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RRS *JAMES CLARK ROSS* CRUISE 115
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Drake Passage repeat hydrography: WOCE Southern
Repeat Section 1b – Burdwood Bank to Elephant Island

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ABSTRACT

This report describes the tenth occupation of the Drake Passage section, established during the World Ocean Circulation Experiment as repeat section SR1b. It was first occupied by Southampton Oceanography Centre in collaboration with the British Antarctic Survey in 1993, and has been re-occupied most years. Thirty-five full depth stations were completed, and 2 repeat shallow stations for biogeochemical sampling only. The full depth stations included a test station, the 30 stations for the SR1b Drake Passage section, with three repeat stations south of Burdwood Bank and one station in the ice in the Bellingshausen Sea for Dr. Mark Brandon. The CTD was a Sea-Bird 911*plus* with dual temperature and conductivity sensors, an altimeter, an oxygen sensor, a PAR (photosynthetically active radiation) sensor and a fluorometer. For 27 of the 30 SR1b stations LADCP data was also collected. The LADCP was a downward looking RDI Workhorse WH300 ADCP (WH) unit. Various underway measurements included navigation, VM-ADCP, sea surface temperature and salinity, water depth and meteorological parameters

KEYWORDS

ANTARCTIC CIRCUMPOLAR CURRENT, ANTARCTIC OCEAN, ADCP, ACOUSTIC DOPPLER CURRENT PROFILER, CRUISE 115 2004, CTD OBSERVATIONS, DRAKE PASSAGE, *JAMES CLARK ROSS*, LOWERED ADCP, LADCP, SOUTHERN OCEAN, VESSEL-MOUNTED ADCP, WOCE, WORLD OCEAN CIRCULATION EXPERIMENT

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BAS:	British Antarctic Survey
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Chappell, Kelvin	Seaman
Raper, Ian	Seaman
Dale, George	Seaman
Holmes, Kevin	Seaman
MacKaskill, Angus	Motorman
Smith, Bruce	Motorman
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Jones, Lee	Senior Steward
Greenwood, Nicholas	Steward
Weston, Kenneth	Steward

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1. OVERVIEW

Mike Sparrow

This report describes the tenth occupation of the Drake Passage section, established during the World Ocean Circulation Experiment as repeat section SR1b, first occupied by Southampton Oceanography Centre in collaboration with the British Antarctic Survey in 1993, and re-occupied most years since then.

The main objectives 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 to identify thereby the significant water masses;

(v)   to calculate the total flux of water through Drake Passage by combining all available measurements.

The tenth occupation of the SOC!/!BAS Drake Passage section was certainly an eventful one. Having arrived in Stanley without incident, we joined the JCR early in the afternoon of December 1st, only to find that we would be doing the section southbound, rather than northbound as planned. The reason for this was the unusual amount of ice to the west of the peninsula. It was hoped that delaying our arrival at Rothera would give the ice time to clear.

Once onboard we leapt into action to get everything set up and ready. There was some delay as it took a while to locate the LADCP equipment that had been left on board from a previous cruise (for example, we found the LADCP PC in the explosives locker and the battery pack tied up in the deck engineers workshop…). Once located it was several days before the LADCP equipment could be made to work (more of this later), but luckily Mark Brandon was available to give invaluable help getting everything else set up and running.

Despite some rather feisty weather, the CTD work started on the evening of December 2nd with a full depth test station just to the south of Burdwood bank (station 01). The CTD section itself started on December 3rd. There were some problems on stations 05, 07 and 08 with data

acquisition failing in mid cast. We believe that this was linked to failure of the Trimble during station 07 which resulted in a disturbance to the NMEA signal. The LADCP was put into operation from this station onwards. A shallow second cast was made on stations 16 and 26 a shallow second cast was made to allow water samples to be collected for biogeochemical analysis (a separate project for the University of East Anglia). These casts were not processed beyond the raw data. After concern about a possible problem with tension readings, the winch was slowed at 200!m during the downcast on station 23 for a safety check on the wire. On station 27 the power button was accidentally pressed instead of a bottle being fired at the bottom of the cast. The downcast data was saved to file, and Deck Unit and software restarted for the upcast. These files were then merged for further processing. On the return leg we took the opportunity to repeat stations 02, 03 and 04 with the LADCP. No salinity samples were taken on these stations. The cruise track is illustrated in Figure 1.1.

The extreme ice conditions to the west of the Antarctic Peninsula (Figures 1.2 and 1.3) made this cruise noteworthy. Despite several days of backing and ramming we were forced to turn back or run the risk of 'doing a Shackleton'.

The JCR was full to capacity on this trip, with scientific personnel, personnel destined for Rothera, a Sky New Team and a novelist. There were several additional science projects (coring, mooring deployment, buoy recovery) but these are not mentioned further in this report except where they impact the Drake Passage section.
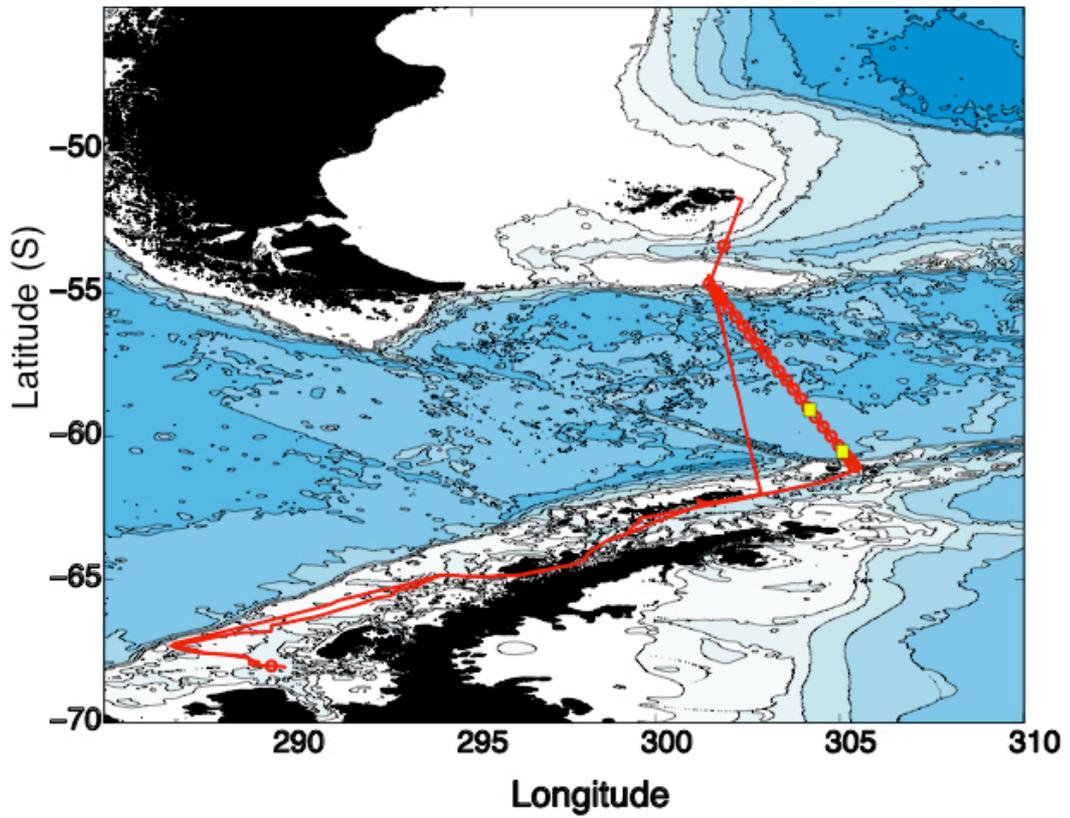
Figure 1.1: Cruise track for JR115.

The cruise track (using data from BestNav) is illustrated in red, with the locations of the CTD stations and the positions of the float deployments represented by red circles and yellow squares, respectively.
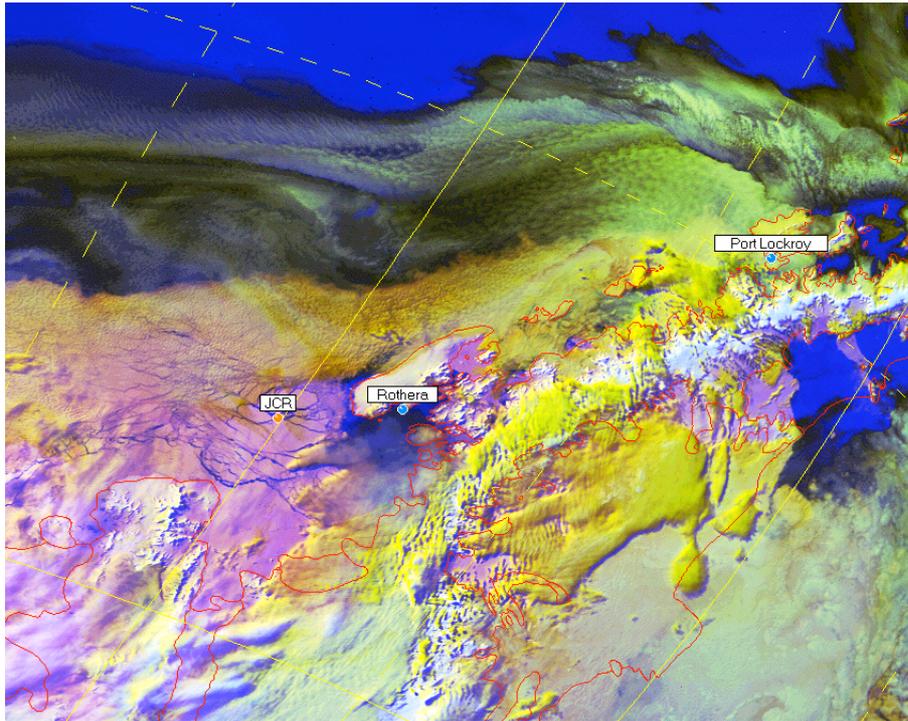
Figure 1.2: Extent of ice cover on Sunday 12th December 2004 at 20:51:02.
Data is from the NOAA HRTP multi-plane data.

Figure 1.3: The JCR in the ice off the Antarctic Peninsula.
Photograph taken from a Dash-7.

2. CTD DATA AQUISITION AND DEPLOYMENT

Elizabeth Hawker, Adam Williams

2.1   Introduction

A Conductivity-Temperature-Depth (CTD) unit was used on JR115 to vertically profile the temperature and salinity of the water column. 35 full depth stations were completed, and 2 repeat shallow stations for biogeochemical sampling only. The full depth stations included a test station, the 30 stations for the SR1b Drake Passage section, with three repeat stations south of Burdwood Bank (to collect LADCP data) and one station in the ice in the Bellingshausen Sea for Dr. Mark Brandon. The method of acquisition and calibration of the data are described below.

2.2   CTD unit and deployment

The CTD unit was a Sea-Bird 911 plus with dual temperature and conductivity sensors, an altimeter, an oxygen sensor, a PAR (photosynthetically active radiation) sensor and a fluorometer. For stations 7 to 31 a UKORS downward looking LADCP was added to the outside of the main CTD frame in a protective cage (see Section 2). A fin was also added to the frame to reduce rotation of the package underwater.

The CTD unit was connected to an SBE 32, a 12 position carousel water sampler (S/N 3215759-0173) and an SBE 35 Reference Temperature Sensor (S/N 0315759-0005). For the first 6 stations, 12 Niskin bottles were fitted to the rosette, while for the later stations, bottles 2 and 3 were removed to accommodate the LADCP battery. The CTD data were logged via an SBE 11 plus deck unit to a 1.4GHz P4 PC, running Seasave Win32 version 5.28e (Sea-Bird Electronics Inc.). This new software is a great advance on the DOS version, allowing numerical data to be listed to the screen in real time, together with several graphs of various parameters. The data rate of recorded data for the CTD was 24 Hz.

The CTD package was deployed from the mid-ships gantry and A-frame, on a single conductor torque balanced cable connected to the CTD through the BAS conducting swivel. This CTD cable was made by Rochester Cables and was hauled on the 10T traction winch. The general procedure was to start data logging, deploy, and then to stop the CTD at 10 db pressure. The pumps are water activated and typically do not operate until 30-60 seconds after the CTD is in the water. If the word display on the Deck Unit is set to 'E' then the least significant digit on the display indicates whether the pumps are off (0) or on (1). After a 2 minute soak, the package was raised to just below the surface and then continuously lowered to near bottom, with the Niskin

bottles being closed during the upcast. The final CTD product was formed from the calibrated downcast data averaged to 1!db intervals.

The altimeter gave correct readings throughout, finding the bottom at its maximum range of about 100!m. The Simrad EA500 and EM120 systems would sometimes lose the bottom or give erroneous readings on station, so care was needed to interpret these digitised records.

The ideal station positions for the Drake Passage section are listed in Table 2.1 and a summary of all CTD deployments is given in Table 2.2. The CTD configurations used during the cruise are detailed in Table 2.3, together with the serial numbers of the relevant sensors. The corresponding calibration coefficients are given in Table 2.4.

On station 05, acquisition of the CTD data stopped at 630!m on the downcast. The cast was restarted and data acquisition again failed during the upcast at 813!m. The deck unit was re-powered and a full cast successfully completed. On station 07, data acquisition again failed on the downcast (at 100 m). The CTD was brought to the surface, the software restarted and a full cast was then completed. At the start of station 08, the CTD PC hung when waiting for the NMEA position data. We believe that this was linked to failure of the Trimble during station 07 which resulted in a disturbance in the NMEA signal. To allow the seasave software to initialise and data acquisition to begin, the NMEA input was disabled (within the configuration file, *115ctd[nn].con*). After this, there was no further interruption to data acquisition on any casts. We believe that if configured to accept NMEA position data, the deck unit waits for an NMEA message so that when communication fails, the system hangs such that no CTD data is acquired. Removing the NMEA signal from the CTD configuration resulted in a noticeable decrease in the time taken to load the Seasave.exe programme suggesting the NMEA input may have a detrimental effect on the running of the software.

On stations 16 and 26 a shallow second cast was made to allow water samples to be collected for biogeochemical analysis (a separate project for the University of East Anglia). These stations were not processed beyond the raw data.

On station 23, the winch was slowed at 200!m on the downcast for a safety check on the wire, after concern about a possible problem with tension readings.

On station 27 the power button was accidentally pressed instead of a bottle being fired at the bottom of the cast. The downcast data was saved to file, and Deck Unit and software restarted for the upcast. These files were then merged for further processing.

2.3   Data Acquisition

1.   At the end of each CTD cast, four files were created by the Seasave Win32 version 5.28e module:

100ctd[nn].dat a binary data file

100ctd[nn].con an ascii configuration file containing calibration information

100ctd[nn].con an ascii header file containing the sensor information

100ctd[nn].bl   an file containing the data cycles at which a bottle was closed on the rosette

These files were saved on the D:\ drive of the CTD PC with a separate folder for each CTD. They were also copied to the N:\ drive, as soon as possible, as a back up.

2.   The CTD data was converted to ascii and calibrated by running the Sea-Bird Electronics Inc. Data Processing software version 5.28f *Data Conversion* module. This program was used only to convert the data from binary, although it can be used to derive variables. This output an ascii file *100ctd[nn].cnv*.

The sensors were calibrated following:

Pressure Sensor:

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

where P is the pressure, T is the pressure period in μS, U is the temperature in degrees Centigrade, D is given by $D = D_1 + D_2 U$, C is given by $C = C_1 + C_2 U + C_3 U^2$, T_0 is given by $T_0 = T_1 + T_2 U + T_3 U^2 + T_4 U_3 + T_5 U_4$.

Conductivity Sensor:

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

where the coefficients are given in Appendix A, , p is pressure, t is temperature, and $\delta = CTcorr$ and $\varepsilon = Cpcorr$.

Temperature Sensor:

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

where the coefficients are given in Appendix A, and f is the frequency output by the sensor.

3. The Sea-Bird Electronics Inc. Data Processing software version 5.28f *Cell Thermal Mass* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This takes the output from the data conversion program and re-derives the pressure and conductivity to take into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output file is of the form *100ctd[nn]_ctm.cnv*. This correction followed the algorithm:

Corrected Conductivity = c + ctm

where,

$ctm = (-1.0 * b * previous\ ctm) + (a * dcdt * dt),$

$dt = (temperature - previous\ temperature),$

$dcdt = 0.1 * (1 + 0.006 * (temperature - 20),$

$a = 2 * alpha / (sample\ interval * beta + 2)$

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

All files were transferred from the CTD PC to the unix system using samba and placed in the directory *~/pstar/data/ctd/ascii_files/115ctd[nn]/* where *nn* was the station number of the cast.

