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**RRS *JAMES CLARK ROSS* CRUISE 94**

**01 DEC – 15 DEC 2003**

Drake Passage repeat hydrography: WOCE Southern  
Repeat Section 1b – Burdwood Bank to Elephant Island

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**2005**

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## *DOCUMENT DATA SHEET*

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<i>ABSTRACT</i> <p>This report describes the ninth 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-two full depth stations were completed, a test station, the RaTS station in Marguarite Bay, and the 30 stations for the SR1b Drake Passage section. The CTD was a Sea-Bird 911<i>plus</i> with dual temperature and conductivity sensors, an altimeter and an SBE35 thermometer. Direct velocity (LADCP) measurements were also made, using 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.</p>	
<i>KEYWORDS</i> ANTARCTIC CIRCUMPOLAR CURRENT, ANTARCTIC OCEAN, ADCP, ACOUSTIC DOPPLER CURRENT PROFILER, CRUISE 94 2003, CTD OBSERVATIONS, DRAKE PASSAGE, <i>JAMES CLARK ROSS</i> , LOWERED ADCP, LADCP, SOUTHERN OCEAN, VESSEL-MOUNTED ADCP, WOCE, WORLD OCEAN CIRCULATION EXPERIMENT	
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Jenkins, Derek	Seaman
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Loveridge, Daniel	Seaman
Robinshaw, Mark	Motorman
Smith, Sidney	Motorman
MacIntyre, Duncan	Chef
Collins, Raymond	2 <sup>nd</sup> Cook
Pratley, Clifford	Senior Steward
Lee, Derek	Steward
Newall, James	Steward



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Brian King

The Scientific party is grateful to the Master, officers, crew and technical staff of RRS *James Clark Ross*, who fulfilled their duties with the diligence and good humour that has become a dependable benchmark over many cruises. Good weather; well-maintained equipment and hard-working personnel made it possible to complete the section in record time. The Principal Scientist gladly recognises the particular contribution of Mike Sparrow, co-leading the scientific party, and Liz Hawker, who edited this report, filled any gaps and ensured its publication.

# 1. OVERVIEW

(editor's notes)

This report describes the ninth 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:

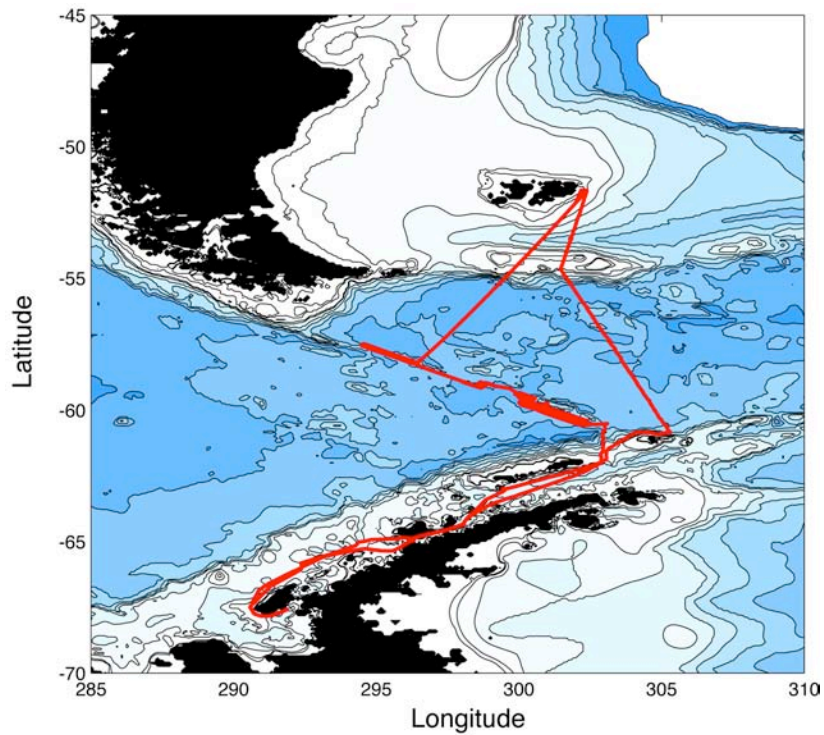
- (i) to determine the interannual variability of the position, structure and transport of the Antarctic Circumpolar Current (ACC) in Drake Passage;
- (ii) to examine the fronts associated with the ACC, and to determine their positions and strengths;
- (iii) by comparing geostrophic velocities with those 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 first days of the cruise were spent on passage from Stanley to Rothera, a British Antarctic Survey research station on Adelaide Island (67°34'S 68°08'W) off the Antarctic Peninsula. Here cargo, including essential kit, fuel, provisions and (long-awaited) fresh food, was offloaded. The fortunate personnel destined for work on base or in deep field also disembarked. The passage days provided opportunity to set up equipment and processing paths in readiness for the SR1b section. A CTD station in Margarite Bay was occupied immediately before docking in Rothera to provide comparison data for the RaTS time series undertaken with a small hand deployed CTD. The SR1b section started on the afternoon of (jday 345) December 11<sup>th</sup>. It was worked northbound across Drake Passage, from Elephant Island to Burdwood Bank. Work was completed on the afternoon of (jday 349) December 15<sup>th</sup>. We assume benign conditions were experienced (i.e. the Drake Pond) since no problems were reported. The cruise was concluded with a steaming passage towards the metropolis of Stanley (Falkland Islands), where the ship docked. The cruise track is illustrated in Figure!1.1.

## **Additional note to Overview**

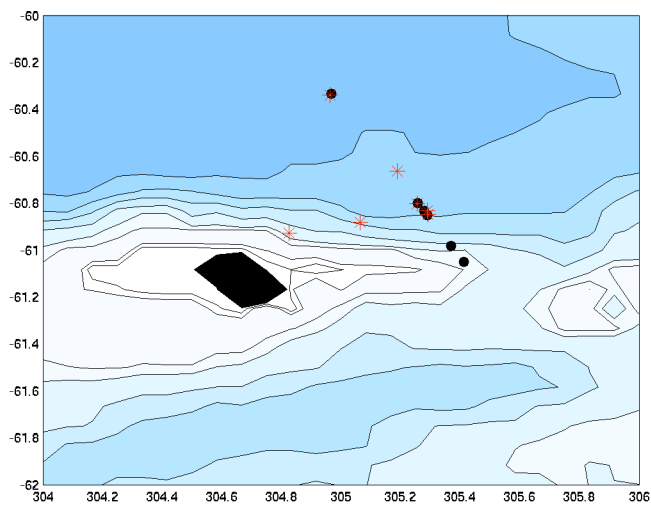
Brian King

Due to ice conditions in Bransfield Strait and to the south of Elephant Island, the normal approach to the start of the section (south and east of Elephant Island) would have required a slow steam and several hours lost. We therefore attempted to approach the nominal position of the section start by passing west and north of Elephant Island. We also encountered ice and drifting bergs on this route, which would have limited speed to about 4 knots as we traversed the length of Elephant Island. Since the first two stations (stations 03 and 04 in Table!2.1) are in shallow water, they account for rather little transport, and are generally south of the Continental Water Boundary, we decided to relocate them at equivalent isobaths further to the west. Figure 1.2 shows the details. This will have no significant impact on transport calculations. While working the early stations on the section, we encountered the RV!*LM!Gould* working a CTD survey with several radial sections on the shelf and slope around Elephant Island. If required, CTD data from the survey could be obtained via the US Office of Polar Programs.



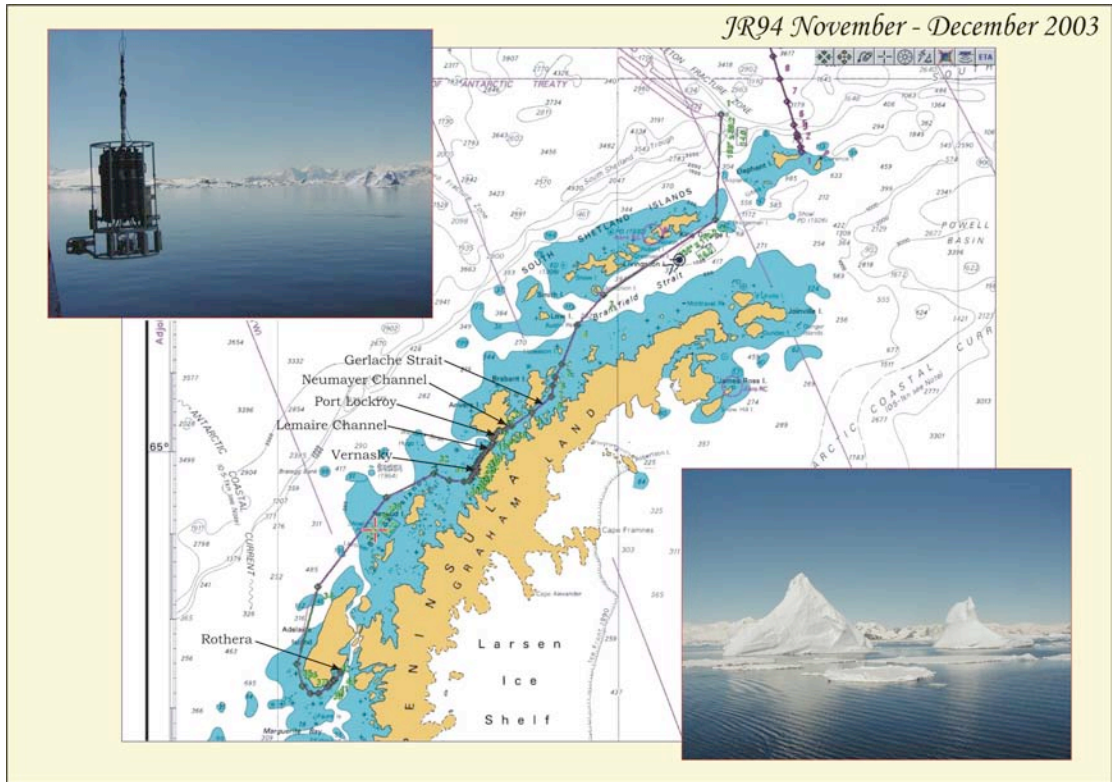
**Figure 1.1:** Cruise track for JR94.

