2009	23:00	328.95833	60	49.99	54	43.17	1626	1618	10.9	<i>snow</i>
28	25/11/2009	01:38	329.06805	60	51.01	54	42.66	983	969	9.9	<i>d, b, g</i>
29	25/11/2009	04:44	329.19722	60	58.66	54	38.02	585	577	6.2	<i>B, n, b</i>
30	25/11/2009	06:45	329.28125	61	3.06	54	35.47	360	354	4.5	<i>B, n, b</i>
31	25/11/2009	23:54	329.99583	60	36.31	54	50.09	n/a	~500	9.0	<i>d</i>
32	26/11/2009	00:53	330.03680	60	35.96	54	50.41	n/a	~500	9.5	<i>d</i>

*Table 2.2: Actual CTD stations carried out during JR195. The time (GMT) and positions given for each station correspond to the time and position of the ship when the CTD was at the bottom of the cast. Corrected water depth (m) is the depth derived from the LADCP data processing.*

*\* Note station 8 took place between the nominal positions of 8 and 9, and station 9 was omitted.*

*\*\* Station 17 took place 10 nm further north than the nominal position to facilitate recovery of a POL BPR mooring.*

*\*\*\* Station 25. Problem with secondary conductivity sensor - see Section 2.5.2*

*\*\*\*\* B=bergs, d=debris, g=growlers, b=brash, n=new year ice, obtained from the bridge scientific log.*

Sensor	Manufacturer	Model	Serial Number ( <sup>1</sup> )	Calibration date
Pressure	Paroscientific Inc.	Digiquartz 410K-105	75429	18/07/2007
Conductivity – primary	SBE	SBE-04	3488	22/04/2008
Conductivity – secondary	SBE	SBE-04	3491	22/04/2008
Temperature – primary	SBE	SBE-03	5042	12/04/2008
Temperature – secondary	SBE	SBE-03	5043	09/04/2008
Oxygen sensor	SBE	SBE-43	0245	12/06/2007 <sup>(2)</sup>
Fluorometer	Chelsea Technologies Group	Aquatracka MkIII	088 249	13/09/2007
Transmissometer	WETLabs	25cm pathlength C-Star	CST-396DR	23/08/2007
PAR sensor	Biospherical Instruments Inc.	QCD-905L4S	7274	01/12/2009
Altimeter	Tritech	PA200/20-6K8	2130.27001	31/07/2006 <sup>(3)</sup>

*Table 2.3: Details of the sensors model, serial numbers and calibration status. NOTES:*

<sup>(1)</sup> All sensors' serial numbers were visually checked at the start of the cruise with the exception of the altimeter, the underwater unit and pressure sensor, and the PAR sensor whose serial numbers were not readily visible.

<sup>(2)</sup> The oxygen sensor had a more recent calibration from 10/12/2008; however it used a different calibration equation which was not compatible with the SeaBird software version currently installed on the JCR. As a result it was decided to use an older calibration from 2007.

<sup>(3)</sup> No calibration coefficient was available for the altimeter but a scale factor of 15 was used in the configuration file in keeping with settings used on previous cruises.

The mapping between sensors and voltage channels was found to be as follows:

V0 ----- PAR

V1 ----- empty

V2 ----- oxygen

V3 ----- altimeter

V4 ----- fluorometer

V5 ----- empty

V6 ----- transmissometer

V7 ----- empty

## 2.4 Data acquisition

The CTD data were logged via the deck unit to a 1.4 GHz P4 PC, running *Seasave Win32 version 5.30b* (Sea-Bird Electronics Inc.) for data acquisition. The software allows numerical data to be listed to the screen in real time, together with several graphs of various parameters. The file naming convention was adapted to match the filename structure expected by the MSTAR processing routines.

Four files were created by the software module for each station:

*ctd\_jr195\_NNN.dat* — a binary data file

*ctd\_jr195\_NNN.CON* — an ASCII configuration file containing calibration information

*ctd\_jr195\_NNN.HDR* — an ASCII header file containing the sensor information

*ctd\_jr19\_NNNN.BL* — a file containing the data cycles at which a bottle was closed on the rosette

where NNN refers to the CTD cast number. These files were saved directly to the PC's hard disk under D:\data\jr195.

SBE-35 precision temperature data download was performed as soon as the CTD was back on deck. The data were acquired using SeaTerm software version 1.4 and saved alongside the other files.

All files were then copied to the ship's network drive immediately after each cast.

## 2.5 SBE Data processing

SBE data processing was carried out in two phases. First the data were processed using SBE Data Processing software version 5.31a installed on the CTD logging PC. The data were then copied to the ship's network drive and then on to the NOCS Linux Sun workstation NOSEA2 for further processing using the MSTAR processing routines.

The following SeaBird Data Processing routines were used:

- DATCNV to convert the raw frequency and voltage data to engineering units as appropriate by applying manufacturer's calibrations stored in the CON file and save both downcast and upcast to an ASCII format file. Output file: ctd\_jr195\_NNN.cnv
- AlignCTD to align the oxygen sensor in time relative to pressure. Output file: ctd\_jr195\_NNN\_a.cnv
- CellTM to correct the pressure and conductivity. Output file: ctd\_jr195\_NNN\_actm.cnv

All processed files were saved to the CTD logging PC under D:\data\jr195, then copied to the ship's network drive. Settings used for the three routines were as follows:

### DATCNV settings

- **Process scans to end of file:** selected
- **Scans to skip over** = 0;
- **Output format** = ASCII;
- **Convert data from:** Upcast and downcast;
- **Create file types:** both data and bottle files;
- **Source of scan range data:** Scans marked with bottle confirm bit;
- **Scan range offset** = 0;
- **Scan range duration** = 2;
- **Merge separate header file** selected;
- **Selected Output Variables:**
  - Pressure in db;
  - Primary and secondary conductivity in mS/cm;
  - Primary and secondary temperature ITS-90 in deg C;
  - Scan count;
  - Pressure temperature;
  - Altimeter;
  - Time elapsed in seconds;
  - Oxygen SBE43 in umol/kg;
  - PAR/irradiance;

- Beam transmission and beam attenuation (note that we used a calibration based on % transmission relative to water);
- Fluorescence;
- Voltage V2 (oxygen voltage)
- Voltage V6 (transmissometer voltage)

### **AlignCTD settings**

AlignCTD was only needed to align the oxygen sensor relative to pressure. Tests to determine the optimum setting for the oxygen measurement were made with data from cast 006, which had some temperature, conductivity and oxygen gradients. AlignCTD was run with O2 sensor voltage and concentrations advanced by (in seconds): 0, +2, +4, +8 and +10. The profiles of oxygen concentrations were then plotted with both downcast and upcast on the same plot. Plots of oxygen versus temperature were also made although noise in the data made diagnostic difficult. From the profiles however, it is clear that the optimum value for alignCTD lies between 2 and 4 sec: 3.5 sec was tested and found to give satisfactory profiles.

### **CellTM settings**

The SeaBird recommended settings of  $\alpha = 0.03$  and  $1/\beta = 7.0$  were used on both primary and secondary conductivities.

## **2.5 Problems**

### 2.5.1 Problems during set-up

#### 2.5.1.1 CTD configuration

This was the first time that the new BAS frame configuration was used and the configuration needed to be entered in a new configuration file in SeaBird. While still in Stanley, the science team went through the list of sensors and serial numbers provided by BAS technical support via email from Cambridge and checked them against what was bolted on the CTD frame.

The serial numbers of the PAR sensor, the underwater unit and pressure sensor, and the altimeter were not visible on the frame because they were hidden by the mounted brackets; so we had to assume that the ones quoted in the list provided by BAS were correct. The other sensors' serial number agreed with those supplied except for the fluorometer which was SN249 (instead of 216).

#### 2.5.1.2. SeaBird software

We would recommend that both the Seasave and the SBE Data Processing software versions be updated. This is particularly important for oxygen data processing because SeaBird have upgraded the processing software with a hysteresis correction algorithm in their version 7 of the software. The problem was unfortunately discovered too late for this cruise and asking for a software upgrade would have been potentially too disruptive to key CTD operations.

#### 2.5.1.3. Sensor calibration issues

For the oxygen sensor, the form of the equation given in the calibration sheet was not compatible with the calibration equation used by the version of the SeaBird software installed on the CTD logging PC so we had to compromise and use the old calibration for that sensor instead.

For the transmissometer, a blocked path and air reading was made before the cruise and M and B were calculated using a Tw of 100% (calibration relative to water). Values of transmission greater than 100% were frequently observed which indicated that either the air and blocked path readings were not correct or that the sensor needs to be re-calibrated. Another air and blocked path readings were made at the end of the cruise which gave lower air reading than the one measured at the beginning of the cruise but would bring no improvement in the calibrated data. Average readings on deck, and resulting SeaBird CON file M and B coefficients are detailed in Table 2.4 below.

date	Air reading (volts)	Blocked path reading (volts)	calculated M (using Tw=100%)	calculated B (using Tw=100%)
16/11/2009	4.660	0.059	22.2106	-1.3104
26/11/2009	4.049	0.060	25.6182	-1.5371

*Table 2.4. Transmissometer calibration data.*

### 2.5.2 Problems or significant events during operations

All sensors, bottle firing operations and deployment routine functioned well. The following issues or events are worth reporting:

- Bad weather on 19/11/2009 stopped the CTD operations for over 24 hours after station 007. Sampling resumed on 21/11/2009 at a position half way between nominal stations 8 and 9. That station was labelled station 008 and it was followed by station 010. There are therefore no station 009.
- For the first test cast (A), an offset of 10 had been wrongly applied to the altimeter. This was corrected in the con file prior to the second test cast.
- For the second test cast (B), bottles 18 and 19 hit the top of the hanger when coming on board with no apparent damage at the time.
- On cast 001, bottle 18 was leaking at the end of cast and was replaced with a new bottle which was re-labelled as 18.
- Rough sea state at station 008 resulted in the CTD being brought back up to 8 m deep instead of the usual near surface before starting the downcast.
- Cast 017 was moved about 10 nm north of its nominal position in order to facilitate recovery of a POL BRP mooring.
- On cast 025, problems with one of the conductivity sensors on the upcast resulted in an increased offset between the two up to ca. 0.005 PSU between 2500 and 1250. The conductivity cells and tubing of both conductivity sensors were cleaned after the cast. Later comparison with bottle salinity indicated that it was the secondary conductivity which developed the offset.

## **2.6 MSTAR data processing**

All CTD stations were processed using NOCS Matlab-based MSTAR processing routines.

SeaBird raw and processed files were copied from the ship's network drive onto the NOCS Sun workstation NOSEA2 and moved to sub-directories BOTTLE\_FILES, ASCII\_FILES, RAW\_FILES, under /users/pstar/jr195/data/ctd/. In the process, \*\_actm.cnv files were renamed \*\_ctm.cnv. The two test casts were also renamed 990 and 991 respectively for testA and testB prior to MSTAR processing. MSTAR routines were generally run in four main phases:

Phase 1 routines grouped under ctd\_all\_part1.m consisted of the following:

- msam\_01 – creates an empty sam file sam\_jr195\_NNN.nc (make sure that the list of variable contains the expected channels);
- mctd\_01 – reads in 24Hz CTD data into ctd\_jr195\_NNN\_raw.nc;
- mctd\_02 – renames SeaBird variable names and creates ctd\_jr195\_NNN\_24hz;
- mctd\_03 – averages data to 1Hz (output to ctd\_jr195\_NNN\_1hz.nc) and calculates derived variables (output to ctd\_jr195\_NNN\_psal.nc);
- mdcs\_01 – creates empty dcs file which will store information about start, bottom and end of good data in CTD file;
- mdcs\_02 – populates dcs file with data to identify bottom of cast.

Phase 2 consisted of running mdcs\_03.m and manually input the scan number corresponding to the start of good downcast data and the end of good upcast data, therefore excluding any measurements taken in air.

Phase 3 routines grouped under ctd\_all\_part2.m ran the following:

- mctd\_04 – extract downcast data from psal file using index information from dcs file; sort, interpolate gaps and average to 2db (output to ctd\_jr195\_NNN\_2db.nc);
- mdcs\_04 – merge positions of start, bottom and end cast from navigation file into dcs file;
- mfir\_01 – read in information from SeaBird .bl file and create netCDF fir file;
- mfir\_02 – merge time from ctd file onto fir file using scan number (output to fir\_jr195\_NNN\_time.nc);
- mfir\_03 – merge CTD upcast data onto fir file;
- mfir\_04 – paste CTD fir data into sam file and output to sam\_jr195\_NNN.nc;
- mwin\_01 – creates win file which will hold winch data and extracts times from start and end of 1Hz ctd file;
- mwin\_03 – merge winch wire out data onto fir file;
- mwin\_04 – paste winch fir data into sam file;
- mdcs\_05 – apply position from dcs \*\_pos file to set of files.

If ctd\_all\_part2.m was run before the processed navigation file was available then mdcs\_04, mdcs\_05 and mctd\_04 were run again using one script (ctd\_all\_part3.m). This populates the position fields and recalculate depth from pressure.

Phase 4 consisted of adding the bottle salinity data from a sal\_jr195\_NNN.csv files under BOTTLE\_SALTS to the MSTAR bottle file. This was done by running msal\_01 (reads bottle salinities), msal\_02 (pastes into sam file) and msam\_02 (calculates residuals botpsal-upsal1 and 2) grouped under ctd\_msall\_all.m.

The final netCDF files from the initial processing carried out on board were, for each station:

ctd\_jr195\_027\_24hz.nc    a 24Hz time series for the full cast, all variables;  
 ctd\_jr195\_027\_psal.nc    a 1 Hz time series for the full cast, all variables;

ctd\_jr195\_027\_2db.nc a 2 db file of the downcast with all variables but excluding the voltage channels and the transmissometer channel (this was not noticed until late in the cruise).

sam\_jr195\_027.nc a bottle sam file containing upcast data at bottle firing time and bottle salinity data (note that SBE35 temperature have not yet been merged from the cap file onto the sam file)

A file jr195\_cordep.txt containing corrected water depth data extracted from the LADCP processed files for each cast (excluding test casts and the two LADCP turbulence test casts) was also generated. The depths were then inserted in the header of the processed netCDF CTD files.

## **2.7 Calibrations**

### 2.7.1 Pressure

Pressures on deck were logged at each start and end of cast. No correction was required.

### 2.7.2 Temperature

Initial comparison was made between the primary and secondary sensors. The agreement between the two sensors was excellent with the mean difference T1-T2 ( $\pm$ one standard deviation) being 0.000 ( $\pm$  0.002) °C

Data downloaded from the SBE35 high precision temperature sensor have not yet been merged onto the MSTAR bottle (sam) file. However, checks carried out on a few stations indicated that the differences between the CTD temperature sensors and the SBE35 were close to zero and generally lesser than  $\pm$  0.005 degree C.

### 2.7.3 Salinity

Initial comparisons were made between the conductivities, and derived salinities, from the primary and secondary conductivity sensors. The agreement was also very good with the exception of a section of the upcast at station 25 when a problem created an offset in readings from the secondary conductivity sensor. Mean differences and one standard deviation between the primary and secondary sensors were as follows:

Before station 25

$$C1 - C2 = 0.001 \pm 0.002 \text{ mS/cm}$$

$$S1 - S2 = 0.001 \pm 0.001 \text{ PSU}$$

After station 25

$$C1 - C2 = 0.001 \pm 0.003 \text{ mS/cm}$$

$$S1 - S2 = 0.002 \pm 0.001 \text{ PSU}$$

Salinity checks against 228 sample bottle salinities were carried out visually first by plotting the offset between bottle salinity and CTD salinity versus depth (pressure), versus time and versus bottle salinity. Outliers were investigated. At the end of our checks, 5 outliers remained unexplained: cast 19 bottle 16, cast 22 bottle 19, cast 27 bottle 22 and cast 29 bottle 13 and 22. All were from bottles fired in the upper 1000 m. Excluding these outliers, as expected the highest variability was in areas of stronger gradients closer to the surface. There was no obvious trend with time or salinity suggesting that the best correction would be to apply an offset correction to CTD salinity.

For pressure > 1000 db there were 107 bottle salinities and for the primary sensor we calculated the following:

mean (botpsal – upsall)  $\pm$  SD = -0.002  $\pm$  0.001 PSU

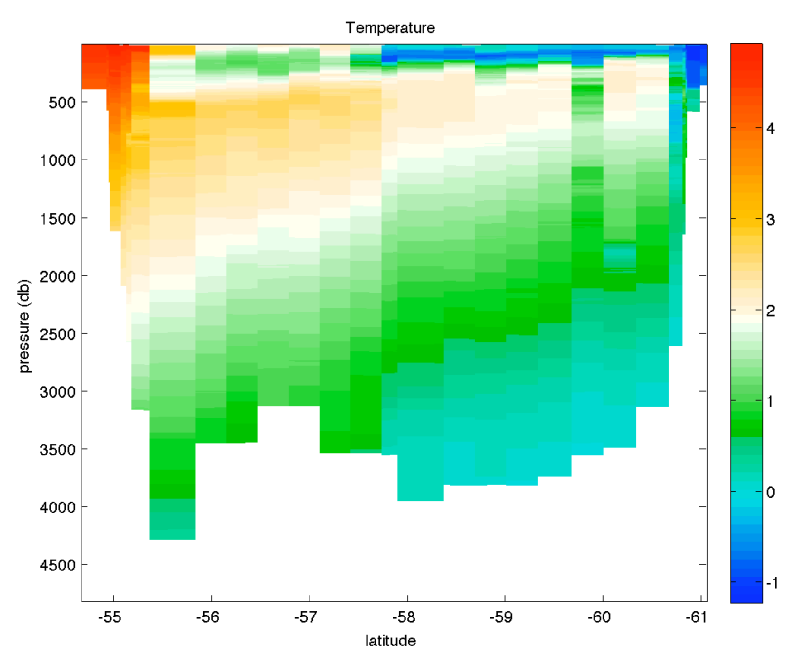
minimum offset = -0.004 PSU

maximum offset = 0.000 PSU

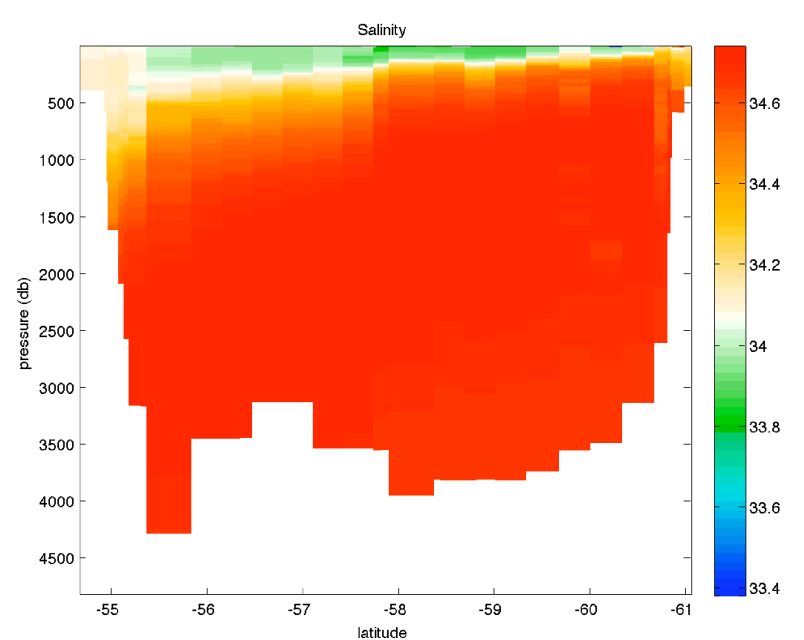
median = -0.002 PSU

## 2.8 Initial results

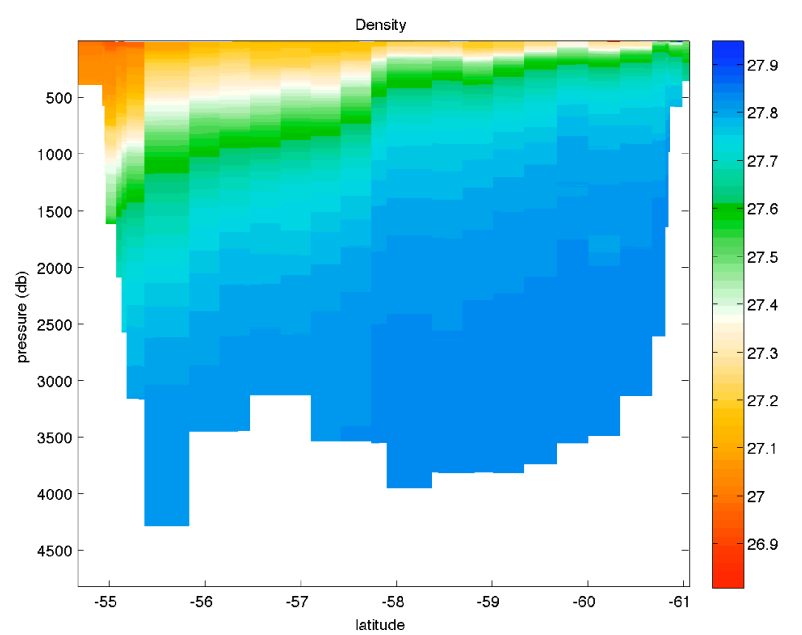
The following figures show the data across the Drake Passage transect as a function of latitude from Station 001 towards the north to Station 030 towards the south. These are data prior to final quality control and calibrations. No smoothing has been applied so that individual casts can be clearly seen.



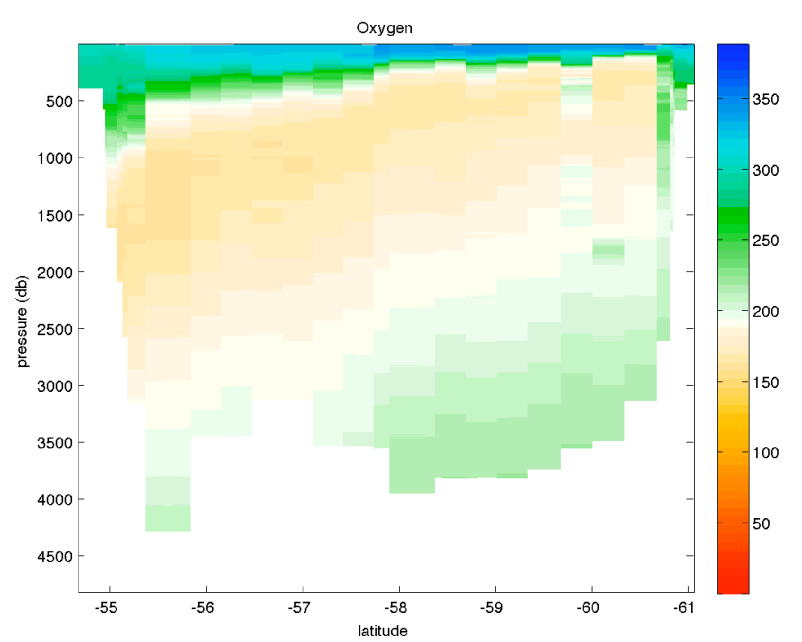
*Figure 2.2: Temperature (°C) across JR195 Drake Passage section.*



*Figure 2.3: Salinity (PSU) across JR195 Drake Passage section.*



*Figure 2.4: Density across JR195 Drake Passage section.*



*Figure 2.5: Nominally calibrated dissolved oxygen concentration ( $\mu\text{mol/kg}$ ) across JR195 Drake Passage section.*

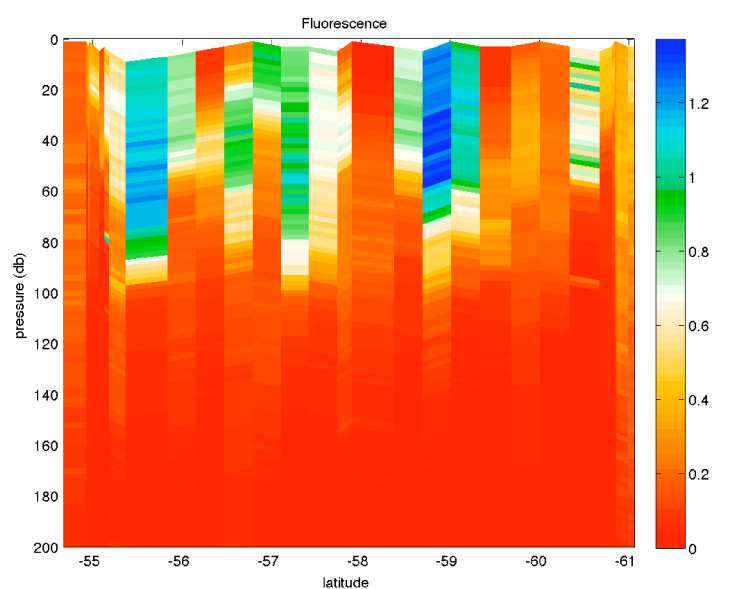


Figure 2.6: Nominally calibrated chlorophyll fluorescence ( $\text{mg m}^{-3}$ ) in top 200m across JR195 Drake Passage section. The distribution shows much patchiness. No chlorophyll sample was taken during the cruise to calibrate the fluorometer against extracted chlorophyll.

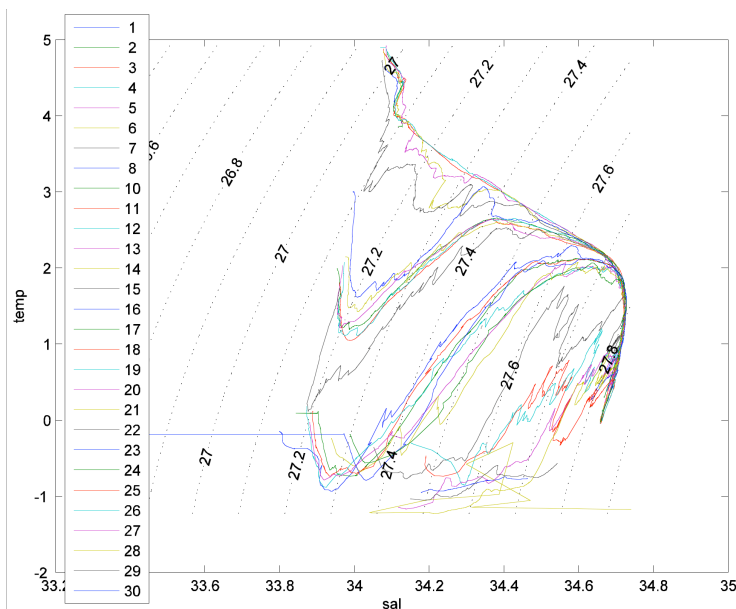


Figure 2.7: T-S plot for Drake Passage section of JR195 using data from the 2db-binned CTD profiles. The profiles contain small spikes, mainly close to the surface, which will need to be edited/flagged out during post-cruise processing.

### 3. LOWERED ACOUSTIC DOPPLER CURRENT PROFILER (LADCP)

Yueng Djern Lenn

#### 3.1 Introduction

Two NOCS LADCP's, two battery packs, a logging PC and associated equipment were shipped for JR195. Both LADCP's were RDI Workhorse Monitor 300 kHz instruments. The main difference between the two was that one (SN1855) had considerably more on-board memory than the other (SN12369). In the absence of AME support for the first 4 days of the 5-day mobilisation period, the battery pack was charged and both LADCPs were tested without

securing anything to the CTD frame, although the battery pack was placed within its brackets on the frame. After the arrival of the AME technician, the battery pack and LADCP were properly secured to the BAS frame and loose cables tied off with the connector end left accessible for pre/post-deployment communications. The instrument setup itself is more fully described in the next sub-section.

Two options were available for battery charging: (1) via the battery charger or (2) via the power supply. During JR195, we chose to use the power supply, as this charges the battery more quickly than the charger, taking care not to overcharge the battery. Typically charge time was comparable to the time taken to download the data file. The LADCP log sheets request the battery voltage be recorded, however, the DVM was not useful for measuring voltage since the cable contained a diode. Therefore we decided to recharge the battery after each cast, when necessary and possible (i.e. not always between closely-spaced shallow shelf stations). It was also necessary to occasionally vent excess pressure within the battery pack through the small allen-key-operated valve near the battery connector. The battery charging procedure is detailed in Section 3.3.

For JR195, a single LADCP was deployed in downward-looking mode, instead of a 2-LADCP upward/downward slave/master configuration. The LADCP/battery pack were connected to the controlling laptop and battery power supply (located in the Chem Lab) while the CTD was on board. Pre-deployment, the LADCP was woken up and the appropriate configuration command file was sent to start the instrument pinging before disconnecting the comms cable and blanking off the free ends. Post-recovery, the comms cable was reconnected to recharge the battery pack and download the data. The data was run through the initial stages of the UH processing and LDEO processing routines in order to diagnose any problems promptly (see section 3.4). As with other NOCS cruises the LADCPs were configured to have standard 10x16m bins, with one water track and one bottom track ping in a two second ensemble. Full description of the deployment and recovery procedures are provided in Sections 3.2 and 3.3.

### 3.1.1 LADCP set-up

The battery pack and LADCP were secured within the base of the CTD rosette frame in the configuration shown in Figure 3.1, with the battery in the position diametrically opposite to the location of the vane on the frame. The battery and LADCP are connected together with the star cable (Figure 3.2)

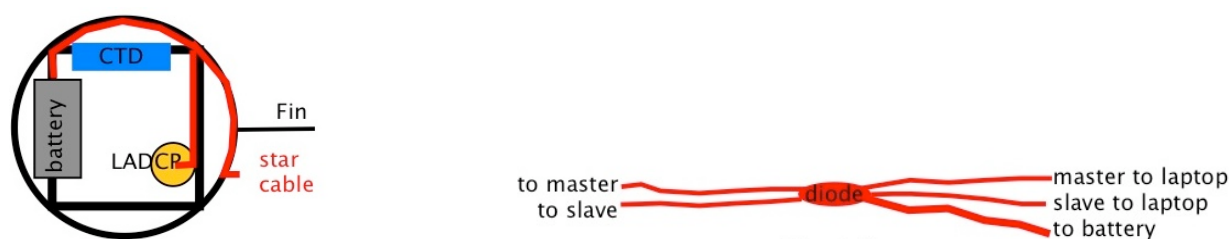


Figure 3.1 Schematic of CTD frame. Figure 3.2. Schematic of star cable (for two LADCPs)

As only one LADCP was deployed in the downward-looking mode, we used only the 'slave' set of cables: we could not establish communications with the LADCP using the 'master' set. The master cables were blanked off and secured neatly aside on the CTD rosette frame. (Note: the cable ends are labelled to distinguish the master and slave pairs.)

The communications cable was passed through the cable duct from the bottle annex where the CTD is stored to the adjacent chemistry lab which housed the LADCP laptop and power supply. To test the LADCPs with the comms cable connected to the star cable, we ran through the deployment and recovery routines in the BBTalk software. The battery was charged as described in Section 3.3. The configuration command file for the downward-looking LADCP used on JR195 contained the following commands:

PS0  
CR1  
CF11101  
EA00000  
EB00000  
ED00000  
ES35  
EX11111  
EZ0011101  
TE00:00:01.00  
TP00:01.00  
WM15  
LD111100000  
LF0500  
LN016  
LP00001  
LS1000  
LV250  
LJ1  
LW1  
LZ30,220  
SM1  
SA001  
SW05000  
CK  
CS

### 3.2 Deployment

Having satisfied ourselves that the instruments were working, secured on the rosette, and connected via appropriate communications and battery leads to the controlling PC, the following steps were completed to set the LADCP pinging prior to deployment of the rosette at each station. The instructions below include notes to record items in the LADCP log sheets (Appendix D).

