National Oceanography Centre, Southampton

Cruise Report No. 25

RRS *James Clarke Ross* Cruise 163

07 DEC – 15 DEC 2006

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

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2008

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DOCUMENT DATA SHEET

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PUBLICATION DATE
2008

TITLE
RRS *James Clark Ross* Cruise 163, 07 Dec-15 Dec 2006. Drake Passage Repeat Hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island

REFERENCE
Southampton, UK: National Oceanography Centre, Southampton, 64pp.
(National Oceanography Centre Southampton Cruise Report, No. 25)

ABSTRACT

This report describes the twelfth repeat hydrography section across Drake Passage, first established during the World Ocean Circulation Experiment. For this work NOC made use of the regular BAS supply trip to Rothera from the Falklands using the *RRS James Clark Ross*. Thirty CTD/LADCP stations were carried out across the 753 km section from Burdwood Bank to Elephant Island, plus one test station in the deep waters to the north of Burdwood Bank. Maximum station spacing on the section was 33 km, with stations closer together on the continental shelves. Water samples were drawn for salinity analysis, for subsequent CTD conductivity calibration. Samples were also drawn for analysis of oxygen isotope fraction $\delta^{18}O$, for later analysis back at NOC. The CTD was a SeaBird 911*plus* with dual temperature and conductivity sensors. There were two LADCP instruments, but no useful data were collected with them. Various underway measurements were also collected, including navigation, vessel-mounted ADCP, sea surface temperature and salinity, water depth and meteorological parameters. Water samples were also collected for subsequent analysis for chlorophyll, particulate carbon and biogenic silica.

KEYWORDS
ADCP, Antarctic Ocean, Acoustic Doppler Current Profiler, cruise 163 2006, CTD Observations, Drake Passage, *James Clark Ross*, Lowered ADCP, LADCP, oxygen isotopes, particulate carbon, phytoplankton, Southern Ocean, WOCE, World Ocean Circulation Experiment

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SCIENTIFIC PERSONNEL

Name:	Affiliation:	Role:
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CONTARDO Stéphanie	BODC	Bathymetry, Salts
DE LA ROSA HOHN Sara	IfM	Navigation, Oxygen Isotopes
ELLIOT James	BAS	Salts
HADFIELD Rachel	NOC	CTD, Salts
HOLLIGAN Patrick	NOC	Surface Sampling
JICKELLS Tim	UEA	Surface Sampling
MASSEY Alison	BAS	Salts
PRESTON Mark	BAS	Technical Support
WATSON Sue-Ann	NOC	Salts
WILLIAMS Adam	NOC	CTD, LADCP, ADCP
WILLIS Doug	BAS	ICT Support

Key:
BAS: British Antarctic Survey
NOC: National Oceanography Centre, Southampton
BODC: British Oceanographic Data Centre
UEA: University of East Anglia
IfM: Institut fuer Meereskunde, Hamburg, Germany

SHIP'S PERSONNEL

Name:	Rank:
Burgan, Jerry	Master
Page, Tim	Chief Officer
King, David	Second Officer
Cox, Joanna	Third Officer
Gloistein, Michael	Radio Officer
Anderson, Duncan	Chief Engineer
Armour, Gerald	Second Engineer
Stevenson, James	Third Engineer
Balfe, Thomas	Fourth Engineer
Trevett, Douglas	Deck Engineer
Rowe, Anthony	ETO Engineer
Turner, Richard	Purser
Gill, Andrew	Cadet
Peck, David	Bosun
Bowen, Albert	Bosun's Mate
Chappell, Kelvin	Seaman
Raper, Ian	Seaman
Dale, George	Seaman
Holmes, Kevin	Seaman
Estibeiro, Anthony	Seaman
MacKaskill, Angus	Motorman
Smith, Bruce	Motorman
Huntley, Ashley	Chef
Lee, Jamie	2^{nd} Cook
Jones, Lee	Senior Steward
Greenwood, Nicholas	Steward
Raworth, Graham	Steward
Weirs, Michael	Steward

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ACKNOWLEDGEMENTS

Adam Williams

It is a pleasure to acknowledge the efficiency and high standards of hospitality of the Master, Officers and crew of the *James Clark Ross.* Their efforts were essential in the smooth running of the cruise and the execution of all operations under tight time constraints.