The cruise track (using data from BestNav) is illustrated in red.



**Figure 1.2:** Station positions at the start of the SR1b section, off Elephant Island.

The nominal (ideal) station positions are represented by black dots, and the actual station positions occupied during JR94 are represented by red asterisks.



**Figure 1.3:** Cruise track and photos off the Antarctic Peninsula. Icebergs, mountains and CTD's.

## **2. CTD DATA ACQUISITION AND DEPLOYMENT**

Brian King, Mike Sparrow, Gwenna Corbel

### **2.1 Introduction**

Thirty-two Stations were occupied during cruise JR94 (see Table 2.1). Station 01 was a test station, and also provided a sound velocity profile for the EM120. Station 02 was the RaTS station, occupied immediately before docking at Rothera. Since the salinity samples from station!01 indicated that the CTD was well calibrated, raw data were left at Rothera for comparison with other RaTS data.

There were no problems of any note with the CTD, pylon bottles or deck unit. On one station the bottle top taps were found to be untightened on return to deck. However, it is unlikely that significant contamination of samples occurred since only salinity analysis was undertaken.

### **2.2 CTD configuration**

A BAS SeaBird 911*plus* system was used, with duplicate CT sensors, altimeter, and SB35 thermometer, but no other sensors. A downward looking UKORS WH300 LADCP in a protective cage was also attached to the outside of the CTD frame. The configuration is described in the JR81 report (Bacon et al., 2003). The LADCP battery pack was accommodated in positions 2 and 3 on the CTD rosette, such that only 10 (of a possible 12) Niskin bottles were used. Details of sensor serial numbers are given in Table 2.2. A substantial swivel was inserted between the load-bearing termination and the package. A fin was added after station 02 to reduce rotation of the package underwater. The non-load-bearing part of the termination had a severe kink in the armoured cable, but this did not seem to affect data quality.

### **2.3 Deployment**

No problems were encountered with the winch or in handling the CTD. The weather was so kind throughout the cruise that there was no need to take special precautions at deployment or recovery. The CTD was started on deck, and deployed to 10 metres wire-out. The instrument was allowed to soak for 30 seconds after the pumps came on, and was then hauled until the termination arrived at the surface. The package was then veered to a nominal 10 metres



above the seabed, where the first bottle was closed and the two empty positions were fired. A table of standard depths was used thereafter. In accordance with normal BAS practice, the CTD was kept powered on until it was on deck, after which data acquisition was stopped. The wire was air-dried while hauling on all stations. Following the deepest station (station!23) the wire washer was used on subsequent stations so that the wire would be stored washed at the end of the cruise.

A new wire had been installed prior to the cruise and some effort expended on a previous leg to ensure it laid right after a test station to over 5000 metres. This effort paid dividends since no problems were encountered.

The altimeter gave correct readings throughout, finding the bottom at its maximum range of about 95 metres.

As ever, 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 EM120 (centre beam) was probably the more reliable of the two.

The operation and results from the SBE35 are discussed elsewhere. We note here that the winch was stopped for 5 seconds before bottle closures and 10 seconds afterwards while the SBE35 sampled.

In the past, maintaining a close eye on the CTD PC clock has been important. Either the PC has software that collects time from a sufficiently accurate time source, or it simply has a good clock. When inspected, the PC clock, which sets the time in the SeaBird file headers, was 2 seconds slow.

## **2.4 Data Acquisition**

Data were recorded on the PC attached to the deck unit to a local (D:) drive using utility *seasave*. After a station, four raw files (HDR, DAT, BL, CON) were immediately copied as backup to a networked (N:) drive. The PC software *SBEDataProc* was used to run *DatCnv*, which converted a binary .dat file to an ASCII .cnv file, and also generated a ROS file. The data in the ROS file are an average of 2 seconds of data acquired immediately after the bottle firing code is received at the deck unit. The cell thermal mass correction, described in the JR67 and JR81 cruise reports (Bacon et al., 2002 and 2003) was then run to generate another ASCII file with suffix *\_ctm.cnv*. The output variables from the *DatCnv* were:

Scan count  
Pressure Digiquartz (db)  
Temperature, ITS90 (°C)  
Temperature2, ITS90 (°C)  
Conductivity (mS!cm<sup>-1</sup>)  
Conductivity2 (mS!cm<sup>-1</sup>)  
Altimeter  
Pressure temperature (°C)  
Bottles fired

Output was in ASCII format, for the upcast and downcast, and the selection was made to create both data and bottle (ROS) files, though the ROS file was not used. It would have been sensible to set the scan range duration to 8 seconds and use the resulting ROS file for comparison with the SBE35, since recreating the 8-second averages in pstar on unix was quite a slow process.

After completing DatCnv and CellTM, a total of seven files (the initial four plus ROS, CNV, \_CTM.CNV) were dropped onto a unix folder mounted as a network drive using samba. Each of the procedures (DatCnv, CellTM, file transfer) took a few seconds, usually not more than 10.

At the end of the cruise, the (program setup) files were also dropped onto unix in the CTD data directory.

## **2.5 Unix Processing**

The data path was essentially unmodified from JR81 (Bacon, S., 2003). Script names were aliased with a symbolic link to something more convenient, for example, so that *94seactdN* became *ctdN*. A few minor wrinkles were ironed out, with comments made in the scripts. Accurate water depth was not available in real time, so water depths were entered early on as zero. At the end of the cruise, true water depth was ascertained from CTD depth plus altimeter height off the bottom. Together with GPS position at the bottom of the cast, which was extracted automatically from CTD stations and nav files, the position and true water depth in pstar headers of all ctd, winch and sam files were rewritten and made consistent.

The final unix files are a 1Hz time series for the whole station (for use in LADCP processing, for example) and a 1db file of the downcast.

To simplify any reprocessing and reduce the possibility of typo errors, the scan numbers for start\_down, bottom, and end\_of\_cast were selected from the 24Hz file, and entered into a file called 94station\_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 near surface, and selecting a scan number shortly before the CTD broke surface at the end.

## 2.6 Data Calibration

There are three opportunities for CTD data calibration and comparison; an internal check between the primary and secondary sensors, comparison with salinity samples, and comparison with the SBE35. We use the notation T1, T2, C1, C2, S1, S2 for CTD sensors, S for salinity samples, and T35 for SBE35.

### 2.6.1 Comparison between primary and secondary sensors

An initial comparison was made at 114 bottle closure events at 2000 metres or deeper. The mean and one standard deviation differences, excluding outliers were:

$$T1 - T2 = 0.0023 \pm 0.0011$$

$$C1 - C2 = 0.0027 \pm 0.0007$$

$$S1 - S2 = 0.0008 \pm 0.0007$$

Thus T1 read slightly higher than T2, and C1 read slightly higher than C2. These effects tend to compensate so that the S difference was small.

Closer graphical investigation showed that T1-T2 varied with pressure, while C1-C2 was steady. If T1 was used as the independent variable, the relationship was noisy, suggesting it was a pressure effect rather than a simple temperature calibration slope error. Since C1-C2 was independent of pressure, there was a corresponding trend in S1-S2.

### 2.6.2 CTD / sample salinity comparison

Deeper than 2000 metres, the mean offsets were as follows:

$$S - S1 = -0.0004 \pm 0.0008$$

$$S - S2 = 0.0004 \pm 0.0011$$

However, a trend with depth in S - S1 was discernable, despite the generally much higher scatter in the upper 1000 metres of water column.

### 2.6.3 CTD / SBE35 comparison

Deeper than 2000 metres, the mean offsets were:

$$T35 - T1 = -0.0028 \pm 0.0009 \quad (\text{mean of data for which } -0.005 < T35-T1 < 0)$$

$$T35 - T2 = -0.0008 \pm 0.0004 \quad (\text{mean of data for which } -0.002 < T35-T2 < 0)$$

When the full dataset was viewed with pressure as an independent variable, a trend was discernable in T35-T1, but not in T35-T2.

### 2.6.4 Conclusions

The observed small trends can be explained by a dependence of T1 on pressure, with a tendency for T1 to read cooler at the surface than at 4000 metres. The T1 offset appeared to change by about 0.0015 over the pressure range sampled on the cruise. Offsets in T2 and C2 were evidently less than 0.001, and C1 had a small positive offset. We accept T2, S2 as being in agreement with sample salinity and SBE35 temperature to within 0.001 in salinity or temperature without further offset.

## 2.7 SBE35 High Precision Thermometer

The SBE35 Deep Ocean Standards Thermometer was used on all 32 stations. The SBE35 records data for NCYCLES seconds after it receives a valid firing code. For stations 01 and 02 NCYCLES was set to 32 but we did not wish to wait that long at each bottle stop. The data from those stations was therefore disregarded. For stations 03 to 32, NCYCLES was set to 8, and the winch was held stationary for 10 seconds after each firing. If a second position is fired before the 8 seconds is complete, as sometimes happened at positions 2 and 3 or when firing multiple bottles on shallow casts, the instrument fails to record a new sample and just completes the measurement in progress.