1. Fill in metadata on the CTD section of the LADCP log sheet.
2. If not running, start\* BBTalk software:

*\* if starting BBTalk say OK in first 3 dialog box windows. If nothing or gibberish then appears in the BBTalk window, go to File, choose Properties, choose Auto-detect ADCP. If you get "no ADCP detected", check all the connections again and try to Auto-detect again. Once the ADCP is detected, type the following commands (in bold type) at the BBTalk prompt :*

- ▶ Press **<F3>** to set log file. Should be .../JR195/log\_files/WHM\_NNN.txt, where NNN is the station number. Check that "LOG ON" is flashing at the bottom of the BBTalk window. Record file name.
- ▶ Press **<End>** (or blue B button in top menu) to wake up workhorse.
- ▶ **ts?** to check time. Is accuracy required - if change required, type **ts YY/MM/DD,hh:mm:ss** Record Time.
- ▶ **rs?** to check available memory (AAA, BBB are USED, FREE Mb). Record BBB.
- ▶ If need to erase data, type **RE ErAsE**
- ▶ **pa** for pre-deployment checks - only bandwidth and transmit may fail. Tick box.

- **pt200** for more checks. Note internal moisture value, stop and seek advice if this does not start with an “8” or “9”.
  - Press <**F2**> to select configuration file\* ( C:/JR195\_LADCP/WHM\_JR195.txt).
  - Record time.
  - Press <**F3**> to stop log file.
  - ADCP is ready to deploy - you should hear the workhorse making a clicking noise if you put your ear near it.
3. Detach communications and charger cables and fit blanking plugs to open connectors, taking care to make sure it all looks clean and sufficiently greased for a good seal - particularly the rosette cable.

During JR195, the workhorse unit always returned acceptable values for the internal moisture, although it occasionally failed the testing of beam 2. However, as the data returned seemed fine we chose to continue with the unit.

### 3.3 Recovery

When the CTD rosette had been recovered at the conclusion of each station, the following steps completed the recovery of the LADCP data. The instructions below include notes to record items in the LADCP log sheets.

1. Dry off connectors, remove blanks and attach communications and charger cables.
2. Startup BBTalk software:
  - Press <**END**> or click blue B button to send a break. Record Time.
3. Recharge battery (see Sect. 3.3.1 below). Make note.
4. Back in BBTalk:
  - **ra?** to check number of deployments. Record total number.
  - **cb811** to reset baud rate from 9600 to 115200 to allow for faster recovery of the data.
  - Go to File, Recover Recorder. Select C:/JR195\_LADCP/downward/.
  - Choose most recent deployment “ RDI.....000”. Click OK.
  - **cb411** to reset Baud rate to 9600.
  - **cz** to power down LADCP
5. Change data file names in folder C:/JR195\_LADCP/downward/ to jr195\_NNNm.000. Record the default names & changes
6. Check that file size is not zero. Copy the raw files and the log files to a memory stick and take to UIC.
7. Log on to NOSEA2 as pstar. Place raw files in :jr195/data/ladcp/uh/raw/jr0911/ladcp.

#### 3.3.1 Charging the battery pack

Check volts using DVM on red and black cables (this only works if no diode is present in the cable). Charge battery up to 58 V (max., min 46V) at 100 mA, using power supply. Power supply is much quicker than the battery charger, BUT it has to be watched. Can also use the diode with the power supply so that the pins are not live when unplugged. The power supply has two speedo type gauges:

1. Turn current knob all the way to the right so that the “c.v.” (voltage controlled) light is lit.
2. Set volts knob so that dial shows 58 V. Set the hi/lo current switch to low - this means the current speedo lower scale will be used, i.e. full range is 0.5 Amp. -
3. When the current falls to 0.1 Amp., battery is charged. Turn off power supply **PROMPTLY - DO NOT OVERCHARGE.**

If the cable has a diode, you can check the battery voltage by turning the voltage knob down until the current dial drops to 0.1 Amp - the voltage speedo then gives the rough battery charge.

### 3.4 Data processing

Data from the LADCP instruments was processed when possible between each station to allow early detection of any problems with the ADCP workhorse. Two sets of software were utilized: University of Hawaii (uh) and Lamont Doherty Earth Observatory at Columbia University (Ideo) programs. Both were run to allow a full picture of the LADCP performance to be obtained. Instructions are given below for initial shipboard LADCP processing during JR195. This set of instructions is based on notes obtained from Brian King prior to the cruise. Additional assistance with processing was obtained from Brian King.

#### 3.4.1 UHDAS processing

Bold text denotes commands to enter at the X-window/terminal prompt. '>>' preceding bold text indicates commands to be entered in the Matlab window. Notes are in italics.

1. To place raw LADCP files on the Unix system, log on as pstar/pstar and copy files (in j195\_NNNm.000 format) to pstar/cruise/data/ladcp/uh/raw/jr0911/ladcp

2. Log on as pstar, password pstar.

*Note: You must be logged on to the jruh station to get access to the matlab licence - this should be set up when NOSEA2 is connected to the ship's network, and not required at each subsequent log in.*

3. setup matlab paths, at the prompt enter

**cd ladcp**

**cd uh**

**source LADall**

4. change location to processing directory:

**cd proc** *(this is not a typo - although the ladcp directory does not contain a subdirectory proc, the path to proc is set in the LADall file)*

**cd Rlad**

**linkscript**

*Check the raw ladcp data; there should be a raw file called jr195\_NNNm.000. Linkscript will make a symbolic link from jNNN\_02.000 to the real raw file. We use \_02 for compatibility with other cruises when there is more than one LADCP. The convention adopted on CD139 was that 02 is a down looking workhorse (WH) and 03 is an upward looking WH. Hence until the instruments are changed, use 03 in the following XXs. For JR195, there is only the downward looking WH, so NN = 02.*

5. scan data file:

**cd proc perl -S scan.prl NNN\_02** *This will output to screen, check that times and depth are sensible, i.e. Zmax is approximately the same as the expected depth, and Zmin and Zend should be < 50m for shallow casts, and < 200m for deep ones.*

6. Update cruise navigation files:

**matlab**

**>> m\_setup**

**>> putpos(NNN,02)** *check syntax*

**>> magvarsm(NNN.02)** *check syntax*

*(ignore decimal year warning)*

**>> exit**

**7. perl -S load.prl NNN\_02**

*loads into database, correcting for magvar.tab. IT IS VERY IMPORTANT THAT THIS STEP IS ONLY DONE ONCE. If you need to do it again, for example if you discover an error in step 5, then you must delete the database files first (i.e. proc/casts/jNNN\_02/scdb/\*.blk)*

**8. perl -S domerge.prl -c0 NNN\_02**

*merge single pings into long shear profiles*

**9. Grabs navigation for the LADCP profile**

**cd Rnav**

**matlab**

**>> m\_setup**

**>> make\_sm**

**>> exit**

**cd proc**

**10. first look at profile:**

**matlab**

**>> plist = NNN.02;** *(this is a decimal number in matlab)*

**>> do\_abs**

*Check figure 1 for X-character in profiles indicative of ADCP failure. Check Figure 5 for good heading, i.e. CTD not rotating.*

**>> exit**

**cd casts/jNNN\_02/merge**

**lpr -Php4550 duNNN02h.ps**

*File printout in the "JR195 LADCP first look" folder*

*Stop UH processing here if CTD has not been processed as far as 1Hz and perform the LDEO processing in Section 4.2*

**11. If/when the CTD has been processed as far as a 1hz file**

**cd proc**

**cd Rctd**

**matlab**

**>> m\_setup**

**>> mk\_ctdfile(NNN)**

*makes ascii version of CTD 1hz file in preparation for ladcp use*

**>> exit**

**12. cd proc/Pctd**

**matlab**

**>> ctd in(NNN,02)**

*incorporates CTD data to LADCP profiles, using CTD to calculate exact sound speed etc.*

**>> exit**

**13. cd proc/Fitd**

**matlab**

**>> plist = NNN.02;**

**>> fd**

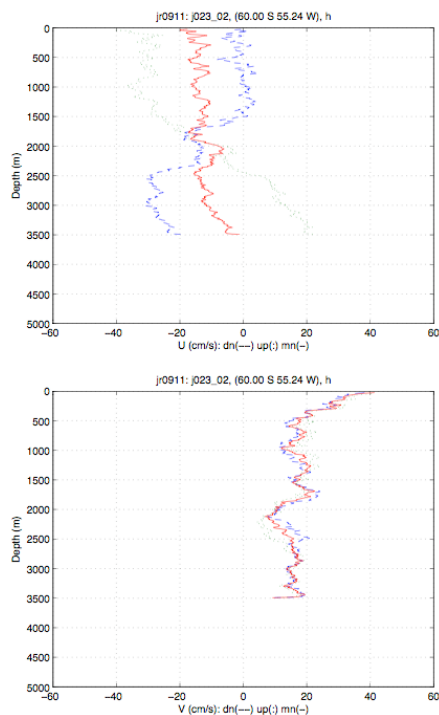
*check vertical velocities from ctd and adcp agree*

**>> exit**

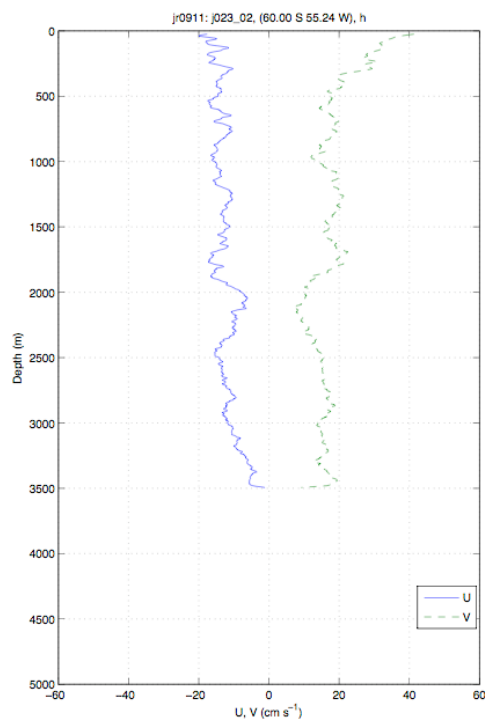
14. final steps:

```
cd proc
perl -S add_ctd.prl NNN_02
perl -S domerge.prl -c1 NNN_02
matlab
>> plist = NNN.02;
>> do abs
>> exit
cd casts/jNNN_02/merge
lpr -Php4550 duNNN02h.ps
```

To simplify the process and avoid user errors, halfway through the cruise, MJY wrote a tidy little script to run through steps 3-9 in the initial UH processing (**pstar/jr195/data/ladcp/uh/script3-9**). Emulating this excellent example, YDL supplemented this with a script to run through the remaining processing steps once the CTD data has been processed to the appropriate stage (**pstar/jr195/data/ladcp/uh/script-uh-withctd**).



*Figure 3.3: Down-/up-cast and mean velocities. This is the figure to check for 'X' character in the down and up cast velocities - some of this is present in the u-profiles but not the v-profiles.*



*Figure 3.4: Merged mean LADCP zonal and meridional velocities produced from the UH processing.*

One check of the LADCP performance was to compare the velocity profiles from the down- and upcasts at each station. This is the duNNN02.ps figure (Figure 3.3) which is printed to go in the processing file. Preferably the up and down cast velocities do NOT form an 'X'. We did see this a few times, but non-X profiles were much more common and the internal moisture readings from the pre-deployment checks were always acceptable. So we carried on

regardless. Figures 3.3 and 3.4 are examples of two of the figures produced from UH processing from station 23.

### 3.4.2 LDEO processing

This is the easiest check of LADCP beam strength. During JR195, it was done after the first running the UH processing, even though you don't need to have done the 1Hz CTD processing yet

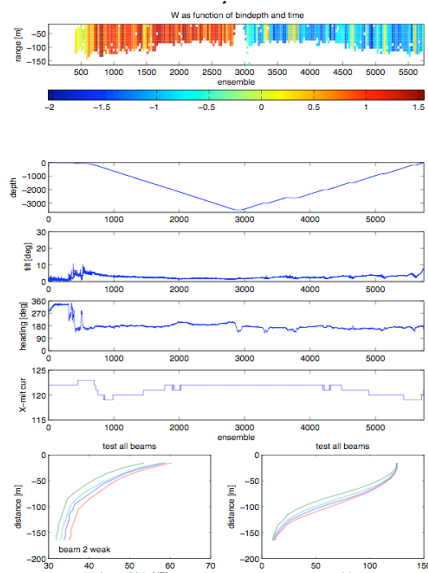


Figure 3.5: This is produced as "Fig. 2" when 'lp' is run in matlab. The subplot in the bottom left corner has the beam statistics. We often got a weak beam 2 warning, but all four echo traces tracked each other well. If there is a real problem, the malfunctioning beam echo trace is expected to diverge significantly.

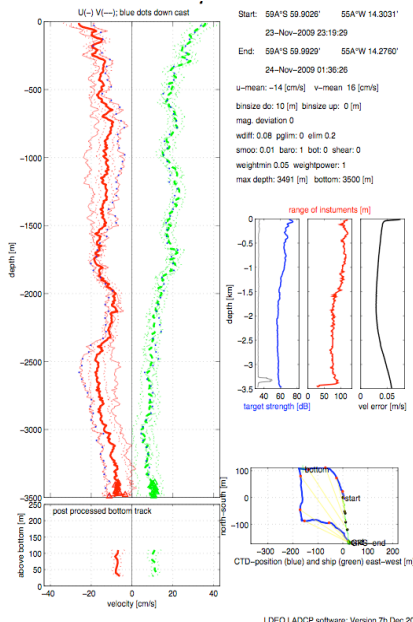


Figure 3.6: This is produced as "Fig. 1" when 'lp' is run in matlab. It gives a summary of the useful output from the LDEO processing, including the mean current components, standard deviation of individual ensembles and on station position variation.

In a terminal window, enter:

```
cd pstar/data/ladcp/ldeo/jr0911
matlab
```

```
>> sp
```

input NNN when prompted, when asked for run letter enter 'noctd' or 'withctd' as appropriate

```
>> warning off
```

```
>> lp
```

```
>> print_ldeo_fig_2_13
```

Save useful figures not automatically saved by ldeo processing.

```
>> warning on
```

Turn warnings off because lp often calls FINITE which still works, although Mathworks has replaced/will soon replace with ISFINITE.

Beam strength and correlation figures should show good agreement between the four (five for the Bangor unit) beams.

```
>> exit
```

If processed without CTD data, the following figures were printed for the JCR LADCP FIRST LOOK file.

**lpr -Php4550 jr195NNN/jr195NNNnoctd.beam stats.ps**  
**lpr -Php4550 jr195NNN/jr195NNNnoctd.ensembles.ps**  
**lpr -Php4550 jr195NNN/jr195NNNnoctd.ps**

As with the UH processing, partway through the cruise, MJY and YDL put together c-shell scripts to run the LDEO processing all the way through the processing with CTD data. (**pstar/jr195/data/ladcp/uh/script-ldeo** and **script-ldeo-withctd**) All the output figures were filed. An example of these is shown in figures 3.5 and 3.6.

### **3.5 LADCP problems on JR195**

Apart from the question about the beam 2 strength, there were few issues with the LADCP during JR195. One inconsistency concerns the station naming convention. Stations 8 and 9 were combined into a single station in between the planned station positions due to a bad weather delay. The data was archived as station 8. We then moved onto the planned location of station 10 which was the ninth cast. I unwittingly labelled the LADCP raw data file as station 009 instead of 010 as in the CTD data, and this was carried through all the processing. The 009 raw and processed files were eventually copied to files labelled with 010 in order to allow the processing routines to match the LADCP data to the CTD data. Readme's note these changes in all the directories and folders affected.

Other problems that arose concerned the charging of the battery pack. We often found it difficult to charge the battery up to 58 Volts. However, as 46 V would have been sufficient to run the LADCP during even the deepest deployments, we frequently managed to recharge up to 52-56 V and considered this adequate.

A more serious issue arose after station 26, when we were unable to get current to the battery pack - although we were still able to talk to the instrument. After re-checking the connections to no avail, we tested the battery with the spare star cable. This proved successful at both carrying a current to charge the battery and also communicating with the workhorse. We suspect that the diode on the original cable may have failed and were doubtful of the LADCP's ability to draw power from the battery during the cast. Consequently we decided to change the star cable out. In the absence of a dummy for the battery connector on the star cable, we had to removed the original cable instead of just blanking it off and attaching the new cable on top of it. No time was lost for the cable change as there were mooring deployment operations going on at the time. In future cruises it would be prudent to ensure there are blanking plugs for all the cable connectors.

### **3.6 Preliminary results**

The results from the UH and LDEO processing were plotted up as sections in order to make a quick comparison of the methods. The main difference in the two methods seems to be the way they reference the bottom velocities. The LDEO bottom velocities are generally smaller than those from the UH processing. This is particularly evident when we look at the currents north of the West Scotia Ridge at about 56° South. The UH results (Figure 3.7) show a strong north-westward flow that is somewhat weaker in the LDEO currents (Figure 3.8).

In general, the LADCP shows that the flow through SR1b is generally northeastwards with a particularly strong deep-penetrating jet located over the Patagonian continental shelf break. Peak velocities in this jet were about 1.0 m/s at the surface. Three of the 29 LADCP profiles show a deep-penetrating reversal of the mean flow south of the West Scotia ridge. These may be indicative of mesoscale eddies.

The geostrophic velocities computed from the CTD and referenced to the deepest common level are shown in Figure 3.9. The strong deep jet in the geostrophic currents confirms that this is due to the presence of the merged SAF and PF. CTD data profiles south of this jet

show the presence of the winter water sub-surface temperature minimum, although the minimum temperature is above 0 degrees. The second jet in the middle of SR1b (south of  $57.5^\circ$ ) is the SACCF. These fronts are much further north than they were in February 2009 on JC31.

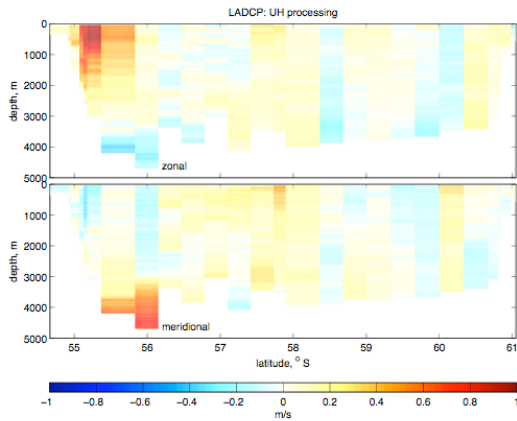


Figure 3.7: LADCP profile data processed using the UH routines.

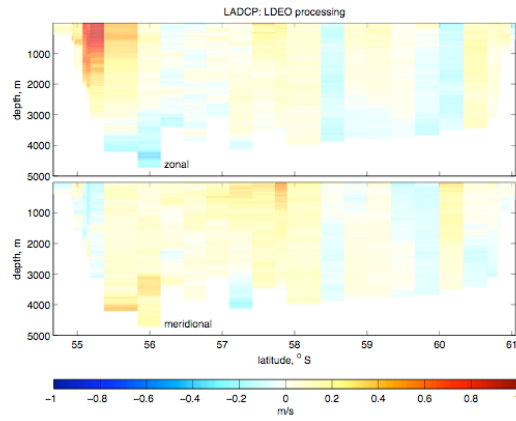


Figure 3.8: LADCP profile data processed using the LDEO routines.

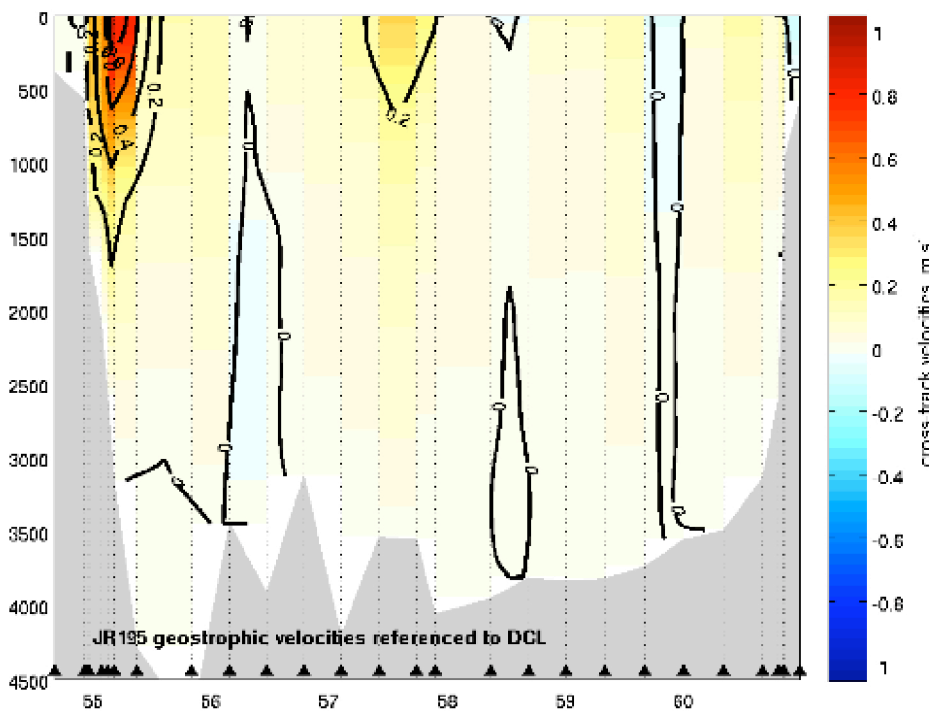


Figure 3.9: Geostrophic velocities across the SR1b track referenced to the deepest common level. Velocities are plotted against depth and latitude, where Burwood Bank is to the left and Elephant Island is to the right of the plot.

## 4. VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER

*Hugh Venables*

### 4.1 Introduction

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

### 4.2 Instrumentation

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

The OS75 transducer on the *JCR* is aligned at approximately 60 degrees relative to the centre line. This differs from the recommended 45 degrees. Shortly after sailing for JR139, the hull depth was measured by Robert Patterson (Chief Officer), and found to be 6.47m. Combined with a value for the distance of the transducer behind the seachest window of 100-200mm and a window thickness of 50mm, this implies a transducer depth of 6.3m. This is the value assumed for JR200, but note that the ship was very heavily laden during cruise JR139, and for other cruises it may be shallower.

During the trials cruise (JR139), it was noted that the OS75 causes interference with most of the other acoustic instruments on *JCR*, including the EM120 swath bathymetry system. To circumvent this, the ADCP pinging can be synchronised with the other acoustic instruments using the SSU. This issue was investigated in detail on JR218 (which see for full details). On JR195 the Swath and EK60 were not used during the CTD transect and the ADCP was run unsynchronised, pinging every approximately 3.1 seconds. In shallow water the ADCP was set in bottom track mode with varying depths (and therefore ping rates).

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

### 4.3 Configuration

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The OS75 ran in two modes during JR200: narrowband with bottom-tracking on and narrowband with bottom-tracking off. While bottom tracking the maximum water depth was either set to 250m, 500m or 800m (16, 32 or 50 bins, each 16 metres). Water-tracking was always fifty 16 metre bins. The matlab code can now (post-JR218) concatenate files with differing numbers of bins. Narrowband profiling was enabled with an 8 metre blanking distance (Note that this blanking distance is larger than the 2m initially used by the RDI technician during the trials cruise. This change was adopted following advice from Dr. Mark Inall and Dr. Deb Shoosmith, who voiced concerns

over the quality of data in the top bin). Despite this, there were still periods, especially in bad weather, where the data in the top bin looked bad. The ‘set modes’ configuration files, as described in JR218 report, were used during the cruise but altered to have 16m bin depths.

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

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

Appendix E contains cue cards for setting up the ADCP.

#### 4.4 Outputs

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

Output files are of the form JR200\_XXX\_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte.

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

.N1R (NMEA telegram + ADCP timestamp; ASCII)

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

.VMO (VmDas configuration; ASCII)

.NMS (Navigation and attitude; binary)

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

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

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

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

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

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

#### 4.5 Post-processing of data: IFM Kiel software.

OS75 data were processed on JR200 using Matlab code originated by IFM Kiel. This was adapted by Dr. Mark Inall, Dr. Deb Shoosmith, Angelika Renner, Mark Brandon and Hugh Venables for use with the *JCR* system. The master file for the processing is “OS75\_JCR\_jr200.m”, which calls a lengthy sequence of routines to execute the following steps. Angelika Renner made changes to the main program following JR165, to calibrate narrowband and broadband data separately. These changes are adopted, though no broadband data has been collected.

- 1) Read RDI binary file with extension .ENX and ASCII file with extension .N1R into Matlab environment.
- 2) Remove missing data and data with bad navigation
- 3) Merge Seapath attitude data with single-ping ADCP data.

The program `read_nmea_att_jcr.m` was modified to cope with a .N1R file where the first line was a PADCP line that was too short. The fix only works if it the first PADCP line that is broken.

- 4) Correct for transducer misalignment and velocity scaling error (calculated during first run-through of code, applied during second)
- 5) Derive ship velocity from Seapath navigation data
- 6) Perform quality control on data, such that four-beam solution is only permitted. Other screening is performed based on maximum heading change between pings, maximum velocity change between pings, and the error velocity. Angelika Renner, after JR165, added checks on the correlation and also removed data with very strong amplitudes, as this is a sign of interference. The latter check involves a large amount of processing time, which caused problems when ADCP data was wanted rapidly. To solve this the check was removed when data were processed initially (amplitude and misalignment as defaults) but included for post-processing. The filter length was reduced, or the filter removed completely for short files (including when data collection was stopped just after a new 10mb increment of the .ENX file). This stopped the processing stopping with an error.
- 7) Average data into ensembles of pre-defined length (120 seconds for JR200). The version of the function `average_pings.m` was modified slightly to cope with cases found during JR200 which initially caused the processing to crash. These were where there was less than 2 minutes data in the last .N1R file and where there was over two minutes of missing data near the end of a file but followed by good data in the period after the last full two-minute interval. Such cases made the code crash so it was adapted to cope with these eventualities.
- 8) Calculates transducer misalignment and velocity scaling error (computation done on first run-through of code, to be applied during second). The data filtering implemented for JR165 was relaxed for this cruise. In particular, heading and speed data outside one standard deviation of the mean were not removed, as it was not seen why these should necessarily be bad. The checks for rapid turning or accelerating were left in and these would catch any spikes in the velocity or heading data. Minor changes were made to `calib_calc_bt.m` and `calib_calc_wt.m` so that the trend line was not calculated if there was insufficient data. This allows short files to run successfully, after the above changes to the use of a filter in `qual_control.m`.
- 9) Velocities from depths deeper than 86% of the bottom-tracking depth are set to missing.
- 10) Determine absolute velocities from either bottom-track ship velocity or Seapath GPS (usually the latter).
- 11) Plots the eastward and northward velocities. Details of this plotting were tidied during JR193 and JR200. In particular, code was added to deal with plotting files that spanned the new year. There is still an issue that for short files too many times are plotted on the x axis, causing them to overlap.

#### 4.5.1 Output Files

Final data are stored in Matlab format. Filenames are of the form:-

- 1) JR195\_00A\_00000B\_raw.mat, where A is the highest number of the user-incremented files. This is the number that VmDas increments every time logging is stopped and restarted.

The version number is B, which increments with the .ENX files, when they reach 10Mb. This contains structured arrays “c” (ensembled-averaged data), and “b” (absolute velocities). Initially the increment was accidentally left as 100Mb from the last cruise. This results in files that sometimes cause matlab to run out of memory. 10 Mb is therefore recommended. The code was changed to load this file if it existed rather than recreate it in post-processing. This is much faster and means that when the large file did process successfully the result could be used instead of trying again.

- 2) JR195\_00A\_00000Bd\_att.mat, where A and B are as above. This contains the ship’s attitude data.
- 3) JR195\_00A\_00000B\_sgl\_ping.mat, where A is as above, and B is the number VmDas increments every time filesize exceeds 10 Mbyte. This contains single-ping data in structured array “d”.
- 4) JR195\_00A\_000000\_ATT.mat. As (3), but for the whole section of data in the user-incremented series A
- 5) JR195\_00A\_00000B\_bad\_heading.mat. Record of the data points removed due to bad heading
- 6) JR195\_00A\_00000B\_bad\_nav.mat. Record of the data points removed due to bad navigation.
- 7) jr195\_000\_000000\_A\_ave\_ping. Two minute averaged data, including ship velocity.
- 8) jr195\_000\_000000\_A\_abs. Two minute averaged data, water velocities.
- 9) adcp\_vel\_contours\_A.ps Individual plots of data in jr195\_000\_000000\_A\_abs, “A” here is the first in any list of files given to OS75\_JCR\_jr195.m. This was introduced at A=43 so is only present before that if data has been reprocessed.
- 10) adcp\_vel\_contours.ps A file with each of the individual plots appended, each as an extra page when converted to pdf.

#### 4.5.2 JR195 Data

The JR195 section data were collected in a series of files (Table 4.1), due to the required changes in configuration file when the VM-ADCP needed to be changed from bottom-tracking to normal mode and also to allow processing of the data during the cruise.

The instrument stopped on several occasion but the reason is unknown – the instrument needs checking regularly as part of the watchkeeping duties (Appendix D) and should be stopped and restarted if a white terminal window appears. On another occasion all navigation data for a period of approximately four hours was rejected in the processing. These instances need to be investigated. During good weather good quality data were collected to approximately 750m. This depth reduced during bad weather, due to bubbles under the hull absorbing or scattering energy from the beams.

As noted on JR193 and JR177, the ADCP velocities can be contaminated by deployed instruments or the cable. This was linked to CTD deployments on JR193 and was seen again on JR200 for CTD and Bongo net deployments. The problem is that in medium to strong flows the instruments are pulled by the flow so that the cable velocity has a horizontal component, which is recorded by the ADCP. This component must only be in one beam so it should be possible to remove it. Indeed it is perhaps a flaw in the processing that it is not already. This will be further investigated in Cambridge. As calculated on JR193, the intersection should be below 40m (as found) as the beam angle of the ADCP is 30° and the transducer is 23m away from the CTD gantry.

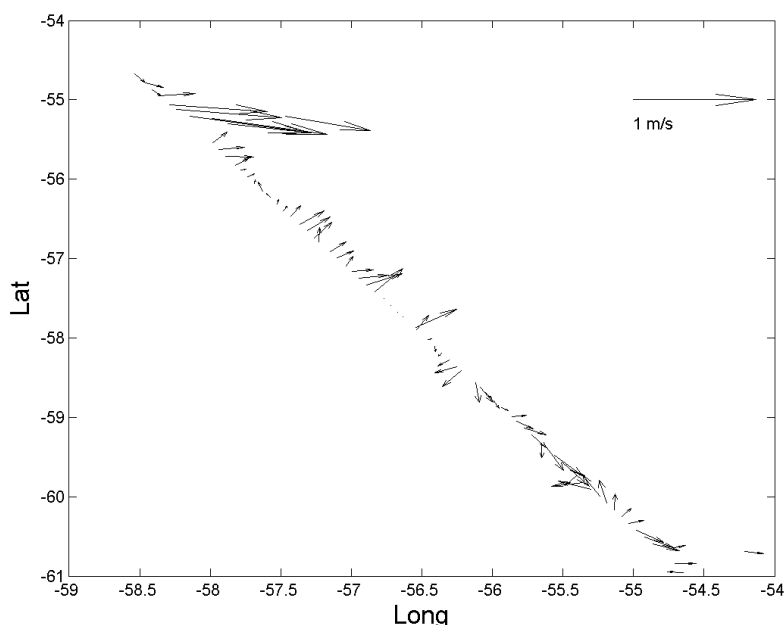
Figure 4.1 shows the surface velocities along the ship track for JR195. Figure 4.2 shows the northwards and eastwards components of the velocity profile plotted against time. These data have had no calibrations applied.