A thank you must go out to the technical and IT support staff, Mark Preston, Doug Willis and Manos Tsentides for bearing with us while we found our feet on the cruise and for their continued high level of support and patience throughout. We also thank Sue-Ann Watson, Alison Massey and Jim Elliott for volunteering to help us and participating on the 12-hour watches.

Finally, we must thank Tim Jickells for his support and advice during the whole cruise which was greatly appreciated.

OVERVIEW

Adam Williams

This report describes the twelfth occupation of the Drake Passage section, established during the World Ocean Circulation Experiment as repeat section SR1b, first occupied by Southampton Oceanography Centre (now the National 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 twelfth occupation of the NOC/BAS Drake Passage section went pretty much according to plan apart from the failure of the LADCP instruments and the usual last minute changes in logistical details. The problems associated with the Dash-7 aircraft and the difficulty in obtaining flights down to the Falklands Islands meant that the science party travelled down in two groups well in advance of the departure date of the cruise. On the 25th November, the majority of the party flew to Montevideo, Uruguay to join the *RRS Ernest Shackleton* for the four-day crossing to Mare Harbour in the Falklands. It was a rare opportunity for NOC scientists to travel on the *RRS Ernest Shackleton* and to meet this year's BAS contingent en-route to Halley Station. The remaining members of our party flew down on the LAN Chile flight via Madrid, Santiago and Punta Arenas on the 30th November, arriving in Stanley on 1st December. We all joined the ship from our various locations on 3rd December, and did not depart from FIPASS until 6th December due to the volume of cargo operations for the trip down to Rothera. We set sail at 2pm after a brief stop in Port William Sound where safety drills were carried out and the cargo was secured down in preparation for the Drake Passage crossing. The ship was almost full to capacity, with personnel destined for Rothera and some extra passengers due to the delayed Dash-7 flights into Rothera. This included the usual contingent of scientists, general assistants and base support crew plus two artists on the ship. The ship was heavily loaded with supplies for the new development at Rothera and after the delays in Stanley the ship was steaming at 15 knots to make up on some of the lost time. The extended mobilization time gave us ample time to get the CTD and LADCP equipment working for the first station. This year we used the BAS CTD equipment and Niskin bottles with the UKORS 300 kHz RDI ADCP and 24-bottle CTD frame.

The CTD operations began with the occupation of a test station at 02:00 GMT on the 8th December half way between the Falkland Islands and Burdwood Bank so that we could test out the LADCP unit in relatively deep waters. We came onto the first station of the section

proper at 0900 on the 8th December and began the section in relatively calm waters. The LADCP data did not record for station 5 and all LADCP operations were ended after station 8 when it was discovered that there were broken beams on both instruments requiring repairs by the manufacturer. There were problems on station 18 when the top 4 Niskin bottles failed to fire and error messages began to appear on the upcast of the station on the CTD aquisition software. On recovery of the CTD is was discovered that the swivel required replacing and was duly replaced and tested with a shallow cast before proper CTD operations were resumed. The bottle firing mechanism on the CTD PC began to fail and was not registering every bottle firing, causing bottles to be fired twice on stations 20, 22 and 26. After Station 26, the computer was rebooted and all bottle-firing was performed manually on the CTD deck unit.
In general, the weather was very calm, with the loss of only 5 hours, on the evening of 9th December, during the whole transect when it was considered unsafe to continue with CTD operations.

Between stations 2 and 3, and 27 and 28, the ship stopped so that the team from the Permanent Service for Mean Sea-Level (PSMSL) from the Proudman Oceanographic Laboratory (POL) could service their bottom pressure recorder moorings. These all went according to plan, with the first mooring coming up straight away, and only a short two-hour delay in recovering the second, southerly mooring.

Elephant Island (and the first iceberg) was first sighted on the morning of the 12th December, before it subsequently disappeared into the mist for the remainder of the day until the final station was completed at 23:00, where it was possible to just make out the form of some land appearing through the cloud. The island did not come properly into view until we were to the south of the island, where we could finally see the true daunting environment of Elephant Island.