2.4   SBE35 High Precision Thermometer

The BAS SBE35 high-precision thermometer was fitted to the CTD frame. Each time a water sample was taken using the rosette, the SBE35 recorded a temperature in EEPROM. This temperature was the mean of 10 * 1.1 seconds recording cycles (therefore 11 seconds) data. The thermometer has the facility to record 157 measurements but the data was downloaded approximately every few casts and then transferred to the unix system using samba. To process the data, communication was established between the CTD PC and the SBE35 by switching on the deck unit. The *Seabird terminal programme* was used to process the data. This is a simple terminal emulator set up to talk to the SBE35. Once you open the program the prompt is ">". The SBE35 will respond to the command '*ds*' (display status) by telling you the date and time of the internal clock, and how many data cycles it currently holds in memory. A suitable file name can be entered via the 'capture' toolbar button, and the data downloaded using the command '*dd*' (dump data). The data currently held in the memory is listed to the screen. This can be slow due to the low data transfer rate. Once the download is completed the 'capture' button should be clicked to close the open file, and the memory of the SBE 35 cleared using the command "*samplenum=0*". To check the memory is clear the command '*ds*' should again be entered before shutting down the system. The SBE35 data files were divided into separate files for each

station with 12 records (one level for each bottle) called *100sbe[nn]*. These were transferred to unix via samba and placed in the directory *~/pstar/data/ctd/ascii_files/SBE35/*.

The data were converted to temperature using the Sea Bird calibration routines:

$$Temp\left(ITS-90\right) = \left\{\frac{1}{a_0 + a_1 \ln(n) + a_2 \ln^2(n) + a_3 \ln^3(n) + a_4 \ln^4(n)}\right\} - 273.15$$

and $t_{90} = slope \times t_{90} + offset$

where *n* is the output from the SBE 35 and the other constants are listed in appendix!A.

2.5   Salinity Samples

At each CTD station ten (or twelve before the LADCP WH unit was fitted) Niskin bottles were closed and sampled for salinity analysis. The primary purpose of this is to calibrate the salinity measurements made by the CTD sensors. Samples were taken in 200!ml medicine bottles. Each bottle was rinsed three times and then filled to just below the neck, to allow expansion of the (cold) samples, and to allow effective mixing upon shaking of the samples prior to analysis. The rim of each bottle was wiped with a tissue to prevent salt crystals forming upon evaporation, a plastic seal was inserted into the bottle neck and the screw cap was replaced. The bottle crates were colour coded and numbered for reference. The salinity samples were placed close to the salinometer (sited in the chemistry lab) and left for at least 24 hours before measurement. This allowed the sample temperatures to equalise with the salinometer.

The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360 against Ocean Scientific standard seawater (batch P143 and P144). One vial of OSIL standard seawater was run through the salinometer at the beginning, and at the end of each crate of samples enabling a calibration offset to be derived and to check the stability of the salinometer. Once analysed the conductivity ratios were entered by hand into an EXCEL spreadsheet, converted to salinities and transferred to the unix system using samba. They were then read into an ascii data file and used in the further CTD data processing.

30 Standard Seawater vials were used for the analysis and the mean difference in the salinity obtained from replicate pairs was 0.0037 with a standard deviation of 0.00033.

2.6   CTD data processing

Further processing of the CTD data using pstar scripts (in unix) required both the salinity data from the bottle samples and the SBE35 temperature data. The pstar execs check for the required

input files, assuming that they have been placed in the correct directories. The final unix CTD files were a 1!Hz time series for the full cast (for use in LADCP processing, for example), and a 1!db file of the downcast. Following the procedure in JR94, to simplify reprocessing the scan numbers for the start of the downcast maximum depth and end of cast were selected from the 24!Hz file, and entered into a file called *115station_dcs*. Scripts requiring knowledge of these scan numbers were modified to interrogate this file. The scan number for the bottom of file was found automatically using *refval*. The start and end scan numbers were found from listings to the screen, judging the start of the downcast after hauling to the near surface, and selecting a scan number shortly before the CTD broke the surface at the end of the cast.

115seactd0

This exec converted data from the Seabird ascii file *115ctd[nn]_ctm.cnv* to pstar. The start time, water depth, latitude and longitude were extracted from the ascii file, simrad file and navigation files respectively. The initial output file was *115ctd[nn].raw*. A second file, *115ctd[nn]*, was created with calculated salinities and potential temperatures. These were moved to the directories *~/ctd/raw/* and *~/ctd/rough/* respectively.

115seactd1.1

This exec finds the datacycle of the maximum pressure of the ctd cast and appends it to a file *115stations_dcs*.

115seactd1.2

This exec finds the datacycle for the start and end of good data (i.e. from the start of the downcast to the end of the upcast).

115seactd1.3

This exec inserts the datacycles for the start and end of good data into the file *115stations_dcs*.

115seactd2

This exec extracts data from *115ctd[nn]* corresponding to the bottle firing times taken from the Seabird ascii file *115ctd[nn].bl*. Data were extracted for 3 seconds before the bottle closed and 5 seconds after the bottle closed (a total of just under 10 seconds). These 10 seconds of data are averaged to give a file containing a single data cycle for each bottle firing. The output file was *115ctd[nn].btl*.

115seactd3

This exec extracts data from *115ctd[nn]* corresponding to the 24 second measurement period of the SBE35. The 24 seconds of data after the bottle firing time were binned on bottle number andthe output file produced was *115ctd[nn].sbe35*.

115seactd4

This exec applies an automatic edit to the file *115ctd[nn]* to remove data where the CTD is out of the water. This is assessed using the noise in the conductivity. The start and end of the file are binned into 5 second bins. The start of good conductivity data was defined as the first bin in which the standard deviation of conductivity was less than 0.05 mScm^{-1} and similarly for the end of good conductivity data. The output was directed to *115ctd[nn].ed1*.

115samblank.exec

This exec creates an empty sample file *115sam[nn]* containing 12 data cycles corresponding to the positions of the 12 bottles on the BAS rosette.

115samfir

This exec pastes variables, pressure, and temperature, conductivity and derived salinity for each sensor pair, from the CTD data into the sample file *115sam[nn]*. The bottle salinity data is also entered into the sample file.

115botcond

This exec calculates the differences in conductivities between the CTD and bottle samples. These are pasted into the sample file *115sam[nn]*.

115seactd5

This exec applies an automatic edit to the file *115ctd[nn].ed11* to remove data spikes. The differences of salinity and potential temperature from their 1 second filtered values were calculated for both the primary and secondary sensors. Conductivity and salinity values where the absolute difference from the filtered value was greater than 0.01 and to remove temperature and potential temperature where the absolute difference from the filtered value was greater than 0.05 C. The output file from the processing is *115ctd[nn].ed2*.

115seactd6

This exec applies a calibration to the CTD conductivities and recalculates salinities and potential temperatures to form calibrated 24!hz CTD data, output in the file *115ctd[nn].24hz*.

115seactd7

This exec creates 1!hz and 1!db CTD data from the 24!hz CTD data, output in files *115ctd[nn].1hz* and *115ctd[nn].1db* respectively.

2.7   CTD Calibration

Opportunities for CTD data calibration and comparison include internal checks between primary and secondary sensors, comparison with salinity samples, and comparison with the SBE35.

An initial comparison was made of 187 bottle closures at 500 m or deeper (avoiding the steep gradients in salinity and temperature within the upper part of the water column).

For these comparisons the notation T_1, T_2, C_1, C_2, $botC_1$, $botC_2$ and T_{35} is used for primary and secondary temperature and conductivity sensors, conductivities from bottle salinities and SBE35 respectively.

$T_1 - T_2 = 0.0007 \pm 0.0015$ C
$T_1 - T_{35} = -0.00065 \pm 0.0083$ C
$T_2 - T_{35} = -0.0014 \pm 0.0083$ C

$C_1 - C_2 = -0.0091 \pm 0.0012$ mmho cm^{-1}

$botC_1 - C_1 = 0.0128 \pm 0.0015$ mmho cm^{-1}
$botC_2 - C_2 = 0.0029 \pm 0.0014$ mmho cm^{-1}

On this basis it was decided to use the primary temperature sensor and the secondary conductivity sensor. An offset of 0.0029 was applied to the conductivity sensor.

Figures 2.1 to 2.4 show the calculated salinity, temperature, geostrophic velocity (relative to the deepest common level) and potential temperature-salinity plots associated with the data.

station number	lat °S	lat min	lon °W	lon min	nominal depth
1	61	03.00	54	35.23	400
2	60	58.86	54	37.80	600
3	60	51.02	54	42.66	1000
4	60	49.99	54	43.30	1500
5	60	47.97	54	44.55	2500
6	60	40.00	54	49.49	3100
7	60	20.00	55	01.88	
8	60	00.00	55	14.28	
9	59	40.00	55	26.67	
10	59	20.00	55	39.07	
11	59	00.00	55	51.47	
12	58	41.00	56	03.24	
13	58	22.00	56	15.02	
14	58	03.00	56	26.79	
15	57	44.00	56	38.57	
16	57	25.00	56	50.35	
17	57	06.00	57	02.12	
18	56	47.00	57	13.90	
19	56	28.00	57	25.67	
20	56	09.00	57	37.45	
21	55	50.00	57	49.23	
22	55	31.00	58	01.00	
23	55	12.86	58	12.24	3500
24	55	10.25	58	13.86	3000
25	55	07.27	58	15.71	2500
26	55	04.18	58	17.62	2000
27	54	57.66	58	21.67	1500
28	54	56.62	58	22.31	1000
29	54	55.34	58	23.10	600
30	54	40.00	58	32.61	250

Table 2.1: Definitive station positions for Drake Passage section (from Bacon et al., 2003).

STATION	Calendar date	Day of Year	Time at bottom (GMT)	Longitude (W)	Latitude (S)	Water depth (db)	Ctd Max pressure (db)	Comment
115ctd01	2/12/2004	337	23:47	58 8.46	53 20.46	1570	1546.425	test station
115ctd02	3/12/2004	338	07:45	58 32.56	54 39.93	379	373.052	SR1b-01
115ctd03	3/12/2004	338	10:04	58 22.97	54 55.42	563	577.256	SR1b-02
115ctd04	3/12/2004	338	11:16	58 22.12	54 56.69	1163	1211.597	SR1b-03
115ctd05	3/12/2004	338	16:17	58 21.74	54 57.61	1585	1608.607	SR1b-04
115ctd06	3/12/2004	338	19:17	58 17.62	55 4.18	2138	2076.562	SR1b-05
115ctd07	3/12/2004	338	23:53	58 15.71	55 7.26	2508	2547.459	SR1b-06
115ctd08	4/12/2004	339	02:45	58 13.90	55 10.26	3011	3067.531	SR1b-07
115ctd09	4/12/2004	339	05:40	58 12.23	55 12.93	4165	4204.930	SR1b-08
115ctd10	4/12/2004	339	09:59	58 0.95	55 30.99	4244	4306.560	SR1b-09
115ctd11	4/12/2004	339	14:41	57 48.86	55 49.90	4780	4849.054	SR1b-10
115ctd12	4/12/2004	339	19:21	57 37.46	56 8.91	3431	3469.784	SR1b-11
115ctd13	4/12/2004	339	23:45	57 25.69	56 28.05	3800	3956.964	SR1b-12
115ctd14	5/12/2004	340	04:19	57 13.75	56 47.03	3207	3332.033	SR1b-13
115ctd15	5/12/2004	340	08:36	57 1.87	57 5.71	3722	3835.477	SR1b-14
115ctd16	5/12/2004	340	13:18	56 50.30	57 24.89	3479	3515.530	SR1b-15
115ctd16b	5/12/2204	340	15:06	56 49.27	57 24.37	250	253	shallow station for biogeochemistry
115ctd17	5/12/2004	340	18:51	56 38.65	57 43.99	3518	3532.267	SR1b-16
115ctd18	5/12/2004	340	23:09	56 26.78	58 3.07	3992	3992.934	SR1b-17
115ctd19	6/12/2004	341	05:17	56 15.23	58 22.01	3930	3949.891	SR1b-18
115ctd20	6/12/2004	341	09:25	56 3.24	58 41.02	3803	3803.613	SR1b-19
115ctd21	6/12/2004	341	13:31	55 51.47	59 0.10	3804	3825.081	SR1b-20
115ctd22	6/12/2004	341	19:00	55 39.07	59 20.00	3790	3816.339	SR1b-21
115ctd23	6/12/2004	341	23:27	55 26.72	59 40.03	3749	3732.776	SR1b-22
115ctd24	7/12/2004	342	03:55	55 14.03	60 0.07	3537	3551.467	SR1b-23
115ctd25	7/12/2004	342	08:12	55 1.75	60 20.00	3477	3488.160	SR1b-24
115ctd26	7/12/2004	342	12:30	54 49.26	60 39.95	3117	3120.522	SR1b-25
115ctd26b	7/12/2004	342	14:08	54 47.52	60 39.80	250	255	shallow station for biogeochemistry
115ctd27	7/12/2004	342	18:41	54 44.47	60 47.96	2560	2604.031	SR1b-26
115ctd28	7/12/2004	342	20:58	54 43.29	60 49.99	1651	1791.335	SR1b-27
115ctd29	7/12/2004	342	22:27	54 42.63	60 50.99	996	1011.159	SR1b-28
115ctd30	8/12/2004	343	00:18	54 37.80	60 58.86	593	575.694	SR1b-29
115ctd31	8/12/2004	343	01:36	54 35.20	61 3.00	362	351.902	SR1b-30
115ctd32	13/12/2004	348	16:52	70 26.13	68 1.72	861	847.210	Station for Brandon et al. (OU)
115ctd33	18/12/2004	353	12:06	58 22.36	54 56.60	1119	1126.548	repeat of SR1b- with LADCP
115ctd34	18/12/2004	353	14:11	58 23.05	54 55.37	522	526.322	repeat of SR1b- with LADCP
115ctd35	18/12/2004	353	16:15	58 32.55	54 40.01	386	379.536	repeat of SR1b with LADCP

Table 2.2: Summary of JR115 CTD deployments.

CTD sensor	Serial Number	date last calibrated
Series 410K-105 Digiquartz pressure transducer	93686	15-April-04
Primary SBE 4C conductivity sensor	42875	17-March-04
Primary SBE 3 plus temperature sensor	4302	02-March-04
Primary pump SBE 5 T submersible pump	2395	
Secondary SBE 4C conductivity sensor	41912	17-March-04
Secondary SBE 3 plus temperature sensor	32191	02-March-04
Secondary SBE 5 T submersible pump.	2400	
Tritech PA200/20-5 Altimeter	2130.27001	
Seabird SBE 43 Oxygen sensor	0620	21-March-04
Chelsea Aqua 3 Fluorometer	88216	21-June-04
Chelsea Seatech Wetlab Cstar Transmissometer	CST-527DR	01-July-04
Biospherical Instruments Par Sensor	7274	24-March-04

Table 2.3: JR115 CTD configuration with sensor instrument numbers.

```
DATE: 12/10/200                            5) Frequency, Conductivity, 2

ASCII file: D:\data\JR115\jr115B.CON       Serial number : 41912
Configuration report for SBE 911/917 plus CTD   Calibrated on : 17 March 04
-----------------------------------------   G          : -4.15895000e+000
                                            H          : 5.35728000e-001
Frequency channels suppressed : 0          I          : -5.18624000e-004
Voltage words suppressed    : 0            J          : 5.00904000e-005
Computer interface          : RS-232C      CTcor      : 3.2500e-006
Scans to average            : 1            CPcor      : -9.57000000e-008
Surface PAR voltage added    : No          Slope      : 1.00000000
NMEA position data added    : No           Offset     : 0.00000
Scan time added             : No
                                            6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor
1) Frequency, Temperature
                                            Serial number      : 7274
Serial number : 4302                       Calibrated on      : 24th March 04
Calibrated on : 2 March 04                 M          : 1.00000000
G          : 4.37260000e-003               B          : 0.00000000
H          : 6.41632000e-004               Calibration constant : 38310000000.00000000
I          : 2.16042000e-005               Multiplier     : 1.00000000
J          : 1.73786000e-006               Offset         : -0.03798000
F0          : 1000.000
Slope       : 1.00000000                    7) A/D voltage 1, Free
Offset      : 0.0000
                                            8) A/D voltage 2, Fluorometer, Chelsea Aqua 3
2) Frequency, Conductivity
                                            Serial number : 88216
Serial number : 42875                      Calibrated on : 21 June 04
Calibrated on : 17 March 04                VB         : 0.387000
G          : -1.05506000e+001              V1         : 2.014200
H          : 1.46804000e+000               Vacetone   : 0.396800
I          : -5.25852000e-003              Scale factor : 1.000000
J          : 5.11651000e-004               Slope      : 1.000000
CTcor      : 3.2500e-006                    Offset     : 0.000000
CPcor      : -9.57000000e-008
Slope      : 1.00000000                     9) A/D voltage 3, Free
Offset     : 0.00000
                                            10) A/D voltage 4, Transmissometer, Chelsea/Seatech/Wetlab CStar
3) Frequency, Pressure, Digiquartz with TC
                                            Serial number : CST-527DR
Serial number : 09P35716-0771(93686)       Calibrated on : 1 July 04
Calibrated on : 15 April 04                M          : 21.1770
C1          : -4.785925e+004               B          : -1.2710
C2          : -3.416160e-001               Path length   : 0.250
C3          : 1.442400e-002
D1          : 3.781000e-002                 11) A/D voltage 5, Free
D2          : 0.000000e+000
T1          : 3.011158e+001                 12) A/D voltage 6, Altimeter
T2          : -3.924450e-004
T3          : 4.201770e-006                 Serial number : 2130.27001
T4          : 2.250320e-009                 Calibrated on :
T5          : 0.000000e+000                 Scale factor  : 15.000
Slope       : 1.00000000                    Offset        : 0.000
Offset      : 0.00000
AD590M      : 1.284610e-002                 13) A/D voltage 7, Oxygen, SBE 43
AD590B      : -8.492756e+000
                                            Serial number : 0620
4) Frequency, Temperature, 2               Calibrated on : 21 March 04
                                            Soc        : 4.0500e-001
Serial number : 32191                      Boc        : 0.0000
Calibrated on : 2 March 04                 Offset     : -0.5123
G          : 4.31969000e-003               Tcor       : 0.0006
H          : 6.38784000e-004               Pcor       : 1.35e-004
I          : 2.26921000e-005               Tau        : 0.0
J          : 2.13675000e-006
F0          : 1000.000
Slope       : 1.00000000
Offset      : 0.0000
```