The SBE35 is accessed via the *seaterm* programme, essentially a dumb terminal running at 300 baud, with the ability to capture the screen session to a file, usually with suffix .cap. Examples of useful commands in *seaterm* are

NCYCLES = 8

SAMPLENUM=0 (reset SBE35 memory, which stores a maximum of 170 cycles)

DDMMYY=162303 (set date)

HHMMSS=120000 (set time)

DS (data status)

DD (data upload)

DC

(display coefficients)

Note that in *seaterm*, commands are not echoed to the screen until you press enter.

The SBE35 has two sets of calibration information. From time to time a bath calibration is performed, the so-called linearisation, in which many polynomial coefficients are determined. At intermediate times, single-point-calibrations are performed, e.g. Triple Point of Water and Melting Point of Gallium, providing a slope and offset correction to the data returned from the linearisation. Thus two calibration dates are reported.

The SBE35 worked well throughout, and provided valuable confirmation that T2 was to be preferred to T1.

Station	Day hhmss	Lat	Lon	Wireout (m)	Pmax (db)	Water depth (m)	Altimeter
01	335 124635	59 01.48 S	61 09.96 W	3640	3669	3722	14.3 Note 1
	335 134953	59 01.50 S	61 09.99 W				
	335 150432	59 01.50 S	61 09.99 W				
02	340 174542	67 35.32 S	68 08.83 W	321	332	326	10.4 Note 2
	340 175400	67 35.32 S	68 08.83 W				
	340 181239	67 35.32 S	68 08.83 W				
03	345 155738	60 55.71 S	55 10.48 W	365	370	371	3.4 Note 3
	345 160739	60 55.71 S	55 10.48 W				
	345 161837	60 55.72 S	55 10.47 W				
04	345 171555	60 52.93 S	54 56.17 W	768	780	781	8.3
	345 173101	60 52.95 S	54 56.17 W				
	345 175258	60 52.95 S	54 56.17 W				
05	345 184854	60 51.00 S	54 42.47 W	944	956	958	9.7
	345 190729	60 51.00 S	54 42.47 W				
	345 193308	60 50.98 S	54 42.47 W				
06	345 201854	60 49.97 S	54 43.20 W	1645	1663	1675	10.5
	345 204807	60 49.99 S	54 42.66 W				
	345 212605	60 50.00 S	54 42.66 W				
07	345 222051	60 48.22 S	54 44.76 W	2590	2616	2642	16.5
	345 231254	60 48.17 S	54 44.69 W				
	346 000728	60 48.15 S	54 44.83 W				
08	346 011400	60 40.13 S	54 49.48 W	3065	3075	3119	9.2
	346 020806	60 39.76 S	54 48.72 W				
	346 030922	60 39.24 S	54 47.39 W				
09	346 050323	60 20.06 S	55 01.74 W	3420	3436	3489	8.6
	346 060552	60 20.03 S	55 02.14 W				
	346 071312	60 19.99 S	55 02.97 W				

10	346 091555 346 101533 346 112657	59 59.94 S 59 59.86 S 59 59.84 S	55 14.43 W 55 14.68 W 55 15.68 W	3472	3495	3548	10.4
11	346 132524 346 142846 346 154257	59 39.81 S 59 39.50 S 59 39.30 S	55 25.55 W 55 25.69 W 55 25.73 W	3645	3673	3730	10.3
12	346 173801 346 184319 346 195854	59 20.01 S 59 20.01 S 59 20.01 S	55 38.96 W 55 38.97 W 55 38.97 W	3742	3752	3812	9.9
13	346 220143 346 230652 347 001727	59 00.02 S 59 00.06 S 59 00.08 S	55 51.44 W 55 51.33 W 55 51.31 W	3741	3768	3829	9.6
14	347 021340 347 031717 347 042957	58 41.04 S 58 41.09 S 58 41.08 S	56 03.25 W 56 03.52 W 56 03.49 W	3718	3745	3805	9.4
15	347 061555 347 072138 347 083450	58 21.99 S 58 22.08 S 58 22.26 S	56 15.14 W 56 15.70 W 56 16.12 W	3835	3859	3923	8.5
16	347 102301 347 113139 347 124831	58 02.93 S 58 02.65 S 58 02.46 S	56 26.83 W 56 26.03 W 56 25.07 W	3947	3974	4042	8.2
17	347 144806 347 154749 347 165634	57 44.01 S 57 44.07 S 57 43.99 S	56 38.50 W 56 37.59 W 56 36.53 W	3469	3498	3542	18.1
18	347 190529 347 201035 347 212553	57 25.06 S 57 25.37 S 57 25.70 S	56 50.14 W 56 48.59 W 56 46.97 W	3814	3832	3894	10.1
19	347 233158 348 004354 348 020333	57 06.13 S 57 06.07 S 57 06.01 S	57 02.30 W 57 02.19 W 57 02.13 W	4153	4184	4253	11.5
20	348 040407 348 045734 348 055622	56 47.12 S 56 47.10 S 56 47.10 S	57 13.95 W 57 13.94 W 57 13.94 W	3025	3051	3090	11.8
21	348 075521 348 090048 348 101148	56 28.00 S 56 27.97 S 56 28.07 S	57 25.69 W 57 25.27 W 57 24.90 W	3738	3760	3824	5.6
22	348 122346 348 132215 348 142835	56 08.96 S 56 08.50 S 56 08.03 S	57 37.43 W 57 36.69 W 57 35.82 W	3381	3396	3449	7.1
23	348 162102 348 174518 348 191648	55 49.99 S 55 49.99 S 55 49.99 S	57 49.25 W 57 49.25 W 57 49.25 W	4709	4732	4826	4.4
24	348 211720 348 223205 348 235233	55 30.91 S 55 30.91 S 55 30.91 S	58 00.89 W 58 00.89 W 58 00.90 W	4190	4213	4290	4.8
25	349 014109 349 024458 349 035556	55 12.76 S 55 12.33 S 55 12.15 S	58 12.33 W 58 12.14 W 58 12.00 W	3740	3754	3813	10.1
26	349 043315 349 052436 349 062132	55 10.25 S 55 10.22 S 55 10.19 S	58 13.86 W 58 13.51 W 58 13.21 W	2954	2979	3013	14.2

27	349 065617 349 073932 349 082818	55 07.33 S 55 07.34 S 55 07.34 S	58 15.72 W 58 15.74 W 58 15.74 W	2497	2517	2547	8.0
28	349 091912 349 095622 349 103746	55 04.19 S 55 04.18 S 55 04.18 S	58 17.64 W 58 17.61 W 58 17.61 W	2045	2064	2083	9.7
29	349 113609 349 120725 349 124122	54 57.67 S 54 57.66 S 54 57.66 S	58 21.69 W 58 21.67 W 58 21.66 W	1584	1594	1612	3.1
30	349 131937 349 134713 349 141409	54 56.60 S 54 56.62 S 54 56.60 S	58 22.30 W 58 22.31 W 58 22.30 W	1127	1136	1146	3.8
31	349 144912 349 150103 349 151503	54 55.35 S 54 55.34 S 54 55.34 S	58 23.12 W 58 23.10 W 58 23.10 W	512	524	521	8.6
32	349 165431 349 170423 349 171434	54 39.94 S 54 39.94 S 54 39.94 S	58 32.68 W 58 32.68 W 58 32.68 W	364	374	369	8.7 Note 4

**Table 2.1:** Station positions occupied during JR94.

Times and positions are given for the start, bottom and end of each cast.

Jday 335 was December 1<sup>st</sup> 2003.

Note 1: Test station

Note 2: RaTs station

Note 3: Start of SR1b section

Note 4: End of SR1b section

Instrument	Type	Serial Number	Calibration Date
T1	SBE 3plus	2679	13-May-03
C1	SBE 4C	2255	21-May-03
T2	SBE 3plus	4235	4-Dec-02
C2	SBE 4C	2813	22-Nov-02
P1	SBE 5T	2395	
P2	SBE 5T	2400	
DOST	SBE 35	15759-0005	5-Aug-02 15-Jul-03
Altimeter		2130.27001	
Pressure	SBE 7	5429	
Underwater unit	SBE 9plus		

**Table 2.2:** CTD Sensors used on JR94

### **3. LADCP**

Mike Sparrow and Brian King

#### **3.1 Introduction**

Cruise JR94 was the fifth 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 JR81, a single WH unit was deployed (S/N 1885) in a downward facing position on the CTD frame. A total of 32 CTD casts were made, with no significant problems encountered. Details of the stations and the operation of the CTD can be found in section 2.

The procedures for the set-up and operation of the WH unit were identical to the previous cruise, JR81 (Bacon et al., 2003), with the exception that slightly different software was used for instrument setup and data retrieval (described in section 3.3). As before, the initial processing of the data was carried out using software from Eric Firing's group at the University of Hawaii.

#### **3.2 JR94 LADCP Positioning**

Figures 3.1 to 3.3 show the positioning of the WH unit and battery pack on the CTD frame. The WH unit was fitted to its mounting bracket and setup in a downward-facing position on the outside of the CTD frame. The mounting bracket was designed for a larger CTD frame, so not all the brackets were attached. 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. Two Niskin bottles were removed from the rosette to accommodate the battery pack.