On the route down to Rothera, we picked up two BAS personnel from Fildes Peninsula on King George V Island on the 13th December, and were lucky enough to have clear skies on the passage through the Neumayer and Lemaire Channels the following day after a cloudy journey past the imposing views of Livingston and Deception Islands. A brief stop at the Vernadsky Station to enable the POL team to service the tide gauge there, allowed all personnel to experience some Ukrainian hospitality and to see the historical site of what used to be BAS's Faraday Station. The ship then headed back out to sea to round Adelaide Island and make its final approach to Rothera Station, which was reached at 14:00 on 15th December. The back deck of the ship was quickly cleared for the mooring operations of JR155 in Marguerite Bay and the ship left the dock at 22:00 to start the next project. This took two more days with the ship returning finally on the 17th December.

1. CTD DATA AQUISITION AND DEPLOYMENT

Rachel Hadfield and Adam Williams

1.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was used on JR163 to vertically profile the temperature and salinity of the water column. Thirty-one stations were occupied in total. The nominal station locations are listed in Table 1.1 and actual locations at the start, bottom and end of each cast, alongside the water depth, are listed in Table 1.2. Station 1 was a test station carried out to a depth of 2000 m. A deep test station was chosen to check the LADCP, which did not return full upcasts on the previous cruise. For more details refer to section 2.

Table 1.1: Nominal station positions for Drake Passage section (from Bacon et al., 2003).

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

Table 1.2: JR163 CTD Stations. The times and positions given for each station represent variables for the start, maximum depth and end of the station. Depth (m) is the depth derived from the maximum CTD depth plus the altimeter height off the seabed.

STATION	Julian Day	Time hh:mm:ss	Latitude °S	Latitude (mins)	Longitude °W	Longitude (mins)	Water depth (m)	Ctd Max pressure (db)
163ctd01	342	01:59:14 02:34:36 03:15:54	53 53 53	30.40 30.40 30.40	58 58 58	11.01 11.00 11.00	2313	2032
163ctd02	342	08:58:39 09:07:16 09:21:34	54 54 54	40.00 39.99 40.00	58 58 58	32.62 32.62 32.62	389	384
163ctd03	342	10:58:51 11:11:45 11:30:55	54 54 54	55.37 55.37 55.37	58 58 58	23.11 23.11 23.11	529	526
163ctd04	342	14:22:52 14:44:47 15:16:25	54 54 54	56.62 56.62 56.62	58 58 58	22.31 22.31 22.31	1145	1146
163ctd05	342	16:07:48 16:37:50 17:16:20	54 54 54	57.65 57.66 57.66	58 58 58	21.68 21.68 21.67	1598	1608
163ctd06	342	18:24:14 19:02:09 19:51:33	55 55 55	4.16 4.18 4.17	58 58 58	17.68 17.63 17.63	2069	2089
163ctd07	342	20:47:33 21:33:20 22:26:28	55 55 55	7.26 7.26 7.26	58 58 58	15.71 15.71 15.71	2516	2546
163ctd08	343	23:13:16 00:05:11 01:02:21	55 55 55	10.30 10.30 10.30	58 58 58	13.80 13.81 13.81	3012	3052
163ctd09	343	01:54:27 03:00:13 04:14:02	55 55 55	12.86 12.86 12.86	58 58 58	12.23 12.23 12.23	3902	3965
163ctd10	343	06:07:00 07:20:38 08:42:52	55 55 55	30.96 30.97 30.99	58 58 58	1.17 1.23 1.29	4228	4300
163ctd11	343	10:54:55 12:18;51 13:50:45	55 55 55	50.04 50.05 50.06	57 57 57	49.13 49.12 49.13	4749	4833
163ctd12	343	16:02:26 17:01:29 18:10:20	56 56 56	8.99 9.04 9.12	57 57 57	37.46 37.03 36.04	3356	3403
163ctd13	343	20:28:09 21:34:15 22:49:20	56 56 56	28.00 28.04 28.08	57 57 57	25.63 23.61 21.31	3792	3852
163ctd14	344	05:52:55 06:43:31 07:39:28	56 56 56	47.23 47.72 48.23	57 57 57	13.99 14.15 14.23	2912	2951
163ctd15	344	09:28:17 10:35:40 11:52:41	57 57 57	6.09 6.18 6.18	57 57 57	2.01 1.93 1.93	3968	4033
163ctd16	344	13:48:33 14:51:42 16:01:06	57 57 57	24.98 24.98 25.21	56 56 56	50.17 50.16 49.37	3526	3579
163ctd17	344	17:58:43 19:15:25 20:27:08	57 57 57	44.00 44.03 44.11	56 56 56	38.50 37.10 36.00	3616	3670
163ctd18	344	22:26:23 23:34:14 00:50:23	58 58 58	2.97 3.03 3.12	56 56 56	26.62 26.30 25.85	3951	4015