Table 2.4: JR115 CTD calibration coefficients.
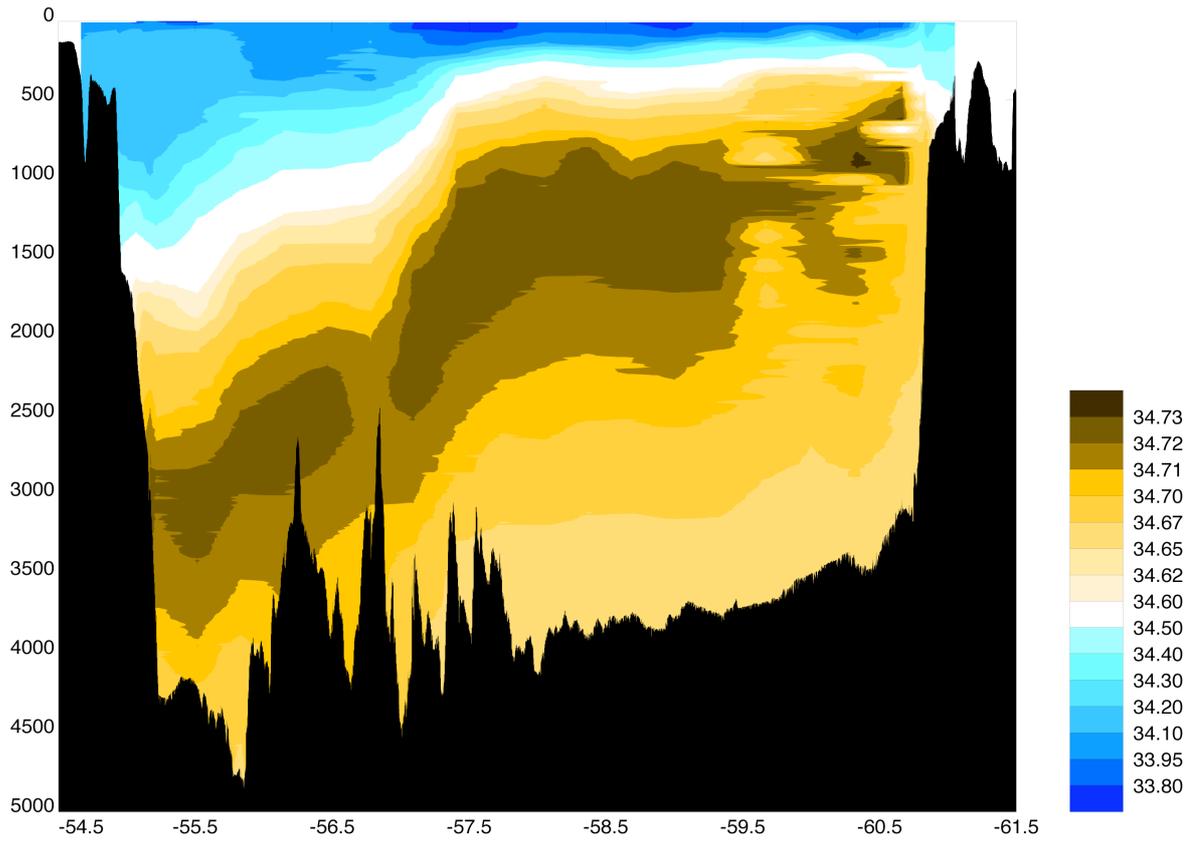
Figure 2.1: Contour plot of salinity for SR1b section across Drake Passage. The section is plotted from north (left hand side) to south (right hand side). The x and y axes are latitude and pressure (db) respectively.
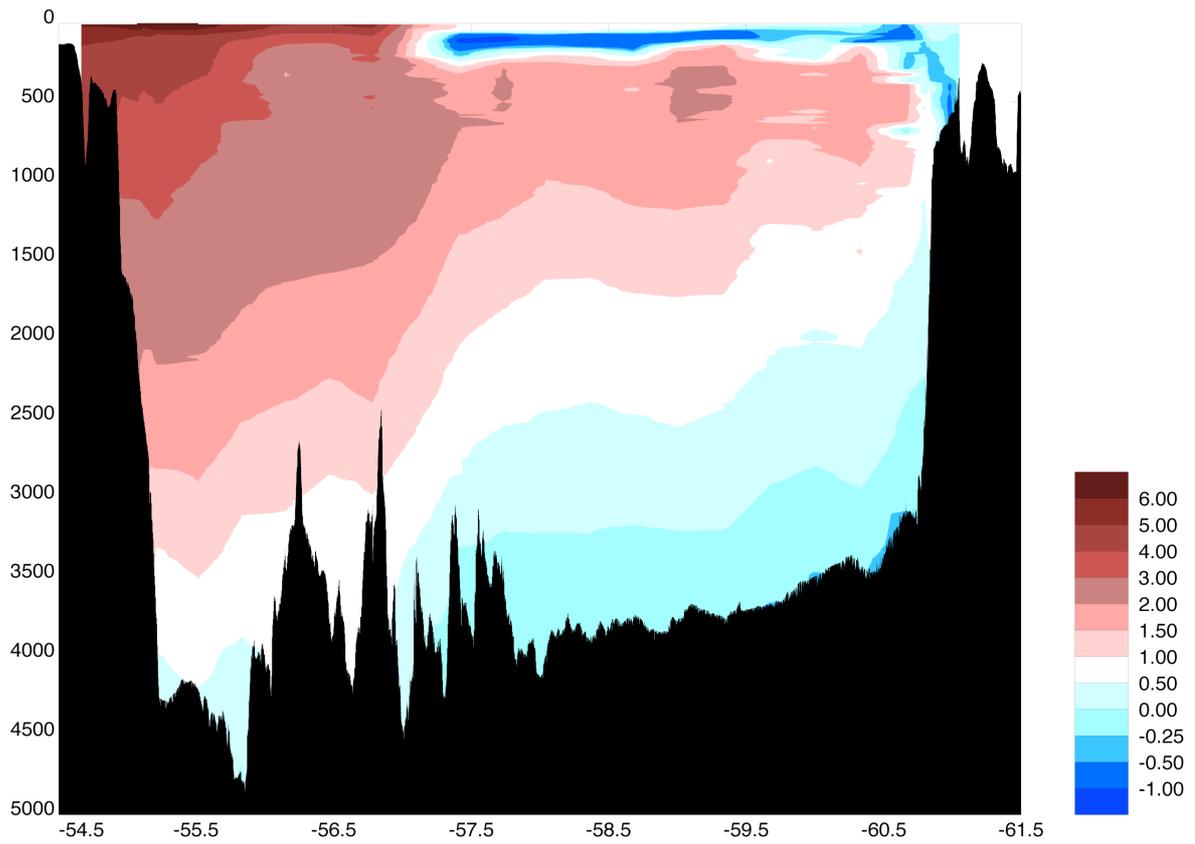
Figure 2.2: Contour plot of potential temperature (°C) for SR1b section across Drake Passage. The section is plotted from north (left hand side) to south (right hand side). The x and y axes are latitude and pressure (db) respectively.
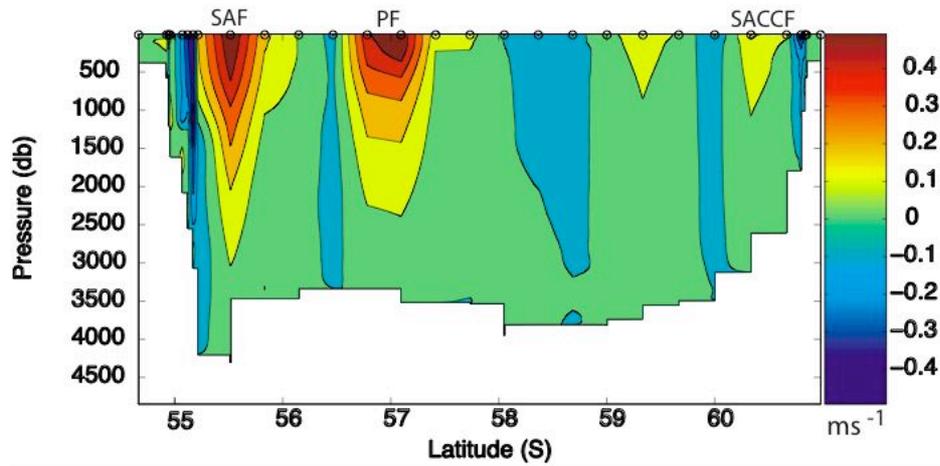
Figure 2.3: Contour plot of geostrophic velocity (cm!s⁻¹) for SR1b section across Drake Passage.

The geostrophic velocity was calculated from adjacent hydrographic stations referenced to the deepest common level (DCL).

The location of the major ACC fronts are marked: Polar Front (PF), Sub-Antarctic Front (SAF), Southern ACC Front (SACCF).
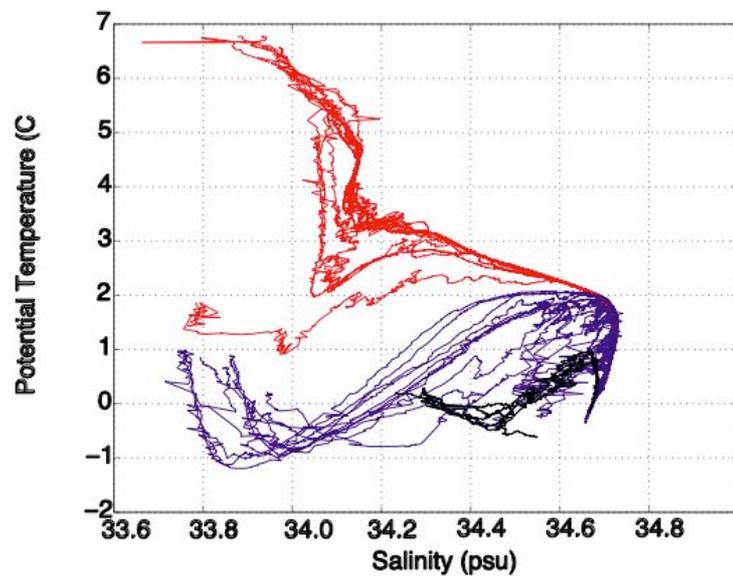
Figure 2.4: Potential temperature!/!salinity plot for the JR115 SR1b Drake Passage section.

Stations to the north and south of the Polar Front are represented in red and blue, respectively. Stations to the south of the Continental boundary marking the southern edge of the ACC, on which Antarctic Continental Shelf waters were observed, are represented in black..

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3. LADCP

Mike Sparrow

3.1   Introduction

Cruise JR115 was the sixth cruise to use a RDI Workhorse WH300 ADCP (WH) unit. The details of its use are described in the JR67 cruise report (Bacon et al., 2002). As in cruise JR115, a single WH unit was deployed (S/N 1885) in a downward facing position on the CTD frame.

The LADCP unit, spares box, computer and battery had been left on board from a previous cruise. Unfortunately the equipment had somehow become scattered throughout the ship (for example, the battery pack was found lashed down in the deck engineers' workshop, and the computer was in the explosives locker). Since the section ended up being worked southbound, there were unnecessary delays whilst the relevant equipment was tracked down. It is to be highly recommended that, in the future, such equipment should not be left on board ship for any length of time.

When the equipment was eventually located it was discovered that the leads/chargers etc. used last year had not been included. This meant that the battery could not be easily charged during the section (though this turned out not to be a problem; see section 3.3). Once the LADCP equipment had been set up in the lab it was found impossible to communicate to the WH unit (many different combinations of baud rate, leads etc. were tried). Rather than delay the section it was decided to start with the CTDs while the problem was being investigated.

After much tearing out of hair and grinding of teeth, and with the help of the UKORS people, Dan and Rob, two problems were discovered:

(i)   The internal fuse in the WH unit had blown. This was replaced.

(ii)   The DOS software supplied with the ancient UKORS computer (BBTALK etc.) was not suitable for communicating to the WH unit. Luckily the UKORS people had some more up-to-date software (WinSc) that, when loaded onto the PC was able to communicate to WH unit. However, this meant remaking a deployment file, the parameters of which are listed in section 3.4. The instructions for use of this software were also different (see section 3.5).

The above problems meant that no LADCP data were collected until station 07, although the first three stations of the SR1b section (i.e. stations 02, 03 and 04) were repeated on the northbound leg. Thus LADCP data was eventually obtained for all but 2 of the SR1b stations

(SR1b-04 and SR1b-05).

A further problem encountered was that after the first deep cast the new WH unit clamps suffered somewhat from the pressure (see Figure 3.1). After this cast holes were drilled in the clamps.

3.2 JR115 LADCP Positioning

Figure 3.2 shows the positioning of the WH unit and battery pack on the CTD frame. The WH unit was fitted to its mounting bracket and set in a downward-facing position on the outside of the CTD frame. The battery pack was mounted in a vertical position, with one bracket attached to an inner support of the CTD frame and another bracket attached to an outer support. A third bracket was taken on the cruise, but was found to be impractical to fit. Two Nisken bottles were removed from the CTD rosette, due to the positioning of the battery pack. A fin was added to the CTD frame to reduce spinning.

3.3 Battery Pack

The performance of the LADCP battery pack (S/N WH003) was far superior to the previous cruise (JR94), when the batteries had to be trickle charged during the section. During JR115, however, the batteries only lost 3.8V (from 49.5V after the 1st cast with the WH unit) over the 28 casts.

It should be noted that it was necessary to remove the vent plug every 10 stations or so. The operation is described in the JR67 cruise report (p. 43 of Bacon et al., 2002).

3.4 Workhorse configuration and deployment

An ADCP planning file had to be produced for the new WinSC software. This was done by opening WinSC -> File -> New Deployment. A single planning file was produced and used for all casts. The parameters are listed in Table 3.1. Most parameters remained the same as for the configuration file described in the JR67 cruise report (p.44 of Bacon et al., 2002).

Note that for cast 035 (repeat of section number 01), EX11111 was changed to EX00111 in order to try collecting some data in beam coordinates, i.e. radial beam dopplers, instead of earth coordinates (transformed to east-north-up). This will be processed at a later date.

3.5 JR115 instructions for use of LADCP

3.5.1 Connections

The WH unit was connected to the battery pack and controlling PC (COM 1) via a double serial cable (the 'slave' cable for use with a second WH unit was blanked off). It was not necessary to connect the battery to a charging unit. See previous cruise reports (e.g. Bacon et al., 2002) for further details.

3.5.2 Software

Since the WH unit refused to talk to the PC using the software provided, the windows based WinSC (named WinScadcp in the following) was loaded. This seemed to have several advantages over the previous DOS based software:

(i) Everything could be done from the same programme
(ii) The Baud rate could be set much higher (115200 instead of 38400) allowing faster uploading of the files on recovery.

However, as the software was adopted and implemented in somewhat of a hurry it would be a good idea to explore the software more fully before the next cruise. It looks as if many of the commands are common to both types of software (one can use the terminal commands by 'File'->'Terminal' and proceed as normal).

Occasionally the rather elderly LADCP PC would crash. The reason for this was never ascertained, but a more modern PC should be acquired for the next cruise.