#### **3.3 LADCP Deployment and Recovery**

The procedures for the deployment and operation of the LADCP were similar to those employed in JR81 (Bacon et al., 2003). As on JR81, it was found that the CTD frame spun considerably until a vane was added to the frame (Figure 3.1). Differences in procedure arose because a laptop with slightly different software to the previous cruise was used. The protocol adopted was as follows:



### 3.3.1 *Pre-deployment*

- (i) Ensure comms/charge lead is in place.
- (ii) In program 'Dumbterminal'
  - On initially opening the program, the parameters should be set to COM1 and Baud 38400 – this only needs to be done once.
  - Send a 'break' command (icon on toolbar) to wake up the LADCP.
  - Log file name (Function 3) and rename the file J94mXXX.txt (where XXX is the station number) – record on log sheet.
  - Do a time check (TS?) and make a time correction if necessary. Write down MASTER clock time and clock error if any.
  - Check memory unused (RS?) and erase if necessary (using RE ErAsE).
  - Run tests (PT200) – all should pass except 'receiver bandwidth' (because the unit is not in the water).
  - Log out of Dumbterminal.
- (iii) Check battery voltage (maximum a little over 52 V) and record on log sheet.

### 3.3.2 *Deployment*

- (iv) In program 'BBSC'
  - Check that COM1 Baud rate is set to 38400 (menu 'Communication' ->'Baud rate'). For some reason this has to be set each time the program was used.
  - Load the command file, WHM.CMD (menu 'Deployment' ->'Load'). The command file for JR94 was the same used in JR81. Save the file as J94MXXX.CMD.
  - Set the unit to start logging data (menu 'Deploy' -> 'File') and check the MASTER clock deployment time (TS?).
  - Save the log file in the form J94MXXX.log.
- (v) Remove comms/charge lead and fit blanks. Secure leads to frame. Ensure LADCP is pinging. Remove protective cap from unit if not already done so.

### 3.3.3 *Recovery*

- (vi) Reconnect comms/charge lead.
- (vii) In Dumbterminal

- As soon as Dumbterminal is opened the LADCP stops logging - note the time of the MASTER clock (TS?).
- (viii) Check and note the battery voltage (this didn't fall below 48V as long as the unit was left to charge between stations).
- (ix) In program 'Hyperterm'
- Check and note the number of deployments (RA?)
  - To download the data do 'RY #' (where # is the station number) and then from the menu 'transfer' -> 'receive file'.
  - Note the default filename (\_RDI\_XXX.000).
  - Rename file to JR94mXXX.000 and record on log sheet. A link was set up using SAMBA so the files could then be dragged and copied straight to UNIX.
- (x) In program 'BBLIST'
- Note the file size.
  - Note the number of ensembles.
  - Send unit to sleep with command 'CZ'.
- (xi) Ensure the unit is left to recharge. Every ten stations or so check the vent plug on the battery unit to release any build up of gases.

### 3.4 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).

Data must be processed as soon as possible after a CTD station. This is 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. The initial steps of data processing on JR94 were as follows:

- (i) Log onto one of the UNIX machines as pstar, password pstar. You must be logged on to jruh to get access to the matlab licence.
- (ii) *cd ladcp* ensures you're in the correct directory  
*setup matlab* 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 j94mNNN.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 JR94 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.
- (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.

### 3.5 Secondary Processing (absolute velocities)

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

(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 3.1:** Positioning of the LADCP unit on the CTD frame.

The photo shows the CTD frame secured to deck, with the LADCP unit (yellow, foreground) and the stabilising fin (to the left).



**Figure 3.2:** Positioning of the battery pack on the CTD frame.

The battery pack is the vertical unit in foreground (between Niskin bottles).



**Figure 3.3:** Detail of the LADCP frame mount.

There are three attachment points between the LADCP and the CTD frame. Note the bracket in the foreground could not be fitted to the CTD frame.

## 4. NAVIGATION

(editor's notes)

### 4.1 Introduction

During JR94 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 are described in more detail below. The daily processing of navigation data was simplified by the use of three *pstar* scripts *dailynav1*, *dailynav2* and *dailynav3*. These included the scripts and processing paths described in the following sections.

### 4.2 Trimble 4000

The Trimble 4000 GPS is the ship's primary source of positional information.

The Trimble 4000 data was converted to the *pstar* format using *94gpsexec0*. This was done by daily chunks throughout the duration of the cruise and produces three files, *94gps[jday]d.raw*, *94gps[jday]d* and *94gps01*.

### 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 not processed during this cruise.

### 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.

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 (94ashexec0)*

Data was read in from the ship's level C system into the *pstar* environment in daily chunks, creating one raw data file, 94ash[jday]d.raw

(ii) *Merging of the Ashtech data with the Gyro data (94ashexec1)*

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, 94ash[jday]d.mrg

(iii) *Quality control (94ashexec2)*

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, 94ash[jday]d.edit and 94ash[jday]d.ave

(iv) *Despiking of data (94ashedit.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, 94ash01.int and 94ash[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 *94gyroexec0*, creating two output files: *94gyrd* and *94gyr[jday]d.raw*

#### **4.7 Bestnav**

Alison Hindley and Mike Sparrow

Bestnav is a standard data stream of the ship computer system. It provides 30 second interval positional information using the best available data source. GPS is used when available, but otherwise the system uses dead reckoning based on data from the ship's gyrocompass and velocity sensors.

In the Unix system, the script *navexec0* was used to convert the data to Pstar format working in 24-hour chunks, from 0000 to 2359 GMT, appending the new data to a master file *abnv941*. The scripts call the 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.

A second script *navexec1* averages and filters the navigation data. This takes the data in the master navigation file *abnv941* and smoothes and despikes it, putting the resulting data in *abnv941.av*.

The cruise track is plotted using *plotxy* so that the longitude and latitude parameters can be altered, (using the file 'nav.pdf' and then 'abnv941.av'). A postscript file is produced and the final cruise track file is named 'jr94nav'.

## 5. VM\_ADCP

Rebecca McCreadie and Brian King

### 5.1 Configuration

An RD Instruments 153.5 kHz Acoustic Doppler Current Profiler (ADCP) is mounted inside a sea chest recessed into the hull of RRS *James Clark Ross*. The chest is filled with a mixture of 90% deionised water and 10% ethylene glycol and is closed to the sea by a 33 mm thick window of Low Density PolyEthylene (LDPE). The transducer head is offset by approximately 45° to the fore-aft direction.

Data was recorded in 40 x 8 m bins and in ensembles of 2 minute duration. The 'blank beyond transmission' was set to 4 m and the approximate depth of the transducer is 6 m. For the routine data processing the depth of the first bin was set to 14 m. This is incorrect, despite being the figure used on many previous cruises. For a pulse length of 8 m, a bin size of 8 m and a blank beyond transmit of 4 m, the first bin is centred at a depth of 12 m below the transducer. The first bin, therefore, should be centred at 18 m. At the end of the cruise a correction of +4 m was applied to all bin depths in all files. The system uses 17.07 firmware and version 2.48 of RDI Data Acquisition Software (DAS) run on an IBM-type PC. The two minute ensembles of data are passed directly to the Level C. Data are available in the PC PINGDATA files in the instance of any problems with the ship's Level C system.

The VM-ADCP was operated in two modes during JR94. Data in bottom tracking (BT) mode were collected in shallow waters (shallower than approximately 500 m), generally over Burdwood Bank and the Antarctic Peninsula shelf. Data in water track (WT) mode were collected where the water depth was sufficient to preclude useful bottom tracking, typically in depths greater than 500m.

**Note on selection of number of bins:** Previous SOC cruises have generally employed 64 x 8m bins. In water track mode we expect to get approximately one ping per second, and over 100 pings in a 2-minute ensemble. Fewer WT pings are achieved when BT is on, even though a ratio of one to four BT to WT pings is used. When we switched to WT mode near the start of the cruise, it was found that the number of WT pings was approximately 40 per two minutes. After some investigation it was found that with the new PC and serial comms configuration introduced in 2002, the serial comms rate between the PC and the deck unit is fixed at 9600. Pat Cooper (ETS) reported that effort had been made to establish comms at a higher speed, but that this had proved impossible. We suspect that the time required to

transmit 64 bins for each ping at 9600 baud was a limiting factor. The number of bins was therefore reduced to 40, and as a consequence the number of pings per ensemble increased to approximately 60. While the collective data acquisition system is therefore a considerable advance on the previous 286-based system, the rate of data acquisition appears to be significantly reduced. The question of baud rate should therefore be revisited. The manuals on board suggest that a baud rate of 19200 should be possible. It would be highly desirable to implement it if at all possible.

## 5.2 Problems

The Ashtech stopped reporting headings for two periods during the duration of JR94. The cause of this is unknown. The first period was between JDAY 338 05:42:32 and JDAY 342 11:32, and the second period was on JDAY 348 between 10:05:36 and 10:28:42. The first failure period unfortunately coincided with the bottom tracking southbound down the Antarctic Peninsula so this data could not be used for calibration of the VM-ADCP.

## 5.3 Routine Data Processing

The VMADCP data for JR94 were processed in 24 hour sections (00:00:00 to 23:59:59). The scripts and sequence of execution were the same as on previous cruises and are summarised in Table 4.1. All scripts were altered to allow processing in 24 hour sections as opposed to the 12 hour sections used previously.

Two corrections were applied to the VM-ADCP data in *94adpexec3* which vary between cruises. These are:

- (i) an inherent scaling factor associated with the VMADCP velocities,  $A$
- (ii) a compensation for the misalignment of the Ashtech antenna array relative to the VM-ADCP transducers,  $f$ .

During routine (pre-calibration) processing, bottom tracked velocities were adjusted using a nominal scaling of  $A = 1$  (scaling factor) and  $f = 0$  (misalignment angle). To calculate the true values of  $A$  and  $f$  the two minute ensembles of VM-ADCP data were merged with a smoothed version of GPS navigation, and 20 minute average absolute speeds and headings were derived from the satellite fixes. The bottom track VM-ADCP data were also used to derive 20 minute average speeds and headings. Data outside the range 400 - 750 cm s<sup>-1</sup> were excluded from the calibration.