#### 4.5.3 Calibration

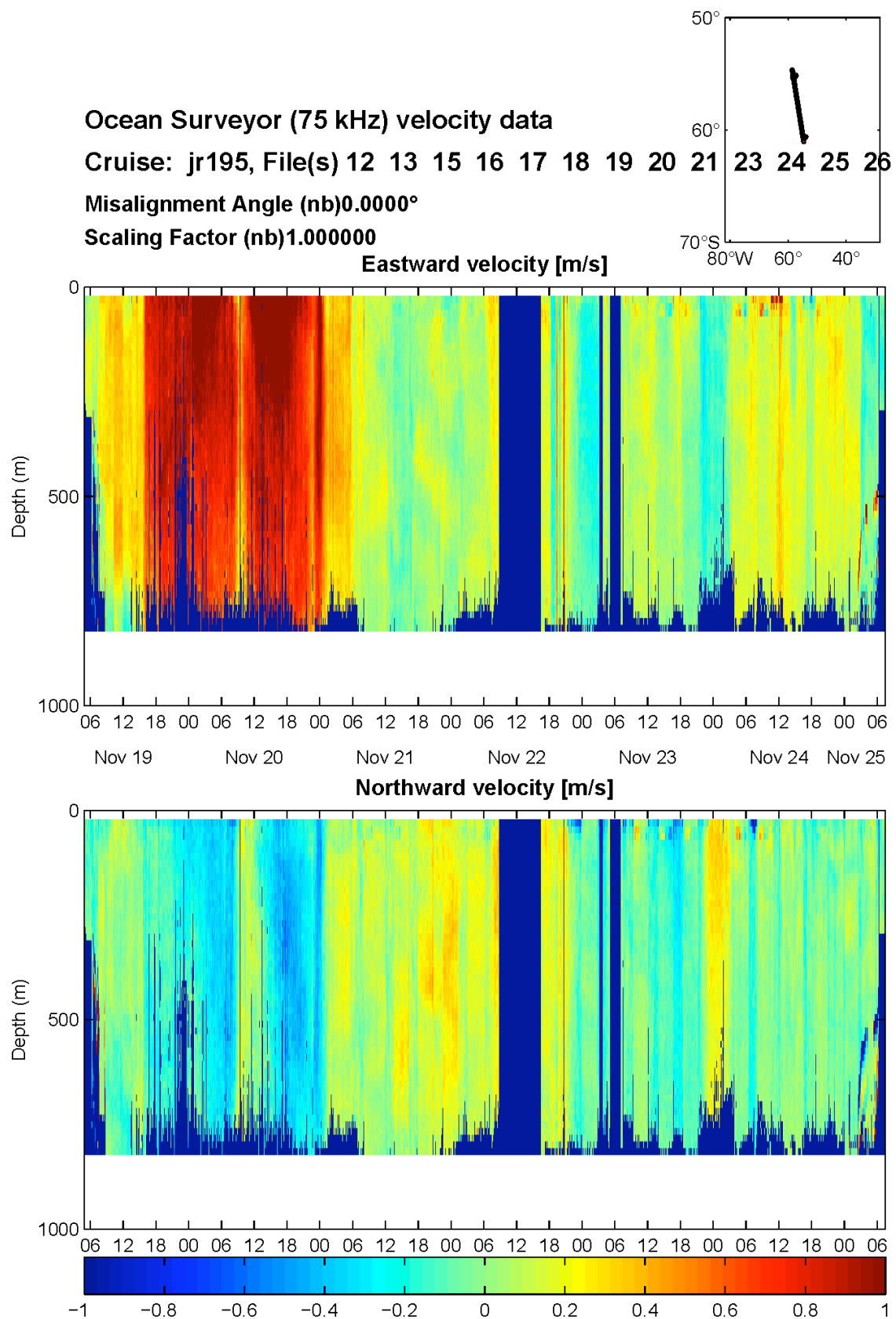
While the ship is steaming, the main signal that the ADCP instrument records is the ship speed. 12 knots (6 m/s) is 1-2 orders of magnitude greater than the water velocity. This velocity is removed using GPS derived ship velocities but there is clearly the potential for a significant error associated with this process as the output data is the small difference between two large numbers. To address this, the velocity of the bottom can be measured and compared directly to the GPS velocity of the ship. This should give the amplitude error for the ADCP and the misalignment with the ship heading. This only works in water where the bottom track ping can reach the sea bed – 800m or shallower.

Table 4.1 lists the files obtained, and whether bottom-tracking or water-tracking calibrations were obtained. Figure 4.3 shows the distribution of calibration results obtained during water-tracking mode: the mean (s.d.) amplitude was 1.0148 ( $\pm 0.0121$ ) and the mean (s.d.) phase or angle was  $-0.0303$  ( $\pm 0.5567$ ). This is similar to calibrations found during previous cruises (Table 4.2). Testing the calibrations on ‘stripy’ files such as file 18 with multiple CTD stops supports the calibration values as the stripyness is removed.

In deeper water the processing uses changes in the ship velocity to assess what proportion of the ship velocity is contaminating the calculated water velocity. This calculation necessarily invokes assumptions that the true water velocity is relatively constant in space (if slowing down) or time (if turning round) and is therefore considered less precise. Similarly to JR177 and JR200 a large number of water track data were collected during JR195, from slowing down and speeding up from CTD stations.



*Figure 4.1 Surface currents vs longitude along the ship track for JR195.*

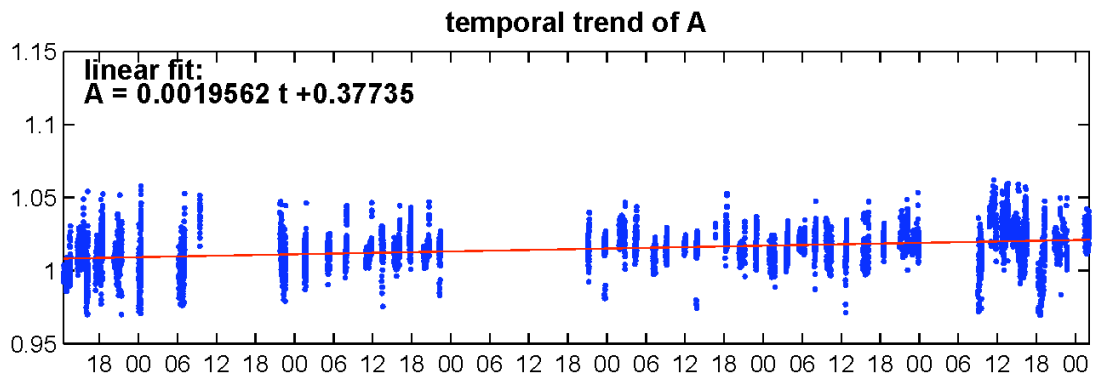
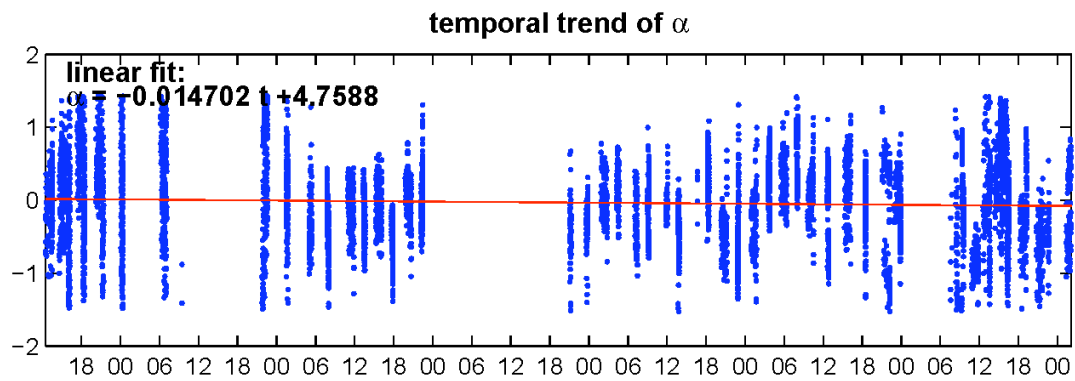
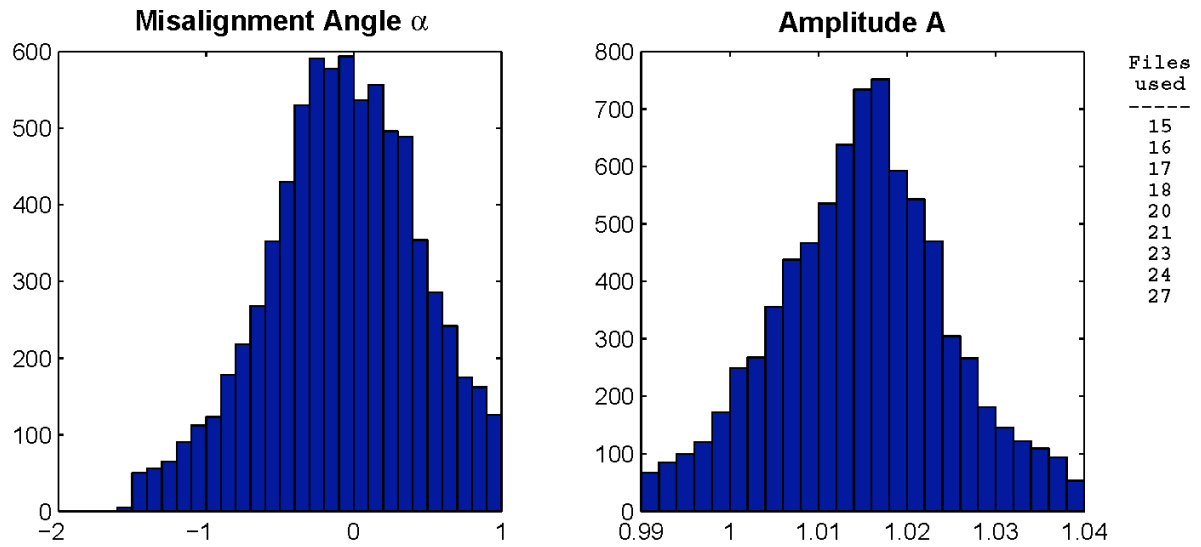


*Figure 4.2 Northwards and eastwards velocity profiles, plotted against date, for JR195. Note that no calibration has been applied to these data.*

# MISALIGNMENT ANGLE DETERMINATION (jr195) (Water Tracking)

from: 2009/11/18 - 12:29  
to: 2009/11/25 - 02:07

Total Duration : 6.568 days  
Calibration Points: 7973 of 8473



**Statistics:**

	amplitude	angle
mean :	1.014760	-0.0330
std :	0.012058	0.5567
median:	1.015153	-0.0412

Figure 4.3: Calibration statistics from water-tracking files for JR195.

File number	Depth (#bins)	Bot/Wat	Comments	CTD stations	jday start	jday end
001			Test			
002						
003	1000 (65)	B				
004	250 (16)	B				
005	(32)	B				
006	(50)	B				
007	(50)					
008	(50)	B			322.84	323.066
009			No data			
010			No data			
011	(16)					
012	(32)			1		
013	(50)	W	Some bottom echoes	2-4	323.265	323.505
014			No data			
015	(50)	W	Windy, some data dropout	5-7	323.512	324.001
016	(50)	W	Hove to			
017	(50)	W	Hove to		324.397	325.04
018	(50)	W	NOTE, no CTD stn 9	8,10-13	325.011	326.042
019	(50)	W		14-17	326.047	326.875
020	(50)	W		18	326.88	327.075
021	(50)	W	Short	part 19		
022			No data			
023	(50)	W		20-23	327.298	328.083
024	(50)	W		24-28	328.089	329.092
025	(50)	W	Bottom echoes	29		
026	(32)	W		30	329.266	329.311
027	(50)	W			329.317	330.353
028	(32)	B			330.417	330.462
029-035			No Data, SSU testing			
036	(32)	B	Short			
037, 038			No Data, SSU testing			
039	(65) 8m bin test				330.509	330.607
040			No data		330.611	330.674
041			No data			
042	(100) 8m bins	B	Short			
043			No data			
044	(50)	-	Short, no cal data			
045	(50)	W?	Data drops out half way			
046	(16)	B	Short. Orig. file 14 after file 19 was reprocessed, renamed			
047	(32)	W?	Orig. file 15, Odd calibration data (and was on bottom track)		332.824	333.644
048			Orig. file 16. Doesn't process			

Table 4.1. VMADCP files obtained during JR195.

cruise	date	bot/water	mean amplitude	mean angle	notes
JR195	Nov 2009	water	1.0148	-0.0330	Kiel processing
JR195	Nov 2009	water	1.0155	-0.2060	CODAS processing
JR195	Nov 2009	bottom	1.0381	+0.6080	CODAS processing
JR200	Mar-Apr 2009	water	1.0150	-0.0876	
JR177	Jan 2008	water	1.0124	-0.0559	
JR165	Mar-Apr 2007		1.0127	-0.0078	
JR158	Feb 2007	water	1.0161	+0.1245	
JR161	Oct-Dec 2006	bottom	1.0127	-0.0481	

Table 4.2. Mean calibration results for JR195 and previous cruises.

## 4.6 VMADCP: CODAS/Hawaii processing.

Margaret Yelland

### 4.6.1 Calibration results.

In addition to the Kiel version processing of the VMADCP data performed by Hugh Venables above, the CODAS software was also used. Note that this software sometimes outputs a decimal day, calculated from time in seconds since the start of the year. Decimal day is 0.5 for noon on the 1<sup>st</sup> January: this contrasts with a jday of 1.5 for noon on the 1<sup>st</sup> January.

It is not straightforward to append all the files together to make a single cruise file. Instead, each file was processed separately and each produced a separate water- or bottom-tracking calibration. These are listed in Table 4.3 for comparison with those found by the Kiel processing described in the previous section. Since some files were only a few hours long, and others more than 24 hours, the weighted averages have been used to calculate the overall amplitude and phase corrections. NOTE that ensemble count in \*out cal files does not make sense, neither does the jday range, so the "ncols" information in the \*.nc files headers were used to derive weighted averages.

For water track mode, the results were: amplitude = 1.0155 phase = -0.206

For bottom track mode, the results were: amplitude = 1.0381 phase = +0.608

Note that the last bottom track file is by far the longest, and the calibration from that file gives:

amplitude = 1.0185 phase = -0.079

which is in reasonable agreement with the weighted averages of the water track results.

File NNN	B/T/WT	Amplitude			Phase			ncols	jday start	jday end	length (hours)
		Median	Mean	s.d.	Median	Mean	s.d.				
<b>008</b>	<b>BT</b>	<b>1.1265</b>	<b>1.1064</b>	<b>0.0569</b>	<b>3.34</b>	<b>3.1348</b>	<b>2.1508</b>	<b>66</b>	<b>322.84</b>	<b>323.066</b>	<b>5.424</b>
008	WT	1.0115	1.0115	0.0049	-0.0174	-0.0174	0.0028	66	322.84	323.066	5.424
013	WT	1.016	1.016	0	-4.528	-4.528	0	70	323.265	323.505	5.76
015	WT	1.003	1.003	0	-1.291	-1.291	0	142	323.512	324.001	11.736
017	WT	1.001	1.001	0	0.782	0.782	0	176	324.397	325.04	15.432
018	WT	1.018	1.0162	0.0084	-0.144	-0.1335	0.5185	298	325.011	326.042	24.744
019	WT	1.0235	1.025	0.0074	0.742	0.5773	0.9084	239	326.047	326.875	19.872
020	WT	1.02	1.02	0	0.233	0.233	0	57	326.88	327.075	4.68
023	WT	1.019	1.0201	0.0034	-0.216	-0.2374	0.3661	227	327.298	328.083	18.84
024	WT	1.025	1.0234	0.0051	0.043	0.0032	0.1678	290	328.089	329.092	24.072
<b>026</b>	<b>BT</b>	<b>1.0236</b>	<b>1.0229</b>	<b>0.0028</b>	<b>-0.4244</b>	<b>-0.1259</b>	<b>0.5767</b>	<b>14</b>	<b>329.266</b>	<b>329.311</b>	<b>1.08</b>
027	WT	1.0235	1.025	0.0057	-0.189	-0.2935	0.6117	299	329.317	330.353	24.864
<b>028</b>	<b>BT</b>	<b>1.0834</b>	<b>1.083</b>	<b>0.0287</b>	<b>1.7406</b>	<b>1.8131</b>	<b>0.9483</b>	<b>14</b>	<b>330.417</b>	<b>330.462</b>	<b>1.08</b>
<b>039</b>	<b>BT</b>	<b>1.0242</b>	<b>1.0403</b>	<b>0.0284</b>	<b>0.1987</b>	<b>0.592</b>	<b>0.7946</b>	<b>29</b>	<b>330.509</b>	<b>330.607</b>	<b>2.352</b>
<b>040</b>	<b>BT</b>	<b>1.0198</b>	<b>1.0193</b>	<b>0</b>	<b>0.0372</b>	<b>0.0792</b>	<b>0.426</b>	<b>19</b>	<b>330.611</b>	<b>330.674</b>	<b>1.512</b>
<b>047</b>	<b>BT</b>	<b>1.0182</b>	<b>1.0185</b>	<b>0.0021</b>	<b>-0.0831</b>	<b>-0.0788</b>	<b>0.1138</b>	<b>237</b>	<b>332.824</b>	<b>333.644</b>	<b>19.68</b>
047	WT	0.997	0.997	0.0099	-0.1675	-0.1675	1.0769	237	332.824	333.644	19.68

Table 4.3 Calibrations derived from the CODAS processing. **BT** indicates bottom tracking mode, and **WT** indicates water tracking.

#### 4.6.2 CODAS processing quick summary

Below is a summary of the processing steps. [UH HTML documentation in /local/users/pstar/cruise/sw/uh\_adcp/programs/adcp\_doc/index.html]. If an OS150 is used instead of an O75 then substitute '150' for '75' throughout.

Steps 3-4 and 6-9 below have been bundled into unix scripts "script3-4" and "script6-9" under /local/users/pstar/cruise/data/vmadcp/jr195\_os75/

1) Create once at start of cruise (done for JR195 os75)

~/data/vmadcp/jrCCC\_os75

~/data/vmadcp/jrCCC\_os75/rawdata

where CCC is cruise number eg 195

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

copy raw data files (ENX, N1R, etc) from /mnt/current/adcp (or where-ever the ADCP VMDAS system puts them) into

/local/users/pstar/cruise/data/vmadcp/jrCCC\_os75/rawdata

file names like OS75\_JR195NNN\_000000.ENX

NNN increments each time the ADCP logging is re-started. **Should stop and start once per day (any time is OK).**

the 000000 increments each time a new file is started, when the previous one reaches 10 Mb.

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

3) **cd ~/data/vmadcp/jrCCC\_os75**

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

**vmadcp\_movescript**

redistributes raw data from rawdata to rawdataNNN; rawdataNNN is created if necessary. (may need to edit movescript so that it parses the file names correctly)

4) **adcp.py jrCCCNNNnbex --datatype enx**

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

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

# q\_py.cnt is

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

--yearbase **2009**

--dbname **jr195026nnx**

--datadir /local/users/pstar/cruise/data/vmadcp/jr195\_os75/rawdata026

#--datafile\_glob "\*.LTA"

--datafile\_glob \*.ENX

--instname os75

--instclass os

--datatype enx

--auto

--rotate\_angle 0.0

--pingtype nb

--ducer\_depth 5

#--verbose

# end of q\_py.cnt

# end of q\_py.cnt

At the start of the cruise check **yearbase**, **dbname**, **os75** or **os150** and datatype **enx** (**glob ENX**). Dbname should be of form jrCCCNNNPTT where P is n for narrowband, b for broadband. The instrument should be operated in narrow unless there is a good reason to choose

broad. TT is “nx” for ENX; “ns” for ENS; “nr” for ENR; “lt” for LTA; “st” for STA. Standard processing is to process ENX. As far as I can tell, dbname must not exceed 11 chars. So if we use 9 for jr195NNNn, there are only two left to identify ENX, ENS, LTA, STA

6) still in directory ~data/vmadcp/jr195\_os75/jr195003nbenx

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

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

7) To see the BT (bottom track) or WT (water track) calibration, look at the ascii output of jr195NNNnbenx/cal/\*/\*out (note that a calibration is not always achieved, for example if the ship has made no manoeuvres while the ADCP is in water tracking mode, so there may be no \*out file).

8) To access data in Matlab

**matlab &**

**>> m\_setup**

**>> codaspaths**

**8a)** can manually clean up data by applying flags to suspected bad data cycles. This can be done post-cruise, i.e. step 8a can be omitted.

**>> cd data/vmadcp/jr195\_os75/jr195NNNnbenx/edit**

use

**>> gautoedit**

to clean up data. Select day and step (typically 0.1 or 0.2 days) to view, then "show now". "show now" may have to be done twice to get the surface velocity plot. "show next" to step through the file. "Del bad times" sets "bad" flags for a section of time, or for a whole profile. "rzap" allows single bins to be flagged. Note that "list to disk" must be clicked each time for the flags to be saved.

use run\_agetmat to access 5-minute averages of data; see

**>> help run\_agetmat**

eg

**>> cd /local/users/pstar/copy\_nosea1/jr195/data/vmadcp/jr195\_os75/jr195NNNnbenx**

**>> [alldata,config]= run\_agetmat('ddrange', [-10 400], 'editdir', 'edit');**

9) To get data into MSTAR:

**>> cd /local/users/pstar/cruise/data/vmadcp/jr195\_os75/jr195NNNnbenx**

**>> mcod\_01**

produces output file

os75\_jr195NNNnnx.nc

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

**>> mcod\_02 [reply os75\_jr195NNNnnx]**

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

10) This step does not apply on JCR. It mainly applies to the Discovery.

11) Applying edits identified in gautoedit - **must have done step 8a FIRST!**

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

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

where q\_pyedit.cnt contains

# q\_pyedit.cnt is

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

--yearbase 2009

--steps2rerun apply\_edit:navsteps:calib:matfiles

```
--instname os75
--auto
# end of q_pyrot.cnt
```

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

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

```
# q_pyrot.cnt is
## comments follow hash marks; this is a comment line
--yearbase 2009
--rotate_angle -0.5644
--rotate_amp 1.0038
--steps2rerun rotate:navsteps:calib
--auto
# end of q_pyrot.cnt
```

## 5. SCS UNDERWAY DATA AQUISITION

*Ben Moat*

### 5.1 Underway data acquisition using the SCS system

The underway data are logged in ascii scs files located under:

jrlb.jcr.nerc-bas.ac.uk:/san/datavol/data/cruise/jcr/current/scs/Compress/

which is a mount point on NOSEA2 (/mnt/...), linked by:

/local/users/pstar/jr195/data/scs\_raw/

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

```
unix> sedexec_stopall
```

```
unix> sedexec_startall
```

This will restart all the sed scripts and create the /data/scs\_sed/\*ACO files from scratch from the beginning of the cruise. It will take a while to 'catch up' if parsing a whole cruise of data. But sed is very quick.

The files in /data/scs\_sed are versions of the ACO files with commas, colons, characters, etc removed, so they are plain numerical files that can be loaded into Matlab. To check that sed is running use

```
unix> top
```

and watch for sed entries appearing every 10 seconds or so. If no sed is present then start and stop the sed scripts using the commands shown above.

In order to make loading subsets of files acceptably fast in Matlab, the scs\_sed/\*ACO files are converted to Matlab. The results are located in:

/local/users/pstar/jr195/data/scs\_mat/\*mat.

Before running the daily processing, go into Matlab and type

```
matlab>>update_allmat
```

which will update all the mat files. Some of the scripts that access SCS files (eg msposinfo) automatically run the Matlab update first.

```
matlab>>mday_00('oc1',jday)
```

will convert the ascii scs data into MSTAR format for the jday specified. To make life really easy,

```
matlab>> mday_00_get_all(200)
```

runs mday\_00 for day 200 on a bunch of variables. So this is a one-stop-shop for all the day's data. mday\_00\_get\_all should be edited to include/exclude variables of interest.

The underway raw and processed data will be contained in the following directories:

```
/local/users/pstar/jr195/data/surfmet/
```

```
/local/users/pstar/jr195/data/oc1/
```

```
/local/users/pstar/jr195/data/sim/
```

```
/local/users/pstar/jr195/data/nav/gyros
```

```
/local/users/pstar/jr195/data/nav/seapos
```

```
/local/users/pstar/jr195/data/nav/ash
```

Appendix C.1 details the daily processing schedule.

## 5.2 Tar file archive on NOSEA2

Tar file archives should be done at the start of the cruise and regularly thereafter.

```
nosea2>cd /local/users/pstar/cruise/data/archive_mnt
```

make a directory with today's date e.g.

```
nosea2>mkdir 25_11_2009
```

```
nosea2>cp -irp /mnt/20091112/* .
```

20091112 will change depending on the start date of the cruise. List the directory and see what the "current" link points at;

```
nosea2>cd
```

Create a tarfile with today's date in the filename

```
nosea2>tar cvf jr195_25_11_2009.tar ./jr195
```

The external disk can only hold a maximum of 4GB in a single file. Therefore to backup the data to external disk or archive the data at the end of a cruise you will have to create multiple tar files (<4 GB) and transfer them across to the external disk. E.g.

```
>tar cvf all.tar ctd DEL docs exec ladcp mexec mexec_processing_scripts MJYtest nav ocl other  
scs_mat scs_raw scs_sed scs_setup_files sim surfmet templates vmadcp
```

```
>bzip2 all.tar
```

## 5.3 Backup to a mac or external drive

Create a directory where you would like to back the data up and go to that directory. Use the following to transfer the data across:

## 6. SURFACE METEOROLOGICAL SAMPLING SYSTEM

*Ben Moat*

### 6.1 Introduction

The surface meteorological conditions were measured throughout the cruise. A brief discussion of the performance of the meteorological sensors is given in this section. All times refer to GMT.

### 6.2 Instrumentation

The RRS *James Clark Ross* was instrumented with a variety of meteorological sensors to measure; air temperature and humidity, atmospheric pressure, short wave radiation (TIR), photosynthetically active radiation (PAR) and wind speed and direction. These are logged as part the 'oceanlogger' and 'met' systems at 2 second intervals. The oceanlogger also recorded the underway salinity and sea surface temperature. These data will be discussed separately in Section 7.

The meteorological instruments were mounted on the ship's foremast (Figure 6.1) in order to obtain the best exposure. The estimated heights of the instruments above the foremast platform were: Sonic anemometer, 0.65 m; air temperature and humidity 0.25 m and the irradiance sensors 0.2 m. The barometers were located in the ocean logger display cabinet in the UIC.

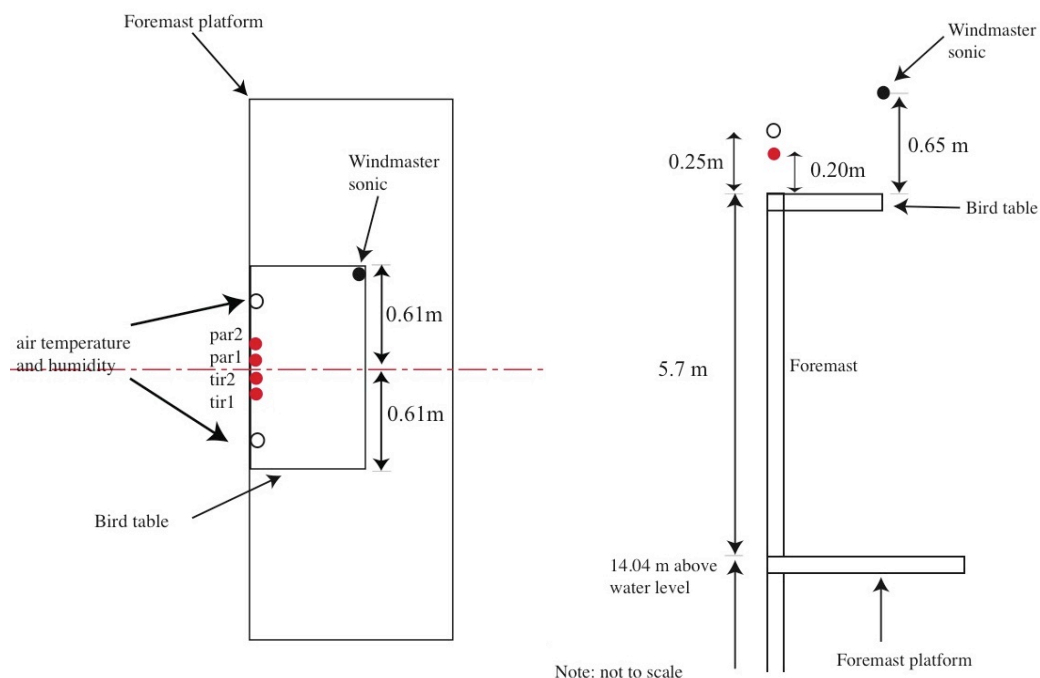


Figure 6.1 Schematic of the sensor positions on the foremast: left - plan view; right - side view

### 6.3 Routine processing

Please refer to Appendix C.1 for the daily processing guide.

matlab>>mday\_00\_get\_all.m.

transferred from the on board logging system (scs) to the UNIX system on a daily basis.

The raw calibrated wind speed data files were located on NOSEA2 under:  
/local/users/pstar/jr195/data/surfmet/met\_jc031\_d\*\*\*\_raw.nc  
where \*\*\* represents the day number.

```
matlab>>mday_clean_all
```

All data outside the following ranges were set to absent:

Air temperature: -50 to 50 degreesC

Humidity: 0.1 to 110 %

TIR: -50 to 1500

PAR: 0.0001 to 50

These values are written into the script which can be edited using

```
matlab>>edit mday_clean_all.m
```

This script also calculates the difference between successive times, and stores it as the variable "deltat". If deltat values are less than 2 then repeated or backward time jumps may be present. Investigate and remove using mdatpik. Deltat values of zero must be investigated and removed.

The daily data file was plotted and any outliers were interactively selected and set to absent data values. This method is used to plot all data stream and is described in detail in Appendix C.

```
matlab>>!mv met_jc031_d***_edit.nc met_jc031_d***.nc
```

```
matlab>> mday_02_run_all
```

Appends all the new daily files to the main cruise file. This will be met\_jr195\_01

```
matlab>>bestnav_all
```

The navigation data required to calculate the true wind speed and direction are calculated.

Note: the daily navigation file pos\_jr195\_01.nc must exist and be up to date. See Appendix C.1 for the daily processing schedule.

```
matlab>>mtrue_01
```

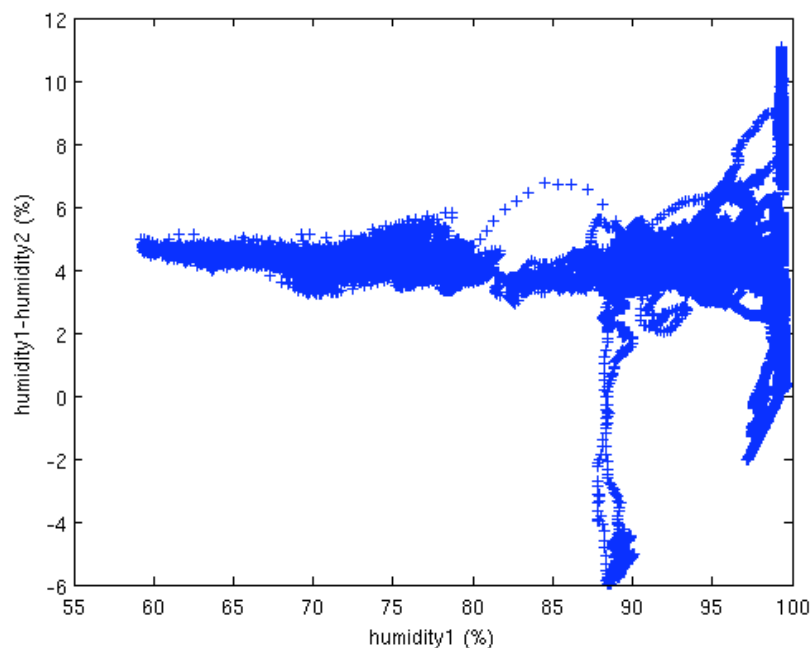
calculates the true wind speed and direction. The wind direction is defined as the direction the wind is going to, rather the meteorological convention of direction coming from.