3.5.3 Pre-deployment

(i) Ensure coms lead is in place (to Upward facing plug on frame – COM1, PC1)

(ii) Open 'WinSCadcp'
  Go to Functions -> import planning file
  Use: c:\Ladcp\Jr115\Dpl1_\Dpl1_.whp
  (This should only need to be done once unless the PC crashes).

(ii) Check settings: Got to 'ADCP' -> 'Settings'
  should be Com1, Baud rate 115200, Parity None, Stop bits 1.

(iii) Check PC clock time: Go to 'Functions' -> Set ADCP time date
  check PC clock is set correctly (rhc bottom right clock icon).

(iv)   Run Tests : Go to 'File'->'Test ADCP' or 'Functions' -> 'Test'

Skip compass verification. Wide band width test fails (LADCP not used in this mode). Remember to 'press any key' sometimes as some of the tests are continuous. Ignore the bit about rubbing the ladcp head (or people will think you're a bit odd) – just press return.

3.5.4   Deployment

(v)   Still in WinScadcp go to 'Functions'->'Deploy'. Note time of deployment.

(vi)   Remove coms lead and fit blanks. Secure leads to frame. Ensure LADCP is pinging. Remove protective cap from unit if not already done.

3.5.5   Recovery

(vii)   Remove blanks and reconnect coms lead.

(viii)   Note time of stop logging

(ix)   In WinScadcp: 'File' -> 'recorder status': Note memory used and memory free.

(x)   Recover data: 'File'->'Recover recorder data': File LADCPXXX.000 is downloaded – change this to 115mNNN.000 (NNN= 3 digit cast number). Note that it didn't seem possible to download only the last deployment (more investigation of the software required), so all files had to be downloaded. In this cruise we adopted the procedure of emptying the memory every second cast ('Functions'->'Erase Recorder Data').

(xi)   Check battery voltage.

(xii)   Drag file to unix_drop (U:\data\ladcp/raw) for further processing.

A basic log sheet (see Table 3.2) was adopted. This should be improved for any subsequent cruises.

3.6   Initial Data Processing

Before any data could be processed the software had to be installed on the UNIX system. The steps in setting up the software were similar to those used in JR81 (Bacon et al., 2003).

Best practice is for data to be processed as soon as possible after a CTD station in order to check the instrument has worked correctly and that the data has been downloaded from the WH unit onto the controlling PC laptop and UNIX system without any problems. However because so little time was available to get the software running correctly the processing was not completed until after the end of the section.

Initial processing of the data was carried out using software that originated from Eric Firing's group at the University of Hawaii.

Due to failure of the NMEA during staions 07 and 08, these were reprocessed using the Ashtech to get position (i.e. for these two stations in gps_ash was used in *putpos2* rather than gps_nmea).

The initial steps of data processing on JR115 were as follows:

(i)   Log onto one of the UNIX machines as pstar, password pstar.
          You must be logged on to jrua to get access to the matlab licence

(ii)   *cd ladcp* (ensures you're in the correct directory)
          setup jr115matlab (set up matlab)
          source LADall (set up paths)

(iii)   *cd proc*
          cd Rlad
          linkscript (checks the raw LADCP data; there should be a raw file called 115mNNN.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 downlooking WH.).

(iv)   *cd proc*
          perl −S scan.prl NNN_02 (allows the user to check the start and end times for the downcast and upcast. The duration of the downcast and upcast should be similar. The minimum and maximum depths should also be checked).

(v)   *putpos2* (collects start and stop times, positions, and gets the magnetic variation correction using a matlab routine. Updates stations.asc and magvar.tab. Note that if you run this more than once for the same station then you should go into these files and delete the invalid entry).

(vi)   *perl −S load.prl NNN_02* (loads data into the CODAS 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. In JR115 these are found in proc/casts/jNNN_02/scdb).

(vii)   *perl −S domerge.prl −c0 NNN_02* (merge single pings into long shear profiles. Occasionally this would give an error that could only be solved by opening a fresh window and running stage (2) again before running the perl script).

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(viii)   *cd Rnav*

       updatesm.exec (updates a navigation file and calls matlab)

       cd proc

(ix)   The data can be plotted and checked using the following commands:

       plist = NNN.02 (sets the station and cast number – always 2 – to process. This is a decimal number in matlab)

       do_abs (generates five plots showing the various velocity components and information about the sensor such as its heading, tilt and angle).

3.7   Secondary Processing (absolute velocities)

Once the CTD has been processed as far as a 1hz file the absolute velocities can be calculated in the following manner:

(i)   In UNIX:

       cd proc

       cd Rctd

       mk_ctdfile NN (makes ascii version of CTD 1hz file in preparation for LADCP use)

(ii)   In Matlab:

       cd to proc/Pctd

       ctd_in(NNN,02)

       cd proc/Fitd

       plist = NNN.02   (set the station and cast - always 2 – numbers)

       fd (check vertical velocities from CTD and LADCP agree)

(iii)   In UNIX:

       cd proc

       perl –S add_ctd.prl NNN_02 (add the CTD data to the CODAS database)

       perl –S domerge.prl –c1 NNN_02 (merge the ping profiles using the CTD data)

(iv)   In Matlab:

       plist = NNN.02

       do_abs (When the velocity profiles are plotted they should be a similar shape to the profiles at the end of the 'first look' data processing, but with a mean velocity, so that the U and V velocities have a mean offset).

Figure 3.3 shows the zonal meridional velocity structure across Drake Passage, which makes

an interesting comparison with the geostrophic velocities calculated from the CTD data and shown in Figure 2.3.

```
CR1
CF11101
EA0
EB0
ED0
ES35
EX11111
EZ0111111
LW1
LD111100000
LF500
LN16
LP1
LS1000
LV250
SM1
SA001
SI0
SW5000
TE00:00:01.00
TP00:01.00
CK
CS
;
;Instrument        = Workhorse Sentinel
;Frequency         = 307200
;Water Profile     = YES
;Bottom Track      = NO
;High Res. Modes   = NO
;High Rate Pinging = NO
;Shallow Bottom Mode= NO
;Wave Gauge        = NO
;Lowered ADCP      = YES
;Beam angle        = 20
;Temperature       = 5.00
;Deployment hours  = 24.00
;Battery packs     = 1
;Automatic TP      = YES
;Memory size [MB]  = 48
;Saved Screen      = 1
;
;Consequences generated by PlanADCP version 2.02:
;First cell range  = 15.15 m
;Last cell range   = 165.15 m
;Max range         = 168.26 m
;Standard deviation = 5.31 cm/s
;Ensemble size     = 468 bytes
;Storage required  = 38.56 MB (40435200 bytes)
;Power usage       = 67.62 Wh
;Battery usage     = 0.2
;
; WARNINGS AND CAUTIONS:
; Lowered ADCP feature has to be installed in Workhorse to use selected option.
; Advanced settings has been changed.
; Expert settings has been changed.
```

Table 3.1: LADCP planning file for WinSC software, with parameters.

CTD Cast Number:

Deployment:

1. Run tests

2. Check Settings: Com1, Baud rate = 115200, stop bits= 1

3. PC clock time:

   Master Clock time:

   Diff:

4. Time of start of logging:

Recovery:

1. Recovery time:

2. Space used:

3. Free space:

4. File name (old):

5. File name (new – 115mNNN.000):

6. File size:

7. Battery voltage:

Table 3.2: LADCP log sheet

Figure 3.1: The WH and the WH unit clamps showing the effects of 4km depth of water.

Figure 3.2: The WH unit and battery pack on the BAS CTD frame.
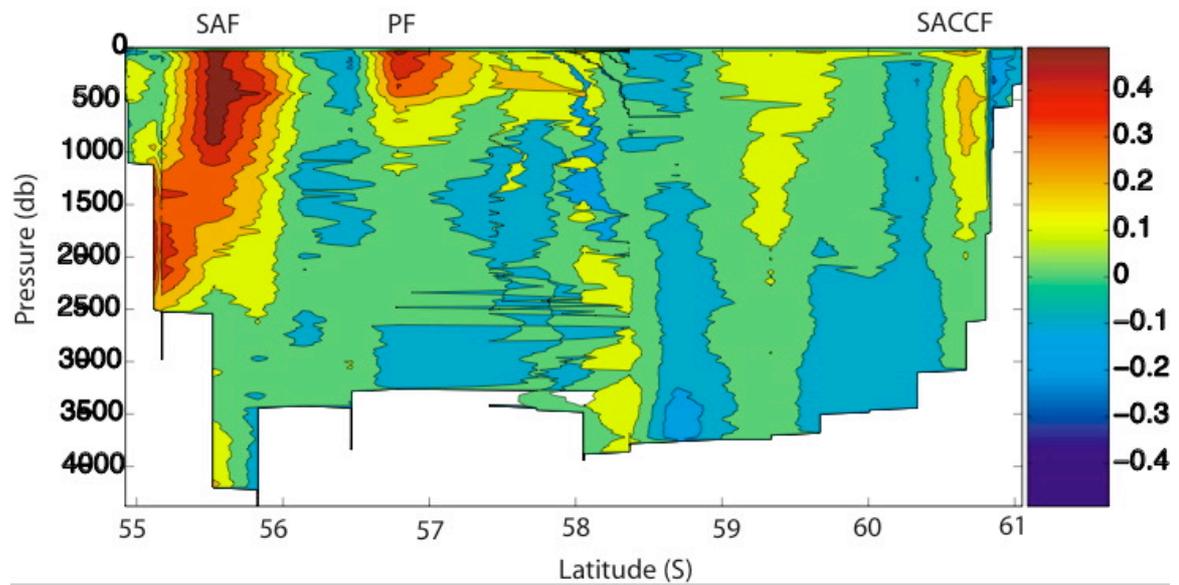
Figure 3.3: The zonal meridional velocity (cm!s⁻¹) field from LADCP data across Drake Passage.

The major fronts are marked; Polar Front (PF), Sub-Antarctic Front (SAF), Southern ACC Front (SACCF). The major features observed in the geostrophic velocity field (Figure 2.3) are also seen here.

4.   NAVIGATION

Sue-Ann Watson, Justin Buck, Marc Lucas, Mike Sparrow

4.1   Introduction

During JR115 data from five of the scientific navigational instruments on *RRS James Clark Ross* were routinely processed. The navigational systems include: Trimble 4000, Ashtech GLONASS (GG24), Ashcheck ADU-2, Gyrocompass and Bestnav. These systems and the data processing are described in more detail below.

4.2   Trimble 4000

The Trimble 4000 GPS is the ship's primary source of positional information. During JR115, the system went down on three occasions and had to be rebooted (see section 7). The dates and times are listed in Table 4.1.

The Trimble 4000 data was converted to the *pstar* format using *115gpsexec0*. This was done by daily chunks throughout the duration of the cruise and produces three files, 115gps[jday]d.raw, 115gps[jday]d and 115 gps01.

4.3   Ashtech GLONASS (GG24)

The Ashtech GG24 records data from both the American GPS and the Russian GLONASS satellite clusters. This extends the constellation of available satellites to 48, increases the accessibility to satellite fixes and hence should provide more accurate navigation than standard GPS coverage allows.

Data was processed using the UNIX script *115ggexec0*, which creates an output file of the form 115glo[jday][a/p].raw. It also carries out some basic quality control and stores the good data in the file 115glo[jday][a/p].

4.4   Ashtech ADU-2

The main role of the Ashtech ADU-2 GPS system is to correct the ship's gyrocompass data. This is necessary because when the ship executes a manoeuvre, the gyrocompass fluctuates significantly for several minutes due to an inherent instrument error.

One of the watch keeper duties is to check that the system is running properly. This is done by regularly checking the data gathering (every four hours) in the unix system by typing the following command *Ashcheck* and insuring that the data stream has been recently updated.

On one occasion the ashtech system failed during JR115 for unknown reasons. This occurred from jday 341 23:26 to jday 342 09:05.

The ashtech data must be processed and merged with the gyro data in order to correct the latter data for gyrocompass oscillations.

(i)   Read data into pstar (115ashexec0)
Data was read in from the ship's level C system into the *pstar* environment in daily chunks, creating one raw data file, 115as[jday]d.raw

(ii)   Merging of the Ashtech data with the Gyro data (115ashexec1)
The gyro and the Ashtech data were merged into a single data stream and the differences between the two ship's heading stream calculated. This created on single file, 115ash[jday]d.mrg

(iii)   Quality control (115ashexec2)
This routine checked the merge data and rejected all the data outside the following limits:

Heading: $0°$ to $360°$

Pitch: $-5°$ to $5°$

Roll: $-7°$ to $7°$

Attf: -0.5 to 05

Mrms: 0.00001 to 0.01

Brms: 0.00001 to 0.1.

a-ghdg: $-5°$ to $5°$

The data were then averaged into two minute bins and once again quality controlled.
This produces two new files, 115ash[jday]d.edit and 115ash[jday]d.ave

(iv)   Despiking of data (115ashedit.exec)
The final step consists of manually removing the a-ghdg outliers using the *pstar* routine plxyed, called up by the executable. This produces two files, 115ash01.int and 115ash[jday]d.ave.dspk.

4.5 SeaTex

The SeaTex SEAPATH 200 unit provides heading data for the em120 swath system. It was not processed during this cruise.

4.6 Gyrocompass

The gyrocompass provides the most continuous information on the ships heading. Its major drawback is that is fluctuates for several minutes following a ship's manoeuvre. The gyrocompass data is used to correct other instruments data such the VM-ADCP and the meteorological acquisition system.

Data was read from the RVS Level C system into the *pstar* environment in daily chunks using *115gyroexec0*, creating two output files: 115gyrd and 115gyr[jday]d.raw

4.7 Bestnav

Bestnav is one of the standard data streams produced by the computer system on the ship and can be viewed by typing *lookd* into pstar. Bestnav provides positional information at 30!second intervals using the best available data source. GPS is used when available, but otherwise the system uses dead reckoning based on data from the gyrocompass and velocity sensors on the ship.

Data processing: In the UNIX system, the script *115navexec0* was run from the directory 'pstar/data/exec'. This script was used to convert the Bestnav data to pstar format and temporarily changed the directory to 'pstar/data/nav/bsn'. The two-digit year number was entered as '04' and the Julian day, or Jday, was entered. The options to select the am, pm or whole day segments of the data were given. The 'whole day' option 'd' was used to analyse the complete 24-hour data set from the Julian day. The start and end times were confirmed as 04XXX000000 and 04XXX235959 GMT for each Julian day analysed, where XXX was the Julian day. The scripts use the following pstar programs: *datapup*, to input the RVS data and form a pstar binary file; *pcopya* and *pheadr* to set the header information; *posspd* to calculate east and north velocities; *pdist* to calculate distance run; *pcopya* to remove the RVS distance variable; and *papend* to append the data to the master file. The new data were appended to the master navigation file 'abnv1151' and the number of data cycles and version number of the file were recorded in the log sheet.

A second script *115navexec1* was then run from 'pstar/data/exec'. This script takes a straight copy of the unsmoothed navigation data from 'abnv115', averages, filters, smooths and despikes the data, and puts the resultant data in the file 'abnv1151.av'. The version number of this file was also recorded in the log sheet.

4.8　　Comparison of Navigation Streams

Justin Buck

The three navigation streams were compared; firstly by plotting the three streams at a time when the ship was stationary (Figure 4.1), and secondly by taking the differences between each stream for the southbound passage across the Drake Passage (Figure 4.2).

Figure 4.1 shows that when the JCR is stationary the differences between the three streams are no more than 0.0002 degrees of latitude or longitude. This corresponds to 22 m of latitude and 12 m of longitude. When the entire southbound passage across the Drake Passage is considered (Figure 4.2) larger differences between the three systems are apparent. The large discrepancy at the start of day 339 is accounted for by the temporary loss of the navigation stream. The large discrepancy during day 342 is due to the loss of the ADU-2 data stream for that period. Apart from a few intermittent spikes in the difference between the Ashtech GLONASS and Trimble 4000 GPS systems (Figure 4.2 e,f) the navigation streams maintain the accuracy observed when the JCR was stationary. The Ashtech ADU-2 is not as accurate as the other sources, with differences of up to 0.003 degrees observed (Figures!4.2!a,b,c,d), corresponding to 330 m of latitude and 206 m of longitude. This is unsurprising since the primary purpose of the Ashtech ADU-2 is to obtain the attitude of the ship. In conclusion, no reason was found for switching from using Trimble 4000 GPS system for the recording of latitude and longitude.