$A$  and  $f$  were calculated following:

$$A = U_{\text{gps}} / U_{\text{VMADCP}}$$

$$f = f_{\text{gps}} - f_{\text{VMADCP}}$$

where  $U_{\text{gps}}$  and  $U_{\text{VMADCP}}$ , and  $f_{\text{gps}}$  and  $f_{\text{VMADCP}}$  are the 20 minute averaged speeds and headings, derived from the GPS and bottom track VM-ADCP data respectively. The direction of  $f$  was reversed so it had the correct orientation and its range was set to  $-180 < f < 180$ . Outliers were excluded.

The values derived were  $A = 1.030$  and  $f = -1.6$ .

These values compare to:

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

$A = 1.0253$  and  $f = -1.48$  (Meredith, JR57)

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

$A = 1.0290$  and  $f = -1.55$  (Meredith, JR70)

$A = 1.0285$  and  $f = -1.275$  (Meredith, JR81)

The data were reprocessed using the new values for  $A$  and  $f$  to produce calibrated water velocities relative to the ship, creating the output files 94adp[jday]d.cal and 94bot[jday]d.cal.

## 5.4 Further Data Processing

The final velocity files were appended into single files, 94adpall (water-track data) and 94botall (bottom-track data). 94adpall was merged with the gyro data to allow the heading variable to be available alongside the velocity data. Data from bin 15 (130m) was then extracted to make a 1row file. This file was manually screened for good data. Obviously bad data was generally obtained during periods when the ship was manoeuvring and good data generally occurred when the ship was on station or steaming with a constant heading. The good data cycles in the 1row file were saved to 94good\_datacycles.1row and then converted to indexes in the full data set using *dnum\_convert* (produced 94good\_datacycles.40rows). Using *94copygood\_adcpdata* all the good data was extracted into 94adp\_good. The results from bin 15 averaged in 10 minute intervals are shown in Figure 5.1.

Good data cycles were also identified for the southbound passage from Stanley to Elephant Island. The times of these good tracks are listed in Table 5.2.

## **5.5 Summary**

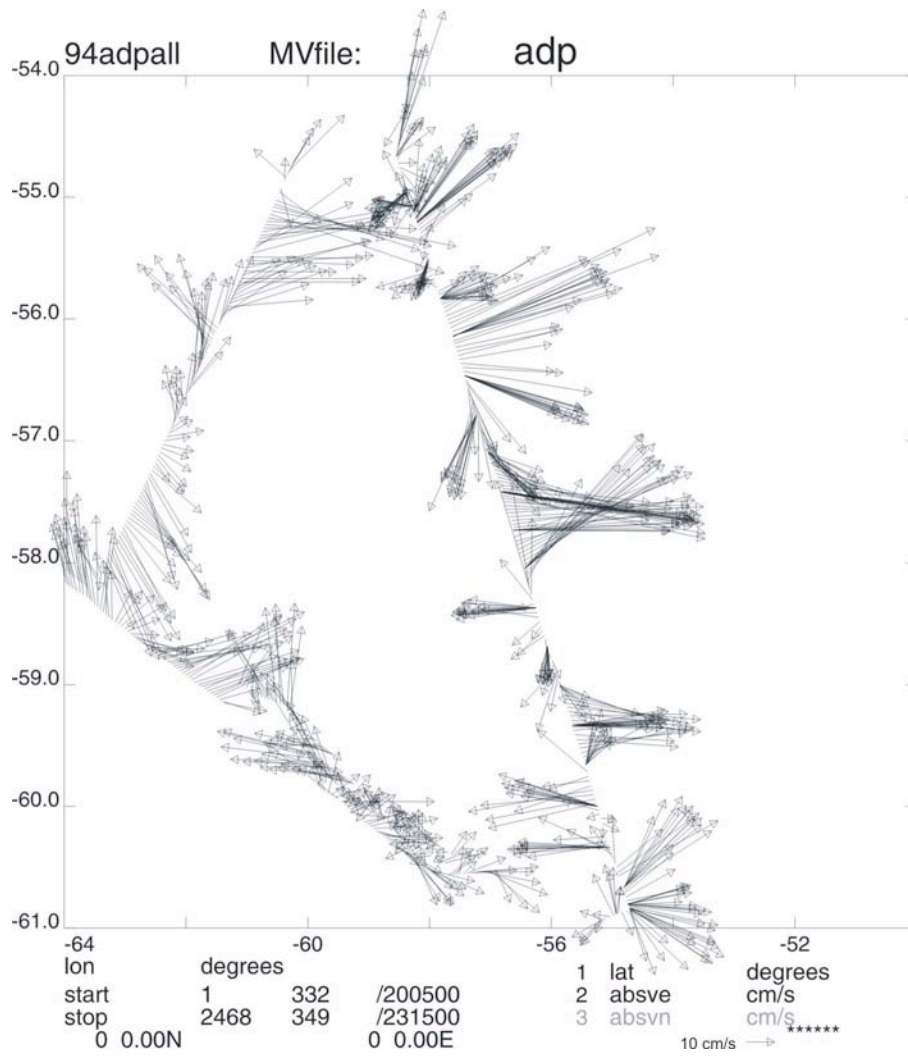
The VM-ADCP performed well throughout. Consistently good data was obtained throughout the 320 metre sampling depth. The only significant data loss was while the Ashtech heading was unavailable. The clock drift continues to be a source of inconvenience; it is easily corrected during post-processing, but it would be preferable to have this problem removed at source. This could be achieved by implementation of the suite of User Exit programs already adopted on other NERC ships. The question of the PC-Deck Unit baud rate should be revisited, and every effort made to increase it from 9600 to 19200. We note that many past cruises have incorrectly assigned the first bin depth to 14 metres, when 18 metres would be more accurate.

	<b>Script</b>	<b>Output Files</b>
Navigation Scripts	gpsexec0	94gps[jday]d.raw 94gps[jday]d 94gps01
	gyroexec0	94gyr[jday]d.raw 94gyr01
	ashexec0	94ash[jday]d.raw
	ashexec1	94ash[jday]d.mrg
	ashexec2	94ash[jday]d.edit 94ash[jday]d.ave
	ashedit.exec	94ash[jday]d.ave.dspk 94ash01.int
VM-ADCP Scripts	94adpexec0	94adp[jday]d 94bot[jday]d
	94adpexec0.1	94adp[jday]d.t 94bot[jday]d.t
	94adpexec1	94adp[jday]d.corr 94bot[jday]d.corr clock[jday]d
	94adpexec2	94adp[jday]d.true 94bot[jday]d.true
	94adpexec3	94adp[jday]d.cal 94bot[jday]d.cal
	94adpexec4	94adp[jday]d.abs 94bot[jday]d.abs

**Table 5.1:** Summary of scripts and output files run in processing the VM-ADCP data.

Track	Start Time		End Time	
	JDAY	hh:mm	JDAY	hh:mm
1	332	20:05	334	11:05
2	334	12:00	334	18:20
3	334	19:25	335	09:10
4	336	01:05	336	06:40
5	336	18:05	336	20:25
6	337	02:05	337	06:10
7	337	06:55	337	13:45
8	337	15:00	337	21:25
9	337	22:00	338	00:10

**Table 5.2:** Periods of good VM-ADCP data southbound between Stanley and Elephant Island.



**Figure 5.1:** VM-ADCP data from bin 15 (130m) averaged in 10 minute intervals.



## 6. SAMPLE SALINITY

Gwenna Corbel and Mike Sparrow

To begin with, the BAS Guildine Autosol 8400B salinometer (S/N 63360) was chosen for measurement of sample salinity during the cruise; but during the analysis of the first few samples it was found to be difficult to obtain a stable reading. It transpired that a second Autosol was on board (S/N 65763), and whilst at Rothera this was set up and used instead. This second Autosol was found to be much more stable.

The salinometer was set up as previously in the Bio Lab on the Upper Deck, with the salinometer bath temperature set to 24°C, and the ship's air conditioning used to try to maintain the laboratory at an ambient temperature of around 23 °C. This was often found to be insufficient and we adopted the sophisticated approach of opening and closing the doors to the lab to maintain the temperature.

A SOC-supplied peristaltic sample intake pump was used. This was found to leak, but was fixed by the use of a small cable tie around the upper pipe leading from the pump to the Autosol.

The Autosol was standardised using batch P143 IAPSO Standard Seawater supplied by Ocean Scientific International Ltd. of Petersfield, Hampshire, UK. A total of 30 bottles of P143 were used during the cruise.

Water samples for the analysis of salinity were drawn from each Niskin into 200 ml glass sample bottles, which were then sealed with clean, dry, disposable plastic stoppers and screw-on caps. The neck of the sample bottle was dried before insertion of the cap. A replicate sample was drawn for each bottle on station 01. Full crates of sample bottles were taken to the Bio Lab to equilibrate 24h before analysis. Most of the analysis was performed by AH, ML and GC, with some samples analysed by MS and BK. During the analysis, the presence of persistent small bubbles was noticed on the 3<sup>rd</sup> arm from the left.