## 6.4 Sensor performance

**Air temperature and humidity:** Two air temperature and humidity sensors were located on the bird table at the top of the foremast platform.

```
matlab>>ocl_jr195_diff
```

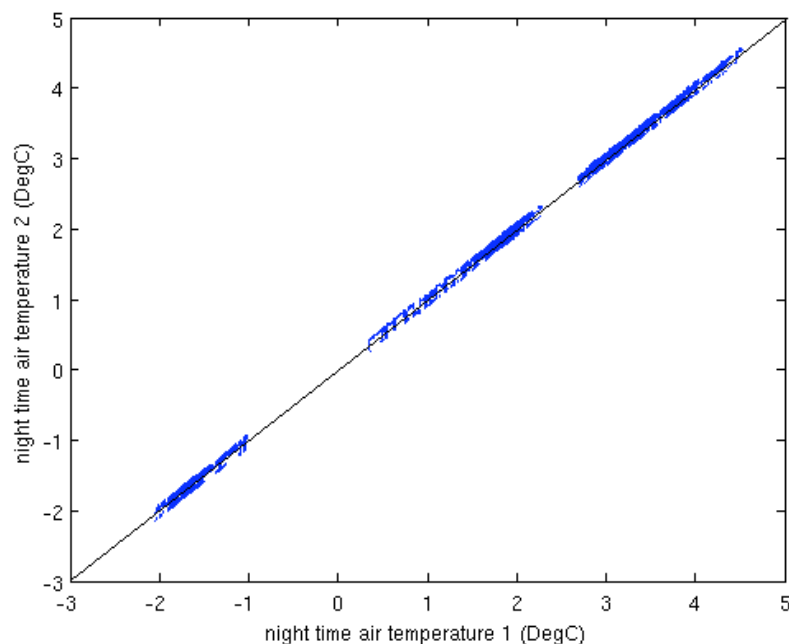
will produce the differences between pairs of instruments. The script produces ocl\_jr195\_01\_diff.nc and only selects night time air temperatures in ocl\_jr195\_01\_air\_night.nc. Night time air temperatures are used to remove any heating effects of the ship from the comparison. Night time is defined as a TIR value  $< 0 \text{ W/m}^2$ .



*Figure 6.2 The difference between the humidity sensors*

Figure 6.2 shows that the difference between humidity sensors is about 4% for relative humidities less than about 90%. For higher humidities the difference between the two sensors becomes very variable.

Airtemp2 was found to be very noisy throughout the cruise. The instrument suffered repeated drop outs of 0.2 degC. To reduce the noise in the data, all temperature data from sensor airtemp2 that were outside  $\text{abs}(\text{airtemp1} - \text{airtemp2}) > 0.1$  were set to absent in the mday\_00\_clean\_all script. A variable called airtemp2\_cln was produced. This feature will need to be removed from the script for future cruises. Figure 6.3 shows that after automatically removing most of the drop outs, the mean difference ( $\text{airtemp1} - \text{airtemp2}$ ) between night time data from the air temperature sensors was -0.016 DegC, s.d. 0.04386. However, it is recommended that air temperature sensor 2 be replaced.



*Figure 6.3 comparison of night time air temperatures.*

**Wind speed and direction:** The windmaster sonic anemometer was located on the bird table. Only data from one anemometer was logged so no comparisons with other anemometers were made. There were no obvious instrument problems during the cruise.

**TIR and PAR sensors:** The ship carried two total irradiance sensors TIR1 and TIR2 on the bird table. These measure downwelling radiation in the wavelength ranges given in Table 6.1. A comparison of the TIR short-wave sensors showed that TIR1 was slightly high compared to TIR2, but the mean difference in the measured short-wave values were below  $1.75 \text{ W/m}^2$  (standard deviation  $5 \text{ W/m}^2$ ). During darkness the TIR sensors had a very small  $-0.5 \text{ W/m}^2$  offset. In addition to the TIR sensors the ship carried two PAR sensors which measured downwelling radiation. The mean difference between the two PAR sensors was  $0.3 \text{ W/m}^2$  s.d.=13.87.

Calibration sheets provided suggested that the calibrations of PAR2 may have been applied to PAR1, and vice versa, and similarly suggested that the calibrations for TIR1 and TIR2 may also have been swapped. Therefore on the 30/11/09 an attempt was made to check the serial numbers of the radiation sensors on the bird table. Unfortunately, no serial numbers or calibration info was visible on the sensors, and the labels as to which sensors was PAR/TIR 1/2 were too faded to read properly. Figure 6.4 shows a photo taken from the starboard side of the platform. The starboard sensor label showed "1" - PAR/TIR was not visible. Second sensor from port showed label "PAR" but no visible number. Manually shaded each sensor, starting from starboard and working across to port - time about 2105 or 2110 GMT. Data showed that from stbd to port, the sensors are TIR1, TIR2, PAR1 and PAR2 - the first 3 showed a dip in radiation when covered, but the last one showed no dip at all. Either it was not covered properly or it did not respond for some reason. The serial numbers may be visible if the sensors are removed, or if the junction box is opened up, but all was sealed up well, so it was not thought wise to do this just before leaving the ship. This can be done when the ship is in the UK.

The difference in calibrations for the PAR sensors would only change the output data by about 1.5%, but for the TIR sensors the difference would be about 4% and would act to reduce the relative overestimate seen in the TIR1 data.

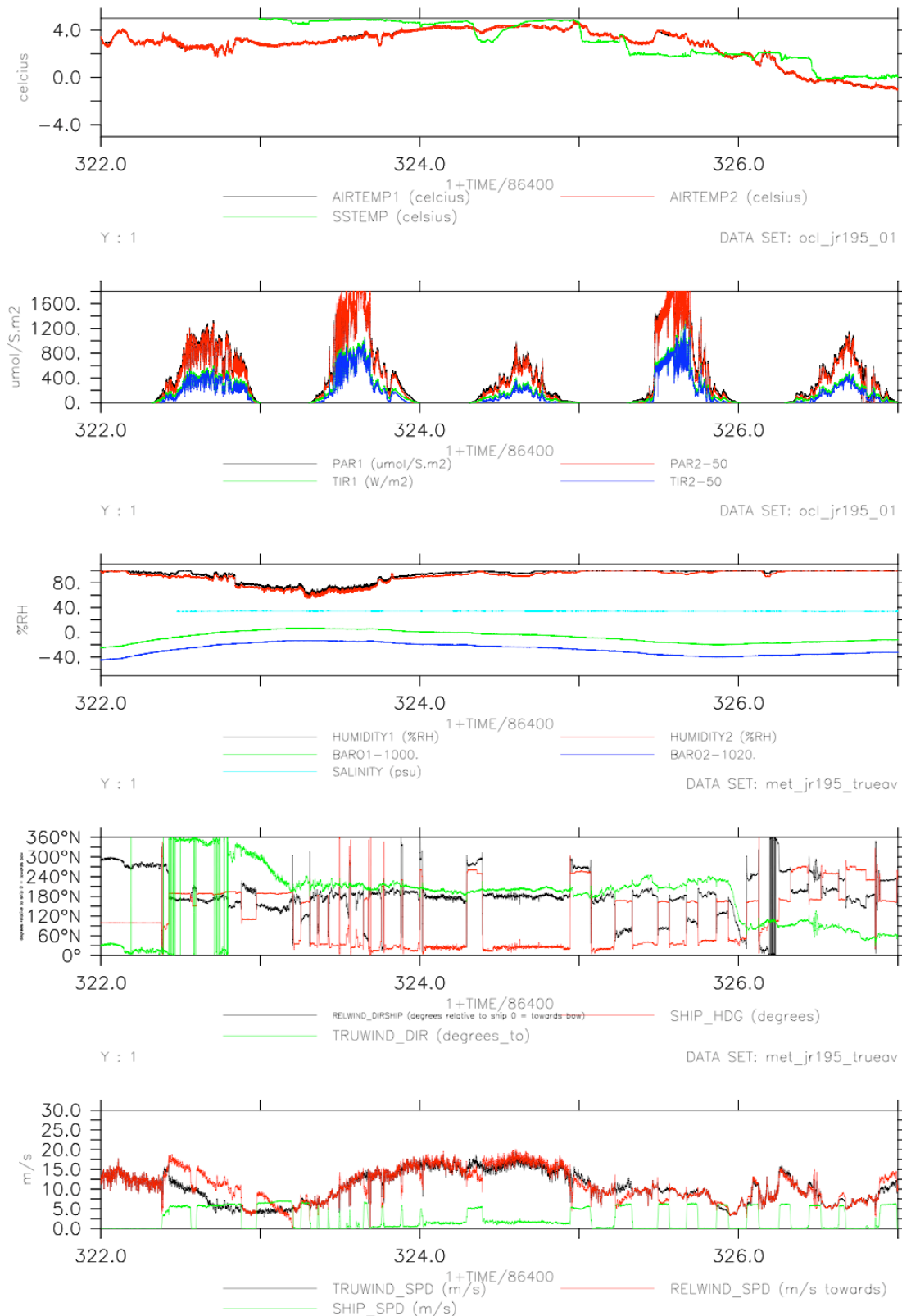


*Figure 6.4 The radiation sensors located on the bird table of the foremast platform.*

Instrument	Serial number on instrument	Serial number on cal sheet	Calibration in oceanlogger $Y=C0+C1*X$	Correct calibration in ocean logger?	Sensor position	Parameter (specified accuracy)
Airtemp1 Rotronic MP103A	not visible	15619015	$C0=-40$ $C1=100$	yes	Foremast	Humidity $\pm 1.0\%$ Temperature $\pm 0.3^{\circ}\text{C}$
Airtemp2 Rotronic MP103A	not visible	60000120	$C0=-40$ $C1=100$	yes	foremast	Humidity $\pm 1.0\%$ Temperature $\pm 0.3^{\circ}\text{C}$
PAR1 Kipp and Zonen SP PAR Lite (400 – 700nm)	not visible	990069	$C1=1/(4.97 \times 10^{-3})$	No Cal sheet: $C1=1/(5.04 \times 10^{-3})$	foremast Port side	$\pm 2\%$
PAR2 Kipp and Zonen SP PAR Lite (400 – 700nm)	not visible	990070	$C1=1/(5.04 \times 10^{-3})$	No Cal sheet: $C1=1/(4.97 \times 10^{-3})$	foremast Port side	$\pm 2\%$
TIR1 Kipp and Zonen SP Lite (335 to 2200nm)	not visible	990684	$C1=1/(73 \times 10^{-3})$	No Cal sheet: $C1=1/(76 \times 10^{-3})$	foremast Starboard side	$\pm 0.14 \mu\text{V/W/m}^2$
TIR2 Kipp and Zonen SP Lite (335 to 2200nm)	not visible	990685	$C1=1/(76 \times 10^{-3})$ ?	No Cal sheet: $C1=1/(73 \times 10^{-3})$	foremast Starboard side	$\pm 0.14 \mu\text{V/W/m}^2$
Vaisala PTB210 Atmospheric pressure	V145002	V145002	No calibration applied by oceanlogger	No information	UIC In ocean logger cabinet	$\pm 0.01$ Hpa
Vaisala PTB210 Atmospheric pressure	V145003	V145003	No calibration applied by oceanlogger.	No information	UIC In ocean logger cabinet	$\pm 0.01$ Hpa
Windmaste sonic anemometer	No information	No information	No information	No information	Foremast	Wind speed: 1.5% Direction: 2 to 4°

*Table 6.1: Meteorological instrument details*

Figure 6.5 gives the time series of the mean meteorological data. Only basic quality control criteria have been applied to these data. Each page contains five plots showing different variables over a four or five day period.



**Figure 6.5a** Meteorological data for days 322 to 327. **Top panel** - the air temperatures and the sea surface temperature. **Upper middle panel** - downwelling radiation from the two shortwave TIR and PAR sensors. **Central middle panel** - Atmospheric humidity and the atmospheric pressure. **Lower middle panel** - relative wind direction (relld = 180 degrees for a wind onto the bow) and true wind direction. Note: the wind direction is degrees to, not the usual convention of degrees from. The ship's heading is also shown. **Bottom panel** - relative and true wind speeds in m/s from the anemometer. The ship's speed over the ground is also shown in m/s.

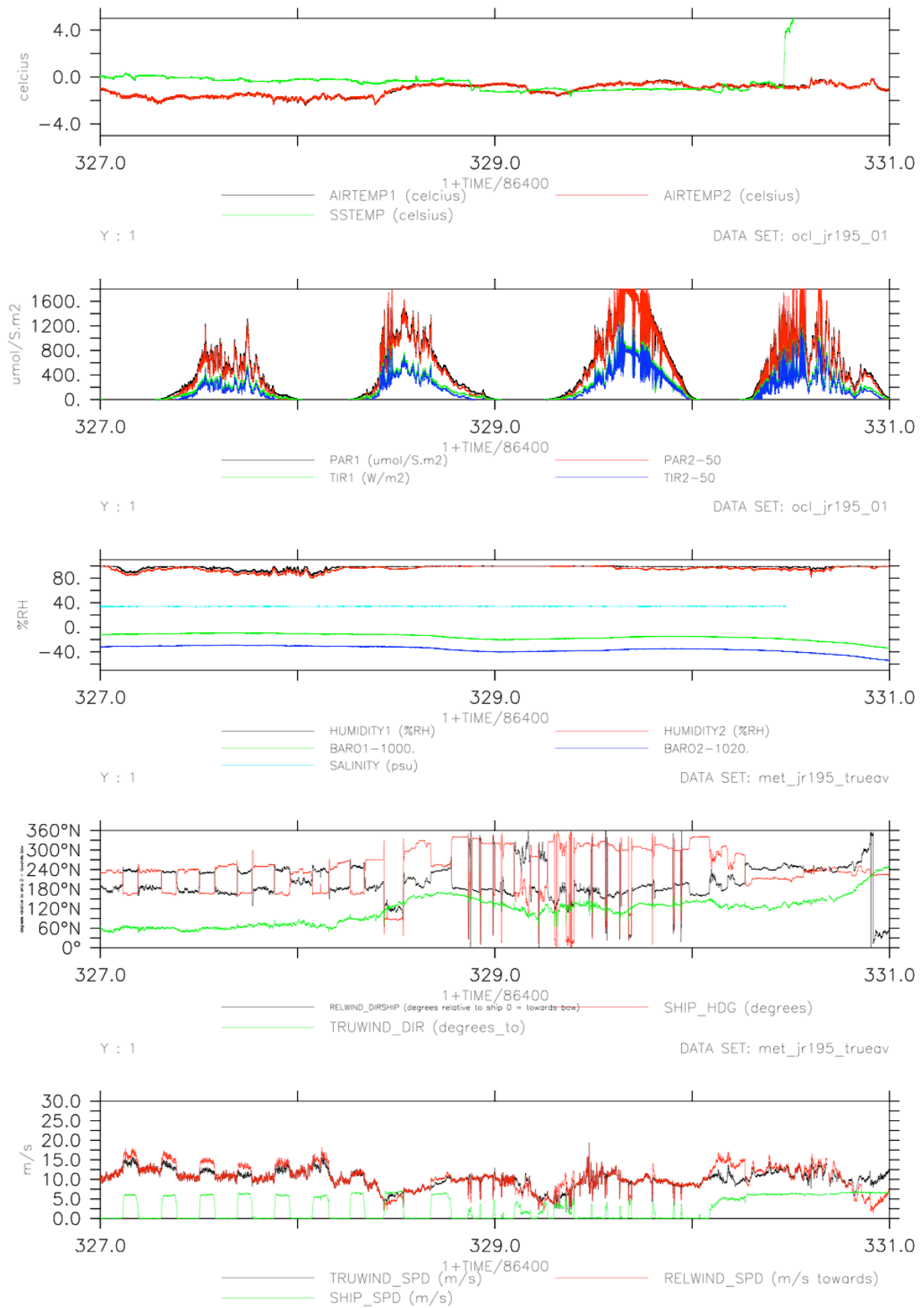


Figure 6.5b. As figure 6.5a but for days 327 to 331

## 7. UNDERWAY TEMPERATURE AND SALINITY

*Ben Moat*

### 7.1 Introduction

Near surface oceanographic parameters were measured by sensors located on the non-toxic supply. These included a Fluorometer which measures fluorescence and a SBE45 thermosalinograph measuring conductivity and water temperature at the point it reaches the instrument. The salinity was calculated in real time using the SBE45 housing temperature and conductivity measurements. The sea surface temperature (SST) was measured by a PRT100 temperature sensor located close to the non-toxic supply intake on the hull at a depth on 6m. See Table 7.1 for serial numbers etc. The SST and salinity are recorded in the oceanlogger file, see Appendix C.1 for routine processing. This section describes the calibration the underway temperature (Section 7.3) and salinity (Section 7.4) measurements using underway bottle measurements of salinity, and SST and salinity measurements from the near-surface CTD data (Section 7.2).

### 7.2 Selecting surface CTD data

SST and salinity measurements were selected at 5 and 7 dbar from the 2db average CTD file. These were accessed using the script:

```
matlab>>ctd_05
if you have a data from number of stations to read in, put a loop around ctd_05. e.g.
matlab>>for stn=1:30
matlab>>ctd_05
matlab>>end
files ctd_jr195_'station number'_surf.nc are created in ./data/ocl/
Now we need to create one file of data so we append them together using:
matlab>>mapend
Now we need to create a 1minute average file of the underway data using.
>>mavрге
Name the output file ocl_jr195_01_1min.nc
Merge the 1 minute averages onto the ctd_jr195_1_30_surf file using
>>mmerge
```

### 7.3 Calibration of underway sea surface temperature

The SST measurements were compared to the surface temperature measurements from the primary (temp) and secondary (temp1) sensors on the CTD frame. Figure 7.1 shows that the remote temperature underestimates the CTD measurements by less than 0.1 degC. The offset was represented by the following linear regression:

$$\text{offset} = -1.945 + 0.0058437 \times \text{jday}$$

The scatter in the data for cast 28 on jday 329 is believed to be from a localised surface feature that was not measured by the underway SST system. The data from this cast was not included in the regression representing the sst and salinity offsets.

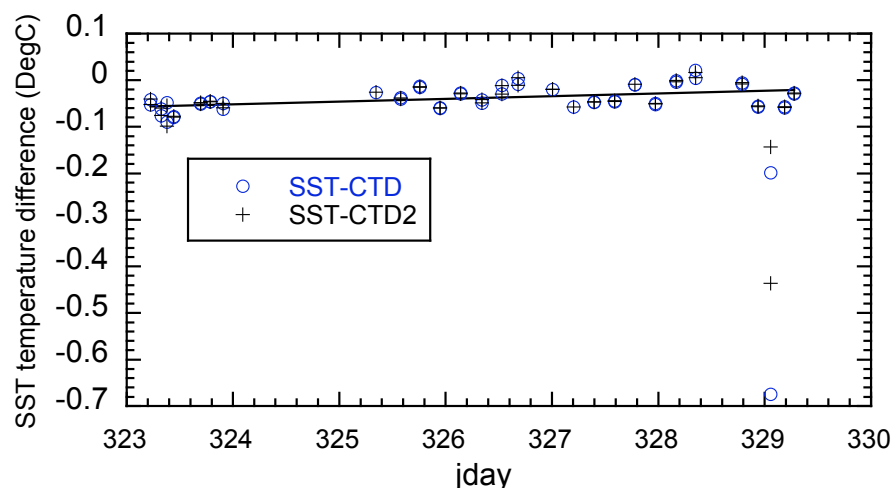


Figure 7.1 The difference between the surface SST measurement and the surface CTD temperature measurements from two sensors.

## 7.4 Calibration of underway salinity data

### 7.4.1 Introduction

Two approaches were taken towards the calibration of the underway salinity data. The salinities measured by the SBE45 were compared with; 1) salinity samples collected from the non-toxic water supply outflow, and 2) the surface salinities measured from near surface CTD. The uncorrected surface salinities from the CTD were used in this analysis. This is believed to be acceptable as the usual correction to be applied to the measured surface CTD salinities will be of the order 0.01, whereas the correction for the SBE45 will be of the order 0.1.

Water samples were collected approximately every 4 hours. Water was taken from the blue outflow pipe from the SBE45 in the prep lab. The sample bottles were filled to half-way up the shoulder and the necks were wiped dry to prevent salt crystallisation at the bottle opening. The bottles were closed using airtight single-use plastic inserts and secured with the original bottle caps. The samples were stored in open crates and left beside the salinometer in the bio lab for a minimum of 24 hours before analysis. This allowed their temperature to adjust to the ambient temperature of the laboratory. A total of 35 TSG samples were taken over the duration of the cruise.

The conductivity ratio of each sample was measured by the Autosol salinometer (Section 10). The conductivity ratios were recorded and salinity was calculated using a Microsoft Excel spreadsheet. The measured salinities of the samples were transferred to a text file, along with the date and time of collection. This file was converted to MSTAR format, and the dates and times were converted into seconds since midnight on 1<sup>st</sup> January 2009. Another method for the calibration of the underway salinity is to use the surface salinity values from the near surface CTD casts. In total 30 out of the 32 stations were used in the analysis.

### 7.4.2 Underway salinity compared to surface CTD measurements and bottle samples

The salinity difference between the underway salinity and the CTD is contained in the file created in Section 7.2. The difference between the underway bottles and the underway salinity are calculated using:

```
matlab>>tag_00_botmerge
```

It is useful to create a text file to import into kaleidagraph for plotting. To do this use:

```
matlab>>d=mload
```

```

matlab>>bot_tsg_jr195_diff
matlab>>y=[d.jday d.botpsal d.salinity d.sstemp d.sal_m_botpsal]
matlab>>fid=fopen('bot_tsg_jr195_diff.txt','wt')
matlab>>fprintf(fid,'%12.6f %12.6f %12.6f %12.6f %12.6f\n',y')
matlab>>fclose(fid)

```

Figure 7.2 shows that the SBE45 underestimated the salinity from the combined bottle and near surface CTD measurements by:

$$\text{offset} = 0.42472 - 0.0013765 \times \text{jday}$$

and was corrected accordingly using

```
matlab>>mcalib
```

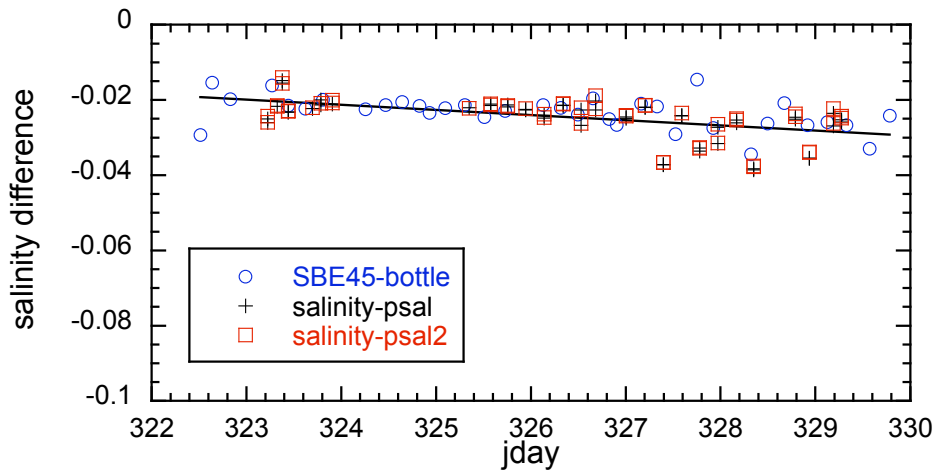


Figure 7.2 The salinity difference SBE45 - CTD or bottle sample.

## 7.5 Residuals

After the salinity and SST data were corrected, the procedure above was repeated to calculate the residuals, i.e.  $\text{SBE45}_{\text{corrected}} - \text{CTD}$  and  $\text{SBE45}_{\text{corrected}} - \text{BOTTLE}$ . Figure 7.3 shows the salinity residuals were within  $\pm 0.01$ . Figure 7.4 shows that the SST residuals are within  $\pm 0.05$ .

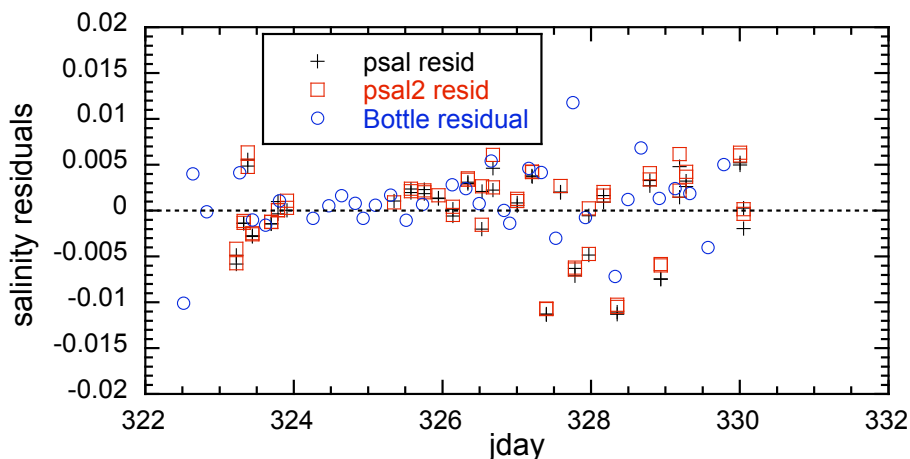


Figure 7.3 The SBE45 residuals after correcting the salinity data.

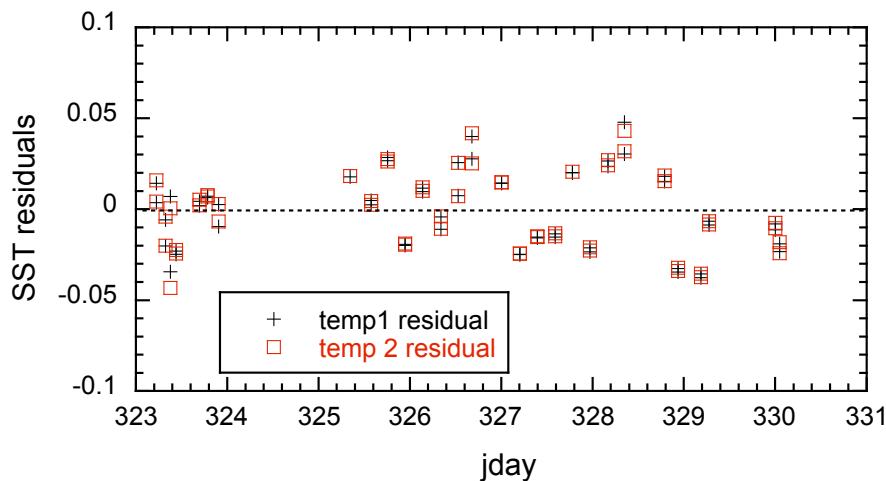


Figure 7.4 The SST residuals after correcting the salinity data.

Instrument	Serial number	Calibration $Y=C0+C1*X$	Sensor position	Parameter (accuracy)
Remote temperature SST	PRT100 RS 455-4056	$C1=1$	Near intake	Sea surface temperature
10-AU Fluorometer	No serial number visible	unknown	prep lab	Fluorescence
SBE45 Micro TSG	4532920-0072	unknown	prep lab	conductivity, temperature

Table 7.1: Underway SST and salinity instrument details.

## 8. NAVIGATION

*Ben Moat*

### 8.1 Instrumentation

#### 8.1.1 Seapath system

A Seapath 200 system is used on the ship. The data are logged via the ‘seatex’ scs data stream at 1Hz. In addition to position the Seapath system outputs heave and roll via the seatex-psxn.ACO files. Unfortunately, there is no indication of which channels are which. The main system for measuring pitch and roll is the tsshrp system. This system was not operational during this cruise as it is currently being repaired. Heave sensors from both systems are located in the grav room. Heading from the Seapath system was not contained within the MSTAR data during this cruise. The data from this system are contained in ./nav/seapos

#### 8.1.2 Ashtech

The Ashtech used to be the primary system for obtaining the most accurate measurement of the ship’s heading and has been replaced by the Seapath and tsshrp systems. Accurate heading is required by the ADCP systems on the ship. The data from this system are contained in ./nav/ash

### 8.1.3 Ship's Gyro

The ships gyro on the bridge was logged via the scs data stream as 'gyros at 1Hz'. The data were used to remove any large outliers in the Ashtech system. The data from this system are contained in ./nav/gyros

## **8.2. Routine processing**

### 8.2.1 SEAPATH

Data were transferred daily from the SCS system using:

```
>> mday_00_get_all(day)
```

where day is the three figure jday. A file pos\_jcr\_d'jday'\_raw.nc containing the data for the jday specified was created in /local/users/pstar/jr195/data/nav/seapos

The raw daily file contains time (seconds), lat (degrees), long(degrees), inst\_time (HHMM.SS), status(Blank).

```
>>mday_00_clean_all
```

The raw daily file contains; time (seconds), depth (feet), depth (m) and depth (fathoms).

Note the mday\_00\_get\_all script(day) transfers the wind speed data, ocean logger, and navigation data streams as well as the bathymetry data. All these data streams are processed in a similar manner. A table showing the daily processing sequence is in Appendix C.1.

```
>>mday_clean_all
```

Longitudes outside the range of  $\pm 181$  and latitudes outside  $\pm 91$  are set to absent data. This script also calculates the difference between successive times which is stored as the variable deltat. If deltat values are less than 1 then repeated or backward time jumps may be present. Investigate and remove using mdatpik. Deltat values of zero must be investigated and removed. File with suffix 'edit' are produced.

```
>>mplxyed
```

Daily values are plotted and outliers are set to absent if required using the *mplxyed* function. After plotting/cleaning the pos\_jr195\_d'jday'\_edit.nc files must be moved to pos\_jr195\_d'jday'.nc. e.g.

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

### 8.2.2 ASHTECH and GYRO

The gyro data is merged onto the ashtech data and the ash-gyro difference is constructed and the data was cleaned using:

```
matlab>> mash_01
```

The 1 Hz data were merged with the ship's gyro and edited using the following criteria:

Ash	$0 < \text{heading} < 360$
Gyro	$0 < \text{heading} < 360$
Pitch	$-5 < \text{pitch} < 5$
Roll	$-7 < \text{roll} < 7$
Measurement RMS error:	$10^{-4} < \text{mrms} < 0.01$ ,
Baseline RMS error	$10^{-4} < \text{brms} < 0.1$
Astech-Gyro headind	$-5 < \text{a-g} < 5$

### 8.3 Summary

No problems were encountered with the Navigation systems during the cruise.

## 9. ECHO SOUNDER BATHYMETRY

*Ben Moat*

Bathymetry data are measured every 7 seconds by a Kongsberg EA600 single beam echo sounder and are processed daily. The data are transferred from the scs system to MSTAR format using the MSTAR routine:

```
>> mday_00_get_all(day)
```

where day is the three figure jday. A file `sim_jcr_day_raw.nc` containing the data for the jday specified was created in `/local/users/pstar/jr195/data/sim/`

The raw daily file contains; time (seconds), depth (feet), depth (m) and depth (fathoms).

Note the `mday_00_get_all script(day)` transfers the wind speed data, ocean logger, and navigation data streams as well as the bathymetry data. All these data streams are processed in a similar manner. A table showing the daily processing sequence is in Appendix C.1.

```
>>mday_clean_all
```

Depths outside the range of 0.0001 to 12000 m and 0.0001 to 50000 feet are set to absent data. This script also calculates the difference between successive times which is stored as the variable `deltat`. If `deltat` values are less than 7 then repeated or backward time jumps may be present. Investigate and remove using `mdatpik`.

```
>>mplxyed
```

The daily data file was plotted and any outliers were interactively selected and set to absent data values. This is described in detail in Section \* `mplxyed`. NOTE: only the depth in meters has been cleaned up. During periods when the POL team are deploying and recovering Bottom Pressure Recorders (BPR) the EA600 was in passive mode. This is to prevent the EA600 interfering with the release signal set to the BPR. In passive mode the data logged by the scs system will be obviously noisy and should be removed using `mplxyed`. During jday 311 the EA600 was left in passive mode and no data was logged for most of the day. After plotting/cleaning the `sim_jr195_d'jday'_edit.nc` files must be moved to `sim_jr195_d'jday'.nc`. e.g.