Jday	Off line time	Online line	notes
338	22:24:15	23:33:40	
339	02:06:30	02:45:00	Switched to LEICA GPS
340	00:45:07	01:05:00	

Table 4.1: Dates and times of Trimble failure.
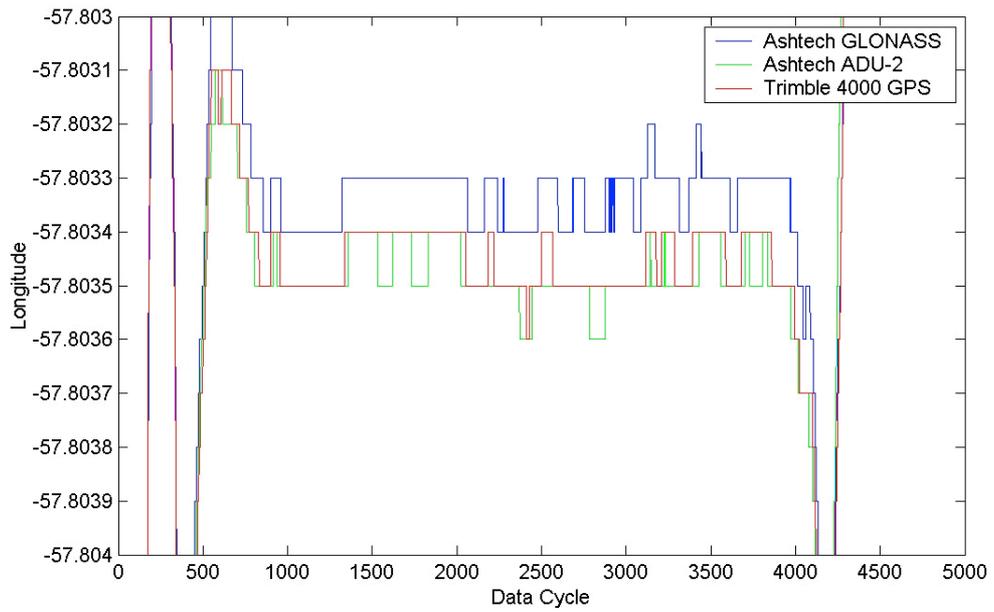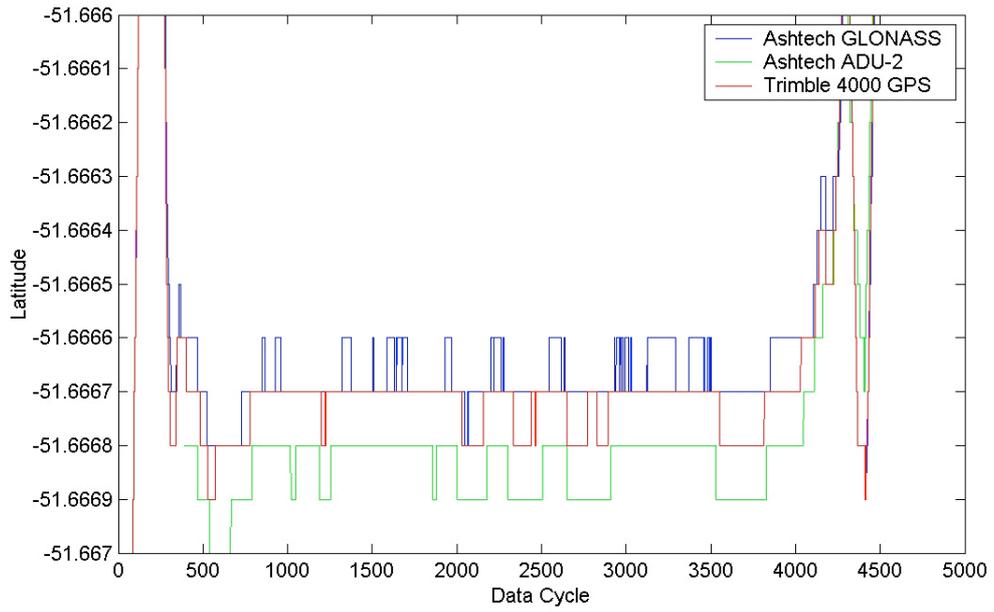
Figure 4.1: Positions derived from the three navigation streams during stationary periods.
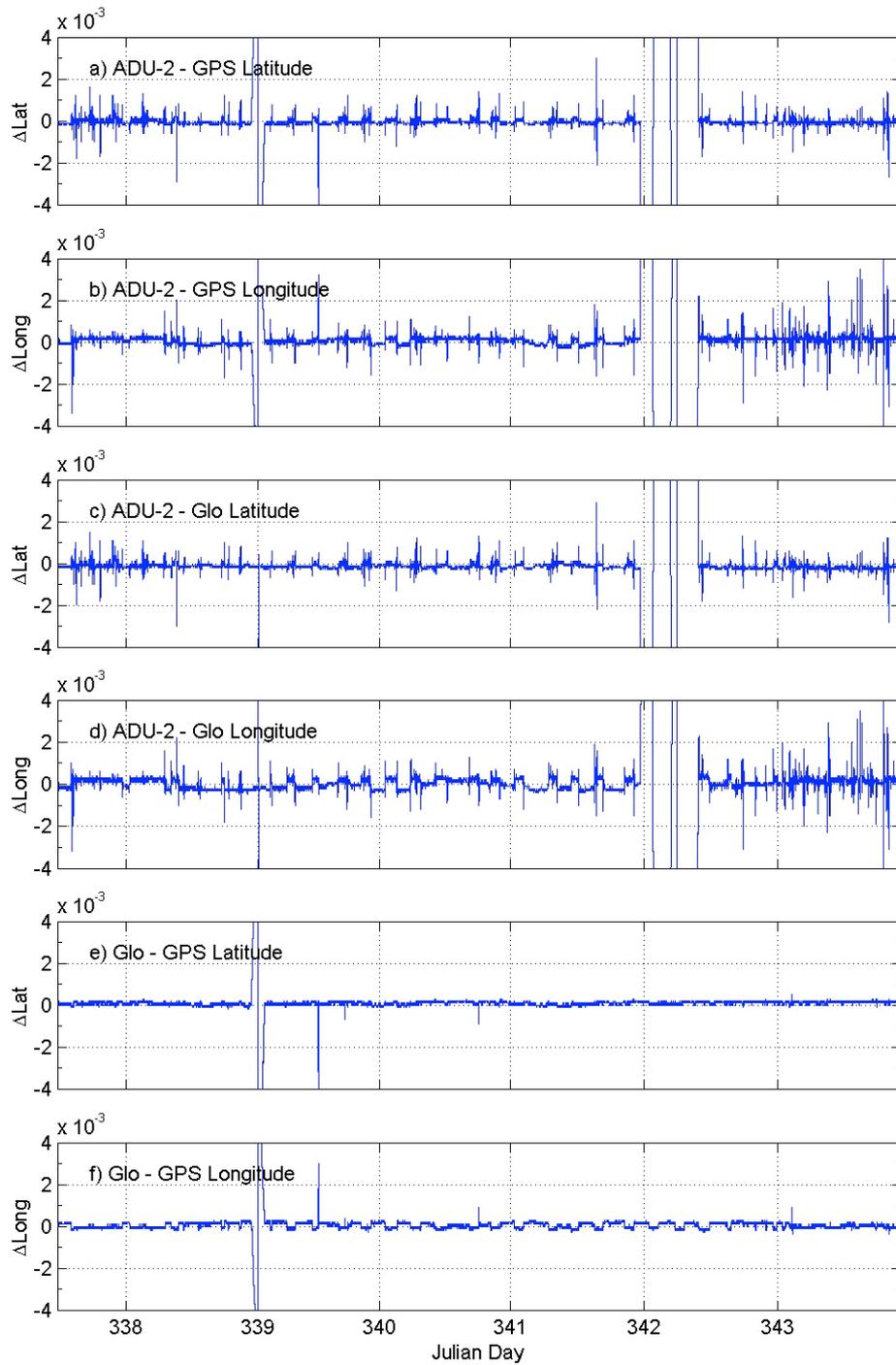
Figure 4.2: Differences between locations derived from the three navigation streams during the southbound Drake Passage section.

ADU-2 is the Ashtech ADU-2, GPS is the Trimble 4000 GPS and Glo is the Ashtech GLONASS system.

5.   VM_ADCP

Marc Lucas, Mike Sparrow

5.1   Introduction

In this section the data acquisition method of the Vessel Mounted Acoustic Doppler Current Profiler (VM-ADCP) is described. The processing steps and the relevant executables are then detailed, and the problems described. Generally, the instruments performed in a satisfactory manner except for two instances: when the Trimble 4000 GPS and theAshtech ADU-2 failed.

5.2   Setup

5.2.1   Configuration of VM-ADCP

The RRS James Clark Ross has a hull mounted RD instrument 150 kHz ADCP which provides near continuous vertical profiles of ocean currents in space and time. The instrument has four beams, resolving all three-velocity components (u, v, w) relative to the ship. The calculation of an error velocity, the difference between the two vertical velocity components, allows an estimate of data quality to be made. By merging the VM-ADCP data with that collected by other instruments such as the GPS and the gyroscope, absolute current velocities can be obtained.

On the JCR, the VM-ADCP is placed in a recess in the hull filled with a mixture of ionised water (90%) and ethylene glycol (10%). This recess is covered by a 33 mm thick Low Density PolyEthylene (LDPE). The transducer head is rotated by 45º to the fore-aft axis. This is done in the hope of increasing the response in the main direction of motion.

During JR115 the data collected by the instrument was averaged into 64 x 8!m bins in ensembles of 2 minutes duration, which were passed directly to the ship's level C. The 'blank beyond transmission' was set to 4 m and the approximate depth of the transducer was 6 m. This means that the centre of the first bin is at a depth of 18 metres (rather than the usual 14!m, see Brian King for details).

The version of the firmware used by the VMADCP was 17.07 and the version of RDI Data Acquisition Software (DAS) was 2.48. The software ran on a Viglen Pentium II 266Mhz desktop machine running DOS located in the UCI laboratory.

5.2.2 *Modes of operation*

The VM-ADCP can be operated in two modes configured through the direct command menu of the DAS, water tracking (WT) and bottom tracking (BT). During the latter mode the instrument was configured to make one bottom track measurement for every four water track measurements.

During JR115, data in BT mode were collected in shallow waters (shallower than approximately 500 m), generally over Burdwood Bank and the Antarctic Peninsula shelf. Data in WT mode were collected when the water depth was in excess of 500!m where useful bottom tracking was not possible.

5.3   Problems

During failure of the Trimble 4000 GPS (see section 3) only the gyro data was available. This led to difficulties in estimating the true direction and speed of the water past the ship.

The Ashtech ADU-2 also failed for unknown reasons. This made it difficult to determine the correction to apply to the gyro heading.

5.4   Processing

(i)   Read data into PSTAR (115adpexec0)

Data was read from the RVS Level C system into the *pstar* environment in daily chunks, creating two output files containing the water track and bottom track data respectively: 115adp[jday]d and 115bot[jday]d.

(ii)   Temperature correction (115adpexec0.1)

The VM-ADCP DAS assumes that the instrument's transducer is placed in ambient water. The speed of sound is calculated using the temperature measured at the transducer's head and an assumed salinity of 35. A correction must be made to the data to take into consideration the composition of the liquid in the recess of the hull where the instrument is located. These corrections were derived using data obtained from RDI by Mike Meredith and Brian King. This routine outputs two files: 155adp[jday]d.t and 115bot[jday]d.t.

(iii)   Clock correction (115adpexec1)

The data gathered from the VM-ADCP is time stamped by the PC running the DAS. Because the PC clock drifts from the ship's Master clock at a rate of about 1 second per hour, the

timing error on the raw data must be corrected. During JR115, the time difference between the Master clock and the PC clock was recorded every four hours. These differences are entered manually while running 115adpexec1 and the relevant correction applied to the data. This routine outputs the following 3 files: 155adp[jday]d.corr, 115bot[jday]d.corr, and clock115[jday]d.

(iv)   Gyrocompass correction (115adpexec2)

As mentioned earlier, the VM-ADCP measures velocities relative to the ship. In order to obtain true East and North velocities, it is necessary to correct the raw data for the ship's heading. This data is obtained from two instruments, the gyrocompass and the Ashtech ADU-2 GPS. It can be found on the ships level C system and needs to be uploaded into the PSTAR environment. This is achieved through running 115gyroexec0 which produces two files, 115gyr[jday]d.raw and 115gyrd.

The gyrocompass provides near continuous data but can oscillate substantially after a manoeuvre. It can be corrected by using the GPS data from the Ashtech ADU-2 system but the Ashtec system does not provide continuous measurements and, as a result, the gyro data must be corrected by 2 minutes ensembles. The data is thus uploaded, merged and then average before being manually despiked using the Ashtec series of executables. This gives the ships true heading. The output files are 115adp[jday]d.true and 115bot[jday]d.true

When the Ashtech ADU-2 failed, the correction was approximated in the following way:

(a)   the ash-gyro on either side of the gap was averaged in two hours chunks.

(b)   The mean of the two values was calculated and the missing data was then filled with the resulting value (-0.5).

(v)   Calibration (115adpexec3)

Two further corrections must be applied to the data in order to take into account an inherent scaling factor associated with the VM-ADCP (A) and to compensate for the misalignment of the VM-ADCP transducers with the GPS Ashtech ADU-2 antennas (ϕ).

These are obtained in the following manner:

$$A = U_{gps} / U_{VMADCP}$$
$$\phi = \phi_{gps} - \phi_{VMADCP}$$

where U_{gps} and U_{VMADCP}, and ϕ_{gps} and ϕ_{VMADCP} are the averaged speeds and headings, derived from the GPS and bottom track VM-ADCP data respectively. The direction of ϕ was reversed to give it the correct orientation and it was put in the range $-180 < \phi < 180$. Outliers were

excluded. Table 5.1 details the steps required to obtain A and φ. Table 5.2 gives the values of A and φ for specified periods.

The VM-ADCP data was then calibrated using the values of A and φ. For JR115, the following values were obtained:

$$A = 1.0361 \qquad \phi = -1.69$$

Since the ship was stuck in ice for about 3 days (jdays 346, 347, 348), the data collected during that period was not suitable for calibration.

These values compare with the following obtained on previous cruises:

A =1.030   φ = -1.60   (Mc Creadie and King, JR94)

A =1.0284   φ = -1.68   (Hardy and Brandon, JR84)

A =1.0285   φ = -1.275   (Meredith, JR81)

A =1.0290   φ = -1.55   (Meredith, JR70)

A =1.0314   φ = -1.81   (Hawker, King and Meredith, JR67)

A =1.0253   φ = -1.48   (Meredith, JR57)

A =1.0269   φ = -1.55   (Meredith and King, JR55)

Two new files are created, 115adp[jday]d.abs and 115bot[jday]d.abs, which contain the calibrated current velocities relative to the ship.

(vi)   Ship velocity correction (115adpexec4)

The final correction subtracts the ship velocity vectors from the data to obtain absolute values of current velocities. This is done by merging the VM-ADCP data to the ships navigation data obtained from the 'bestnav' executables. The final absolute velocities are written to the 115adp[jday]d.abs and 115bot[jday]d.abs. The processing steps are summarised in Figure!5.1.

5.5   Results

The files for jdays 337 to 343 were merged together, creating a file named 115adpall.abs. From this file the values for the depth of 106 m were extracted (115adpallc.bin) and then averaged in half hour chunks (115adpallc.ave). Finally, the periods of bad data, such as when the Trimble failed were removed (115adpallc.ave). The data was then plotted using *parrog* and saved a postscript file before being imported into Corel Draw for further editing (Figure!5.2).

Derivation of A and φ in the pstar environment.

1) Periods during which the VM-ADCP provides good quality bottom track data and during which the ship's heading remains nearly constant are identified for each jday.

2) The files of jdays with bottom track data are processed through 115adpexec3 by setting A to 1 and φ to 0 (dummy runs). This produces two files, 115adp[jday]d.cal and 115bot[jday]d.cal.

3) The data is then merged with the Trimble 4000 GPS data, which gives the ships true heading and speed to obtain absolute current velocities. This is done by running 115adcpexec4, which produces two new files: 115adp[jday]d.abs and 115bot[jday]d.abs

The final step consists of running 115adcp_calibration_exec and entering the lower and upper cycles limits for each of the periods identified in section 1. The routine outputs values for A and φ for the specified periods. It also outputs a 115bot[jday]d.abs.ext where ext is a file extension chosen by the user (see Table 5.2).

Table 5.1: Derivation of A and φ in the pstar environment.