163ctd19	345	03:39:52 04:46:46 05:58:06	58 58 58	21.99 22.00 22.00	56 56 56	15.04 15.03 15.04	3893	3956
163ctd20	345	07:53:48 08:58:43 10:09:32	58 58 58	40.99 41.00 41.00	56 56 56	3.24 3.23 3.24	3751	3812
163ctd21	345	12:05:14 13:10:53 14:26:16	59 59 59	0.01 0.01 0.01	55 55 55	51.42 51.41 51.42	3773	3831
163ctd22	345	16:22:49 17:27:08 18:42:35	59 59 59	19.99 19.99 19.99	55 55 55	39.10 39.08 39.08	3756	3814
163ctd23	345	20:37:48 21:46:47 22:58:19	59 59 59	40.05 40.39 40.75	55 55 55	26.60 26.03 25.43	3673	3726
163ctd24	346	00:50:00 01:49:47 02:56:15	60 60 60	0.02 0.02 0.02	55 55 55	14.30 14.30 14.31	3499	3553
163ctd25	346	04:52:27 05:51:29 06:56:21	60 60 60	19.98 20.00 20.00	55 55 55	1.82 1.90 1.89	3437	3491
163ctd26	346	08:54:44 09:46:29 10:46:31	60 60 60	39.96 39.96 39.96	54 54 54	49.44 48.98 48.58	3091	3135
163ctd27	346	11:52:54 12:39:40 13:30:17	60 60 60	47.96 47.96 47.96	54 54 54	44.54 44.54 44.54	2576	2605
163ctd28	346	17:01:13 17:32:45 18:10:55	60 60 60	49.99 49.98 49.98	54 54 54	43.31 43.31 43.31	1777	1791
163ctd29	346	19:22:18 19:41:51 20:06:10	60 60 60	51.02 51.02 51.02	54 54 54	42.66 42.66 42.66	1001	1000
163ctd30	346	21:21:26 21:34:58 21:52:29	60 60 60	58.86 58.86 58.86	54 54 54	37.81 37.81 37.82	580	576
163ctd31	346	22:38:36 22:47:23 23:02:41	61 61 61	2.94 2.97 3.00	54 54 54	35.20 35.21 35.22	360	352

1.2 Configuration

A full-sized SBE 24 carousel water sampler, holding 12 bottles, connected to an SBE 9 plus CTD and an SBE 11 plus deck unit was used to collect vertical profiles of the water column. The deck unit provides power, real-time data acquisition and control. The underwater SBE 9 plus unit featured dual temperature (SBE 3 plus) and conductivity (SBE 4) sensors, and a *Paroscientific* pressure sensor. A TC duct and a pump-controlled flow system ensure that the flow through the TC duct is constant to minimize salinity spiking. Used in conjunction with the SBE 32 and SBE 911, the SBE 35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired. A file containing the time, bottle position and temperature is recorded allowing comparison of the SBE 35 record with the CTD and bottle data.

In addition, an altimeter, fluorometer, oxygen sensor and transmissometer were attached to the carousel. The altimeter gave real-time accurate measurements of height off the sea-bed once the instrument package was within approximately 100 m of the bottom. The Simrad EA600 system would sometimes lose the bottom or give erroneous readings on station, so care was needed to interpret these digitised records.

For all stations two UKORS LADCPs (one upward-looking, the other downward-looking) were attached to the main CTD frame, data were only logged for the first five stations before instrument failure was detected (see LADCP section). A fin was also added to the frame to reduce rotation of the package underwater.

1.3 Deployment

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 m cable out. 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 a nominal 10 m above the seabed.