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

```
>> mmerge_sim_nav_01
```

The position data from the *seapath* system were merged on the bathymetry data and the corrected depths calculated from the carter tables using `mmerge_sim_nav_01`. This step must be done after the seapos file has been cleaned up. Refer to the daily processing table (Appendix C.1).

```
>> mday_02_run_all
```

appends a number daily of underway files including the bathymetry.

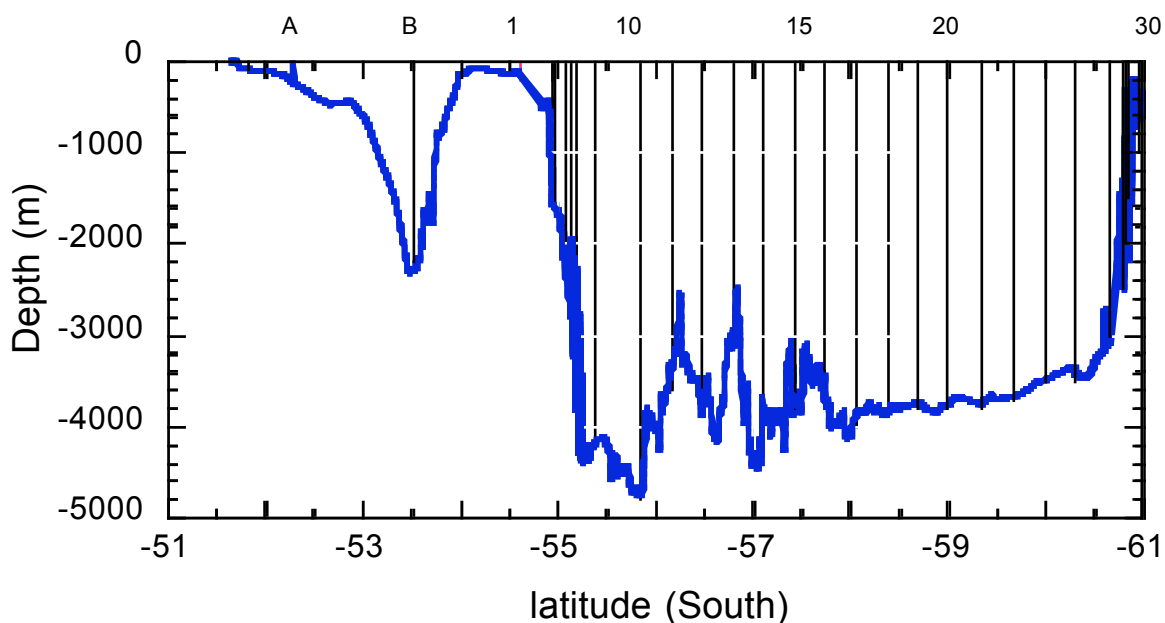


Figure 9.1: Carter corrected depth data for the section from Stanley to Elephant Island. NOTE that station 17 is shown at the nominal position, rather than the actual position 10 nm further North.

## 10. SALINOMETER

Margaret Yelland and Jeff Polton

### 10.1 Introduction.

Two Autosal salinometers were set up in the Bio Lab by Mark Preston (AME) at the end of the previous JCR cruise. The aftermost of the two, serial number 65763, was used throughout JR195. Standard seawater (SSW) batch P150 was used throughout. During mobilisation, the salinometer was set up by adjusting the RS trim knob until the reading agreed with  $2 \times K_{15}$  value of the SSW.

The Bio Lab is not a constant temperature lab, but is surrounded by other labs and is as far from external doors as possible. Initially the salinometer bath temperature was set to 24 degrees and the lab temperature was kept at about 22 degrees. A crate of salinity bottle samples had been obtained from all 24 Niskin bottles from the CTD cast test A. Once these samples had reached lab temperature (being stored there for more than 24 hours), the crate was analysed and used to train one of the science team (Jeff Polton) in use of the salinometer. Part way through this analysis it was noticed that the lab temp was becoming unacceptably high and the analysis was halted. It was not possible at the time to reduce the lab temp to an acceptable level using the thermostat in the lab, so the bath temperature was increased to 27 degrees. A few days later it became difficult to keep the lab temp high enough since the AC heating to the area had been decreased without our knowledge, so the bath temp was once again set to 24 degrees. Each change in bath temperature required the salinometer to be left to come to temperature for 24 hours before re-standardising by adjusting the RS trim knob. Table 10.1 contains the RS values and bath temperatures used throughout JR195.

Later in the cruise it was realised that the lab temp is affected by a thermostat in the bottle annex. This thermostat controls the heating to a different area of the ship, but the air duct that it controls passes through the Bio Lab. In future, this thermostat should be set as low as possible,

making the Bio Lab temperature controllable by the thermostat in the lab. A request to the ship's engineers to not adjust the AC heating without prior consultation would also be advisable.

Table 10.1 also contains the SSW readings obtained at the start and end of each crate of samples, plus the standby and zero values at the start and end. These latter values are an indication of electronic drift: minimal change was observed over the period of the cruise.

By mistake, one crate was analysed using an old bottle of SSW which had been opened and partly used an hour earlier. Even though stoppered, evaporation of the SSW caused its salinity to change by 0.01 PSU: c.f. a desired accuracy of 0.001 PSU. Fortunately the crate affected contained samples from the non-toxic supply rather than the Niskin bottles. In addition, the salinometer behaviour was very stable, which meant that we could assume a measured SSW value equal to  $2 * K_{15}$ , and be confident that this would be within 0.001 PSU of the actual value.

The following sections describe: how to set up the salinometer at the start of a cruise (and who to re-standardise if the bath temperature is changed); the procedure for obtaining bottle samples and how they should be stored; obtaining a stable lab temperature; routine operation of the salinometer once it is set up; and potential problems which can be encountered during routine operation.

date	crate	end - start SSW	RS trim	bath temp	SSW start	SSW end	stndby start	stndby end	zero start	zero end
320	initial standardisation	0	5.1	24	1.99956	1.99956	6010	6010	1	1
324	crate00a-4green	lab temp high	5.1	24	<b>1.99949</b>		6010		-1	
<b>325</b>	crate00b-4green		<b>4.52</b>	<b>27</b>		1.99956	6010		0	
<b>325</b>	crate01-2red	0	<b>4.52</b>	<b>27</b>	1.99956	1.99956		5962	1	1
<b>325</b>	crate02-redyellow	-0.00001	<b>4.52</b>	<b>27</b>	1.99956	1.99955	5962	5962	1	1
327	crate03- 10bluegreen	<b>0.00004</b>	5.1	24	1.99955	1.99959	6010	6010	1	1
327	crate04-Byellow	<b>-0.00005</b>	5.1	24	1.99959	1.99954	6010	6010	1	1
327	crate05-4green		5.1	24	1.99954	<b>OLD SSW</b>	6010	6010	1	1
327	tsg01- 1greenyellow		5.1	24	<b>OLD SSW</b>	<b>OLD SSW</b>	6010	6010	1	0
328	crate06- Aredyellow	<b>0.00008</b>	5.1	24	<b>1.99948</b>	1.99956	6009	6009	0	1
328	crate07-2red	-0.00002	5.1	24	1.99956	1.99954	6009	6009	1	1
330	crate08- 1yellowgreen	0.00000	5.1	24	1.99952	1.99952	6009	6009	0	1
330	crate09- yellowblack	0.00001	5.1	24	1.99952	1.99953	6009	6009/8	1	1
330	crate10-4green	0.00000	5.1	24	1.99953	1.99953	6009/8	6009	1	1
330	tsg02-5blue	0.00002	5.1	24	1.99953	1.99955	6009	6009	1	1

*Table 10.1. Standardisation history of the salinometer used on JR195. Change of lab temp and use of old SSW are highlighted in bold.*

## 10.2 Running the Salinometer (Autosal)

### 10.2.1 Initial setup of the Salinometer.

The salinometer should be set up on the bench in the "bio lab" at least 24 hours before use to allow time for the water bath to equilibrate to room temperature and to perform checks.

Connect the deionised water supply (Millipore) to the tank fill/drain nozzle and run a tube from the tank overflow to the drain/sink - all pipes are push fit. Make sure the tank fill/drain

valve is open and fill the chamber until water runs out of the overflow - tank is about 18 litres. Turn the cell drain knob on bottom left.

Turn off the water supply. Close the tank drain/fill knob and remove the tubing from the nozzle. Making sure the standby/read/zero switch is set to standby, turn on the unit at the mains.

Set the bath temperature to 2-3°C **above** the lab temperature (bath was set to 24°C in the bio lab on JCR193). Both heating lamps in the water bath should come on until the water has come to the right temperature. Once up to temperature, one lamp stays on and the other flashes intermittently to maintain the bath temperature a few degrees above ambient.

The check "check heater" lamp also flashes intermittently, but if it is ALWAYS on then there is a lamp problem.

A short length of tubing should be connected to the cell drain valve. Ideally this should drain into an isolated bucket that it does not touch. The cell drain must not provide an electrical path to ground, nor must it be long enough to cause a siphoning effect out of the conductivity cell (meaning the cell does not fill fully after flushing).

When not in use, the conductivity cell should be filled with deionised water. Flush the cell by placing a finger over the flush hole, until completely drained and no significant flow is coming out of the cell drain tube. Refill. Repeat at least twice.

When filled with deionised water, switch the function knob to read, and turn the suppression knob fully anticlockwise. The readout should be no higher than  $0.0 \pm 0.050$ . When finished with the reading, switch back to standby. Then switch off the pumps, leaving the chamber full.

Note that the **function knob should never be switched to read unless the cell is full**. Doing otherwise can damage the cell, and lead to unstable readings.

### 10.2.2 Initial standardisation

Use RS trim knob to set salinometer so that it reads the same as a standard sea water (with 2 or 3 places in the last digit). Suppression knob will need turning clockwise a long way until the display stops flashing and shows a **positive** reading. This should only be done once at the start of the cruise unless serious problems are encountered. Note that if the display on the salinometer is in ratio, this is twice the value of the standard seawater (marked "k" on the standards). Note SSW should be stored on bench near salinometer so the sample is at lab temp.

### 10.2.3 Taking bottle samples

**Procedure for sampling Niskin Bottles.** - old sample bottles are upside down in the crate, newly filled ones right way up. Protect from contamination by rain/salt (e.g. only put a few stoppers out ready for use each time - use a new small plastic bag each time to prevent the stoppers becoming salty through exposure). Rinse bottles 3 times. Fill to just below neck of bottle - need room to mix the water but want to minimise evaporation into air space.

Once a crate is full, move it in to the Bio Lab (where the salinometer lives). Put the log sheet (Appendix D) in with the crate and **note on it the date and time** it was put in the lab. Samples need to be in the lab at least 24 hrs before analysis so they come to lab temp.

Getting the **lab temp stable** is a balance between the thermostat inside the lab, and an external thermostat in the bottle annex/CTD hanger. The external thermostat regulates temps in the chem lab, but the hot air duct runs through the bio lab and can cause the temp to rise in there uncontrollably. If turning the external thermostat down does not work, ask the engineers to adjust the A/C in that part of the accommodation. A fan in the Bio Lab would help mix the air - large temp gradients seem to exist.

### 10.3 Analysing a crate of samples once the salinometer is set up.

A standard seawater (SSW) sample is run at the start and end of each crate.

If possible run 2 crates back-to-back, using a total of 3 SSW.

**NOTE that a new SSW bottle should be used each time.** We are aiming for 0.001 PSU accuracy, i.e. conductivity display good to 5 in the last digit. Experience of an open SSW bottles showed that after being open for just 1 hour the salinity had increased by 0.01 PSU, i.e. an order of magnitude greater than the accuracy we need.

Make sure that the second digit is noted properly - there were at least two occasions when this digit was wrong and the salinity value was way out.

- 1) Note bottle details, time/date and lab temperature. Get zero and standby value. Work out twice the conductivity "k" ratio shown on the SSW vial label and note on the log sheet (Appendix D).
- 2) **Gently agitate the bottle** to mix out any salinity gradients which can develop in the standards and samples. Don't shake it - this introduces small bubbles.
- 3) Check function knob is on **STANDBY** whenever flushing/filling. If cell is empty at any time when knob is on READ, turn to STANDBY, fill and leave for 1 hr to recover.
- 4) Turn the flow rate on the salinometer to full and leave it there. Switch on the external pump to its first setting and leave it there.\*
- 5) Open the SSW vial and insert the sample intake tube **using a tissue to hold the tube. The tube should be wiped before and after each sample.**
- 6) Fill and flush the cell 3 times.
- 7) Allow the chamber to refill, make sure there are **no bubbles in the cell**, and switch the function knob to READ.
- 8) If the display is flashing adjust the suppression knob until it stops flashing and shows a **positive** reading (usually a suppression of 1.9 for seawater).
- 9) Wait for the reading to stabilise, and note the entire display.
- 10) Switch to '**STANDBY**' and flush and fill the chamber once before the next reading.
- 11) Repeat until 3 consecutive (near) identical readings are obtained. ( $\pm 2$  or 3 in last digit)
- 12) **Run a crate of samples.** Make sure to prevent contamination by wiping the sample tube and try not to touch it with bare fingers. Turn external pump off when swapping samples.
- 13) Again agitate (turn over) the samples and follow steps 6 to 11 in the procedure above.
- 14) **Note any and all problems. For example:**
  - stopper may be missing**
  - neck of bottle crusty with salt**
  - fluff/shrimps floating in the sample - do not use!**
  - anything else...**
- 15) After analysing a sample, put bottle upside down in the crate.
- 16) Once the crate is done, run **another SSW** vial to standardise again,.
- 17) Fill and flush chamber 3 times with **MilliQ de-ionised water**.
- 18) Allow chamber to refill with MilliQ and switch **pumps off**.

19) Note zero and standby again (this is a sign of electrical drift, and should not change by more than  $\pm 5$  in the last digit between standardisations). Note lab temp.

\* The advice re pump flow rates varies a great deal (see notes below). However, having the internal pump on full and the external pump on low has always worked reliably and simplifies the procedure. If very pushed for time the external pump rate can be increased to speed up fill/flush but the advantage is very marginal.

#### **10.4 Potential problems:**

If difficulty is encountered obtaining a stable reading, the external pump can be turned off to prevent the sample running out.

When running the SSW, the salinometer display should be within  $\pm 20$  in the last digits compared to  $2 \times K_{15}$ . If it is more than this the salinometer may need the RS trim knob adjusting but this should be avoided if at all possible - it is best to keep the same RS trim value throughout a cruise.

If large offsets (0.1 PSU or more) are seen in the salinometer/CTD comparison this may be due to the second decimal place in the salinometer readout not being noted correctly. The 1st decimal is usually constant but the second sometimes changes un-noticed by the operator.

Air in cell: The Autosol can be used without an external pump but in this case the internal pumps require an airtight seal to be made around the neck of the sample bottle at the sample intake tube. The external pump removes this requirement, and also allows quicker filling of the conductivity cell. However, a potential drawback is that the external pump requires a longer sample intake tube, and this can harbour bubbles which may significantly affect the conductivity reading. In the absence of an external pump, air can be prevented from entering the cell uptake tube by turning the internal pump to low when the tube was not submerged. The pump was turned to low rather than off completely to prevent water running back down the tube and contaminating the new sample. During JR195 the external pump was left at the low setting at all times. Occasionally small bubbles could be seen entering the cell from the left and entering the first of the 4 arms of the cell. In this case the cell was flushed and re-filled before a reading was taken. Even if bubbles are not noticed, an indication of their presence can be seen in an unusually low (and sometimes wandering) reading.

### **11. COMPUTING SETUP AND SUPPORT**

*Jeremy Robst*

#### **11.1 Personal Computers**

No problems were encountered with the personal computers used during this cruise. The wireless LAN in the UIC was useful for connecting personal laptops to the ships network.

#### **11.2 Netware**

JRNA ran without any faults and no work was required during the cruise.

#### **11.3 Unix**

Most of the scientific processing was done on the NOCS NOSEA2 Linux machine which had been installed on the ship prior to leaving the UK. It was configured to mount the /san/datavol/data/cruise/jcr directory from the central Linux machine, JRLB. This directory

contains all the underway data logged by the ship, and is where the CTD files are copied to from the CTD and VMADCP PCs.

#### 11.4 SCS Logging system / Data logging

v4.2.3 of the SCS logging system was used during the cruise. This is the first cruise this version has been used. The 'compressed' .ACO files are no longer created in a real time by the SCS software, so an additional raw2compress process is run on the central unix server, JRLB. This generally worked very well, with some minor bugs pointed out by Brian King, which have now been fixed. One bug required the recreation of all the .ACO files, this took around 20 minutes for 6 days of cruise data.

Currently v4.2.3 of the SCS is not generating graphs of the logged streams, nor providing 'gauges' of individual variables. The SCS web interface previously developed was used to provide a simple interface to the streams and variables and an effort is underway (though not completed in time for this cruise) to provide graphing capability whilst waiting for more information from NOAA about the SCS graphing programs.

The Ashtech GPS regularly (approx every 5 days) stops outputting heading information and requires power cycling, although this is less important now that the heading data from the Seatex GPS (which does not suffer this problem) is logged.

Date / Time	Event / Reason
2009/11/12 13:52	Data logging started
2009/11/18 20:08	Brian King noticed a bug in the .RAW to .ACO file conversion process, so the conversion was stopped, the ACO files deleted and the conversion rerun, which took ~ 20 minutes for 6 days worth of data.
2009/11/22 11:00	The clock on the SCS server (JCR-SCS-S1) had drifted by about 4 seconds due to a crash of the Tardis time sync program. Tardis was restarted and the time corrected.

*Table 10.2 : Data acquisition events.*

#### 11.5 Network

No problems reported.

## 12. SUMMARY AND RECOMMENDATIONS:

Once the hydrographic equipment was mobilised the JR195 Drake Passage section went very well, despite some unfavourable weather. The equipment all functioned throughout the cruise and the science team worked hard to produce the initial results shown in this report.

An additional initial result (*pers. comm.*, King) is that the estimated total transport measured across the section was 115.0 Sv which compares to an average transport measured from the 15 previous UK cruises of 136.7 Sv (standard deviation of 6.7 Sv).

Some recommendations from the cruise, in no particular order, are;

- Suitable AME technical support staff should be available during mobilisation. This is particularly important for the hydrographic section since there is very little passage time in which to iron out any problems and prepare equipment: everything needs to be made ready prior to the ship sailing.
- We would recommend that both the Seasave and the SBE Data Processing software versions be updated. This is particularly important for oxygen data processing because SeaBird have upgraded the processing software with a hysteresis correction algorithm in their version 7 of the software. The problem was unfortunately discovered too late for this cruise and asking for a software upgrade would have been potentially too disruptive to key CTD operations.
- Data from airtemp2 sensor is noisy. The sensor should be replaced.
- A fan in the Bio Lab would prevent large gradients in air temperature and would make monitoring and regulation of the lab temp easier when using the AutoSal salinometer.
- A graphical display of atmospheric pressure on the oceanlogger PC would be useful. Similarly, a graphical display of wind speed and direction would be good. Both of these would allow weather conditions and trends to be assessed more easily.
- A winch repeater in the CTD hanger / bottle annex would be useful to people working on that deck.
- The underway pCO<sub>2</sub> CASIX system did not work throughout Drake Passage. This system was not requested on the SME for JR195 but will be requested in future.
- Calibrations for TIR1 and TIR2 may need to be swapped. Similarly for PAR1 and PAR2

### 13. REFERENCES

- Bacon, S. and Cunningham, S.A. (eds.) (2005): Drake Passage summary report: Cruises on RRS "James Clark Ross", 1993-2000. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Elephant Island to Burdwood Bank. Southampton, UK, Southampton Oceanography Centre, 151pp. (Southampton Oceanography Centre Cruise Report, 44)
- Bacon, S. and et al, . (2002): RRS James Clark Ross Cruise 67, 19 Nov-17 Dec 2001. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 118pp. (Southampton Oceanography Centre Cruise Report, 38)
- Bacon, S and et al, . (2003): RRS James Clark Ross Cruise 81, 18 Dec 2002-02 Jan 2003. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b – Elephant Island to Burdwood Bank. Southampton, UK, Southampton Oceanography Centre, 86pp. (Southampton Oceanography Centre Cruise Report, 43)
- Cunningham, S. A., (2001): RRS *James Clark Ross* Cruise JR55, 21 Nov – 14 Dec 2000. Drake Passage Repeat Hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island. Southampton Oceanography Centre Cruise Report, No. 35, 75 pp.
- Gersonde, R., (1993): The Expedition Antarktis X/5 of RV *Polarstern* in 1992. Berichte zur Polarforschung, 131, 167 pp.
- Hargreaves, G. W., M.A.M. Maqueda and S. Mack, (2010): RRS James Clark Ross, Leg 1, October 27, 2009 – November 12, 2009, Leg 2, Cruise JR198, November 17, 2009 – November 28, 2009, Sea Level Measurements in the Drake Passage and Southern Ocean. Proudman Oceanographic Laboratory, Cruise Report, No xx, 15 pp
- Hawker, E.J., King, B.A., Sparrow, M. and et al, . (2005): RRS James Clark Ross Cruise 94, 01 Dec-15 Dec 2003. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 56pp. (Southampton Oceanography Centre Cruise Report, 55)
- McDonagh, E.L. and et al, .Hamersley, D.R.C. and McDonagh, E.L. (eds.) (2009): RRS James Cook Cruise JC031, 03 Feb-03 Mar 2009. Hydrographic sections of Drake Passage. Southampton, UK, National Oceanography Centre Southampton, 170pp. (National Oceanography Centre Southampton Cruise Report, 39) (In Press)
- Quartly, G. JR193 in prep
- Quartly, G. JR194 in prep
- Read, J. F., J. T. Allen, P. Machin, G. W. J. Miller, A. I. Morrison, R. T. Pollard and P. G. Taylor, (1993): SeaSoar data collected on RRS *Discovery* Cruise 198 (Sterna) across Drake Passage and in the Bellingshausen Sea. Institute of Oceanographic Sciences Deacon Laboratory, Internal Document, No. 320, 59 pp.
- Roether, W., R. Schlitzer, A. Putzka, P. Beining, K. Bulsiewicz, G. Rohardt and F. A. Delahoyde,(1993): Chlorofluoromethane and hydrographic section across Drake Passage - deep-water ventilation and meridional property transport. *J. Geophys. Res.* 98 (C8): 14423-14435.
- Sparrow, M., Hawker, E.J. and et al, . (2005): RRS James Clark Ross Cruise 115, 01 Dec-19 Dec 2004. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 80pp. (Southampton Oceanography Centre Cruise Report, 56)
- Stansfield, K., Meredith, M. and et al, . (2008): RRS James Clark Ross Cruise 139, 05 Dec-12 Dec 2005. Drake Passage Repeat Hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island. Southampton, UK, National Oceanography Centre Southampton, 72pp. (National Oceanography Centre Southampton Cruise Report, 24)
- Turner, D. R., (1993): BOFS ‘Sterna 92’ Cruise Report, Discovery 198 11/11/92 – 17/12/92. Plymouth Marine Laboratory, Plymouth, UK, 85 pp.
- Williams, A., Hadfield, R.E. and Quartly G.D., (2008): RRS James Clark Ross Cruise 163, 07 Dec-15 Dec 2006. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 80pp. (National Oceanography Centre Cruise Report, 25)

## APPENDIX A. BRIDGE LOG OF SCIENTIFIC OPERATIONS.

Date and Time (GMT)	Start of event	Lat	Lon	Comment
11/18/09 1:48 PM		-52.24704	-57.81933	Vessel stopped in position on D.P. depth 207 meters.
11/18/09 1:50 PM	CTD test A	-52.24704	-57.8194	CTD in water.
11/18/09 1:59 PM		-52.24703	-57.8194	CTD at depth (wire out at 120 meters).
11/18/09 2:10 PM		-52.24703	-57.81939	CTD out of the water.
11/18/09 9:18 PM	CTD test B	-53.50712	-58.1813	On station for CTD.
11/18/09 9:23 PM		-53.50711	-58.1813	CTD deployed. Deep test. Water depth 2347 metres.
11/18/09 10:07 PM		-53.50708	-58.18136	CTD at depth. 2275 metres wire out.
11/18/09 11:15 PM		-53.5071	-58.18133	CTD out of the water
11/19/09 5:15 AM		-54.66653	-58.54543	commenced deploying ctd
11/19/09 5:20 AM	CTD 1	-54.66656	-58.54523	CTD in the water
11/19/09 5:33 AM		-54.66662	-58.54457	CTD all stopped at 376 meters.
11/19/09 5:55 AM		-54.66668	-58.54393	CTD out of the water
11/19/09 7:39 AM	CTD 2	-54.92334	-58.3825	On station for CTD 2.
11/19/09 7:44 AM		-54.92335	-58.38241	CTD deployed. Water depth 549 metres.
11/19/09 8:01 AM		-54.92334	-58.38245	CTD stopped at 566 metres.
11/19/09 8:27 AM		-54.92334	-58.38243	CTD recovered.
11/19/09 8:55 AM	CTD 3	-54.94469	-58.3718	On station for CTD 3.
11/19/09 9:01 AM		-54.94467	-58.37184	CTD deployed. Water depth 1144 metres.
11/19/09 9:27 AM		-54.94467	-58.37185	CTD stopped at 1176 metres wire out.
11/19/09 10:04 AM		-54.94465	-58.37183	CTD recovered.
11/19/09 10:27 AM	CTD 4	-54.96172	-58.36039	On station for CTD 4.
11/19/09 10:32 AM		-54.96174	-58.3602	CTD deployed. Water depth 1620 metres.
11/19/09 11:05 AM		-54.96166	-58.36034	CTD at depth 1589M wire out.

11/19/09 11:44 AM		-54.96164	-58.36031 CTD out of the water
11/19/09 12:05 PM	recover BPR	-54.94566	-58.35978 Vessel on DP for first BPR recovery.
11/19/09 12:08 PM		-54.94566	-58.35982 Hydrophone deployed for easterly BPR of Drake passage north station.
11/19/09 12:12 PM		-54.94569	-58.35981 Released BPR from frame.
11/19/09 12:26 PM		-54.94567	-58.3598 BPR confirmed rising 1000M range.
11/19/09 1:10 PM		-54.94438	-58.34769 BPR alongside. two grappling hooks attached.
11/19/09 1:19 PM		-54.94711	-58.34935 BPR recovered on deck.
11/19/09 1:40 PM	recover BPR	-54.94641	-58.37894 Vessel on D.P. at western BPR Drake passage north location.
11/19/09 1:42 PM		-54.9464	-58.37891 Hydrophone deployed
11/19/09 1:52 PM		-54.94638	-58.37891 BPR released from frame and coming up.
11/19/09 2:44 PM		-54.94965	-58.36208 BPR on deck.
11/19/09 2:57 PM	deploy BPR	-54.94317	-58.35684 In position and on DP preparing for deployment of BPR.
11/19/09 3:02 PM		-54.94306	-58.35684 BPR released and sinking.
11/19/09 3:03 PM		-54.94306	-58.35683 Hydrophone in water.
11/19/09 4:25 PM	CTD 5	-55.07059	-58.2912 Vsl on DP and commenced deploying ctd
11/19/09 4:48 PM		-55.07112	-58.28786 Vsl experiencing 2.5 Knts current in this position
11/19/09 5:15 PM		-55.07252	-58.2777 CTD @ 2055m commence hauling
11/19/09 6:06 PM		-55.07616	-58.25833 CTD on deck
11/19/09 6:48 PM	CTD 6	-55.12063	-58.26383 commenced deploying ctd
11/19/09 7:37 PM		-55.12573	-58.24197 CTD stopped at 2534 metres wire out.
11/19/09 8:58 PM		-55.1349	-58.20947 CTD recovered.
11/19/09 9:36 PM	CTD 7	-55.17234	-58.22795 On station for CTD 7. Heading 025T.
11/19/09 9:42 PM		-55.17289	-58.22602 CTD deployed. Water depth 3026 metres at start. Wind 030T 28 knots. Heading 021T.
11/19/09 10:40 PM		-55.17896	-58.19685 CTD at depth. 3110 metres wire out (approx.)
11/19/09 11:49 PM		-55.18482	-58.16257 CTD7 out the water.
11/20/09 12:31 AM		-55.21427	-58.20579 Vessel on DP for CTD 8 assessing weather situation wind average approx 34kts.
11/20/09 12:50 AM		-55.2178	-58.19402 Vessel off DP waiting for wind to moderate.
11/20/09 7:04 AM		-55.18442	-57.72178 Ship turned back in general direction of station for CTD 8.
11/20/09 9:30 AM		-55.348	-58.33701 Ship heading up towards station. Wind still NNE force 7 and conditions too rough for CTD.
11/20/09 2:47 PM		-55.22572	-57.94749 Vessel Hove to making approx 3 knots on 080 throughout watch.