Jday	Start of cycle	End of cycle	A	φ
338	132	165	1.0354	-1.8662
338	168	186	1.0390	-1.9075
338	249	281	1.0385	-1.5878
343	12	144	1.0276	-1.8113
344	10	34	1.0742	-1.7181
345	382	393	1.0306	-1.8344
345	421	456	1.0319	-1.8090
345	517	540	1.0317	-1.8654
349	548	559	1.0277	-1.2834
349	555	583	1.0274	-1.4807
349	625	681	1.0323	-1.5212
Weighted average for JR115			**1.0361**	**-1.69**

Table 5.2: Values of A and φ for JR115.
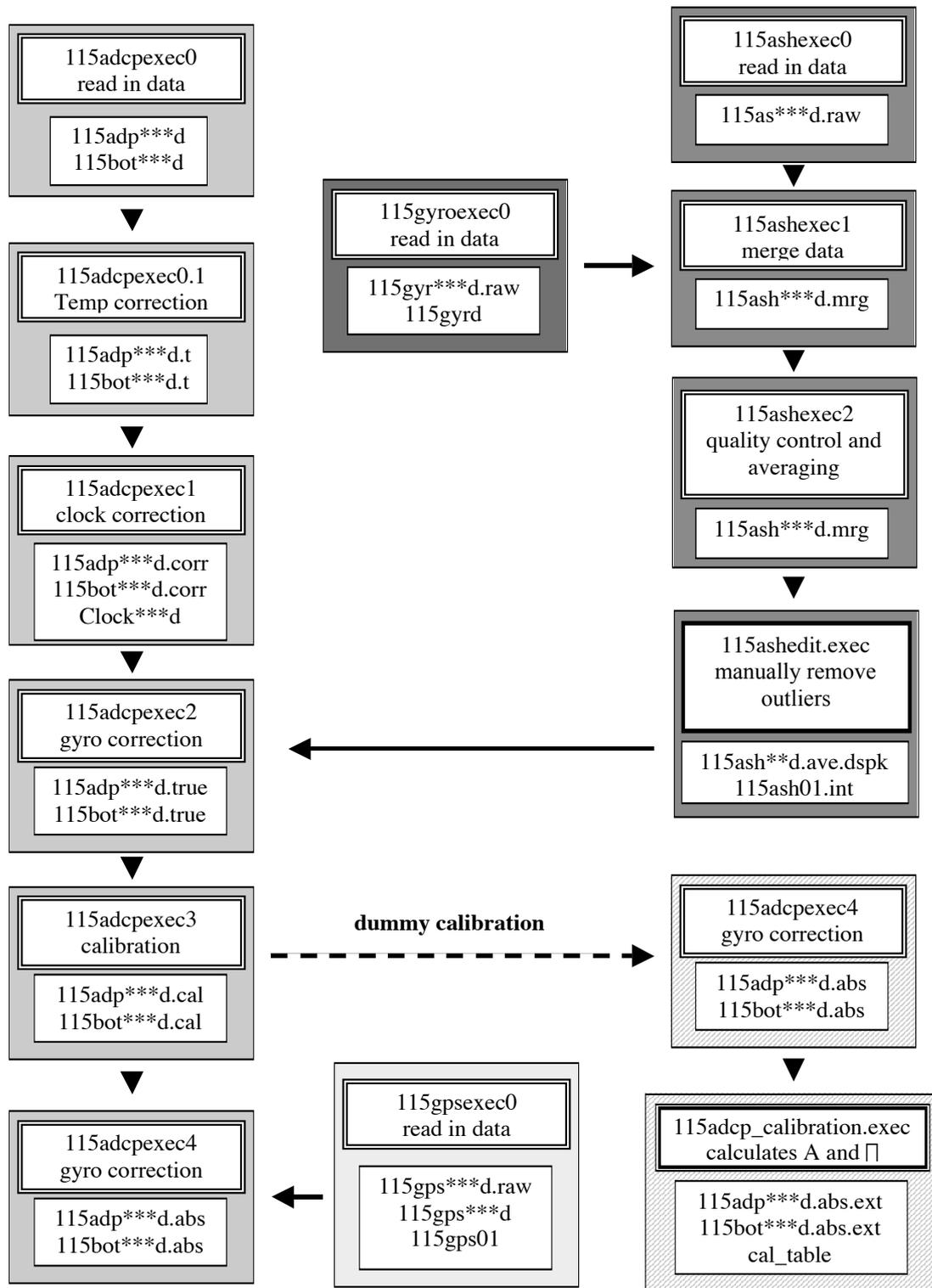
Figure 5.1: Summary of VM-ADCP processing.
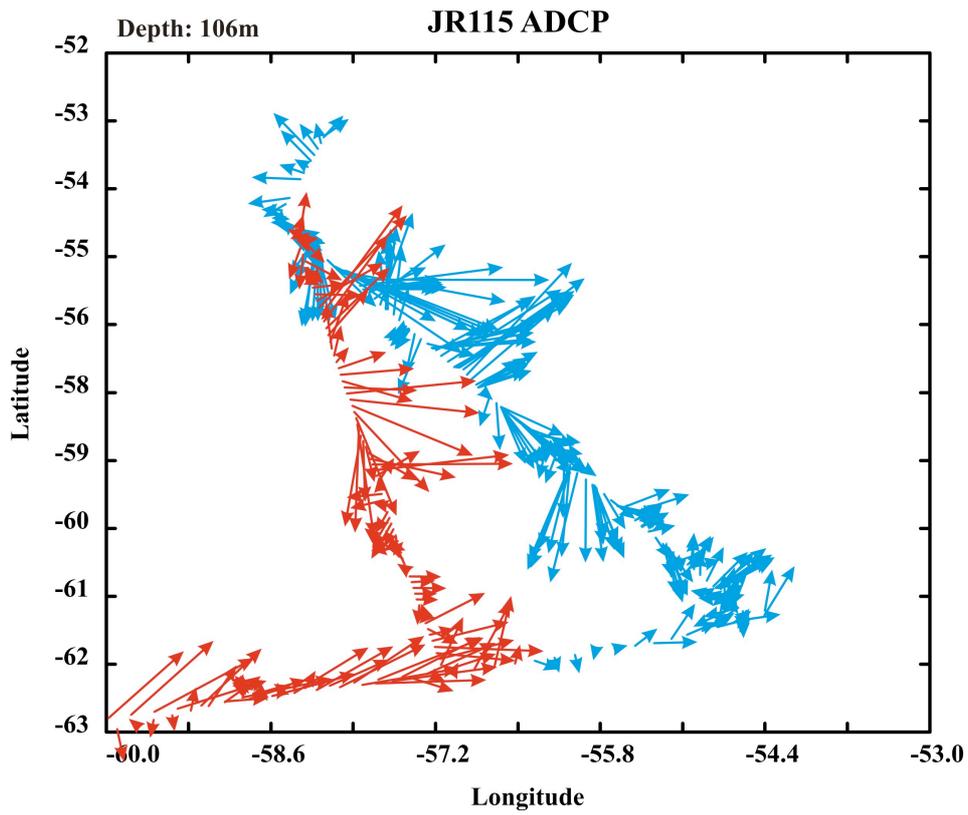
Figure 5.2: VM-ADCP Current vectors at a depth of 106 m across the Drake Passage. The southbound and northbound legs are represented in blue and red, respectively.

6. UNDERWAY

Justin Buck

6.1 Introduction

Throughout the Drake Passage section data was recorded onto the oceanlogger system. This data was passed to the Shipboard Computer System (SCS), after which it was accessed and processed using pstar (see section 6.2). The parameters collected are summarised in Table 6.1. Meteorological data were measured by instruments on the forward mast, and surface layer oceanic parameters were measured using the ships uncontaminated water supply. Many of the meteorological parameters are recorded with duplicate sensors, allowing some redundancy in the system if an instrument fails. The ship anemometer data was also available in a separate stream, and processed with the meteorological data.

Recording of underway data began at 00:00 day 337 and continued throughout the cruise. Recording was stopped during the afternoon of day 353 over the Burdwood Bank. The data presented in this section is for the southbound leg across the Drake Passage (jdays 337 to 343) and the northbound leg across the Drake Passage (jdays 351 to 353). Since most of the CTD casts were made southbound, the northbound leg was of much shorter duration.

There was a problem with logging the gyro heading between 20:00 on jday 341 and 07:00 on jday 342.

6.2 Data Capture and Processing

Data was processed in 24 hour sections using pstar. The scripts are based on those used during the previous JR94 Drake Passage cruise.

The executables for processing the data are described here:

115oclexec0: reads the ocean-logger and anemometer data streams and stores them into a single pstar type file.

115oclexec1: splits the data into separate ocean data and meteorological data files. It also de-spikes the conductivity data and calculates a raw salinity value.

twvelexec: Merges the met data file with gyrocompass and navigation data streams in order to calculate ship motion and true wind velocity.

papend: used to append the one day processed sections of data together.

pmerge: used to merge ocean, meteorological, navigation and sim500 echo sounder

data sets together.

Data were then despiked and plotted using MATLAB, and the differences between duplicate instruments were calculated (instrument 1 - instrument 2).

6.3   Air Temperature (Figures 5.1a and 5.2b)

During the southbound leg the air temperature had the same trend as the SST, with values between 0°C and 2°C south of the Polar Front (57°S) and between 5°C and 7°C north of the front. The temperature offset between the two instruments was between -0.3°C and +0.4°C throughout the section. Interestingly, this pattern was not observed during the northbound leg with the air temperature steadily increasing from –2°C at 61°S to 5°C at 54.5°S.6.3.

6.4   Humidity (Figures 5.1b and 5.2c)

The humidity had a range between 75% and 100% throughout the southbound leg, with the maximum values of 99% between 60°S and 58.7°S. Values of 90% to 100% were recorded between 54.3°S and 57.5°S. The periods of high pressure corresponded to the periods of low humidity. During the northbound leg the humidity also increased with decreasing pressure (75% at 61°S to 99% at 56°S) and vice versa (78% at 54.5°S). The humidity difference between the two instruments was between -1% and +4% throughout the southbound leg and between -1% and +3% for the northbound leg.

6.5   Sea Surface Temperature (Figure 5.1c)

Values of between 5°C and 7°C were recorded for the first part of the southbound section (53°S to 57°S). Once the Polar Front was reached the values decreased to around 0°C for the remainder of the section (57°S to 61°S). As in the case of salinity, the Polar Front was observed further south on the northbound leg (~57.7°S) and was less well defined.

6.6   Salinity (Figure 5.1d)

Values of approximately 34.0 were recorded for the first part of the southbound leg (53°S to 57°S). Once the Polar Front was reached, the values decreased to around 33.8 (57°S to 60.6°S). The salinity then increased to 34.4 when the Antarctic continental shelf was reached

(60.6°S). A similar situation was observed on the northbound leg, although the front was less well defined and was observed further south (57.7°S).

6.7   Fluorescence (Figure 5.1e)

Fluorescence estimates the amount of phytoplankton in the surface water, giving an indication of primary production. For most of the southbound leg the fluorescence had values of around 0.5 µg l^{-1}. On the continental shelf edges (53.6°S, 55.5°S and 60.7°S) this value increased to between 1.5 and 2 µg l^{-1}. This was most apparent at 55.5°S where the area of increased fluorescence covered 0.5 degrees of latitude. There was an additional area of increased fluorescence in the region of the Polar Front at 57°S, with values up to 1!µg!l^{-1}. The northbound leg had a different pattern with the lowest values (<!0.5!µg!l^{-1}) south of the Polar Front (57.7°S). The values increased north of the front to up to 2!µg!l^{-1} and then reduced in value to around 1!µg!l^{-1} at 55.5°S for the remainder of the leg.

6.8   Air Pressure (Figure 5.2a)

The air pressure was 998!mbar at the start of the southbound leg, and decreased to 980!mbar at 57°S. It subsequently increased to 988!mbar at 58°S with another minimum at 59.5°S. The pressure returned to 988 mbar until the end of the section (61°S). During the northbound leg the pressure decreased from 1000 mbar at 61°S to 987 mbar at 55.5°S. The pressure then increased for the remainder of the leg. This variation in pressure during the northbound leg was associated with a low pressure weather system (cyclonic). The air pressure difference between the two instruments was ±0.2!mbar throughout the cruise.

6.9   Total Incident Radiation (Figure 5.2d)

The TIR showed near zero values at night with values that increased towards midday, and decreased towards night. The maximum daily values of TIR varied from 500 W!m^{-2} up to 900!W!m^{-2}. Variation in the maximum values was due to the degree of cloud cover or mist. During the day the difference between the two instruments was less than +150!W!m^{-2}. There was a night-time offset from zero of -0.3!W!m^{-2}. Similar results were observed for both the southbound and northbound legs.

6.10 Photosynthetically Active Radiation (PAR) (Figure 5.2e)

The same patterns were observed in the PAR as for the TIR, with a daily maximum and an evening minimum. The maximum values of PAR varied from 1500 $\mu m!s^{-2}!m^{-2}$ to 2300 $\mu m!s^{-2}!m^{-2}$. During the day the difference between the two instruments had a maximum value of +100 $\mu m\ s^{-2}\ m^{-2}$. There was a night offset between the two instruments of +3 $\mu m!s^{-2}!m^{-2}$. Similar results were observed for both the southbound and northbound legs.

6.11 Anemometer (Figure 5.2f)

Throughout the southbound leg the wind direction was predominantly southerly with wind speeds ranging from 10 m s^{-1} to 20 m s^{-1}. There were two regions where this was not the case; firstly, between 58°S and 59°S the winds direction were easterly with speeds between 5 and 10 m!s^{-1}, and secondly, there were also easterly winds between 56.5°S and 57°S with wind speeds between 5 and 10 m s^{-1}. During the northbound leg the winds were predominantly northerly, changing to westerly at 55°S. Wind speeds during the northbound leg were between 10 and 20 m s^{-1}. The change in direction was associated with the cyclonic weather system.

6.12 Flow Meter

Flow rates of between 0.5 and 0.8 (uncalibrated) were maintained throughout both legs. When ice was encountered the flow was switched off to prevent the system getting blocked.

6.13 Water Masses and Ocean Fronts

Three principle water masses were observed in the underway data. These are clearly observed in Figure 6.3, where SST is plotted against the salinity for both the southbound and northbound legs. The first of these water masses is Sub-Antarctic Surface Water, with salinities between 33.8 and 34.1 and temperatures between 5°C and 7°C. This water is located north of the Polar Front. To the south of the Polar Front two further water masses are observed. The first is Antarctic Surface Water, with salinities between 33.6 and 34.0 and temperatures between -0.5°C and 1.5°C. The second is Continental Shelf Water, observed south of 60.6°S during the southbound leg on the continental shelf with salinities between 33.8 and 34.4, and temperatures between -0.8°C and 0.4°C.

	Parameters	No. of Sensors
Meteorological	Air Pressure	2
	Air Temperature	2
	Air Humidity	2
	Total Incident Radiation (TIR)	2
	Photosynthetically Available Radiation (PAR)	2
	Wind Speed	1
	Wind Direction	1
Oceanographic	Sea Surface Temperature (SST)	1
	Salinity	1
	Fluoresence	1

Table 6.1: Environmental parameters recorded by the Oceanlogger system.
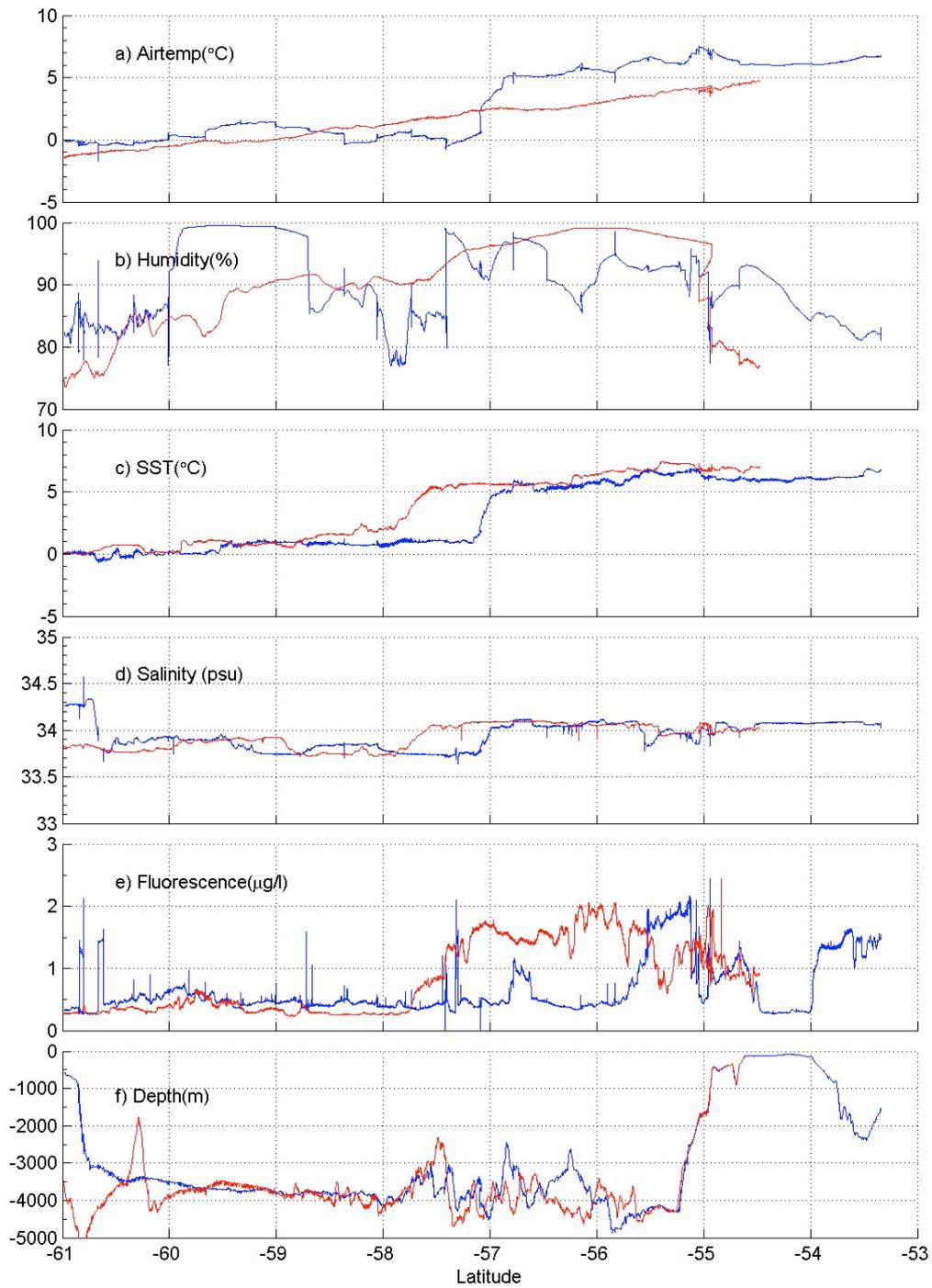
Figure 6.1: Plots of air temperature, humidity, SST, salinity, fluorescence and depth against latitude.