At each CTD station the first Niskin bottle was fired at the bottom of the downcast and subsequent Niskin bottles were fired during the upcast, with a pause of 5 seconds between the winch stopping and the bottle firing and a pause of 10 seconds between the bottle firing and the winch restarting while the SBE35 sampled. At all stations all 12 bottles were fired. Each bottle was sampled for both salinity and $\delta^{18}O$ analysis. The salinity sample collection and analysis is discussed below (section 1.8), $\delta^{18}O$ samples are discussed briefly in section 7.1. In addition, bottles fired in the upper 50 m of the water column were analysed for chlorophyll, silica, particulate organic carbon and particulate inorganic carbon (see section 7.2)

When inspected, the PC clock, which sets the time in the SeaBird file headers, was 6 seconds slow.

1.4 Data Acquisition

The CTD data were logged via the deck unit to a 1.4GHz P4 PC, running Seasave Win32 version 5.37b (Sea-Bird Electronics Inc.). This new software allows numerical data to be listed to the screen in real-time, together with several graphs of various parameters.

Four files were created by the Seasave Win32 version 5.28e module for each station:

163ctdnn.dat a binary data file

163ctdnn.con an ascii configuration file containing calibration information

163ctdnn.con an ascii header file containing the sensor information

163ctdnn.bl a file containing the data cycles at which bottles were closed on the rosette

where *nn* refers to the CTD cast number. These files were saved directly to the \\samba\\pstar drive.

The CTD data were converted to ascii and calibrated by running the Sea-Bird Electronics Inc. Data Processing software version 5.37b *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 *163ctdnn.cnv.*

The pressure sensor was calibrated following:

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

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

The conductivity sensor was calibrated following:

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

where p is pressure, t is temperature, and $\delta = CTcorr$ and $\varepsilon = Cpcorr$.

The temperature sensor was calibrated following:

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

where f is the frequency output by the sensor.

The Sea-Bird Electronics Inc. Data Processing software version 5.37b was then used to apply a cell thermal mass (ctm) correction. This correction 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 *163ctdnn_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 processed files were saved to the smb://samba/pstar drive, and the *_ctm.cnv*, *.ros* and *.bl* files also copied to *~/pstar/data/ctd/ASCII_FILES/*

1.5 Problems

On station 18, only 8 of the 12 bottles fired successfully. Investigation revealed that the swivel had failed; the insulation resistance of a good sea cable is 4Gohms, after station 18 it was around 5Mohms indicating an internal breakdown of the CTD swivel (see section 9.4 for more details). This was quickly replaced and a test dip suggested the problem was fixed. However, on station 20 difficulties in firing the bottles were again encountered with the computer indicating that bottles 1 and 3-12 had fired, but with all bottles closed when the CTD returned to deck. It appears that both bottles 1 and 2 fired at the bottom. After this time bottles were fired manually using the button on the deck unit. Two further stations, 22 and 26, also suffered errors during bottle-firing. The logging PC was rebooted before cast 27 and no further problems were encountered. On station 13, bottle 10 and station 29, bottle 2, the top tap was found to be untightened on return to deck. It is thought unlikely that this resulted in significant contamination of samples.

1.6 SBE 35

The BAS SBE35 high-precision thermometer was fitted to the CTD frame. For each water sample taken using the rosette, the SBE35 recorded a temperature in EEPROM. This temperature was the mean of 8 * 1.1 seconds recording cycles of data. The thermometer has the facility to record 157 measurements but the data were downloaded approximately every few casts.

To process the data, communication was established between the CTD PC and the SBE35 by switching on the deck unit. The *SeaTerm* 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 are 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. Some problems were experienced in the data download as incomplete records were being written to the .txt files. The remaining records had to be entered manually into the file before the instrument memory was reset.

The SBE35 data files were divided into separate files for each station with up to 12 records (one level for each bottle) called jr163*sbenn.txt*. These files were saved directly to the \\samba\\pstar drive *~/pstar/data/ctd/SBE35/.*

1.7 Data processing

Further processing of the CTD data using pstar scripts (in unix) required both the salinity data from the bottle samples and SBE35 temperature data. 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 *163station_dcs*. Scripts requiring knowledge of these scan numbers 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.

Routines used:

163seactd0

This exec converts the seabird ascii file *163ctd[nn]_ctm.cnv* to pstar. Depths from the EA600 were initially used at this processing step and were later updated using information on the maximum depth of the CTD and the final height off the seabed from the altimeter.

163seactd1

This exec calculates the salinity and potential temperature, creating the file *163ctd[nn].sal*

163seactd1.1

Obtains the data cycle for the bottom of the cast in the *.sal* file and adds it to *163stations_dcs.*

163seactd1.2

This produces listings of the pressure and salinity near the start and near the end of the cast for extraction of start and end cycle numbers.