11/20/09 10:38 PM		-55.1521	-57.29511 Apparent moderation in weather. Ship turned towards station line course over ground 242T.
11/21/09 1:53 AM	CTD 8.5	-55.36812	-58.11125 Vessel all stopped at CTD station 8.5
11/21/09 2:17 AM		-55.36665	-58.10985 CTD in water.
11/21/09 3:35 AM		-55.36815	-58.09907 CTD @ 4204m. commence hauling
11/21/09 5:08 AM		-55.36865	-58.08618 CTD out of the water
11/21/09 8:08 AM	CTD 10	-55.83411	-57.82102 On station for CTD 10.
11/21/09 8:16 AM		-55.8341	-57.82104 CTD deployed. EA 600 depth 4754 metres. Heading 033T.
11/21/09 9:42 AM		-55.83354	-57.82075 CTD stopped at 4719 metres wire out. Adjusting spooling on recovery.
11/21/09 11:40 AM		-55.8335	-57.82071 CTD out of the water.
11/21/09 11:42 AM		-55.83351	-57.82075 CTD on Deck.
11/21/09 1:46 PM	CTD 11	-56.15045	-57.62553 CTD in the water. EA600 water depth 3406.
11/21/09 2:47 PM		-56.1501	-57.62442 CTD 11 at depth 3377M of wire.
11/21/09 4:01 PM		-56.15012	-57.62443 CTD out of the water
11/21/09 6:05 PM	CTD 12	-56.46668	-57.42911 CTD in the water depth 3714
11/21/09 7:18 PM		-56.46666	-57.428 CTD stopped at 3830 metres wire out.
11/21/09 8:36 PM		-56.46665	-57.42801 CTD recovered and gantry stowed.
11/21/09 10:35 PM	CTD 13	-56.78307	-57.23318 On station for CTD 13.
11/21/09 11:35 PM		-56.78304	-57.23323 CTD wire all stopped at 3065M.
11/22/09 12:53 AM		-56.78306	-57.23314 CTD out of the water.
11/22/09 3:12 AM	CTD 14	-57.10024	-57.0336 Vessel all stopped on D.P. CTD 14.
11/22/09 3:17 AM		-57.10026	-57.03352 CTD in the water 4200 m
11/22/09 4:30 AM		-57.1001	-57.03361 CTD stopped at 4112m - Commence hauling.
11/22/09 5:58 AM		-57.10008	-57.03357 CTD out of the water
11/22/09 8:01 AM	CTD 15	-57.41607	-56.83649 On station for CTD 15.
11/22/09 9:13 AM		-57.41609	-56.83294 CTD stopped at 3467 metres wire out.
11/22/09 10:29 AM		-57.41555	-56.82521 CTD recovered on heading of 250T and speed 0.6 knots astern.
11/22/09 12:35 PM	CTD 16	-57.73215	-56.64165 Vessel on DP for CTD 16. EA600 depth 3485M.
11/22/09 1:42 PM		-57.73144	-56.63727 CTD at depth 3489M of cable out.
11/22/09 2:55 PM		-57.7296	-56.62896 CTD out of the water
11/22/09 4:13 PM	CTD 17	-57.89597	-56.54484 Vessel on D.P for CTD 17

11/22/09 5:30 PM		-57.89594	-56.54485 CTD at depth 3971m.
11/22/09 6:56 PM		-57.89594	-56.5449 CTD out of the water
11/22/09 7:01 PM	recover BPR	-57.89594	-56.54484 Hydrophone deployed.
11/22/09 7:08 PM			Release signal sent. Hydrophone recovered and moving ship back.
11/22/09 8:29 PM		-57.89161	-56.53491 Buoy on surface. Starboard quarter.
11/22/09 8:56 PM		-57.88337	-56.52508 Buoy recovered to deck.
11/23/09 12:03 AM	CTD 18	-58.36708	-56.24948 CTD in the water. EA600 depth 3925M
11/23/09 1:13 AM		-58.36661	-56.25021 CTD all stopped at 3870M
11/23/09 2:35 AM		-58.36657	-56.25027 CTD out of the water.
11/23/09 4:50 AM	CTD 19	-58.68228	-56.05234 CTD in the water
11/23/09 5:58 AM		-58.6833	-56.05381 CTD all stopped at 3730M & commenced hauling
11/23/09 7:21 AM		-58.68329	-56.05381 CTD recovered and gantry stowed.
11/23/09 9:23 AM	CTD 20	-58.99945	-55.85658 On station for CTD 20.
11/23/09 10:36 AM		-58.99949	-55.85655 CTD all stopped at 3756 metres.
11/23/09 11:55 AM		-58.99949	-55.85647 CTD out of the water.
11/23/09 1:57 PM	CTD 21	-59.33228	-55.64999 Vessel all stopped on DP for CTD 21. EA600 depth 3793M
11/23/09 3:14 PM		-59.33276	-55.6503 CTD all stopped at 3735 metres.
11/23/09 4:31 PM		-59.33273	-55.65026 CTD out of the water
11/23/09 6:39 PM	CTD 22	-59.66497	-55.44224 Vsl on DP and commenced deploying ctd
11/23/09 7:48 PM		-59.66662	-55.4443 CTD stopped at 3660 metres wire out.
11/23/09 9:06 PM		-59.66668	-55.44426 CTD recovered and gantry stowed.
11/23/09 11:09 PM	CTD 23	-59.99827	-55.23851 Vessel all stopped on DP for CTD 23. EA600 3540M.
11/24/09 12:19 AM		-59.99964	-55.23798 CTD all stopped at 3500M
11/24/09 1:37 AM		-59.99988	-55.23793 CTD out of the water.
11/24/09 4:00 AM	CTD 24	-60.33199	-55.03388 CTD in the water
11/24/09 5:01 AM		-60.33333	-55.03117 CTD all stopped at 3425m & commenced hauling
11/24/09 6:13 AM		-60.33338	-55.0311 CTD out of the water
11/24/09 8:15 AM	CTD 25	-60.66578	-54.82477 On station for CTD 25.
11/24/09 9:14 AM		-60.66586	-54.82473 CTD stopped at 3074 metres wire out.
11/24/09 10:25 AM		-60.66585	-54.82471 CTD recovered and gantry stowed.

11/24/09 12:59 PM	MYRTLE	-60.62317	-53.83184 Vessel stopped on DP for Myrtle recovery. EA600 2768M. Heading 295. 1000M downwind from Myrtle.
11/24/09 1:01 PM		-60.62321	-53.83182 Hydrophone deployed.
11/24/09 1:11 PM		-60.62325	-53.83191 Release signal for buoy sent.
11/24/09 1:18 PM		-60.62326	-53.83188 Decision made to release entire frame after no response from first signal.
11/24/09 1:21 PM		-60.62325	-53.83189 Release signal for frame sent.
11/24/09 1:29 PM		-60.62324	-53.83189 Myrtle release possibly worked but expected not to have. Release still being worked on.
11/24/09 1:40 PM		-60.62323	-53.83191 Release of frame believed to have worked.
11/24/09 3:00 PM		-60.62327	-53.83203 Waiting on station for buoy to surface.
11/24/09 4:06 PM		-60.62323	-53.832 Hydrophone back on board. Contact been made Myrtle but failed to release from sea bed
11/24/09 4:09 PM		-60.62325	-53.832 Vessel off D.P and proceeding to next CTD station 26
11/24/09 6:48 PM	CTD 26	-60.80099	-54.74116 Vessel on DP commenced deploying CTD
11/24/09 7:41 PM		-60.79981	-54.74219 CTD stopped at 2562 metres wire out.
11/24/09 8:38 PM		-60.79983	-54.74219 CTD recovered. Moving slowly off station to find water depth of 2000 metres for BPR deployment.
11/24/09 9:21 PM	deploy BPR	-60.82478	-54.73072 Relocated to BPR deployment position. On DP.
11/24/09 9:26 PM		-60.82478	-54.73074 BPR deployed from starboard quarter. EA600 depth 1980 to 2000 metres. Wind 330 x 20 knots. Heading 335T.
11/24/09 10:05 PM		-60.82476	-54.73077 Hydrophone recovered and ship proceeding to CTD 27.
11/24/09 10:22 PM	CTD 27	-60.8333	-54.71947 Ship on station for CTD 27.
11/24/09 10:59 PM		-60.83318	-54.71956 CTD stopped at 1614 metres wire out.
11/24/09 11:41 PM		-60.8332	-54.71955 CTD out of the water.
11/25/09 12:01 AM	recover BPR	-60.85403	-54.70476 Vessel Stopped on DP for BPR recovery.
11/25/09 12:05 AM		-60.85317	-54.70701 Hydrophone in the water.
11/25/09 12:10 AM		-60.85317	-54.707 Release signal sent to BPR.
11/25/09 12:55 AM		-60.85037	-54.70372 BPR on the crane and out of the water.
11/25/09 1:02 AM	deploy BPR	-60.84988	-54.70937 At position all stopped on DP for BPR deployment
11/25/09 1:06 AM		-60.84994	-54.71073 BPR released EA600 depth 984M
11/25/09 1:07 AM		-60.84998	-54.71077 Hydrophone deployed.
11/25/09 1:18 AM	CTD 28	-60.85003	-54.71088 CTD in the water.
11/25/09 1:21 AM		-60.85003	-54.71088 CTD going down to approximately 950M.
11/25/09 1:32 AM		-60.85025	-54.71098 Hyrdophone back on board. BPR on the seabed.
11/25/09 1:38 AM		-60.85022	-54.71097 CTD stopped at depth 966m

11/25/09 2:09 AM		-60.85031	-54.71118 CTD out of the water.
11/25/09 4:23 AM	CTD 29	-60.97796	-54.63372 Vessel on D.P for CTD 29
11/25/09 4:43 AM		-60.97767	-54.63365 CTD all stopped at 574M
11/25/09 5:08 AM		-60.97674	-54.63374 CTD out of the water
11/25/09 6:30 AM	CTD 30	-61.05112	-54.58993 Vessel on DP commenced deploying CTD
11/25/09 6:34 AM		-61.05102	-54.59122 CTD in the water
11/25/09 6:38 AM		-61.05105	-54.59123 CTD veering down to near bottom 350 m
11/25/09 6:58 AM		-61.05059	-54.59188 CTD out of the water
11/25/09 9:43 AM	VMP start	-60.85138	-54.71744 On station for VMP. Water depth 1061 metres. Wind 315 x 18 knots.
11/25/09 10:09 AM		-60.85131	-54.71775 VMP deployed. Test cast. Speed 0.4 knots. Heading 320T. Thrusters only.
11/25/09 10:13 AM		-60.85096	-54.7183 Commence heaving.
11/25/09 10:17 AM		-60.85069	-54.71875 VMP at surface. Commence new test cast. Speed 0.3 knots.
11/25/09 10:46 AM		-60.84899	-54.72232 VMP at surface.
11/25/09 10:47 AM		-60.84892	-54.72243 Commence third cast. Water depth 1169 metres. Speed 0.3 knots. Heading 320T. Wind 312 x 21 knots.
11/25/09 11:09 AM		-60.84755	-54.72507 Commence recovery from 700 metres.
11/25/09 11:38 AM		-60.84573	-54.72843 VMP out the water.
11/25/09 11:57 AM		-60.8552	-54.71367 Vessel back on DP after returning to start position.
11/25/09 11:59 AM		-60.85511	-54.71387 VMP deployed. Cast number 4. EA600 depth 950M. Speed 0.3 knots. Heading 314T.
11/25/09 12:22 PM		-60.85373	-54.71657 Commence heaving from 766 metres.
11/25/09 12:42 PM		-60.85291	-54.71819 VMP on the surface.
11/25/09 12:44 PM		-60.8528	-54.7184 5th Cast of VMP commencing EA600 1053M
11/25/09 1:23 PM		-60.85077	-54.72068 VMP clear of the water.
11/25/09 1:47 PM		-60.85421	-54.68339 Stopped on DP in new position clear of ice.
11/25/09 1:49 PM		-60.85418	-54.68348 6th cast of VMP deployed. 882 metres water depth. Heading 315T. Speed 0.3 knots.
11/25/09 2:12 PM		-60.85336	-54.6851 Starting to heave in on VMP.
11/25/09 2:25 PM		-60.85277	-54.68618 VMP recovered redeployed - 7th cast.
11/25/09 2:47 PM		-60.85209	-54.68798 VMP at bottom of cast 841M.
11/25/09 3:04 PM		-60.85187	-54.68883 VMP clear of the water.
11/25/09 3:06 PM		-60.85184	-54.6889 VMP secured going off DP
11/25/09 3:26 PM		-60.85534	-54.68242 Vsl on position for the 8th cast

11/25/09 3:27 PM	-60.85532	-54.68239 VMP deployed 8th cast depth 866m
11/25/09 3:50 PM	-60.85494	-54.68348 Commence recovering VMP depth 854 m
11/25/09 4:14 PM	-60.85451	-54.68425 VMP at surface & recovered vessel off DP looking for new position
11/25/09 4:41 PM	-60.85537	-54.59514 Vsl on DP and commenced deploying VMP
11/25/09 4:43 PM	-60.85528	-54.59515 VMP deployed 9th cast depth 854m
11/25/09 5:05 PM	-60.85478	-54.59573 Commence recovering VMP depth 845 m
11/25/09 5:24 PM	-60.85427	-54.59609 VMP at surface. Commenced 10th cast.
11/25/09 5:47 PM	-60.85369	-54.59645 Commence recovering VMP depth 816 m
11/25/09 6:08 PM	-60.85311	-54.59664 VMP at surface. Commence new cast No 11
11/25/09 6:32 PM	-60.8525	-54.59717 Commence recovering VMP depth 815 m
11/25/09 7:04 PM	-60.85166	-54.59777 VMP at surface & secured. Vessel off DP looking for new position in loose pack.
11/25/09 7:36 PM	-60.83623	-54.63586 Cast 12. VMP deployed. Water depth 947 metres. Heading 316T.
11/25/09 7:56 PM	-60.83544	-54.63736 Commence recovery from 760 metres.
11/25/09 8:15 PM	-60.83468	-54.63881 VMP on surface. Commence cast 13. Water depth 968 metres.
11/25/09 8:36 PM	-60.83421	-54.63973 Commence recovery from 790 metres.
11/25/09 8:52 PM	-60.83393	-54.64037 VMP at surface.
11/25/09 8:54 PM	-60.83388	-54.64046 VMP redeployed. Cast 14. Water depth 984 metres.
11/25/09 9:15 PM	-60.83345	-54.64158 Commence recovery from 790 metres.
11/25/09 9:36 PM	-60.83308	-54.64254 VMP clear of water and secured for repositioning.
11/25/09 9:55 PM	-60.83121	-54.61117 On DP in new position. Water depth 1192 metres.
11/25/09 9:59 PM	-60.83116	-54.61193 VMP deployed. Cast 15.
11/25/09 10:19 PM	-60.83089	-54.61289 Commence recovery from 784 metres.
11/25/09 10:34 PM	-60.83071	-54.61363 VMP recovered clear of water and secured for positioning.
11/25/09 10:51 PM	-60.834	-54.60099 On DP in new position.
11/25/09 10:52 PM	-60.834	-54.60104 VMP deployed. Cast 16. Water depth 1168 metres.
11/25/09 11:13 PM	-60.83393	-54.60232 VMP stopped at 804m commence hauling
11/25/09 11:32 PM	-60.8345	-54.60443 VMP on the surface.
11/25/09 11:36 PM	VMP end -60.83457	-54.60494 VMP recovered on deck.
11/25/09 11:58 PM	Bangor 1 -60.83474	-54.60645 CTD in the water.
11/26/09 12:02 AM	-60.83475	-54.60646 CTD on its way down to 500M.

11/26/09 12:11 AM	-60.83477	-54.60638 CTD all stopped at 500M
11/26/09 12:45 AM	-60.8354	-54.60494 CTD out of the water.
11/26/09 12:47 AM	-60.83552	-54.60475 CTD on deck being reset before redeployment. Vessel coming slowly astern away from ice.
11/26/09 1:02 AM	-60.83939	-54.60011 Vessel all stopped on DP
11/26/09 1:04 AM	Bangor 2 -60.83937	-54.60006 CTD in the water heading 340.
11/26/09 1:10 AM	-60.83941	-54.59997 CTD on its way down to 500M.
11/26/09 1:19 AM	-60.83982	-54.59934 CTD all stopped at 500M.
11/26/09 1:55 AM	-60.84078	-54.59892 CTD out of the water.
11/26/09 1:57 AM	-60.84077	-54.59892 CTD back on deck.
11/26/09 2:03 AM	-60.84078	-54.59894 Vessel off DP heading around the Northern Edge of pack to north of elephant island.

*Table A. Scientific events obtained from the bridge log.*

## **APPENDIX B – JCR193 CTD INSTRUCTIONS**

*Gwen Moncoiffe*

### **B.1 CTD deck unit setup, processing and data transfer.**

#### **PRE-SAIL CHECKS**

##### **CTD unit configuration**

Make a list of the sensors (with serial numbers) deployed on the CTD frame. Crosscheck with list provided by BAS technician. Highlight any discrepancies.

##### **CON file checks**

1- Once the configuration of the CTD package is known, the SeaBird configuration master file needs to be checked or written from new. For JR195, the CTD configuration is completely new so a new CON file needs to be setup.

Open SeaSave and under the Configure menu go to “New Instrument Configuration”. Click <Create new> or <Modify> depending on whether or not you already have a CON file to edit.

If creating from existing config save the new configuration under a new name using <Save as>.

In addition to the list of sensors deployed on the frame (and their serial numbers), you will need the sensors calibration sheets and the mapping between voltage ports (V0, V1, V2, ... V7) and the ancillary sensors or, for conductivity and temperature, whether the sensor is used as primary or secondary sensor. Remove any unused sensor setup and ensure that all sensors on the CTD frame are represented in the CON file.

Enter the new serial numbers, calibration date and calibration coefficients for each sensor. Save as you go along.

2- Print the CON file report and cross-check against calibration sheets again to catch any typing mistakes.

3- Save the final CON file under the JR195 cruise directory ready for use on the first station.

##### **Data path directory setup**

- Check that there are at least 5 Gbytes free on hard drive;
- Create new directory for cruise data path under D:/data/ : e.g. D:/data/jr195/;
- Create sub-directory “config” under D:/data/*cruise* to store the master config file and SeaSave windows setup.

## B.2 CTD Deployment Tasks and Routines

### Pre-cast

- In CTD annexe:
  - Set up CTD, ensuring bottles are ready for firing, all taps are closed (pulled out), all air valves closed, and syringes from the T and C sensors are removed;
  - Make sure salt crate and plastic bottle stoppers are ready.
- In CTD operation / winch control room:
  - Fill in a CTD Cast log sheet (Appendix D) with lat, long, time, etc.;
  - Prepare the CTD salt sampling log sheet (Appendix D);

### Setup of Seasave for data acquisition

- Start seasave.exe (v5.30b for JR195 – BAS should update to a more recent version);
- Check water sampler configuration under **Configure>Water Sampler Configuration**;
- Check instrument configuration under **Configure>New Style Instrument Configuration> Select instrument configuration**: select the correct con file under /data/jr195/config/jr195.CON;
- Check depth of water from the main echosounder (EA600 on JR195);
- Setup the display window by right click over plot, 'setup', 'modify display params'. Save setup in the PC's config directory for the cruise. Try to have 1 full depth plot with primary temp, conductivity, salinity, and oxygen if present; 1 upper water column plot with primary temp, salinity, fluorescence and PAR (if present); 1 full depth plot with primary-secondary conductivity, % transmission;
- Set depth range on plots;
- Ensure other depth ranges (temp, cond) are suitable for location;
- Check the PC clock – adjust to GMT if required;
- Switch on the SBE911plus Deck Unit (red button);
- Click **RealtimeData> Start Acquisition**
- Select correct CON file for the cruise and enter output data filename (e.g. ctd\_jr195\_NNN);
- Check deck pressures in the realtime display window;
- If station depth > 100m, check that altimeter reading is about 100 m at surface (it will remain constant until it is about 100 m above the seabed – check behaviour carefully on first test cast).

## The cast

- The winch should be zeroed when the CTD is just in the water (the winch operator will probably do this);
- Lower CTD to 10 m for 3 minutes;
- 60 s after immersion – check pumps are on (0010 changes to 0011 on Deck Unit). The pump comes on approximately 1 minute after the CTD enters the water. If conductivity frequency drops below 3500Hz, the pump will stop and delay will start again.
- Bring CTD back to near surface;
- Lower CTD at reasonably constant speed (e.g. 60 m/min) to 10 m above seabed;
- Monitor SeaSave display for unusual features, with close attention to the ALTIMETER;
- When altimeter height start decreasing, tell winch driver 90 m to go;
- Check altimeter height and wire out reading:
  - $\text{Wire\_out} + \text{altimeter\_reading} = \text{depth\_to\_go}$
- Underwater Unit error may be indicated by alarm on Deck Unit – ok if occasional but if persistent then problem with the termination – call the technician;
- When altimeter starts reading, call out distance from the bottom and stop at 10 m though higher depending on sea state and/or bottom slope;
- At bottom, wait for 10-15 s for things to settle;
- Go to **View>Fire>Bottle Control** to bring up the bottle firing window;
- Close the first bottle. Red light will come on briefly. Wait for a further 10 s for SBE35 to capture (if set to 8 sec) and bottle firing power to recharge; fire other 2 bottles as required and using the same waiting routine;
- Fill in the Cast log sheet (Appendix D) with appropriate pressure, temp and sal values;
- Up to next depth, fire 3 bottles (allows for 2 missing bottles), following the waiting times as above: 10-15 s after arriving at firing depth and 24 s after closing each bottle;
- Continue up to surface firing bottles at chosen depths, and filling in Cast Logsheet;
- Fire all remaining bottles at the surface;
- Complete Cast Logsheet.
- DO NOT SWITCH THE DECK UNIT OFF until the SBE35 data are downloaded (see next section).
- Click **RealtimeData> Stop Acquisition**

## **Immediate post-cast operations.**

### Download of SBE35 data

When CTD is back on deck:

- Run “seaterm.exe” (on desktop, v1.44 for JR195) to configure and check SBE35;
- Click “connect” (deck unit must still be turned ON);
- Click “capture” and enter ctd\_jr195\_nnn.cap (as the output file name);
- Then run the following commands (note that the typed command does not appear until return is hit):
  - dc     (displays calibration coefficients)
  - ds     (displays status)
  - dd     (uploads data)
- click “capture” again to end;
- Check that the .cap file is under D:/data/jr195;
- Type samplenum = 0 to clear the data
- Check time on the SBE35 clock. Accurate time makes merging the data with CTD bottle data easier. To check/reset time do:
  - ds - check clock is accurate compared to GPS time – if not reset by:
    - ddmmyy=311109 for example
    - hhmmss=123000 for e.g.
- Click "disconnect";
- Switch off deck unit;
- Quit out of seaterm.exe.

### Water bottle sampling

- Go down to CTD bay with salt sampling log sheet (Appendix D) to sample salt;
- Write salinity bottle numbers in log sheet against CTD Niskin bottle numbers;
- Sample rosette for salt when ready; bottles should be filled up to, or near, the base of the neck.
- Dry bottle neck before putting push stopper in and screw tap on;
- Place back in crate the right way up (old bottles should be upside down);
- If salt crate is full then put samples in Bio Lab, making a note on the log sheet of the date and time this was done.

### Files transfer

- Copy files (.HDR .BL .cap .CON .dat) from D:/data/jr195/ to U: drive (note: all files are ascii except the .dat file which is binary)

## B. 3 SeaBird Data processing

### Setting up DATCNV

Once set up for the cruise, DATCNV will only require you to enter the CON file and its corresponding DAT file for the cast you want to process. Unless new sensors are added or removed from the CTD package, the initial setup should not need to be modified. To setup the DATCNV processing:

- Open SBE Data Processing (v5.31a for JR195 – BAS should update to a more recent version);
- Click **Data conversion** tab;
- Click **File setup** tab:
  - Click "save as" under for the "program setup" and enter \data\jr195\config\DatCnv.psa;
  - Instrument config – click "select" and choose the configuration file ctd\_jr195\_NNN.CON for the cast you want to process;
  - Input directory - type: D:\data\jr195;
  - Input file – select ctd\_jr195\_NNN.dat;
  - Output directory – accept default (it should match input directory);
  - Output file name – accept default (it should be the same name as input filename but with extension .cnv);
  - Save your DatCnv.psa again.
- Click **Data setup** tab and check the following settings:
  - **Process scans to end of file** is ticked;
  - **Scans to skip over** = 0;
  - **Output format** = ASCII;
  - **Convert data from:** Upcast and downcast;
  - **Create file types:** both data and bottle files;
  - **Source of scan range data:** Scans marked with bottle confirm bit (this is what it is at the moment and what we used for JR195; Bottle log is also commonly used; **check with CTD tech**);
  - **Scan range offset** = 0;
  - **Scan range duration** = 2 (**check with CTD tech**);
  - **Merge separate header file** is ticked off.
  - **Select Output Variables:**
    - Pressure in db;
    - Primary and secondary conductivity in mS/cm;
    - Primary and secondary temperature ITS-90 in deg C;
    - Scan count;
    - Pressure temperature;
    - Altimeter;
    - Time elapsed in seconds;
    - Output channel for each sensor connected to the underwater unit e.g. for JR195 these were:
      - Oxygen SBE43 in umol/kg;
      - PAR/irradiance;
      - Beam transmission and beam attenuation (note that we used a calibration based on % transmission relative to water);

- Fluorescence;
- Selected voltage channels V2 (oxygen voltage) and V6 (transmissometer voltage); for JR195 the transmissometer voltage channel was included because the transmissometer calibration did not look correct (% trans values > 100%); we also added the oxygen voltage channel V2 to check possible issues with alignCTD.
- Click Data Conversion tab again and save your DatCnv.psa again;
- Click "start processing" to test your setup – check output.
- If making changes which you want to apply to all future casts processed, make sure you save the changes to the DatCnv.psa.

### Setting up AlignCTD

AlignCTD aligns parameter data in time, relative to pressure. This ensures that calculations of e.g. salinity and dissolved oxygen are made using measurements from the same parcel of water. Generally, this will only need to be run to align the oxygen data if present. The primary and secondary conductivity sensors no longer need alignment since this is carried out automatically by the 11*plus* Deck Unit.

Unless the optimum setting is already known, tests with different advance times should be carried out to determine the optimum setting for the oxygen measurement. Choose a profile with marked temperature, conductivity and oxygen gradients. Run alignCTD with O2 sensor voltage and concentrations advanced by: 0, +2, +4, +8 and +10 seconds. Plot oxygen concentrations versus pressure with downcast and upcast on the same plot using for example **SBE Data Processing > Run > Seaplot**. The best setting is the one which minimises the difference between upcast and downcast. Try other time advances if necessary. Some difference will remain of course because misalignment is not the only cause for mismatch between upcast and downcast. Sensor hysteresis and natural variations due to internal waves or special/temporal patchiness could also cause mismatch between upcast and downcast.

Once the optimum time advance is known:

- go the SBE Data Processing
- run AlignCTD
- click the File setup tab and save settings in new AlignCTD.psa file (Save as) under D: \data\jr195\config\
- change input directory and choose the input .CNV file
- default output directory will be the same as the input directory. Accept the default option.
- **Name append:** enter “\_a”
- save setup file alignCTD.psa
- click the **Data setup** tab and click **Enter advance value**
- set the advance value for oxygen concentration and oxygen voltage (if voltage was selected during DATCNV)
- ensure advance values for all other variables are set to zero
- click ok

- go back to the File setup tab and save your setup again.
- Start processing

### Cell Thermal Mass (CellTM)

Run using SeaBird recommended settings.

- go the SBE Data Processing
- run Cell Thermal Mass
- click the File setup tab and save settings in new cellTM.psa file (Save as) under D: \data\jr195\config\
- change input directory and choose the input .CNV file (\*\_a.cnv)
- default output directory will be the same as the input directory. Accept the default option.
- **Name append:** enter “ctm”
- save setup file
- Click the **Data setup** tab and select both primary and secondary conductivity
- set  $\alpha = 0.03$  and  $1/\beta = 7.0$  for both sensors, using Primary and Secondary temperature respectively.
- click ok
- go back to the File setup tab and save your setup again.
- Start processing

### **Routine SBE processing**

- Run DATCNV – select ctd\_jr195\_NNN.con file and corresponding .dat file;
- Run alignCTD – select output of DATCNV as input file;
- Run CellTM – select output of alignCTD as input file.

Remember to save the \*.psa setup files after each session as this helps keep track of data processing status.

### **File transfer and backup**

- Copy files to U: drive

.HDR

.BL (will need to be renamed .bl later to comply with Mstar settings)

.cap

.CON

.dat

.cnv (there should be three of these if AlignCTD is run, two otherwise)

.ros

- Keep all the files as they are on D: drive
- When U: drive has approx. 600Mb of data then back up on a CD or external drive!!!

**Deck pressures**

At the start of each cast the CTD is set logging on deck, and we therefore have a record of the deck pressure. This information can be extracted from the files to check whether a pressure correction is needed. This was not deemed necessary for JR195 as pressures on deck were fairly stable and required no correction.

## B.4 Mstar Data Processing

- Login on NOSEA2 as pstar (directly or `ssh -X nosea2 -l pstar`);
- `cp` files from `/mnt/current/ctd/` to `/local/users/pstar/jr195/data/ctd/`;
- under `users/pstar/jr195/data/ctd/` edit the driver file `moveall.drv` with new cast number and use `cs` to run and move files to appropriate sub-directories as expected by Mstar;
- Note that Mstar also expects specific file name structures and some renaming might be necessary; `moveall.drv` can take care of some of them. For JR195 for example we changed:
  - the case of the “.bl” extension (generated in upper case by SeaSave but expected in lower case by Mstar);
  - the “a” before `ctm` which indicated that `alignCTD` had been run and needed edited out prior to Mstar processing;
  - also Mstar does not accept non numerical as casts identifiers so we renamed casts `testA` and `testB` to 990 and 991 respectively.
- run Matlab and type `m_setup`
- start Mstar processing routine (see details in Appendix B.5):
  - **ctd\_all\_part1** will run:
    - `msam_01` – creates an empty `sam` file (make sure that the list of variable contains the expected channels);
    - `mctd_01` – read in 24Hz CTD data;
    - `mctd_02` – rename SeaBird variable names;
    - `mctd_03` – average data to 1Hz and calculate derived variables (salinity, potential temperature);
    - `mdcs_01` – creates empty `dcs` file which will store information about start, bottom and end of good data in CTD file;
    - `mdcs_02` – populates `dcs` file with data to identify bottom of cast.
  - **mdcs\_03** must be entered separately as it requires manual input (beware to enter the scan number and NOT the data cycle number!!)
- Once the `nav` file is ready for that day, run:
  - **ctd\_all\_part2** which will run:
    - `mctd_04`
    - `mdcs_04`
    - `mfir_01`
    - `mfir_02`
    - `mfir_03`
    - `mfir_04`
    - `mwin_01`
    - `mwin_03`
    - `mwin_04`
    - `mdcs_05`
  - if `ctd_all_part2` was run before `nav` data were available, run `ctd_all_part3` which will run:
    - `mdcs_04`
    - `mdcs_05`
    - `mctd_04`
- Once the bottle salinities spreadsheet is ready (see next section) for that cast:

- cd to BOTTLE\_SALTS and run the matlab script convert\_sal\_ascii
- go back up one directory and run ctd\_msall which runs the three sub-routines:
  - msal\_01
  - msal\_02
  - msam\_02

### Bottle salinities

The bottle salinity reading from the salinometer will be entered in a XL file manually. There will usually be one file per bottle salinity crate with typically three stations per crate. Once completed, the data will need to be saved in a CSV file containing the following columns: Rosette position number (should be the same as Niskin bottle number), Station number, Bottle salinity.

- Rename this file so that file name is of the form sal\_jr195\_001.csv for station 1 for example.
- The same file can be used for multiple stations; i.e. if a bottle salinity file contains station 001, 002 and 003 the file can be copied three times with file names sal\_cruise\_001.csv, sal\_cruise\_002.csv and sal\_cruise\_003.csv without having to delete any records.
- run msal\_01, msal\_02 and msam\_02 in Matlab once this is done.

### Salts calibration

- Plot pressure vs botpsal-upsal and botpsal-upsal2 using matlab script jr195ctdcal.m (station numbers will need edited first);
- Look at residuals below 1000 m and check trends with depth, time and bottle salinities;
- Investigate outliers;
- Calculate the conductivity scaling equivalent to chosen salinity adjustment (e.g. 0.01PSU):
  - $sw\_cndr(salinity,temp,pressure)$
  - $sw\_cndr(35.01,15,0)/sw\_cndr(35,15,0)$
  - $sw\_cndr(35.02,15,0)/sw\_cndr(35,15,0)$
- Apply conductivity adjustment to 24Hz file to PSAL1 and PSAL2
- Re-run (grouped into **ctd\_all\_part4**):
  - mdc5\_05
  - mctd\_03
  - mctd\_04
  - mfir\_03
  - mfir\_04
  - msam\_02
- plot botpsal-ctdpsal (x axis) versus pressure (y axis) and check that mean residuals are zero or close to zero.

### Plots generation

### 3.8.1 Section plots

Sections of temperature, salinity, oxygen, fluorescence etc... may be plotted against latitude along the Drake Passage transect.

### 3.8.2 TS diagram

Plots of temperature versus salinity

## B.5 Details of MSTAR processing

**NB: The `cnv` file MUST contain the scan number and pressure temperature as one of the output variables**

3 Feb 2009; updated 13 Oct 2009; updated for jr195 Nov 2009 (gmon+bim)

This table shows the sequence for ctd and bottle processing

There will be extra steps around 17 & 18 for all the other bottle sample analyses

There will be extra steps after 19 for applying the psal and oxygen calibrations

The raw input files, `.cnv` and `.bl` will need to be in the correct place, and have the correct name. The ‘correct place’ is whatever is entered in `MDIRLIST` in `m_setup.m`. If the file name doesn’t agree with what the script expects, you either need to rename the file or link to it with a symbolic link, or edit the processing script. I prefer the option of getting the file name to agree with the template, so that we can avoid editing scripts for every cruise depending on the choice on the day of whoever named the SBE output files.