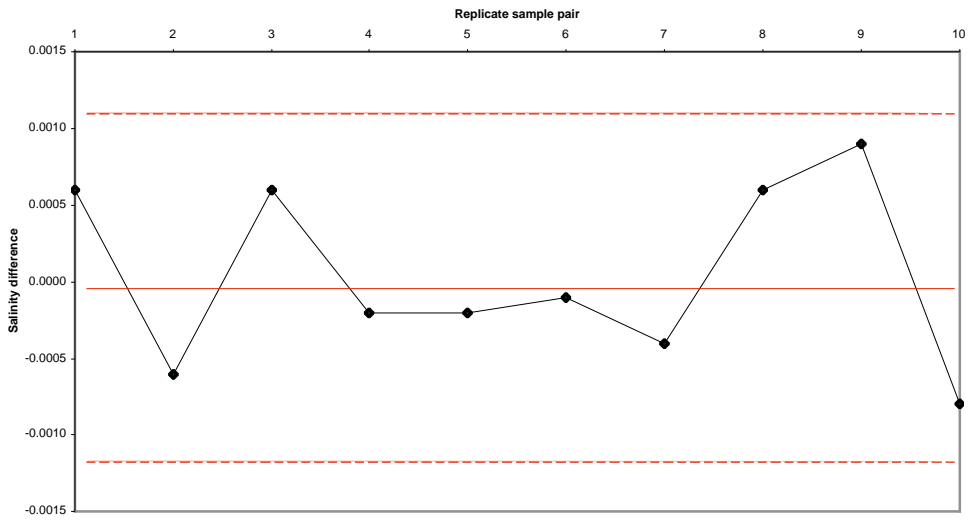
The salinity obtained for the 10 replicate sample pairs is presented in Table 6.1. The mean difference was 0.0000, and the standard deviation of the difference about the mean was 0.0006 (see Figure 6.1).

The S/N 65763 salinometer standardisation history is shown in Figure 6.2, in which the first analysed bottle of P143 is used as a pseudo-standard to reference subsequent measurements

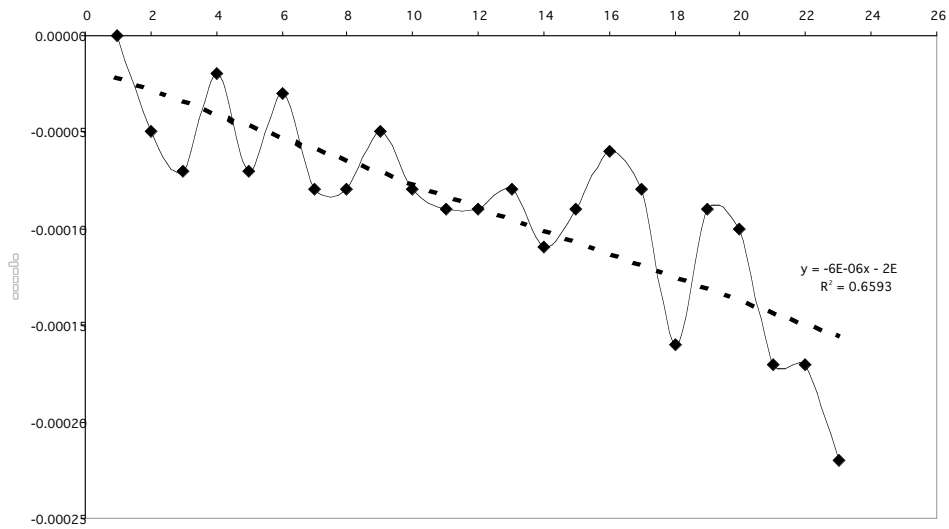
of P143 conductivity. A decreasing trend can be observed showing that in 5 days the value decreases by more than 0.00015 counts.

Sample	Salinity	
	<i>Replicate 1</i>	<i>Replicate 2</i>
940101	34.6995	34.6989
940102	No data	No data
940103	No data	No data
940104	34.7022	34.7028
940105	34.7211	34.7205
940106	34.7286	34.7288
940107	34.7203	34.7205
940108	34.6850	34.6851
940109	34.4848	34.4852
940110	34.0282	34.0276
940111	33.7691	33.7682
940112	33.7680	33.7688

**Table 6.1:** Calculated salinities for the 10 replicates sampled on station 01.



**Figure 6.1:** Salinity difference between replicates sampled on station 01. The mean difference and the two standard deviation interval are represented by the solid and the dotted red lines respectively.



**Figure 6.2:** S/N 65763 salinometer standardisation history.

## 7. UNDERWAY

Mei-Man Lee, Mike Sparrow, Brian King

### 7.1 Introduction

Throughout the Drake Passage section, underway data was recorded by the oceanlogger data system and passed to the Shipboard Computer System (SCS). It is then transferred to the unix and PC computer network for further processing. Meteorological data were recorded by instruments situated on the forward mast, and oceanic data were recorded by ocean surface layer sensors which measure the properties of the uncontaminated water supply. The oceanographic measurements include temperature, conductivity and fluorescence. The meteorological measurements include air temperature, humidity, atmospheric pressure, total incident radiation and photosynthetically available radiation. Additional parameters included the temperature of the conductivity sensor and the flow rate of the uncontaminated water supply. Data from the ship's anemometer is also available, in a separate stream, and is processed together with the other meteorological data.

Underway data first became available on jday 332 and was then collected continuously until the end of the cruise. The uncontaminated water supply was sometimes switched off due to the presence of sea ice. There was also no oceanographic data collected during the period of docking in Rothera (~ between days 340 and 343).

### 7.2 Data Capture and Processing

Data from the ocean logger and anemometer data streams were processed using scripts based on those used during JR81 (Bacon et al., 2003). The major change was to create an option to process data in 24!hour rather than 12!hour chunks. The unix execs used to process the underway data streams are:

*94oclexec0*: Reads the ocean-logger and anemometer data streams and stores them into a single pstar type file called 94oclXXXd.raw.

*94oclexec1*: Splits the data into separate ocean data and meteorological data files. It also performs some de-spiking of the conductivity data and calculates a raw salinity value. However, it is often necessary to perform further de-spiking using pstar program, *plxycd* (followed by *pintrp*). This gives a file called 94oclXXXd.

*twvvelxec*: Merges the met data file with gyrocompass and navigation data streams in order to calculate ship motion and true wind velocity. Some de-spiking is also performed. The final file is called 94metXXXd.

### **7.3 Salinity**

Sea surface salinity (SSS) was calculated from the ship's thermosalinograph (TSG) measurements of conductivity (variable *cond*) and water temperature (variable *saltemp*). In addition, water samples were taken every 4 hours from the ship's uncontaminated water supply (08:00 to 20:00 during the southbound leg, and 24!hrs during northbound leg). The salinity from the TSG was slightly lower than that from the water samples (Figure!7.1). The offset had a mean and standard deviation of 0.322 and 0.0095, respectively. The salinity from the top 5m CTD bottle samples was compared with that from the TSG (Figure!7.1). Again, the TGS salinity was lower than the CTD. The offset was about 0.0316, with a standard deviation of about 0.0057.

### **7.4 Sea Surface Temperature**

Sea surface temperature (SST) is measured at the hull intake sensor. On JR94 it gave a higher temperature than that from the top 5 m of CTD data (Fig. 7.2). The offset was about 0.0316 °C, with a standard deviation of about 0.0426 °C.

### **7.5 Air Pressure**

There is only one pressure sensor, which seemed to give reasonable values.

### **7.6 Humidity**

The data were not processed.

### **7.7 Air Temperature**

There was a slight difference between the two air temperature measurements. The offset ( $T1 - T2$ ) was about 0.02 °C, with a standard deviation of about 0.19 °C.

## 7.8 Total Incident Radiation (TIR)

There was a slight difference in the sensitivity of the two instruments measuring total incident radiation. The offset ( $TIR1 - TIR2$ ) was  $18.74 \text{ W m}^{-2}$ , with a standard deviation of  $37.89 \text{ W m}^{-2}$ .

## 7.9 Photosynthetically Active Radiation (PAR)

There was a nighttime offset for both sensors (Figure 7.3). The mean offset was  $-1.5 \text{ } \mu\text{m}^{-2}$  for sensor one, and  $-3.5 \text{ } \mu\text{m}^{-2}$  for sensor two.

## 7.10 Anemometer

The anemometer measures both the wind direction and its speed relative to the ship. The script *twvelexec* first adds in the ship's heading to give the direction relative to north. It then adds in the ship's velocity, calculated from gps measurements, to give the true wind direction and speed.

## 7.11 Flow meter

The average flow rate during the cruise, was about  $0.6 \text{ l min}^{-1}$ , while the flow meter was switched on.

## 7.12 Data Processing

The main ocean logger data streams were processed daily. This produces *94oclXXXd.raw*, *94oclXXXd* (oceanographic data) and *94oclmXXXd* (meteorological data). The dataset for whole period of cruise (both northbound and southbound) are merged together into files call *94oclall* and *94metall*. There are two variants of *94oclall* called *94oclall\_gps*, containing latitude and longitude, and *94oclall\_day*, which has julian day as a time variable.