The southbound and northbound legs are represented in blue and red, respectively. For duplicate instruments, only the primary data is plotted.
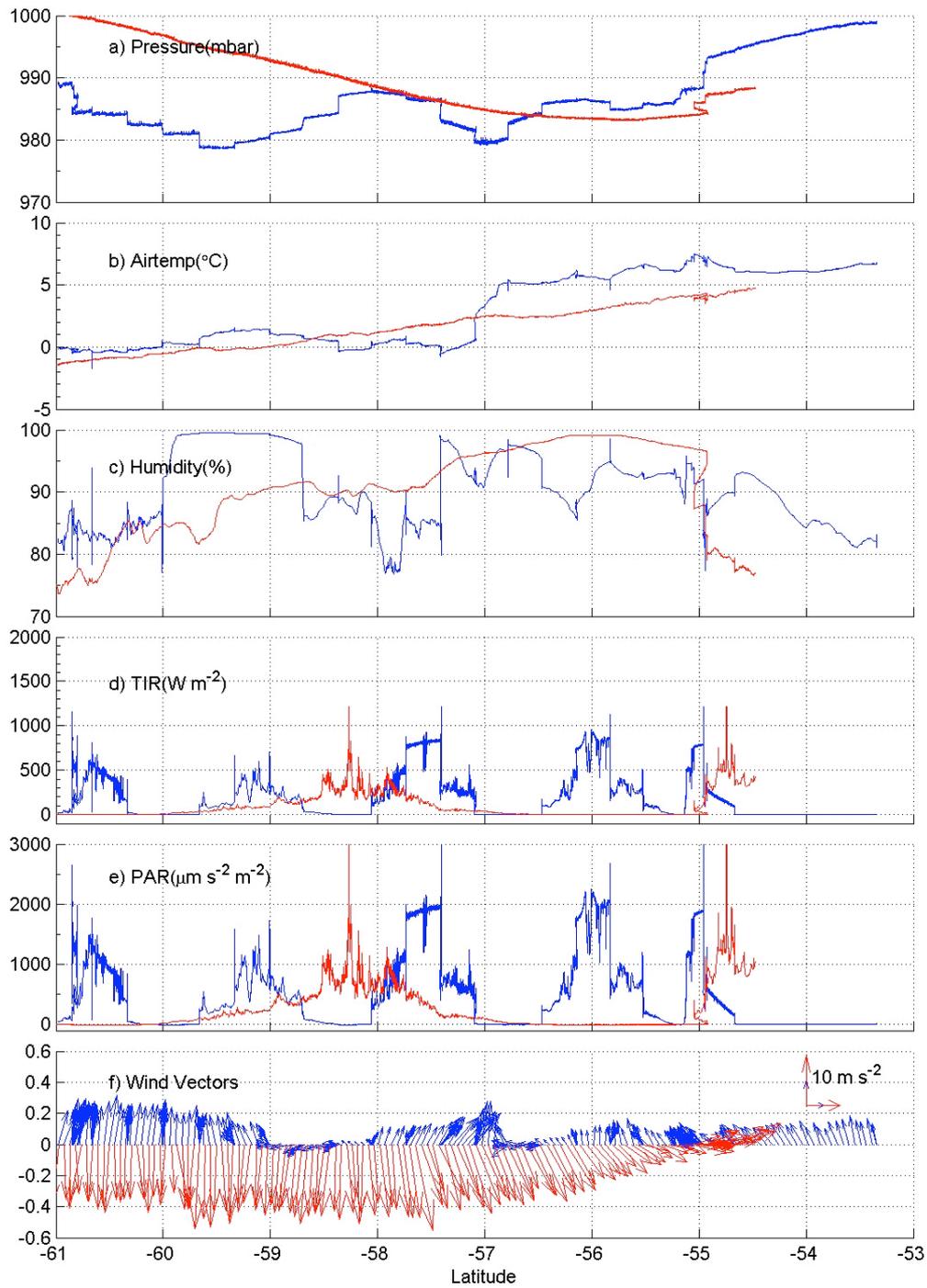
Figure 6.2: Plots of the meteorological parameters with latitude.

Data from the southbound leg is illustrated in blue, and from the northbound in red. For duplicate instruments, only data from the primary instrument is shown.
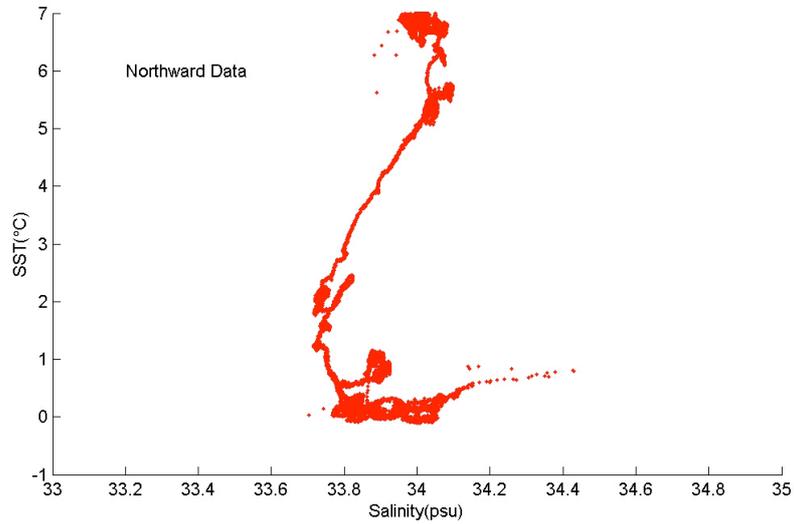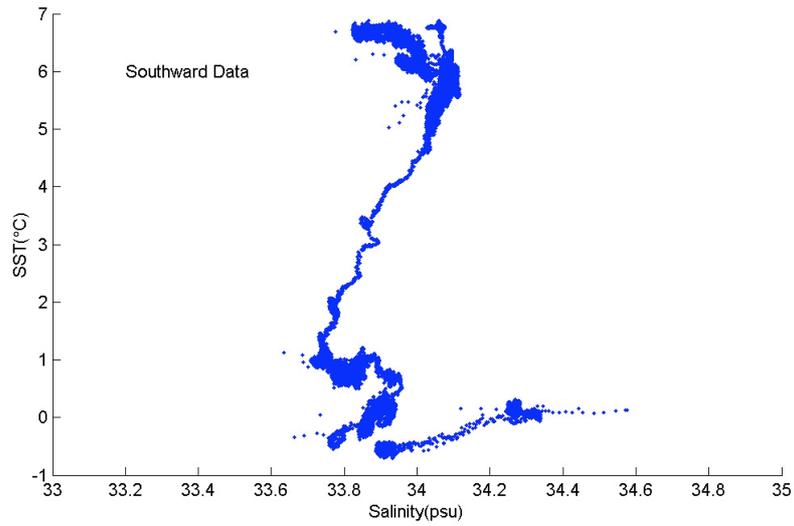
Figure 6.3: Plots of sea surface temperature (SST) against salinity.

The upper panel (blue) corresponds to data from the southbound leg across Drake Passage, and the lower panel (red) to data from the northbound leg.

7.   ECHO-SOUNDER

Sue-Ann Watson

7.1   Introduction

The RRS *James Clark Ross* is equipped with two SIMRAD echo-sounders, the single beam EA600 and the swath bathymetry system EM120. The EA600 has been upgraded from the EA500 used on previous cruises. The EA600 has one transducer mounted on the hull to starboard. The two echo-sounder systems are synchronised so they can be run simultaneously. Both echo-sounders were used to produce a bathymetry profile. For comparison with EA600, only the centre beam of EM120 was used. Logging and data processing are similar for both systems.

7.2   Data processing

Raw data with an assumed sound velocity of 1500!m!s^{-1} are logged by the SCS onto simulated level C streams. Raw data were retrieved into a twice daily pstar file using the pstar scripts *115sim* and *115swt* for EA600 and EM120, respectively. For EA600, initial processing was done by running the script *115sim* from 'pstar/data/exec'. The script retrieves data from the level C stream (monitored by *lookd*), does some preliminary processing and reads the data into pstar format. The script takes raw data from the SCS every 30 seconds and runs a 5 point filter. The filter removes values greater than 100 metres from the median and assigns an absent data value to zero depths, which occur when no good data are available. This processing removes many spikes from the data.

From the options 'am', 'pm' or 'whole day' of data, the 'whole day' option 'd' was used to analyse all data from each Julian day. This produced a file '115simXXXd', where XXX was the Julian day of the data being processed. The times were set from XXX!0!0!0 to XXX!23!59!59 GMT for each day analysed. The Julian day, number of data cycles, and the version number of the file were recorded on the log sheet for each day processed.

Data from EM120 was processed using the same method as above, but using the script *115swt* which produced the bathymetry file '115swtXXXd'.

The bathymetry produced by the two echo-sounders was compared by running the script *115pbath.exec*, which sent a plot of depth against time for the two bathymetry data sources to print. This plot was used as an aid in the manual despiking of data.

For EM120 data, from the directory 'pstar/data/swt' the pstar program *plxyed* with pdf file *swt.pdf* was run to manually edit out areas of poor data. The start and stop times were set as XXX0!0!0 to XXX!23!59!59 GMT for each day analysed, where XXX was the Julian day of the data being processed. The file '115swtXXXd' was plotted and obvious spikes removed. The pstar programme *pintrp* was used to interpolate between the data gaps.

Manual despiking was repeated in the directory 'pstar/data/sim' using *sim.pdf* and the file '115simXXXd' for EA600 data.

Final EA600 processing was done from the directory 'pstar/data/exec' using the script *115simpapall*. This script merges the bathymetry data with the bestnav navigation data and performs a depth correction using Carter's tables. The script appends the old data with the new data overwriting the previous master file. The version number of the resultant file 'sim115.al' was logged.

Final EM120 processing was repeated in the same way, using the script *115swtpapall* to produce the file 'swt115.al'.

The bathymetry for the whole transect was plotted using the pstar program *overxy*. In the 'pstar/data/sim' and 'pstar/data/swt' directories, the plot description files (pdf) over.ea.pdf and over.em.pdf were used to plot EA600 and EM120 data, respectively.

The EA600 and EM120 generate similar depth data where the topography is reasonably flat and shallow. With variable or particularly deep topography, the values of EA600 and EM120 become offset from one another. Both echo-sounders generate noisy data in rough or steep topography, particularly the EA600. These findings are similar to those in previous cruises. In these conditions, it is hypothesised that the beam of the EA600 is contaminated by adjacent topographical features. The EA600 is switched off in sea ice conditions, so there is no data available for comparison. The EA600 can sometimes produce erroneous spikes $c.\,0-10$ m in depth. The EA600 also produces a more noisy profile, especially just before and after a depth change. The EA600 was switched off whilst stationary in shallow water.

The EM120 is generally thought to be the most useful for routine recording of bathymetry data, however, in rough weather the swath system is more sensitive, making the EA600 system preferable in these conditions. In pack ice the EM120 can lose the bottom and produce erroneous readings of $c.\,!4000!$m in depth. Neither of the bathymetry systems worked when the ship was breaking through pack ice (jday 346). In pack ice, EM120 generated very deep values, whereas EA600 produced few accurate values or was switched off for much of the time.

7.3   CTD depths

The variation in depth data from the single beam EA600 and swath EM120 bathymetry systems were compared by analysis of the difference between the depths measured from CTD mounted instruments (considered to be the most accurate depth data) and shipboard mounted bathymetry systems. Altimeter and pressure data from instruments mounted on the CTD were converted to depth data using the pstar command *peos83* in the directory 'pstar/data/ctd/raw'. Data were converted from the input file '115depthXX.raw' where XX was the CTD number. An output file '115depthXX' was made for each CTD cast, where XX was the CTD number. Parameters 1,3,8 were converted and the output variable 11 (depth83) was chosen and renamed to 'depth'.

Bottom depth data were viewed by typing the command *plistf* 115depthXX into the same above directory, where '115depthXX' was the file created in the previous step. Data were viewed in steps of 1000 and the time of the greatest depth according to the altimeter, and greatest depth (altimeter data plus pressure data converted to depth) noted.

The 'sim115.al' and 'swt115.al' files were then viewed from their respective directories, 'pstar/data/sim' and 'pstar/data/swt', by typing the pstar command *plistf* followed by the filename. Data cycle and depth (options 1 and 6) were viewed and the depth at the time of greatest depth according to the bathymetry system was recorded.

The variation in depth from the CTD mounted systems (altimeter and pressure sensors) and the bathymetry systems are shown in Figure 7.1. The EA600, records depths a median of 9 m shallower than CTD mounted instruments. By contrast the EM120 produces more reliable depths, with a median of 0.5 m deeper than the CTD mounted instruments. Figure 7.1 shows the swath EM120 system produces depth data most consistent with CTD mounted systems. Consistent with findings from previous cruises it seems the middle beam of the EM120 swath system is more accurate than the single beam EA600.
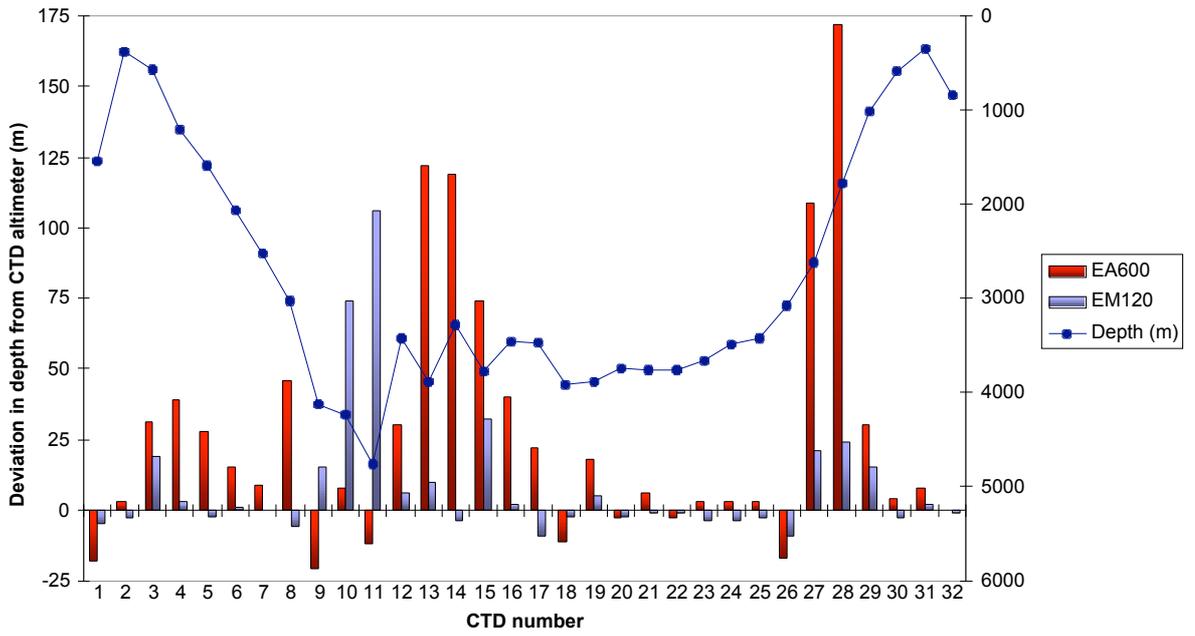
Figure 7.1: Comparison of EA600 and EM120 bathymetry systems

8.   IT SUPPORT

Johnnie Edmonston

8.1   Personal Computers

8.1.1   LADCP PC

An old Win98 machine was used to talk to the LADCP. Sophos was installed and the machine and the machine was connected to the lan to allow LADCP to be uploaded to the pstar unix account via SAMBA. The PC would hang when running through pre flight checks on the LADCP. Other operations ran normally. When the interrogating software ran, the machine would hang when interrogating the memory of the LADCP. After a thorough diskcheck and disabling all non essential startup items and processes on the machine the same process was followed. The same problem reoccurred. At this point the LADCP on board memory was cleared. The next pre-flight check on the LADCP ran without hitch.