Once in Matlab, type ‘`m_setup`’, and everything “should work”, including scripts automatically changing to the correct working directories. We’ll see!

### CTD DECK UNIT

Run `alignCTD` and cell thermal mass after running `datcnv`. Must also output scan number.

`Datcnv` will output the following files:

- \*.`cnv` - hold raw ascii 24Hz ctd data. (file format: see information in the header of the \*.`cnv` file)

- \*.`hdr` – header file from the `.cnv` file

- \*.`ros` – ctd data when bottles are fired.

Raw input files are:

- \*.`dat` (or maybe \*.`hex`) – raw hex file.

- \*.`bl` –bottle firing information. Date,time,start scan number and end scan number. (for file format see Appendix B.6)

- \*.`con` – instrument configuration file used in the seabird processing software to convert raw signal data into engineering units. Note: we don’t use the seabird software to process ctd data.

Header information in the `.cnv` file describes what has been applied to the data.

Under `/local/users/pstar/jr195/data/ctd/`

`RAW_FILES - keep *.hdr, *.con, *.ros, *.dat`

ASCII_FILES –	*.cnv	hold	raw	ascii	24Hz	ctd	data,	e.g.
ctd_jr195_001_ctm.cnv.								
	The header in this file holds information from datcnv.							
BOTTLE_FILES	*.bl (see Appendix B.6)							
BOTTLE_SALTS	sal_jr195_001.* (see Appendix B.6)							

To start processing CTD data on nosea2:

cd jr195

cd data/ctd/

step	script	example infile(s)	example otfiles	comments	requires previous step
1	msam_01	none	sam_di344_016.nc	create empty sam file (eg list of vars is in sam_di344_varlist.csv) variable list file is kept in directory M_TEMPLATES	-
2	mctd_01	ctd_di344_016_ctm.cnv	ctd_di344_016_raw.nc	read in ctd data (may need to be edited for exact ctd file name)	-
3	mctd_02	ctd_di344_016_24hz.nc	ctd_di344_016_24hz.nc	rename SBE variable names	2
4	mctd_03	ctd_di344_016_24hz.nc	ctd_di344_016_1hz.nc ctd_di344_016_psal.nc	average to 1 hz and calculate psal, potemp	3
5	mdcs_01	none	dcs_di344_016.nc	create empty dcs file; this is used to store information about start, bottom and end of good data in ctd file	-
6	mdcs_02	dcs_di344_016.nc	dcs_di344_016.nc	populate dcs file with data to identify bottom of cast	3,5
7	mdcs_03	dcs_di344_016.nc	dcs_di344_016.nc ctd_di344_016_surf.nc	populate dcs file with data to identify start and end of cast	3,6
8	mdcs_04	dcs_di344_016.nc pos_di344_01.nc	dcs_di344_016_pos.nc	merge positions onto ctd start bottom end times (requires nav file) can be left until calibration stage	7 & nav
9	mdcs_05	dcs_di344_016_pos.nc	dcs_di344_016_pos.nc ctd_di344_016_raw.nc ctd_di344_016_24hz.nc ctd_di344_016_1hz.nc ctd_di344_016_psal.nc ctd_di344_016_surf.nc ctd_di344_016_2db.nc fir_di344_016_bl.nc fir_di344_016_time.nc fir_di344_016_winch.nc fir_di344_016_ctd.nc sal_di344_016.nc	apply positions to set of files. Any of this list have positions set if the file exists  The list should be extended to include any other chemistry files, and the winch file if it exists  It can be used at any time, once step 8 is complete  Can be left until calibration stage (see 8)	8

			sam_di344_016.nc sam_di344_016_resid.nc dcs_di344_016.nc		
10	mctd_04	ctd_di344_016_psal.nc	ctd_di344_016_2db.nc	extract downcast data from psal file using index information in dcs file; sort, interpolate gaps and average to 2db. Plot t,s curves using 2bd file.	4,8
11	mfir_01	ctd_di344_016.bl	fir_di344_016_bl.nc	read in .bl file and create fir file	-
12	mfir_02	fir_di344_016_bl.nc ctd_di344_016_1hz.nc	fir_di344_016_time.nc	merge time from ctd onto fir file using scan number	4,11
13	mfir_03	fir_di344_016_time.nc ctd_di344_016_psal.nc	fir_di344_016_ctd.nc	merge ctd upcast data onto fir file	4,12
14	mfir_04	fir_di344_016_ctd.nc	sam_di344_016.nc	paste ctd fir data into sam file	1,13
15a	mwin_01	techsas_files	win_di344_016.nc	times extracted from start and end of ctd 1hz file, plus 10 minutes at either end	4
15	mwin_03	fir_di344_016_time win_di344_016.nc	fir_di344_016_winch.nc	merge winch wireout onto fir file (only relevant if winch data available)	12 & 15a
16	mwin_04	fir_di344_016_winch.nc	sam_di344_016.nc	paste win fir data into sam file	1,15
17	msal_01	none	sal_di344_016.nc	read in the bottle salinities	-
18	msal_02	sal_di344_016.nc	sam_di344_016.nc	paste sal data into sam file	1,17
19	msam_02	sam_di344_016.nc	sam_di344_016_resid.nc	calculate residuals in sam file	14,18

## B.6 Bottle file formats

### \*BL files

This file is output by the SeaBird data acquisition software SeaSave and should be located under:

/local/users/pstar/jr195/data/ctd/BOTTLE\_FILES/

file name format is : ctd\_jr195\_001.bl

Pylon number, firing number, date, time, firing start scan number, firing end scan number.

e.g. D:\data\jr194\data\jr194\_020\jr194\_020.BL

RESET Dec 16 2008 15:37:33

1, 1, Dec 16 2008 16:49:16, 103197, 103233

2, 2, Dec 16 2008 16:55:17, 111862, 111897

3, 3, Dec 16 2008 17:01:03, 120159, 120194

4, 4, Dec 16 2008 17:11:09, 134704, 134739

5, 5, Dec 16 2008 17:20:47, 148582, 148617

6, 6, Dec 16 2008 17:30:20, 162331, 162366

7, 7, Dec 16 2008 17:39:48, 175970, 176005

8, 8, Dec 16 2008 17:49:08, 189407, 189442

9, 9, Dec 16 2008 17:58:40, 203130, 203165

10, 10, Dec 16 2008 18:02:27, 208577, 208612

11, 11, Dec 16 2008 18:05:01, 212280, 212315

12, 12, Dec 16 2008 18:07:08, 215319, 215354

13, 13, Dec 16 2008 18:09:12, 218316, 218351

14, 14, Dec 16 2008 18:11:14, 221245, 221280

15, 15, Dec 16 2008 18:12:56, 223689, 223724

16, 16, Dec 16 2008 18:14:27, 225878, 225913

17, 17, Dec 16 2008 18:15:59, 228075, 228110

18, 18, Dec 16 2008 18:17:34, 230366, 230401

19, 19, Dec 16 2008 18:18:24, 231547, 231582

### Salinity Bottle file

A file needs to be created from the Excel file containing the readings for the crate, under

/local/users/pstar/jr195/data/ctd/BOTTLE\_SALTS/

file name format needs to be station specific (e.g. sal\_jr195\_001.csv) but file can contain more than one station

file should have no header and 3 columns: Pylon number, station number, bottle salinity value

## B.7 – Instrument calibration constants

The final ASCII output file is of the form *193ctdnn\_ctm.cnv*. This correction followed the algorithm:

$$\begin{aligned} \text{Corrected Conductivity} &= c + \text{ctm}, \text{ where,} \\ \text{ctm} &= (-1.0 * b * \text{previous ctm}) + (a * \text{dcdt} * dt), \\ dt &= (\text{temperature} - \text{previous temperature}), \\ \text{dcdt} &= 0.1 * (1 + 0.006 * (\text{temperature} - 20)), \\ a &= 2 * \alpha / (\text{sample interval} * \beta + 2) \end{aligned}$$

and  $b = 1 - (2 * a / \alpha)$  with  $\alpha = 0.03$  and  $\beta = 7.0$

All processed files were saved to the //jrual/pstar drive, and the *\_ctm.cnv*, *.ros* and *.bl* files also copied to *~/pstar/data/ctd/ASCII\_FILES/*.

The pressure sensor was calibrated following:

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

where  $P$  is the pressure,  $T$  is the pressure period in  $\mu S$ ,  $U$  is the temperature in degrees Centigrade,  $D$  is given by  $D = D_1 + D_2U$ ,  $C$  is given by  $C = C_1 + C_2U + C_3U^2$ ,  $T_0$  is given by  $T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$ .

The conductivity sensor was calibrated following:

$$\text{cond} = \frac{(g + h f^2 + i f^3 + j f^4)}{10(1 + \delta t + \varepsilon p)}$$

where  $p$  is pressure,  $t$  is temperature, and  $\delta = CT_{corr}$  and  $\varepsilon = Cp_{corr}$ .

The temperature sensor was calibrated following:

$$\text{Temp}(ITS-90) = \left\{ \frac{1}{g + h(\ln(f_0/f)) + i(\ln^2(f_0/f)) + j(\ln^3(f_0/f))} \right\} - 273.15$$

where  $f$  is the frequency output by the sensor.

The oxygen sensor was calibrated following:

$$\text{oxygen}(ml/l) = [Soc (V + V_{offset})] e^{T_{cor} \cdot T} O_{xsat}(T, S) e^{P_{cor} \cdot P}$$

where  $V$  is voltage output from SBE43,  $T$  temperature,  $S$  Salinity,  $O_{xsat}(T, S)$  is oxygen saturation and  $P$  pressure while  $Soc$ ,  $T_{cor}$ ,  $P_{cor}$  are the constants from calibration sheet characteristic to instrument.

PAR/Irradiance sensor was calibrated following:

$$PAR = \frac{\text{multiplier} (10^9 10^{(V-B)/M})}{\text{cal.const}} + \text{offset}$$

where calibration constants  $M$  and  $B$  are dependent on sensor type,  $V$  is output voltage while multiplier, cal.const and offset are the constants from calibration sheet characteristic to instrument.

Fluorometer was calibrated following:

$$\text{conc}(\mu g/l) = \text{slope} \frac{[10^{V/SF} - 10^{VB}]}{[10^{V1} - 10^{V_{acetone}}]} + \text{offset}$$

where  $V$  is output voltage measured by CTD

and  $VB$ ,  $V1$ ,  $V_{acetone}$ ,  $SF$ , offset are the

constants from calibration sheet characteristic to instrument.

Numerical values for all of the constants can be found in Appendix B.8, which includes the configuration report for the cruise.

## **B.8 Seabird CTD configuration file as used throughout JR195.**

Date listed: 25/11/2009  
ASCII file: D:\data\jr195\ctd\_jr195\_030.CON  
Configuration report for SBE 911/917 plus CTD  
-----

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

### 1) Frequency, Temperature

Serial number : 5042  
Calibrated on : 12/04/2008  
G : 4.33201372e-003  
H : 6.33549986e-004  
I : 2.08531346e-005  
J : 1.84440097e-006  
F0 : 1000.000  
Slope : 1.00000000  
Offset : 0.0000

### 2) Frequency, Conductivity

Serial number : 3488  
Calibrated on : 22/04/2008  
G : -1.02006618e+001  
H : 1.56812636e+000  
I : -2.01455756e-003  
J : 2.36866095e-004  
CTcor : 3.2500e-006  
CPcor : -9.57000000e-008  
Slope : 1.00000000  
Offset : 0.00000

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

Serial number : 0541-75429  
Calibrated on : 18/07/2007  
C1 : -4.398881e+004

C2 : -5.551403e-001  
 C3 : 1.279490e-002  
 D1 : 3.603000e-002  
 D2 : 0.000000e+000  
 T1 : 2.986716e+001  
 T2 : -5.274889e-004  
 T3 : 4.092900e-006  
 T4 : 1.616590e-009  
 T5 : 0.000000e+000  
 Slope : 0.99994000  
 Offset : 0.52570  
 AD590M : 1.287420e-002  
 AD590B : -8.793390e+000

#### 4) Frequency, Temperature, 2

Serial number : 5043  
 Calibrated on : 09/04/2008  
 G : 4.34448076e-003  
 H : 6.34699898e-004  
 I : 2.11669515e-005  
 J : 1.90896423e-006  
 F0 : 1000.000  
 Slope : 1.00000000  
 Offset : 0.0000

#### 5) Frequency, Conductivity, 2

Serial number : 3491  
 Calibrated on : 22/04/2008  
 G : -1.01164027e+001  
 H : 1.55766840e+000  
 I : -1.88282087e-003  
 J : 2.27423366e-004  
 CTcor : 3.2500e-006  
 CPcor : -9.57000000e-008  
 Slope : 1.00000000  
 Offset : 0.00000

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

Serial number : 7274  
 Calibrated on :  
 M : 1.00000000  
 B : 0.00000000  
 Calibration constant : 2500000000.00000000  
 Multiplier : 1.00000000  
 Offset : -0.56500000

#### 7) A/D voltage 1, Free

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

Serial number : 0245  
Calibrated on : 12/06/2007  
Soc : 3.8470e-001  
Boc : 0.0000  
Offset : -0.4229  
Tcor : 0.0011  
Pcor : 1.35e-004  
Tau : 0.0

9) A/D voltage 3, Altimeter

Serial number : 2130.27001  
Calibrated on : no calibration available  
Scale factor : 15.000  
Offset : 0.000

10) A/D voltage 4, Fluorometer, Chelsea Aqua 3

Serial number : 088-249  
Calibrated on : 13/09/2007  
VB : 0.181000  
V1 : 2.097600  
Vacetone : 0.202800  
Scale factor : 1.000000  
Slope : 1.000000  
Offset : 0.000000

11) A/D voltage 5, Free

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

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

13) A/D voltage 7, Free

## APPENDIX C - UNDERWAY DATA PROCESSING

*Ben Moat*

### C.1 Daily underway data processing schedule.

\*\*\*\* Note that these steps need to be done in the order listed here. \*\*\*\*

step	script	Infiles	outfiles	comments
1	update_allmat	/*ACO	/*.mat	Updates the matlab data files used in the mstar processing
2	mday_00_get_all(jday)	/*.mat	sim_jr195_d*_raw.nc met_jr195_d*_raw.nc pos_jr195_d*_raw.nc ocl_jr195_d*_raw.nc ash_jr195_d*_raw.nc gyr_di344_d*_raw.nc	* = jday
3	mgyr_01 enter jday at the prompt	ash_jr195_d*_raw.nc	gyr_di344_d*.nc	This will discard data cycles with repeat or backwards time jumps.
4	mplxyed	gyr_di344_d*.nc	same	Plot head_gyr and set any data to absent if required
5	mplxyed	ash_jr195_d*.nc	same	Plot head_ash and set any data to absent if required
6	mash_01 enter jday at the prompt	ash_jr195_d*_raw.nc	ash_jr195_d*_edt.nc ash_jr195_d*.nc	Merge on gyro data, construct ash-gyro difference and clean up the data. Averages into 2 minute sections.
7	mday_00_clean_all enter jday at the prompt	sim_jr195_d*_raw.nc met_jr195_d*_raw.nc pos_jr195_d*_raw.nc ocl_jr195_d*_raw.nc	sim_jr195_d*_edit.nc met_jr195_d*_edit.nc pos_jr195_d*_edit.nc ocl_jr195_d*_edit.nc	Sets data to absent outside defined ranges. Creates the difference between subsequent times (deltat)
8	mplxyed	sim_jr195_d*_edit.nc met_jr195_d*_edit.nc pos_jr195_d*_edit.nc ocl_jr195_d*_edit.nc	sim_jr195_d*.nc met_jr195_d*.nc pos_jr195_d*.nc ocl_jr195_d*.nc	Plotting and cleaning up the daily data <b>After cleaning, move the *edit.nc files into the outfiles named .e.g.</b> >>>!mv met_jr195_d319_edit.nc met_jr195_d319.nc Deltat should be between 1 5. If it is not investigate why by listing the data using: >>>m1st met_jr195_d319_edit
9	mmerge_sim_nav_01	sim_jr195_d319.nc pos_jr195_d319.nc	sim_jr195_d319.nc	Merge on position to the depth file and carter correct the depth.
10	mmerge_ocl_nav	ocl_jr195_d319.nc	ocl_jr195_d319.nc	Merge position onto the oceanlogger file

		pos_jr195_d319.nc		
11	mday_02_run_all(319)			Appends the daily files onto the cruise files
12	mbest_all	pos_jr195_01.nc	bst_jr195_01.nc pos_jr195_spd.nc pos_jr195_ave.nc	Creates a bestnav file over 30 seconds.
13	mtruew_01	bst_jr195_01.nc met_jr195_01.nc	met_jr195_true.nc	True wind processing
14	make_plot_jr195.jnl	ocl_jr195_01.nc met_jr195_01.nc	met_jr195_316-318.ps ferret.jnl.*	<pre> unix&gt;&gt;cd /local/users/pstar/jr195/data/ocl unix&gt;&gt;setup v6.2 ferret unix&gt;&gt;ferret yes? go make_plots_jr195.jnl start stop yes?quit e.g. go make_plots_jr195.jnl 316 318 would plot data between 316 and 318 </pre>
15	ocl_diff_jr195	ocl_jr195_01.nc	ocl_jr195_01_diff.nc ocl_jr195_01_diff_night.nc	<p>Do not run daily.</p> <p>Calculates the difference between meteorological variables. Used to examine offsets between different sensors.</p> <p>Air temperature difference is selected for night time only.</p>

## C.2 mplxyed editing of data.

The mstar routine mplxyed is used to plot data and interactively set data cycles to absent. A description of how to use mplxyed is described here using the bathymetry data. A matlab session should be started and m\_setup need to be entered at the matlab prompt.

```
>>pwd
ans=
/local/users/pstar/jr195/data/sim
>> mplxyed
*** mplxyed ***
Enter name of input disc file Type name of mstar file, e.g. sim_jr195_d316_edit
*****
Data Name : sim_jr195_d316 <version> 11 <site> jr195_atsea
Platform : ship | RRS James Clark Ross | Cruise 195
Instrument : dpthi -999.00 dpthw -999.00
Position (lat lon) : -999.00000 -999.00000
Position (lat lon) : -999 00.000 -999 00.000
Data time origin : 2009-01-01 00:00:00
Fields : 5
Dimension sets:
set nrows ncols norecs
1: 1 37903 37903
***** *name *units *dims* min * max * nabs *
absval *
***** 1*time *seconds * 1 * 27216000.000 * 27302397.000 *
0 * -99999.000 *
* 2*depth_feet *feet * 1 * 0.0 * 7170.660 * 0 * -99999.000 *
* 3*depth *m * 1 * 2.150 * 2185.620 * 21619 * -99999.000 *
* 4*depth_fathoms *Fathoms * 1 * NaN * NaN * 37903 * -99999.000 *
* 5*deltat *seconds * 1 * 1.000 * 796.000 * 0 * -99999.000 *
*****
comment: This mstar file created from scs stream
comment: ea600
comment: at 2009-11-14 11:31:25
comment: Time converted from matlab day number to seconds after mstar time origin
File last updated : 2009-11-15 12:11:31
```

Type variable name or number of independent (x) variable:

1

Type variable names or numbers of dependent (y) variables:

3

Type the number of the variable you wish to edit from the list below

1 depth

: 1

which action ?

s : select data cycles

l : list selected data

w : plot with selected data cycles removed

o : plot with original data

a : zoom but make 'auto' tick values

z : zoom to exact area chosen with cursor

f : replot with first pdf

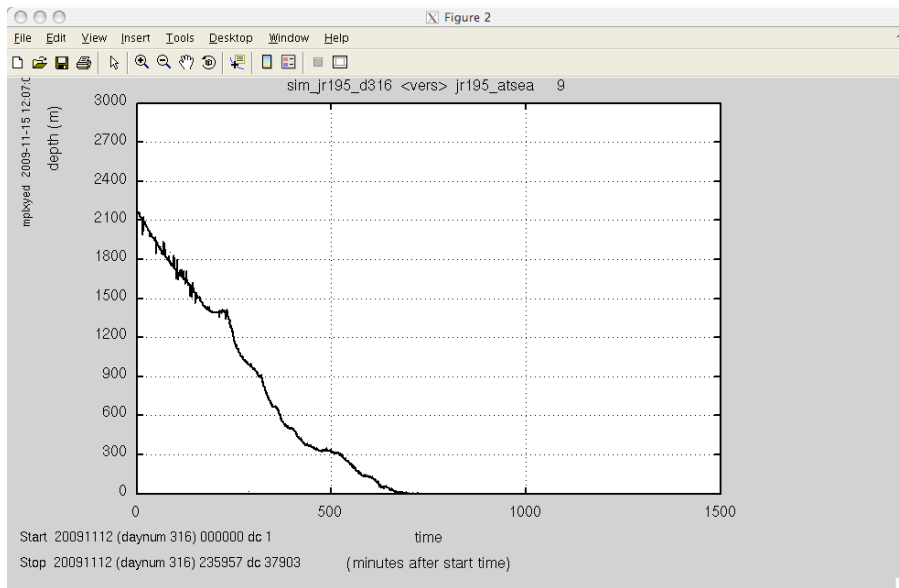
b : go back to previous pdf

e : edit selected data to NaN

r : refresh

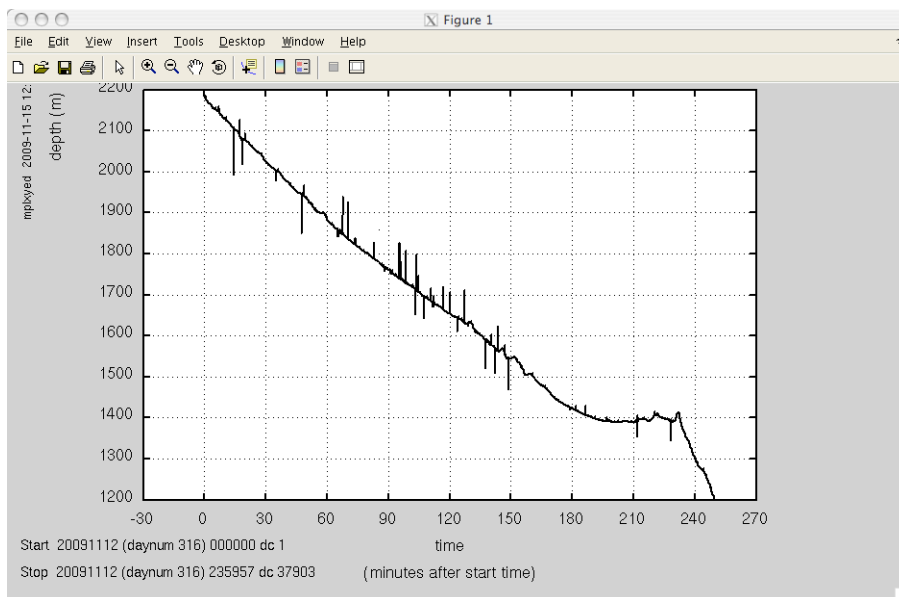
q : quit

A window has appeared showing the change in depth with time. Using the actions above s through to q we can clean up the data.

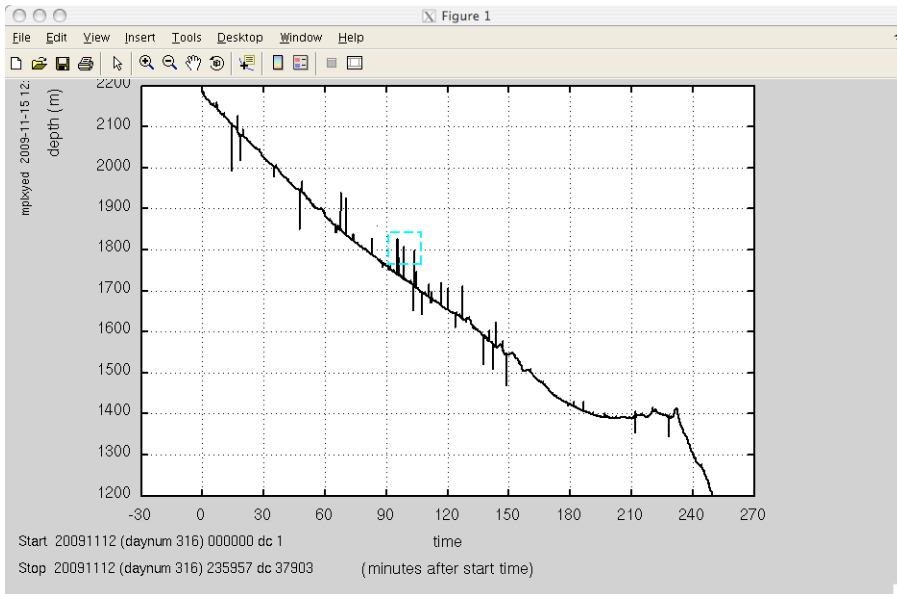


in the matlab window at the action prompt type a

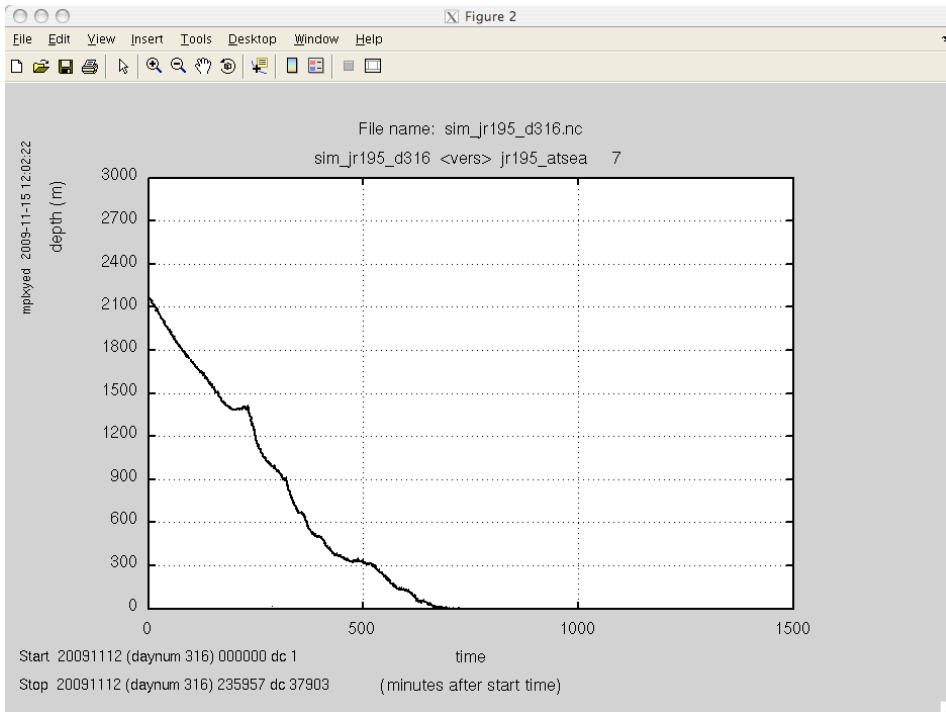
You are taken to the depth vs time window. Using the cross hares click a box around the early part of the time series where the data is noisy.



we can now select the obvious outliers as absent. At the action point in the matlab window press s. You are taken to the depth vs time window. Use the cross hares select the data you wish to set to absent (see cyan box below).



At the action point in the matlab window press w. This shows you the data without the data cycles you have select. If you are happy press e which will edit selected data to absent (NaN in matlab). After repeating this a few times the window has lots of cyan boxes around so lets refresh it using r. Repeat this process and the data will look something like:



When you are happy use the action q to quit out of mplxyed.

Now the IMPORTANT bit. Rename the sim\_jr195\_d316\_edit.nc file sim\_jr195\_d316.nc. We can do this in matlab by using !

```
>>!mv sim_jr195_d316_edit.nc sim_jr195_d316.nc
```

If the sim\_jr195\_d316.nc file is not present the sim\_jr195\_d316\_raw.nc file will be appended instead.

## **APPENDIX D - LOG SHEETS**

The following log sheets are appended below:

- CTD deck sampling log - used by the operator of the CTD deck unit.
- CTD salt sampling log sheet - partly filled in by the operator of the CTD deck unit, then passed to the people taking the salt samples from the Niskin bottles.
- LADCP log sheet - completed by the person setting up the LADCP before and after each CTD cast.
- TSG sampling log sheet - completed by the person performing the watchkeeping check when sampling the non-toxic supply.
- Salinometer operations - completed by the person operating the Autosal salinometer.
- Underway log sheet - completed by the person performing watchkeeping checks.

**CTD Sampling Deck Log**  
**JR195** (Drake Passage 2009)

<b>Station:</b>	<b>Time in water:</b>
<b>Date:</b>	<b>Time start down:</b>
<b>Julian Day:</b>	<b>Time at bottom:</b>
<b>Operator:</b>	<b>Wire Out (m):</b>
<b>Water depth (EA600):</b>	<b>Pressure (db):</b>
<b>Deck Pressure (db) Start:</b>	<b>Altimeter (m):</b>
<b>End:</b>	<b>Time start up:</b>
	<b>Time inboard:</b> -
<b>Start Lat (°S):</b>	<b>End Lat (°S):</b>
<b>Start Lon (°W):</b>	<b>End Lon (°W):</b>

Rosette Num.	Niskin Bottle Num.	Actual wire out (m)	Pressure (db)	Temp (°C)	Salinity	Expected Niskin to sampled	Actual Niskin sampled	Comments (expected wire out pre-cast)
1	1							
2	2							
3	3							
4	4							
5	5							
6	6							
7	7							
8	8							
9	9							
10	10							
11	11							
12	12							
13	13							
14	14							
15	15							
16	16							
17	17							
18	18							
19	19							
20	20							
21	21							
22	22							
23	23							
24	24							

**Salts sample crate number:** **colour:**

**Sea Ice observations:**

**JR195 - CTD SALT sampling log sheet**

CRATE IDENTIFIER (colour code of bottles and/or number)\_\_\_\_\_

### CTD operator to fill in columns 2 and 3

SAMPLER to fill in columns 1 and 4

**Once crate is full, move to BIO LAB and NOTE DATE AND TIME.**

[illegible]

CTD CAST	
Lat:	

Date:	
Long:	

JDAY	
Depth:	

**LADCP Deployment / Recovery Log Sheet**

**Pre-Deployment (Comms. and Charge leads should be in place)**

**In BBTALK: <End>**

	MASTER	SLAVE
1. Log file name (F3)		
2. Time check (TS?) and time correction if necessary	:	:
3. Memory unused (RS?) and erase if necessary (RE ErAsE)		
4. Run tests (PA and PT200)		

5. Battery Voltage

(max. 58V) Measure across charger

**Deployment**

6. Deploy (F2)	MASTER	SLAVE
7. Deployment time, from GPS/vessel clock:	:	:
8. Stop Log (F3)		

**Recovery**

**In BBTALK : <End>**

9. Time of logging stopped:	MASTER	:	SLAVE	:
-----------------------------	--------	---	-------	---

10. Battery Voltage

Measure across charger if no diode.

**Data Transfer**

In BBTALK	MASTER	SLAVE
11. Number of deployments (RA?)		
12. Default filename	-RDI-	-RDI-
13. Renamed file		

**In BBLIST**

	MASTER	SLAVE
14. File size		
15. Number of ensembles		

16.

**JR195 - TSG underway sampling log sheet**

CRATE IDENTIFIER (colour code of bottles and/or number)\_\_\_\_\_

**NOTE JDAY (or date if unsure) and time the sample was taken.**

Samples to be taken at least every 4 hours.