## 7.13 Southern Ocean Fronts

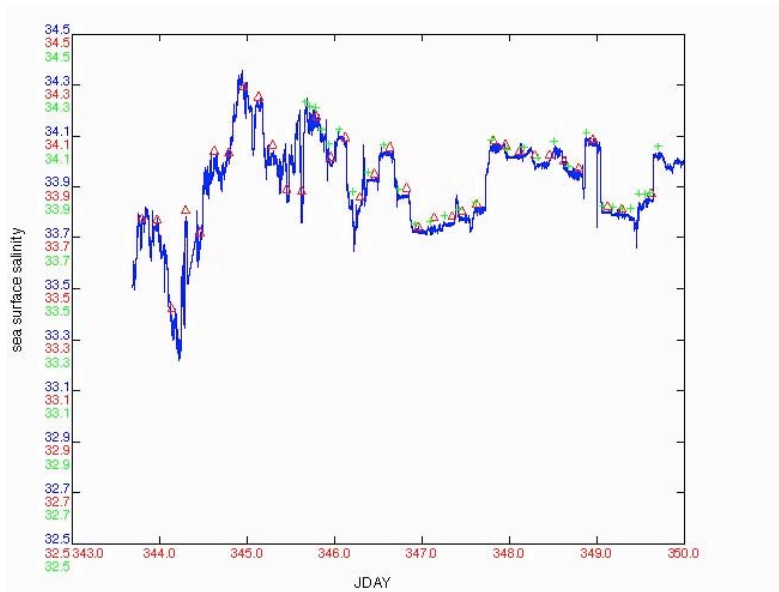
In the northbound section, the Polar Front was observed near  $57.5^\circ\text{S}$ . To the south of the front, temperatures and salinities were in the region of  $1.8^\circ\text{C}$  and 33.8, respectively; while to the north of the front, temperatures and salinities were in the region of  $5^\circ\text{C}$  and 34.1, respectively (Figure 7.4). There was an apparent warm water pool to the south of the main

front. Within this pool, temperatures were just above 2°C and salinities were ~33.9. To the south of the pool, the temperatures decreased to ~1°C and salinities were ~33.8. To the north of the Polar Front, there was a plateau with almost uniform temperature and salinity. Continuing further north, the Sub-Antarctic Front was observed, with a rise in temperature to near 7°C, but a decrease in salinity to 34.0.

The fluorometer data indicated increased productivity in a region to the north of the Polar Front and the Sub-Antarctic Front. It also showed increased productivity within the warm pool region. Interestingly, these fronts were also observed in the atmospheric properties, together with an additional front in the region of the warm water pool (Figure!7.5). The separation of the three atmospheric fronts is not well defined. They appear as a continuous increase of air temperature from near -4°C at 61°S to 6.4°C at 56°S, suggesting an incoherence in temperature changes between ocean and atmosphere. To the south of 61.5°S, however, the ocean and atmosphere temperature changes are synchronous. Note that the salinity does not change in a similar manner, presumably due to the presence of sea-ice near the Antarctic Peninsula.

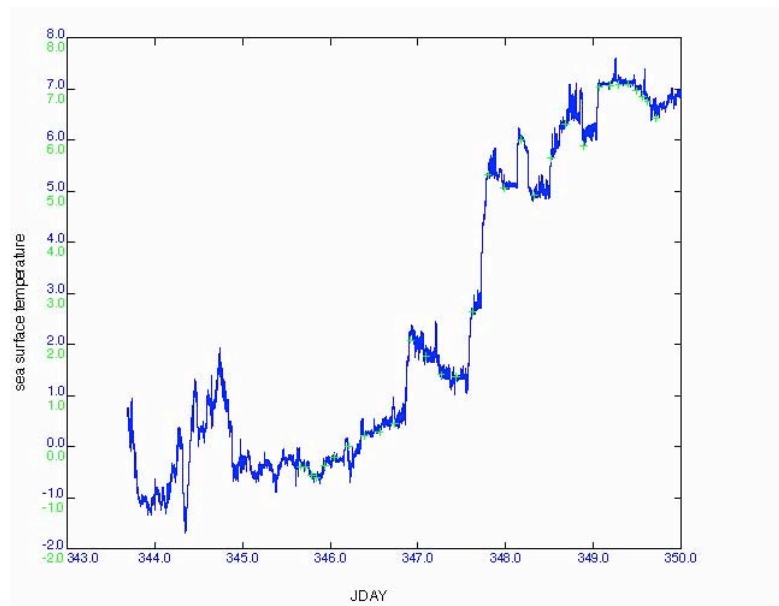
During the southbound passage leg the Polar Front was observed at similar latitude to its position during the northbound leg. However, the Sub-Antarctic front was less obvious (Figure!7.6). The fluorometer data indicated enhanced productivity within the Polar Front rather than to the northern edge of the front. The air temperature changes were similar to those in the sea surface temperature (Figure!7.7).

The larger scale meteorology was not fully analysed, but local winds were generally light with an average wind speed about 5 mls<sup>-1</sup> during the northbound section (Figures 7.5 and 7.7).



**Figure 7.1:** Sea Surface Salinity against Julian day (jday).

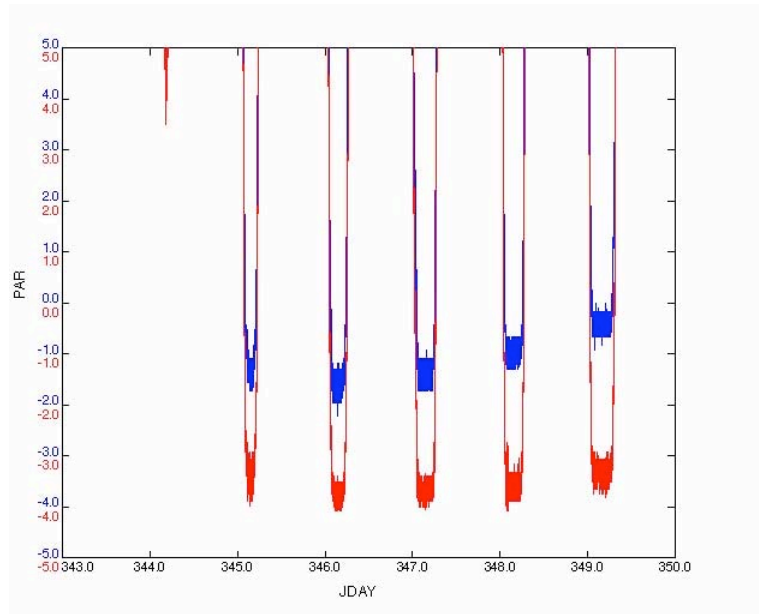
Oceanlogger salinities are illustrated in blue, bottle sample salinities in red, and CTD salinities in green.



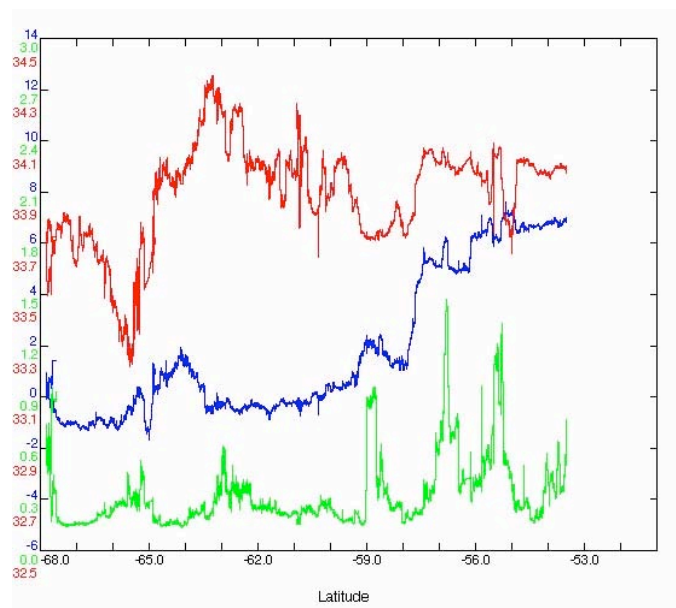
**Figure 7.2:** Sea Surface Temperature (°C) against Julian day (jday).

Oceanlogger temperatures are illustrated in blue, and CTD temperatures in green.

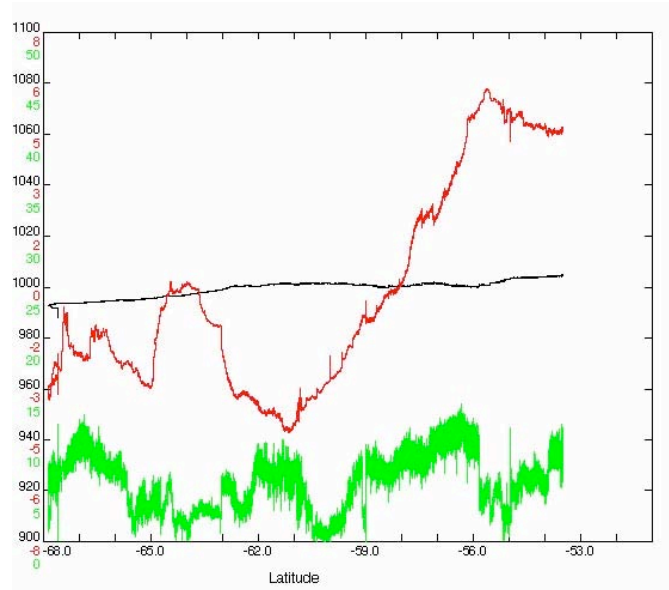




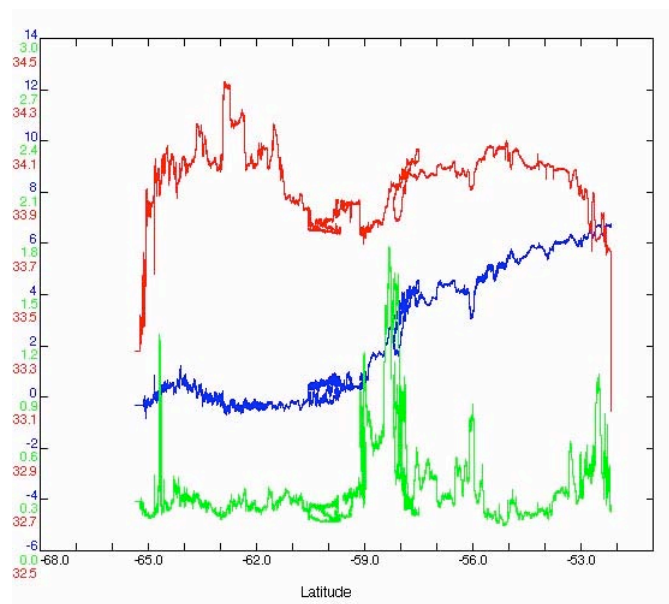
**Figure 7.3:** Photosynthetically active radiation (PAR) against Julian day (jday). Data from both sensors are illustrated (blue and red).