8.1.2   CTD PC

The CTD seabird software was configured to accept an NMEA string from the Trimble differential GPS via the CTD deck unit. Throughout the day of 3rd December (jday 338) the machine would intermittently hang. No obvious fault was found with the CTD PC, yet the machine would hang intermittently. To make matters more confusing, the CTD deck unit crashed on one occasion displaying an unknown word message on the display. NMEA output was not needed or wanted by the PSO's so the NMEA socket message from the SCS was switched off. The configuration of the CTD software was changed to not require NMEA output from the deck unit. As it transpires later events would lead us to be believe that the intermittent hangs were the product of an intermittent fault with the trimble output to the deck unit. Further details are given later in the report.

8.1.3   MET laptop (Bridge)

The old win MET laptop on the bridge used to compile MET reports was connected to the network. The MET software now mails MET reports directly, no longer requiring to be transferred to the SAT-C laptop for transmission. The PC is not fitted with a netware client, but has IP. PC-Cillin antivirus which was already on the laptop (but never registered or set up) was registered and updated. The bridge team are aware that despite antivirus software, external web browsing and the downloading of data are to be discouraged. The bridge team

intend to use the laptop, in conjunction with Jeremy Robst, to log software available via the JCR intranet.

8.1.4   ADCP PC (UIC)

Hung from jday 348 03:11:48z to 348 09:19:16.

The message on the screen indicated a problem reading drive D:

Machine was reset, later scandisked, no fault found.

8.2   Netware

JRNA was rebooted on 12th December 2004. This was due to Groupwise messages no longer showing up in the official mail queue. DSRepair and groupwise checks indicated no problems, and rebooting was the quickest solution.

8.3   Unix

8.3.1   JRUA

No problems with JRUA.

8.3.2   Matlab V14

Mark Brandon brought along a copy of matlab for installation on JRUA. There were some initial problems with the licence manager.

V14 of Matlab which Mark brought along was installed to */nerc/packages/jr115matlab*

/nerc/packages/matlab/14/etc/MLM.opt was edited and the username altered to pstar, which was the user account used throughout the cruise for RVS processing.

Libf77compat.so.1 was copied from */nerc/packages/forte/6.0/SUNWspro/WS6/lib* into */nerc/packages/jr115matlab/14/bin/sol2*

8.4   SCS Logging System

The SCS had to be rebooted after resolution of the problem with the Trimble GPS to reacquire the time signal. There were some locked com ports after rebooting, these were resolved using the java comport utility. The instruments logged are detailed in Table 8.1.

8.5   Network

No network problems were experienced during the cruise, and no changes made.

8.6   Other

8.6.1   Trimble

Problems were experienced with the CTD unit (see section 8.1). These were resolved when the NMEA socket message from the Trimble to the CTD deck unit via the SCS was switched off, and the CTD software reconfigured to no longer expect it.

At 2255!GMT on December 3rd 2004 (jday 339), the Trimble stopped output entirely. First suspicions fell on the SCS, which was restarted, but with no success in getting Trimble data back. Multiplexor indicators showed no traffic through port 2 to the SCS, however when another instrument was swapped into port2, the multiplexor was found to not be the problem. The same procedure was carried out on the multiplexor in the navigational bridge electrical locker. The next step was to check the serial patch panel, which indicated that there was no output from the SCS. Leads to and from the Trimble were checked as ok and the unit restarted, with still no data output evident. Due to difficult working conditions at this time, i.e. total darkness in the Bridge and working via head torch, it was decided to swap the output from the Leica GPS in its stead until morning. In the morning ETS checked the unit and reseated all cables.

To summarise: the CTD PC failures throughout the previous day were believed to be due to an intermittent problem with the serial cables in the Trimble itself. Error checking on the CTD deck unit resulted in the deck unit being unhappy with the data and freezing communications with the software on the PC, such that it would hang.

Chronology of events:

3/12/04 22:34   Watch keeper noticed Trimble SCS display as gone red

3/12/04 22:55   last Trimble output to SCS logged.

3/12/04 23:30   ITS notified that a problem had occurred

4/12/04 02:47   Leica swapped into Trimbles place

4/12/04 12:39   trimble back on SCS

8.6.2   Gyro

Whilst working in the cabinet on the navigational bridge deck the gyro to level A had become dislodged sufficiently to stop data getting to the level A, and thereafter the SCS. Reseating the plug, with great difficulty, brought data back on line.

8.7   Recommendations

Improve access to the back of the cabinet on the Navigational Bridge Deck.

Sensor name	levc credat names
Glonass	gps_glos
GPS-ADU	gps_ash
Trimble	gps_nmea
Anemometer	anemom
TSSHRP	tsshrp
Oceanlogger	oceanlog
Emlog	em_log
Dopperlog	dop_log
Simrad-ea500	sim500
Simrad-em120	em120
Winch	winch
Truewind-spd	
Truewind-dir	
Seatex	seatex
Minipack	Minipack
Ngyro	ngyro
	adcp
	new_stcm
	gyro
	relmov
	bestnav
	bestdrf

Table 8.1: Instruments logged by SCS system.

9. TECHNICAL SUPPORT

Mike Sparrow

No report was submitted by ETS.

The CTD pumps should be carefully observed, since sometimes they do not switch off when brought on board (not good for the pumps). There were no other technical problems (see section 8.6 for note about NMEA).

10.   ARGO FLOATS

Mike Sparrow

10.1   Introduction

Four PROVOR Argo floats were left on board to be launched during the Drake Passage section. Unfortunately one sustained damage to the conductivity sensor whilst being transported from the box in the Prep (TSG) lab to the Chem (LADCP) lab. This float was repacked and shipped back to SOC for repairs. A fourth float stopped communicating during the testing phase. Several attempts were made to rouse the instrument, but without success. This float was also returned to SOC.

The launching positions of the two floats launched are shown in Figure 1.1 and summarised in Table 10.1.

10.2   Instructions for testing and deploying a PROVOR float

The procedure followed is detailed here, based on a procedure supplied by Brian King.

10.2.1   Testing

In principle, tests are not required. However, in practice tests should be carried out, due to the time elapsed since the floats were programmed at the factory.

(i)   Use the lead marked '4-WAY LEAD'. Do not use the '5-WAY LEAD' without reading the notes in that section.

(ii)   The tests should be conducted with the float out of the box and upright, so that the data port on the float endcap can be accessed properly. It will need to be lashed securely. Do not allow the protective coating on the hull to be scratched.

(iii)   The magnet should still be in place.

(iv)   A laptop or desktop with a COM1 port will need to be located near to the float, loaded with TALK.EXE. TALK.EXE only seems to work on COM1. TALK is a simple terminal program, but is capable of sending +9volts onto pins 4 and 7 of the RS232 port.

(v)   Start TALK.EXE and check configuration is 9600,8,none,1, no flow control. Settings are changed using F2, F3 etc keys, as summarised in the top line of the window. Note F8 and F9. F8 switches +/- 9 volts on RTS and DTR pins of RS232. Ensure F8 and F9 are toggled to give –9 volts. The plus volt settings are interrupts.

(vi)   Connect the data lead to the data port of the float. Be very careful to align the rib on the plug with the groove on the socket. This can be hard to see.

(vii)   Check the parameter settings (described on pages 16/34 of the manual)

If the float is not already awake ($ response when you press the enter key), wake it up by toggling F9 to send plus and then minus 9 volts on DTR. You get a wakeup message, which includes float serial number and ARGOS Platform Hex ID. Note these on the log sheet. If the float is already awake, you can get these by typing MDOWN (to power down) and then use F9 to wake it up again.

MCONFIG note the responses in the logsheet.

MTIME note the UTC time and float clock error. If the clock error is more than one minute, reset the clock and recheck the error. Note the clock error in the log sheet. Setting parameters (including the clock) is described below.

MBATTERY note the two voltages in the logsheet

MVACUUM note the vacuum. This is factory set to 700 when the internal oil reservoir is empty. It may vary if some of the oil has been pumped into the interior reservoir, or due to temperature variations. Values in the range 600 to 800 are acceptable. Outside this range means the float has leaked and SHOULD NOT BE DEPLOYED.

MTRIPLET note the three values. Temperature should be sensible in mdeg, eg 17000. Pressure is in centibars. Conductivity should be small.

MLEVEL This should be zero. If it is not, use MEMPTY as many times as necessary until MEMPTY says the level is zero. If there is a lot of oil to empty, then MEMPTY times out and needs to be run several times. MEMPTY runs the pump in bursts. The float must be upright for MLEVEL and MEMPTY to work properly. It can be horizontal for most other checks.

MTESTPUMP Listen for the pump running.

MTESTVALVE Listen for a valve click (solenoid valve near the bottom of the float)

MTESTARGOS When I tried this, I got:

45 seconds wait

5 beeps at 30 seconds interval

timeout after a total of 8m15seconds.

You simply have to wait patiently for timeout. Control then returns to terminal and float may (or may not!) give powerdown message. The ARGOS message echos to screen at each beep.

NOTE THAT THE MAGNET SHOULD STILL IN PLACE

(viii)   Changing parameters (described in manual pages 20ff)

MPREMISSION 1 (numeral one) float responds 'System Status is INIT'

MUNLOCK to unlock parameters. Be careful, because now it is possible to mess up.

MCONFIG still lists the parameter list

MCONFIG 03 (zero padded to two characters) lists only the parameter VAL03 (reference day)

MCONFIG 03!7 will reset the parameter to a value of 7.

The float will always echo the value back, even if you don't change it or get the syntax wrong, so watch responses carefully.

MTIME YYYY/MM/DD hh:mm:ss sets the time.

Choose and set the REFERENCE_DAY. The reference day is the number of days after which the float will start its first cycle.

Set reference day using

MCONFIG 03 7 (or whatever).

MCONFIG (to check)

MPREMISSION R locks the parameters, tests some of the values (vacuum, level, battery, triplet) and powers down.

(ix)   You can also power down with MDOWN, which is not described in the manual.

(x)   The float can be woken up again using F9, and parameters listed as before.

(xi)   Disconnect the data lead, and fit the blank plug. Be careful with the pin alignment, using rib and groove as for the data lead. If it is correctly aligned, it fits nicely and the sleeve screws down easily. The O-ring on the blank should be lightly lubricated. Suggest you use the same silicone spray as used for LADCP/CTD blank plugs.

10.2.2   Starting the mission

(i)   Install the damping disk.

The manual describes a procedure for a different kind of damping ring. Use the following procedure:

> Peel the protective film off both sides of the disk if it is still in place.
>
> The disk must be in the correct orientation for the holes to align. There is a number written on the disk, which aligns with the corresponding number on the disk securing ring.
>
> The disk is fed on from the bottom of the float, and secured to the underside of the ring using three bolts. The nuts should have threadlock applied.

(ii)   Remove the magnet.

This starts the mission. Note the time to the nearest second on the logsheet. This is time T.

> At T+3m10s (3mins 10 secs), expect the first beep on the ARGOS tester. (The easiest thing is to attach this to the float antenna sleve, eg with an elastic band, but don't accidentally leave it in place for deployment !!!!
>
> Expect 5 beeps at 30 second intervals, ie T+3m10s, 3m40s, 4m10s, 4m40s, 5m10s. After 5 beeps, put the argos tester somewhere safe.
>
> Listen out for 10 clicks at T+10m45s The clicks are fairly distinctive, and occur at about 2Hz.
> If you hear the 5 beeps and 10 clicks, all is well, that's it. The float is ready to go. The mission has started at T+11m. The external bladed stays inflated for one hour. Then it starts to deflate, but slowly at first. The float will take anything up to another 2 hours to sink, depending on surface buoyancy.

(iii)   Deploy the float. This should be between T+11m and T+71m. After that, the bladder has started to deflate.

(iv)   IF THERE IS A PROBLEM:

i.e. no success with 5 beeps and 10 clicks.

First line of attack is to try the magnet again. Wait until at least T+16m. Reattach the magnet. Wait a further 5 minutes with the magnet in place. Then remove the magnet again as in (2). This is a new time T. Listen for 5 beeps and 10 clicks.

(v)   If you don't have a success with the second attempt, attach the magnet again, then you need to plug the data lead back in, and try to check everything out again. (MLEVEL, MEMPTY, MPREMISSION!R to check all tests are passed). Detach the data lead, insert the blank, remove the magnet and listen again. Note the new time T of magnet removal. Remember that TALK.EXE should have F8 and F9 toggled to minus volts. F9 can be used to send plus 9 volts and then returned to minus 9 volts.

10.2.3   Notes on the use of the 5-way lead

The 4-way lead does not have the RTS pin on the RS232 connected. This is pin 4 on the 5-way float connector, on p15 of the manual. Therefore the F8 key in TALK.EXE has no function with the 4-way lead. In the 5-way lead, this extra pin is connected, and F8 toggles plus/minus volts on this pin. The preferred way to wake up the float is with F9 on/off. The plus volts from F8 is some sort of CPU interrupt, and should be used sparingly. In particular, if plus volts is left on F8 tests can fail or the mission may not start properly. Therefore, if the 5-way lead is being used, make extra sure that F8 is toggled to minus volts in TALK.EXE.

10.2.4   Launching the Float

We don't have a launching cradle or procedure for these PROVORs. APEXs can be launched with a rope through the hole in the damper plate, but PROVORs cannot. During JR115 and JR110 the floats were launched by throwing them off the stern of the ship (see Figure 10.1). As well as being hugely satisfying it seemed to have no ill effects on the floats themselves.

Note time and position of deployment on the logsheet. Transmit deployment information to bak@soc.soton.ac.uk and rebl@bodc.ac.uk as requested in the logsheet.

Note any anomalous circumstances in the log sheet (see Table 10.2).

Argo ID	Mission Start Time (JDAY: HR: MM)	Float Launch time	Latitude	Longitude	Reference Day
64AF800	341: 14:30	341: 15:16	59°00'S	55°51'W	2
5F74300	342: 14:09	342: 14:30	60°40'S	54°29'W	1

Table 10.1: Details of PROVOR floats deployed during JR115.

SHIP AND CRUISE NUMBER _____

Date (YYYY/MM/DD) & Day number: _____ *(eg 2004/11/01=306)*

Float number from crate eg 02-F2-01 _____

Float Serial number from TALK.EXE eg MT001 _____

ARGOS Hex number _____

			Expected value
VAL01	NUMBER_OF_CYCLES		255
VAL02	CYCLE_PERIOD		10
VAL03	REFERENCE_DAY		User select
VAL04	ASCENT_TIME		21
VAL05	DELAY_BEFORE_MISSION		60
VAL06	DESCENT_SAMPLE_PERIOD		0
VAL07	DRIFT_SAMPLE_PERIOD		12
VAL08	ASCENT_SAMPLE_PERIOD		10
VAL09	DRIFT_DEPTH		2000
VAL10	PROFILE_DEPTH		2000
VAL11	GROUNDING_MODE		0
VAL12	ARGOS_PERIOD		45
VAL13	ARGOS_TRANS_DUR		6
VAL14	ARGOS_ID		Float specific
VAL15	RETRANSMISSION		25

MTIME YYYY/MM/DD HH:MM:SS _____

UTC time DDD/HHMMSS _____

Clock error (UTC minus MTIME) _____ Adjust if necessary

MBATTERY 1		Should be near 14000	
2			
MVACUUM		MUST be 600 to 800	
MTRIPLET P		P should be small	
T		T should be sensible	
C		C should be small	
MLEVEL zero ? (Tick)		MUST be ZERO. Use MEMPTY to empty	
Magnet removal time T (DDD/HHMM)			
Deployment time T2			
Deployment Lat			
Deployment Lon			
CTD station identifier			

COMMENTS ON DEPLOYMENT _____

Table 10.2: PROVOR deployment sheet.

Figure 10.1: Launching of a PROVOR float.

REFERENCES

Bacon, S., 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 Oceanography Centre, Cruise report No. 38, 118 pp.

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