**Once crate is full, move to BIO LAB and NOTE DATE AND TIME.**

[illegible]

## SALINOMETER OPERATION LOG SHEET

Ship:

Cruise no.:

Day/date

Analyst:

Lab Temp Start:

End

Cell temp:

SSW Batch:

K15:

2\*K15

Crate No, Colour:

## Standby Start:

Zero start:

Rs set:

Standby End:

## Zero End:

File name:

[illegible]

## JR195. Watch keeping sheet.

(complete at least every 4hours)

[illegible]

## APPENDIX E. VM-ADCP SETUP.

### JCR ADCP cue card

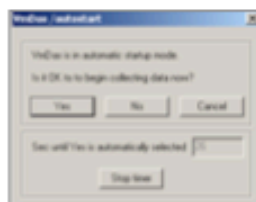
1. Turn ADCP on at the wall (switch above monitor labelled "ADCP Power" needs to be switched to "ON" and should light up red)
2. Check there is sufficient space on the hard drive (at least 3GB)

3. Make sure the Navigation Repeater is running (find this in the Start menu); (JR165 is now the default, no need to create for each cruise)

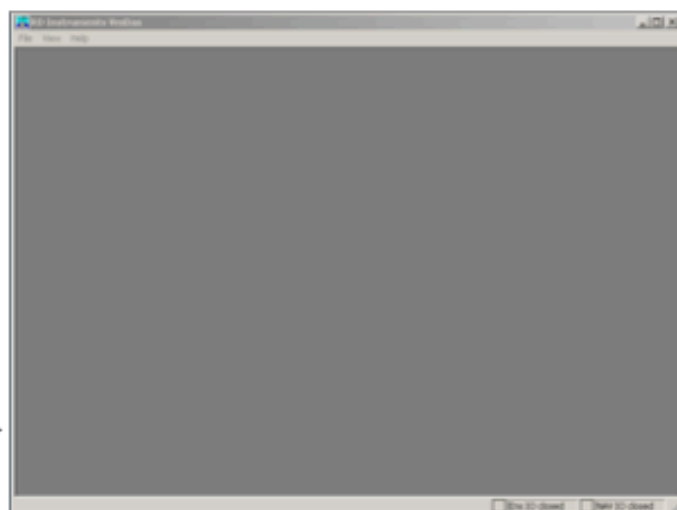


4. Run VmDas (icon on desktop and in start menu)

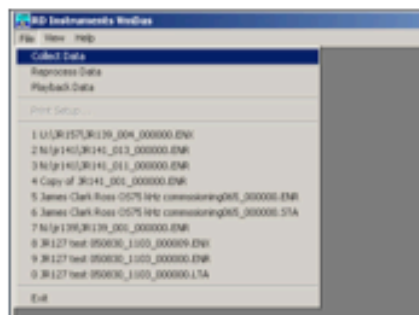
If you get the following Autostart screen, click **Yes**



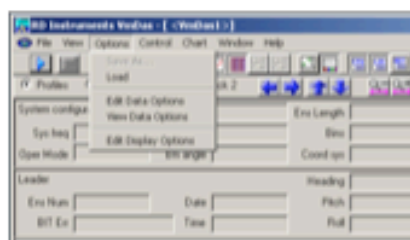
This window should then appear.



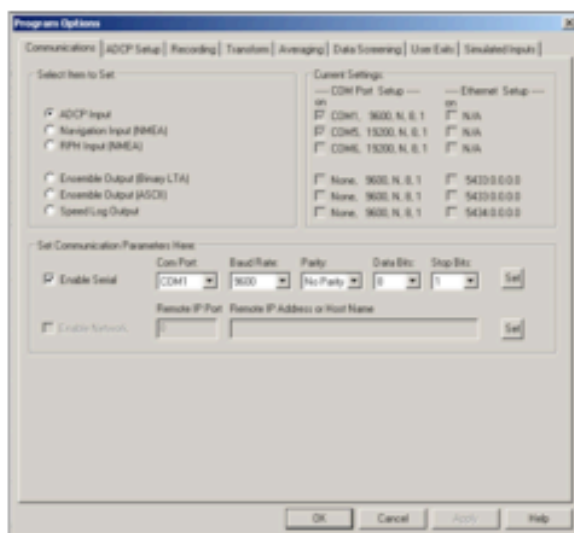
5. In the File menu, click on **Collect Data** (this actually starts the setting up to collect data)



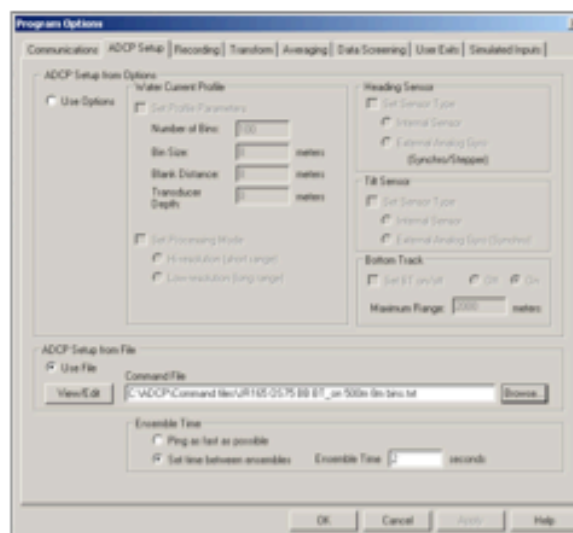
6. In the Options menu, select **Edit Data Options**



#### a) Communications tab



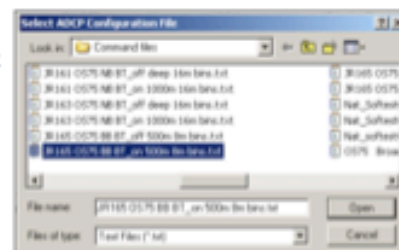
#### b) ADCP Setup tab



You shouldn't have to touch any of this... it should be set up as above.

Enable ADCP Setup from File.  
Set to Ping as fast as possible (not as shown).

Click on **Browse** to pick command file.  
(See note at end)



### c) Recording tab

Program Options

Communications | ADCP Setup | Recording | Transform | Averaging | Data Screening | User Exit | Simulated Inputs

Deployment File

Name: JRNNN

Number: 1

Max Size (MB): 10

Output Directories

☒ Dual Output Directories

Primary Path: U:\data\

Backup Path: C:\ADCP\_Data\_Secondary\JRNNN

OK Cancel Apply Help

Name = JRNNN\_ (where NNN = cruise number, e.g. JR165\_)

Number = 1 or 2 or ... **make sure this increments since last time or you will over-write data!**

Max Size = 10

Primary Path = U:\data\

Backup Path = C:\ADCP\_Data\_Secondary\JRNNN

### d) Transform tab

Program Options

Communications | ADCP Setup | Recording | Transform | Averaging | Data Screening | User Exit | Simulated Inputs

Heading Source

☐ ADCP compass/gps

☐ NMEA/HDT

☐ NMEA/HDG

☒ NMEA/PRDID

☐ Fixed Heading

deg

Heading Correction

☒ Enable

EV: magnetic offset

EA: heading alignment error

HeadingT = Heading + EV + EA

HeadingT = measured heading

Tilt Source

☐ ADCP tilt sensor/gps

☐ NMEA/PTD

☒ Fixed Tilts

Pitch (deg)

Roll (deg)

Tilt Correction

☐ Enable

EA: heading alignment error

EJ: pitch alignment error

EI: roll alignment error

PitchT = start/truePitch\*cos(EA) - tan(PitchT)\*sin(EA) - EJ

RollT = start/trueRoll\*cos(EA) + tan(PitchT)\*sin(EA) - EI

PitchT = measured pitch

PitchT = true pitch

RollT = measured roll

RollT = true roll

OK Cancel Apply Help

Heading Source = NMEA/PRDID

Tilt Source = Fixed Tilts (0 for both)

Heading Correction = Enable: 0 (EV), 60.08 (EA)

Tilt Correction = don't enable

### e) Averaging tab

Program Options

Communications | ADCP Setup | Recording | Transform | Averaging | Data Screening | User Exit | Simulated Inputs

Averaging Method

☒ Temporal

First Time Interval (STA): 120 seconds

Second Time Interval (LTA): 600 seconds

Profile Ping Normalization Reference Layer

☒ Enable

Start bin: 0

End bin: 10

OK Cancel Apply Help

STA = 120 (for 2 minute averaged data)

LTA = 600 (for 10 minute averaged data)

### f) Data Screening tab

Program Options

Communications | ADCP Setup | Recording | Transform | Averaging | Data Screening | User Exit | Simulated Inputs

These options allow you to select additional screening thresholds beyond what is applied in the ADCP. Selecting lower thresholds than are used in the ADCP will have no effect.

Bottom Track

Thresholds

Rise: 10 counts

Correlation: 100 counts

Error Velocity: 1000 m/s

Vel. Velocity: 1000 m/s

Fish: 10 percent

Percent Good: 10 percent

Water Mass Reference Layer

Thresholds

Rise: 10 counts

Correlation: 100 counts

Error Velocity: 1000 m/s

Vel. Velocity: 1000 m/s

Fish: 10 percent

Percent Good: 10 percent

Water Column Profile

Thresholds

Rise: 10 counts

Correlation: 100 counts

Error Velocity: 1000 m/s

Vel. Velocity: 1000 m/s

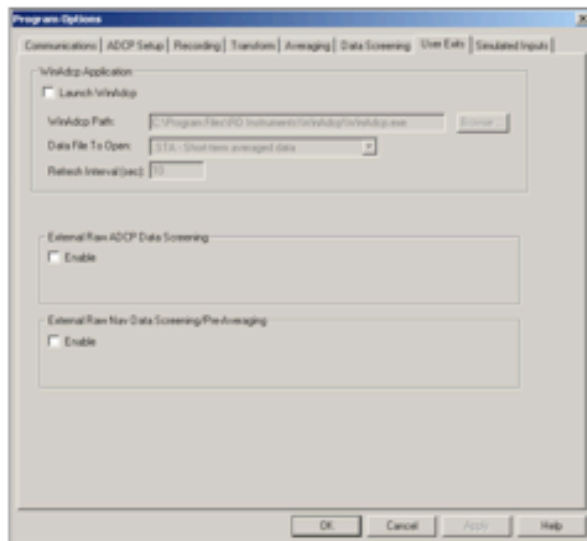
Fish: 10 percent

Percent Good: 10 percent

OK Cancel Apply Help

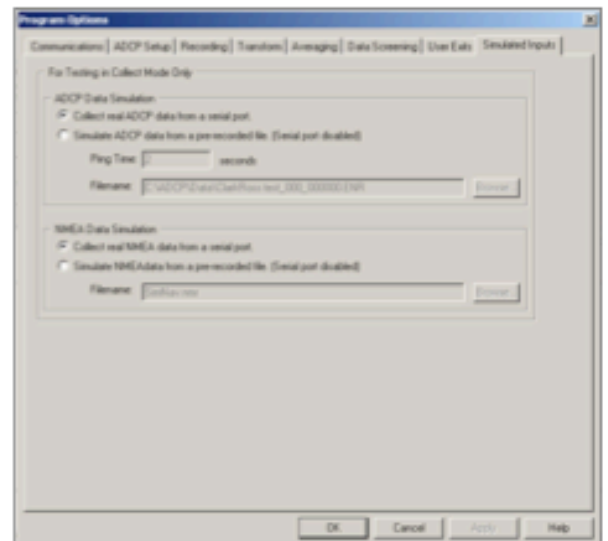
Don't touch this.

#### g) User Exits tab



Don't enable or use any of this.

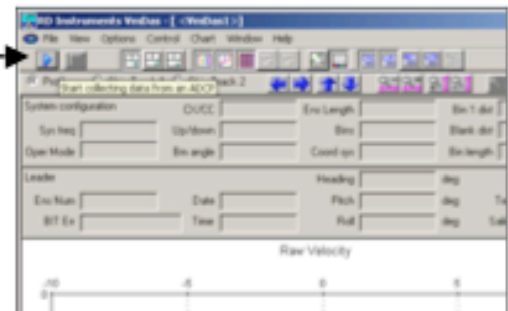
#### h) Simulated Inputs tab



Collect real ADCP data from a serial port  
Collect real NMEA data from a serial port

- To start the ADCP ping and collecting data, click on blue arrow (in top left corner under "File" menu, looks like a "play" button), or click on **go** in the **Control** menu.

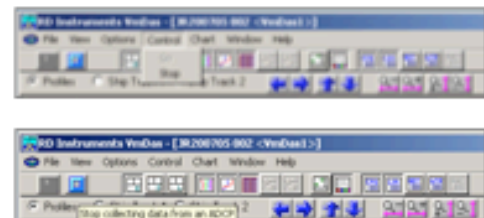
If it is working the log screen should run through a number of commands, and eventually say something like "ADCP pinging" and then disappear and data should appear and change regularly.



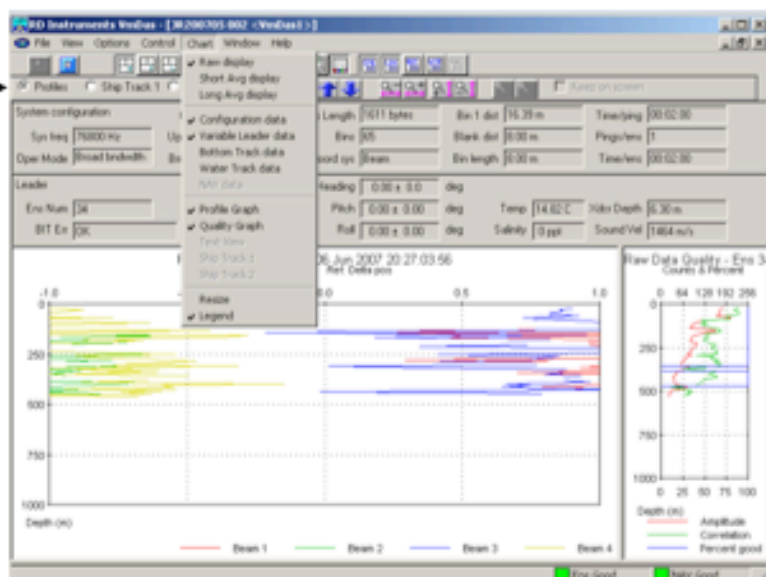
- To stop the ADCP ping, either

click on **stop** in the **Control** menu

or click on the blue square in the top left hand corner



9. To change the data display, use the **Chart** menu and/or the toggle buttons



To find out more see the **VmDas User's Guide**, which is on the ship in both printed and electronic format.

#### Note on command files

Command files have been created for different scenarios - personnel on cruise, depth, need to calibrate instrument. These can be found in C:\ADCP\Command Files\SetModes

JCR\_BT250.txt = 250m Bottom Track 8mBins Through SSU  
 JCR\_BT500.txt = 500m Bottom Track 8mBins Through SSU  
 JCR\_BT\_opp.txt = 500m Bottom Track 8mBins Not Through SSU  
 JCR\_WC\_opp.txt = 800m Water Track 8mBins Not Through SSU  
 JCR\_WC800.txt = 800m Water Track 8mBins Through SSU

Note: Bottom tracking data (BT\_on) is very important for calibration purposes, but reduces the temporal resolution and does not work when ADCP is synchronised with other acoustic devices on the ship.

Note: These all use Narrowband mode, which is recommended unless there is a specific requirement for broadband, at which point you will know what you're doing anyway.

#### Potential Problems

The ADCP can run into problems, mostly if it does not receive a trigger from the SSU to ping, causing it to timeout. This causes a white window to appear and start scrolling. Sometimes the ADCP recovers and continues pinging, though the ensemble number may reset to 1, though the actual data file recorded is fine despite this. Other times the instrument stops recording and it should be stopped and restarted immediately. If this fails then check the SSU, it may have crashed.

#### Outputs

The ADCP writes a series of files to the unix drive (the primary path) and the raw data to the secondary path (sufficient to recover the data, but needs to go through VmDas again to be processed in matlab). The file types and numbering is:

JRNNN\_XXX\_YYYYYY.EEE

Where:

XXX is a number that increments when the data collection is stopped and restarted. The matlab processing expects this to change so data collection has to be stopped and restarted before matlab processing (as things stand with the code). This is usually done once per day.

YYYYYY is a number that increments once the file size has reached 10Mb, the matlab code scrolls through these for each XXX. Different file types (see below) have different rates of data collection so YYYYYY may be different between them. This is fine.

EEE is the file extension:

.N1R (NMEA telegram + ADCP timestamp; ASCII)

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

.VMO (VmDas configuration; ASCII)

.NMS (Navigation and attitude; binary)

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

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

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

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

.LTA (Earth co-ordinate long-term averaged data; binary). This is used for google earth real time plotting

The matlab code expects the XXX number to increment so the data collection should be stopped and immediately restarted each day if the data is being processed during the cruise. The file number should be changed in OS75\_JCR\_JRNNN and the program run. Data can then be checked for problems or used.

**APPENDIX F. RRS JAMES CLARK ROSS CRUISE JR198**

**RRS JAMES CLARK ROSS CRUISE JR198  
REPORT ON VERTICAL MICROSTRUCTURE PROFILER  
CASTS  
OFF ELEPHANT ISLAND  
25 NOVEMBER 2009**

**YUENG-DJERN LENN<sup>1</sup>, JEFF POLTON<sup>2</sup> AND MIGUEL ÁNGEL MORALES MAQUEDA<sup>2</sup>**

**1. UNIVERSITY OF BANGOR**

**2. PROUDMAN OCEANOGRAPHIC LABORATORY**

## Introduction

As part of the field work programme of cruise JR198, we carried out a series of 20 Vertical Microstructure Profiler (VMP) casts off Elephant Island on 25 November 2009. This work was motivated by a recent paper of Heywood et al. (2007). This paper describes an attempt at detecting internal tides in Drake Passage using bottom pressure recorder (BPR) and inverted echosounder (IES) data. Bottom pressure recorders measure predominantly the barotropic tide, while IES data combine information about sea level and stratification. Heywood et al. (2007) used BPR-IES pairs and a one-dimensional barotropic-baroclinic model to measure internal tide signals in Drake Passage. They failed to detect such signals with their technique and concluded from this negative result that any internal tide in southern Drake Passage should have an amplitude of less than 20 m, as this was the limit of detectability that could be achieved with their method.

The aim in JR198 was try to measure the amplitude of the internal tide directly by carrying out a 24-hour hydrographic survey in a station adjacent to the BPR site that POL has been maintaining for nearly the past 20 years off Elephant Island (Figure 1). Although a conventional CTD is all that is needed to monitor the evolution of isopycnal depths, we decided, prompted by a suggestion from Simon Holgate (POL), to complement this activity with a survey of the water column's microstructure, which would allow us, as a bonus, to assess the role of internal tides in the local vertical mixing. In what follows, we present a brief description of the equipment used, a summary of the VMP casts and a few preliminary results.

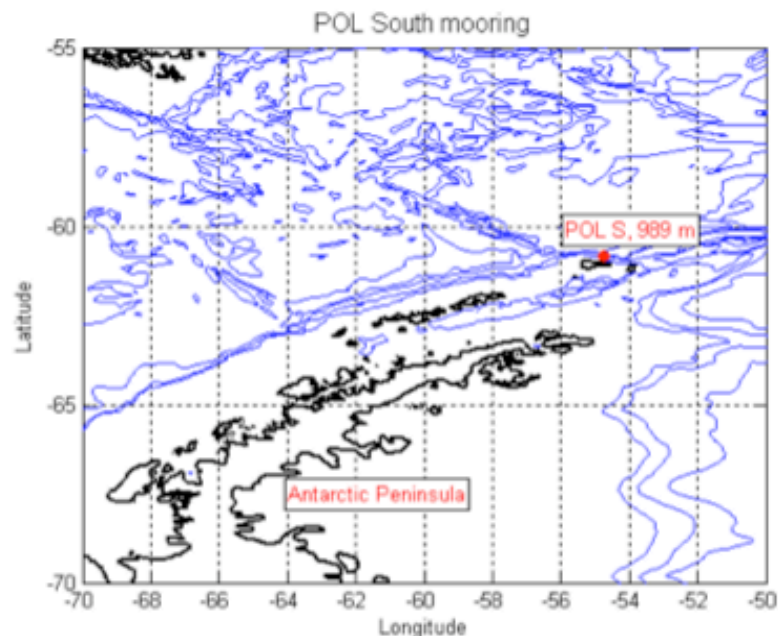
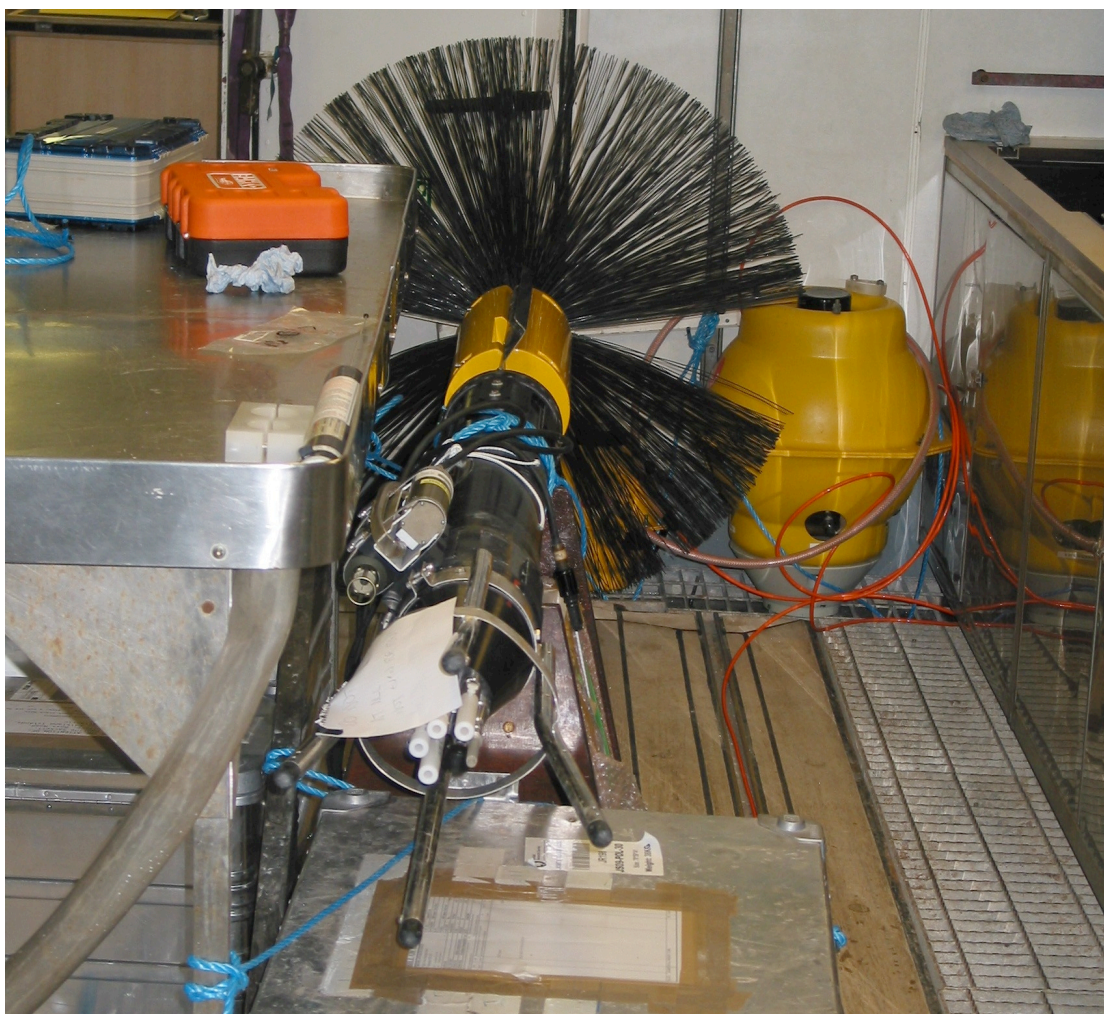


Figure 1: Location of the POL mooring in southern Drake Passage (red dot). The bathymetry lines are for depths of 500 m, 1000 m, 2000 m, 3000 m and 4000 m.

## VMP Description

The instrument used in this cruise is a Rockland Scientific International profiling system. It is a tethered free-falling profiler consisting of a telemetering microstructure system (TMS), a tail section and a tether. The maximum operating depth is 2000 m. The TMS allows real time measurement and display of data using ODAS4-RT software. The TMS is installed on the VMP body and requires a communication cable to transmit data back to the ship.

The VMP collected data from three accelerometers (in the x, y and z directions), two pre-emphasized thermistors, one pre-emphasized micro-conductivity sensor, one fluorometer, two shear probes and two pressure transducers (one pre-emphasized and one without pre-emphasis). The instrument also supported a Sea-Bird SBE 9plus CTD for accurate measurement of temperature and conductivity.



**Figure 2: The VMP assembled in the wet laboratory of RRS James Clark Ross during JR198. The VMP probes are covered by white guards (near end). The CTD package is also installed (near end, top left). Note also the four-legged probe guard (near end), the syntactic foam yellow guards protecting the tail section and the plastic brush, which slows down the free fall of the instrument to terminal velocities of 0.5 m/sec to 0.75 m/sec.**

## VMP Casts

Twenty VMP casts were carried out on the 25<sup>th</sup> November 2009. Of these, the two first were test casts to optimize the speeds of the winch and line puller. In the 4<sup>th</sup> and 10<sup>th</sup> casts the instrument was set to record data but was not actually deployed. Casts 14 and 15 are in fact the same cast; the instrument just stopped recording for a few seconds after reaching 29 m depth. Similarly, casts 19 and 20 are also the same cast. In this case, the instrument did not record for about 14 seconds after reaching a depth of 274 m. The table below and Figure 3 summarise all casts containing valid data, including the initial location of the cast, start and end times and maximum pressure attained.

Cast	start latitude (deg. min.)	start longitude (deg. Min.)	start time	stop time	max. pressure (db)
003	-61 -50.9460	-55 -43.3230	10:43:56	11:05:15	784
005	-61 -51.3126	-55 -42.8190	11:57:08	12:19:21	767
006	-61 -51.1812	-55 -43.0770	12:40:14	13:02:53	826
007	-61 -51.2532	-55 -41.0034	13:47:12	14:08:58	847
008	-61 -51.1743	-55 -41.1582	14:22:03	14:44:24	842
009	-61 -51.3285	-55 -40.9503	15:25:50	15:47:11	854
011	-61 -51.3342	-55 -35.7228	16:39:29	17:02:23	845
012	-61 -51.2598	-55 -35.7636	17:21:58	17:43:57	820
013	-61 -51.1902	-55 -35.7966	18:05:47	18:27:09	804
014	-61 -50.1732	-55 -38.1510	19:34:11	19:35:02	29
015	-61 -50.1732	-55 -38.1522	19:35:04	19:52:54	761
016	-61 -50.0880	-55 -38.3148	20:12:00	20:32:18	793
017	-61 -50.0376	-55 -38.4192	20:50:16	21:11:53	791
018	-61 -49.8714	-55 -36.7062	21:55:48	22:16:15	786
019	-61 -50.0394	-55 -36.0636	22:52:13	22:59:15	274
020	-61 -50.0394	-55 -36.0870	22:59:29	23:13:09	799

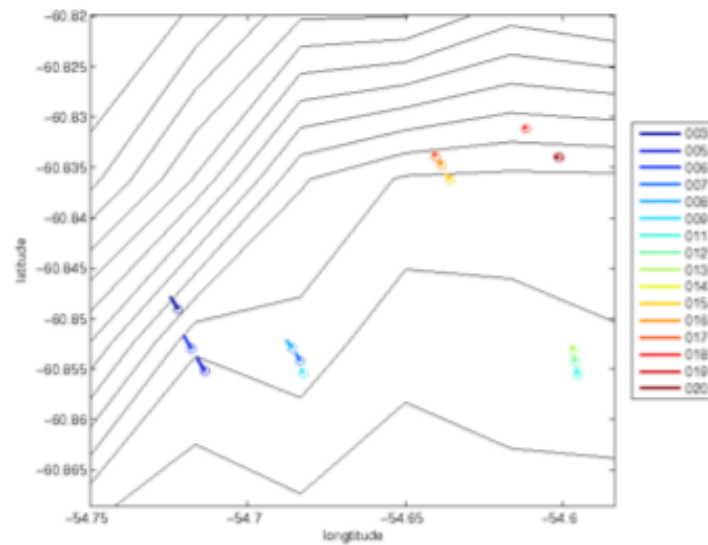


Figure 3: Initial location of valid VMP casts (circles) and ship track during each cast (lines). The black lines delineate the bathymetry according to Smith and Sandwell (1994). The shallower isobath is the 800 m one (bottom of the figure) and the depth interval between isobaths is 100 m.

Figure 4 shows temperature and salinity profiles for all the casts described in the table above. The

temperature profiles reveal a fairly well defined two-layer structure, with a cold (approximately -1 C) surface mixed layer 350 m to 500 m deep and a warmer (~0.5 C) deep layer separated from the surface layer by a 100-m-thick thermocline. In agreement with the temperature profiles, the salinity profiles show also a well mixed, several hundred meter thick surface layer. Worryingly, though, the salinity changes in the thermocline are such that, if they were true, the water column could not be hydrostatically stable. We suspect that the conductivity sensor of the SBE 9plus requires calibration and is not providing reliable readings. Two CTD casts were carried out with the BAS CTD rosette immediately after VMP cast 20, and we hope to be able to calibrate the SBE 9plus conductivity sensor using data from these two casts before embarking on a more detailed analysis of the VMP data.

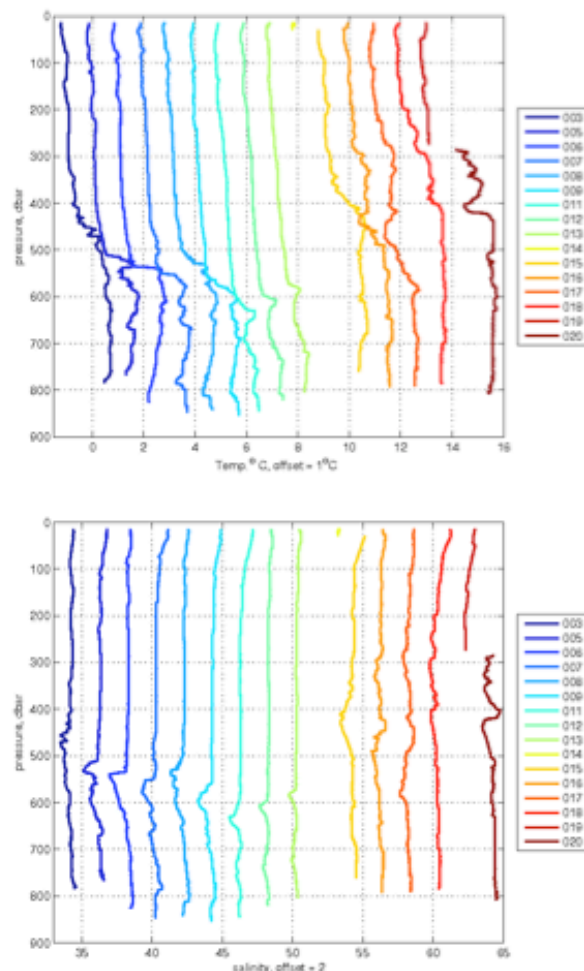


Figure 4: Temperature (top) and salinity (bottom) profiles for all valid VMP casts.

## Acknowledgements

We would like to thank Matthew Palmer and Jonathan Sharples, from POL, for lending us their VMP for this cruise. We are grateful to Margareth Yelland (NOCS), principal scientist of the concurrent cruise JR195, for sacrificing some of her CTD stations in order that our VMP casts could be accommodated within the tight ship's schedule. Many thanks also to Ben Moat (NOCS) for preparing the ship's underway and bathymetry data corresponding to the VMP casts.

## References

- Heywood, K. J., J. L. Collins, C. W. Hughes, I. Vassie, 2007. On the detectability of internal tides in Drake Passage. *Deep-Sea Res.* 1, 54, 1972-1984.
- Smith, W. H. F. and D. T. Sandwell, 1994. Bathymetric prediction from dense satellite altimetry and sparse shipboard bathymetry. *J. Geophys. Res.*, 99, 21803-21824.