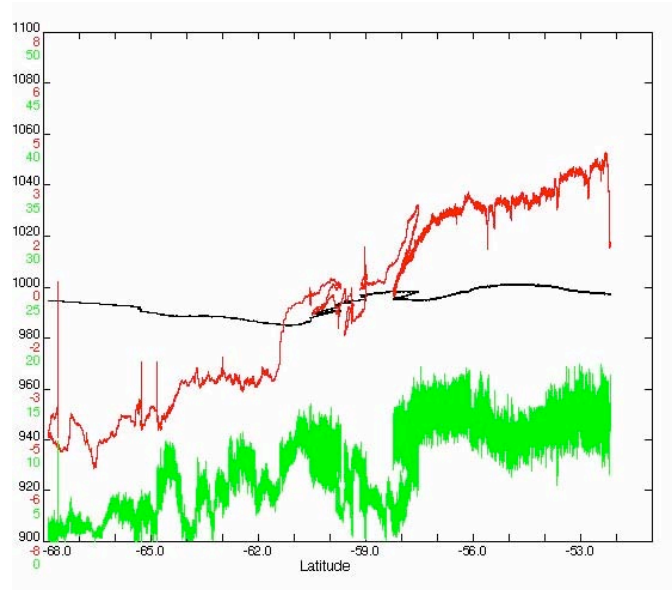
**Figure 7.4:** Latitudinal variability in surface ocean characteristics (northbound leg). Sea surface temperature ( $^{\circ}\text{C}$ ) is illustrated in blue, fluorescence ( $\mu\text{g l}^{-1}$ ) in green, and salinity in red.



**Figure 7.5:** Latitudinal variability in meteorological characteristics (northbound leg). Air pressure (mbar) is illustrated in black, air temperature ( $^{\circ}\text{C}$ ) in red, and true wind speed ( $\text{m}\cdot\text{s}^{-1}$ ) in green.



**Figure 7.6:** Latitudinal variability in surface ocean characteristics (southbound leg). Sea surface temperature ( $^{\circ}\text{C}$ ) is illustrated in blue, fluorescence ( $\mu\text{g}\cdot\text{l}^{-1}$ ) in green, and salinity in red.



**Figure 7.7:** Latitudinal variability in meteorological characteristics (southbound leg). Air pressure (mbar) is illustrated in black, air temperature ( $^{\circ}\text{C}$ ) in red, and true wind speed ( $\text{m!s}^{-1}$ ) in green.

## 8. ECHO-SOUNDER

Alison Hindley, Mike Sparrow and Brian King

### 8.1 Introduction

The RRS *James Clark Ross* is equipped with two echo-sounders, the SIMRAD EA500 and the EM120. The latter is a swath bathymetry system. Proper synchronisation between the two has now been achieved, so that they can be run simultaneously. The logging and processing procedures are similar for both.

### 8.2 Processing and Echo-sounder comparison

Raw data with assumed sound speeds of  $1500 \text{ m!s}^{-1}$  are logged by the SCS onto the simulated level C streams and retrieved daily using the pstar scripts *94sim* and *94swt* for the EA500 and EM120, respectively. Each script takes raw data from the SCS every 30 seconds and runs a 5 point filter. The filter removes values greater than 100!m from the median and assigns an absent data value to zero depths. The zero depths occur when no good data is available. This processing effectively removes many of the spikes in the data.

A comparison of the bathymetry derived from the two echo-sounders was made by using *pbath.exec* to plot depth against time. *plxied* was used to manually edit out areas of poor data (on the files '94simXXXd' and '94swtXXXd', where XXX is the Julian day in question). *pintrp* was run to interpolate between the data gaps. The last stage of processing was carried out by the exec *simpapall*. This script merges the data with the BESTNAV navigation data, and carries out a depth correction using Carter's tables. The resultant files produced are 'sim94.all' and 'swt94.all'. The bathymetry for the whole transect was examined using *plotxy*.

The EM120 recorded data at approximately 4 m (median) greater depth than the EA500 when the ship was south of the Polar Front. This offset increased to 10 m towards the end of the transect, when the ship was north of the Polar Front. This offset was due to the sound speed profile used in the swath (EM120) echo-sounder being calculated from temperature data obtained on the first transect (south of the Polar Front). This sound speed profile remained unchanged during the remainder of the cruise, so the calculated depth was shallower than the real depth, in the warmer water to the north of the Polar Front.

Generally, the EA500 and EM120 bathymetry show similar readings when the topography is fairly flat and shallow, but become offset from one another when there are large changes in topography or, in some regions, when the depth  $> \sim 2000$  m. It is worth noting no bathymetry comparison could be made for Julian days 339 and 340, since the EM120 was switched off while the ship was docked at Rothera.

The difference between the two echo-sounders becomes very noisy in the vicinity of rough or steep topography. This may be due to the wider EA500 beam providing a depth record 'contaminated' by side echoes from adjacent topographic features. The centre-beam EM120 data stream thus appears to be better for routine recording of bathymetry, although the swath bathymetry system has greater sensitivity to rough weather.

### **8.3 CTD Depths**

The times at which each CTD cast reached the bottom (starting) depth of the profile were sought from *plistf*, so that a comparison of the bottom depths and times could be made for both echo-sounders. CTD casts were made during Julian days 335 to 349, and the file input was '94simXXXd' and '94swtXXXd' (where XXX is the Julian day) to obtain bottom depths from the EA500 and EM120 echo-sounders respectively.

Two ASCII files were created, which list the CTD number, Julian day, time (GMT) and bottom depth; 'ctd\_depth.txt' and 'ctddepth\_em120.txt'. These were placed in the '/pstar/sim' and '/pstar/swt' directories, respectively.

## 9. UNIX COMPUTING

Brian King

Unix computing was carried out on jruh (Sun Blade 150) in the data prep lab and jrui (Sun Blade 100) in the UIC. 45 Gb of Networked disk was available on jruf, of which a little over 7Gb was used. We were given excellent support from Jeremy Robst, who assisted with networking and a number of other computer-related issues.

### 9.1 Pstar

A copy of the JR81 pstar exec directory was brought from SOC. Scripts were copied into a new exec directory when required, and modified if necessary. Most, if not all, scripts used were modified to introduce `#!/bin/csh -f` on the first line to provide fast start without running `.cshrc`.

Minor changes were made to iron out a few glitches. The most significant changes were the adaptation of daily processing (nav, adcp, underway) to allow processing in 24 hour blocks, while retaining backwards compatibility with 12-hour am/pm options.

Otherwise, there was little to report. Post-cruise backups were by tar dump to DLT.

### 9.2 Important note on DLT density

The DLT on jruf in the computer room can operate at a range of generally low densities, up to 20Gb. The tapes brought to upload data from SOC were written at a density of 35Gb, which was beyond the range of jruf but compatible with the Neptune workstation intended for the swath system. Available density and media should be double-checked before future cruises, as DLTs are in limited use within BAS. At present, 20Gb is available on both jruf and neptune drives.

### 9.3 Matlab

It appears that Matlab is licensed for a single user on a single machine. Therefore all Matlab computing was done by pstar logged on to jruh. Matlab was chiefly used for LADCP processing, incidental calculations, and some float work by BAK and REBL before the main section work began.

## **9.4 Laptops**

Two laptops were brought. A Mac iBook was used for calculating and transferring sample salinities and TSG bottle times and numbers. A Toshiba laptop was networked in the chem. lab and used to transfer raw LADCP files. A unix directory was mounted using samba so that files could be transferred to unix by drag and drop.

## **9.5 Desktops**

The windows desktops in the data prep lab were used for drafting text.

## **9.6 Shipboard Computing System (SCS)**

The SCS performed without problems. Apart from the CTD data, all data streams were logged to SCS files, and then transferred to RVS files so that they could be accessed by *datapup* and other rvs utilities (*lookd*, *dinfo*, *posinfo*, *listit*, *gaps* etc). A new utility was written to monitor the Ashtech heading stream while alongside at Rothera. Several days of data was lost through the peninsula when the Ashtech hung and started sending blanks in the heading field. Since position was still being reported correctly, the SCS monitoring did not show a fault. The new utility made a point of inspecting Ashtech heading and displaying it prominently in the SCS monitor window. When the Ashtech went down again on day 348, the display turned red and was noticed by watchkeepers. The Ashtech seems to recover quite easily after power cycling, but at present it needs to have various output parameters reset from a local terminal, so the expertise required is slightly above routine watchkeeping. The Ashtech failed three times in all: it was hung in Stanley on arrival, it failed in Bransfield Strait southbound, and failed briefly before being noticed during the SR1b section northbound. A suggestion was made to recover GPS heading from the SeaTex attached to the EM120, but unfortunately the logged SeaTex stream on the SCS does not contain heading as a variable.

## 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.

Bacon, S., 2003: RRS *James Clark Ross* Cruise 81, 18 Dec 2002 – 02 Jan 2003. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island. Southampton Oceanography Centre, Cruise report No. 43, 86 pp.