163seactd1.3

This exec inserts the noted start and end cycle into*163stations_dcs*.

163seactd2

This extracts data from *163ctd[nn]* corresponding to the bottle firing times taken from the Seabird ascii file *163ctd[nn].bl.* Data were extracted for 3 seconds before the bottle closed and 5 seconds after the bottle closed. The extracted data are averaged to give a file containing a single data cycle for each bottle firing. The output file is *163ctd[nn].btl*.

163seactd7

This performs averaging to output files *163ctd[nn].1hz* (which has both downcast and upcast) and *163ctd[nn].1db* (which only has downcast).

1.8 Data calibration

There are three opportunities for CTD data calibration/comparison: 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.

Primary/Secondary comparison:

An initial comparison was made at 84 bottle-closing events at 2000 m or deeper. The mean and standard deviations were:

$$T1 - T2 = 0.0011 \pm 0.0004\ °C$$

$$C1 - C2 = 0.0007 \pm 0.0003\ \text{mmho cm}^{-1}$$

$$S1 - S2 = 0.0015 \pm 0.0004$$

Thus T1 reads slightly higher than T2, and C1 reads slightly higher than C2.

Closer graphical investigation shows that both T1-T2 and C1-C2 appear to vary with pressur**e.** If T1 is used as the independent variable, the relationship is noisy, suggesting it is a pressure effect rather than a simple temperature calibration slope error. The corresponding trend in S1-S2 also exhibits a dependency on pressure.

CTD/sample salinity comparison:

Salt samples were taken for calibration of the CTD salinity profiles. Each 200 ml medicine 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 neck of the bottle 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 ambient temperature.

The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360 against Ocean Scientific standard seawater (hereafter OSIL) from batches P144 and P146. At the beginning, and at the end of each crate of samples one vial of OSIL standard seawater was run through the salinometer enabling a calibration offset to be derived and to check the stability of the salinometer.

Several problems were encountered during analysis of the salt samples. In particular, the salinometer readings were found to be highly unstable. The fluctuating readings observed here were caused by the presence of small bubbles in the cell. A similar problem was noted during the previous cruise (Shreeve, 2006) and was thought to be fixed by replacing the new external pump with an old peristaltic pump. After analysing the first 20 stations the old external pump was removed and samples were forced into the cell using air, as per standard Autosal.

Once analysed, the conductivity ratios were entered by hand into an EXCEL spreadsheet, converted to salinities and saved on the Unix system. Using the routines *163samblank.exec, 163samfir_new* and *botcond* the bottle conductivities were computed for comparison with the CTD conductivity sensors.

Deeper than 2000 metres and after removal of outliers, the mean offsets were as follows:

S – S1 = -0.0083 ± 0.0019

S – S2 = -0.0072 ± 0.0018

C - C1 = -0.0073 ± 0.0016 mmho cm^{-1}

C - C2 = -0.0058 ± 0.0015 mmho cm^{-1}

Thus it is apparent that the secondary sensor is preferable to the primary one. The conductivity offsets calculated using the first 20 stations and the final 11 stations were not dissimilar (0.0060 ± 0.0015 mmho cm^{-1} and 0.0056 ± 0.0015 mmho cm^{-1}, respectively) indicating that removal of the external salinometer pump did not greatly alter the accuracy of the salinometer.

No trends with depth in S – S2 or C - C2 were discernable. Note that after the calibration of the conductivity cell, for all bottles (expect outliers) there remains an offset of 0.0031 ± 0.0146 mmho cm^{-1}.

CTD/SBE35 comparison:

Deeper than 2000 metres, the mean offsets are:

T35 – T1 = -0.0009 ± 0.0021 (for data: –0.0078 < T35-T1 < 0.0048)

T35 – T2 = -0.0002 ± 0.0019 (for data: –0.0075 < T35-T2 < 0.0037)

Only 67 bottles were used for this comparison given the difficulties in firing bottles during some casts and the associated uncertainty in the firing depths.

When the full dataset is viewed with pressure as an independent variable, no trend is discernable in T35-T1, or in T35-T2. Comparisons of T1 and T2 with T35 suggest that T2 is to be preferred to T1.

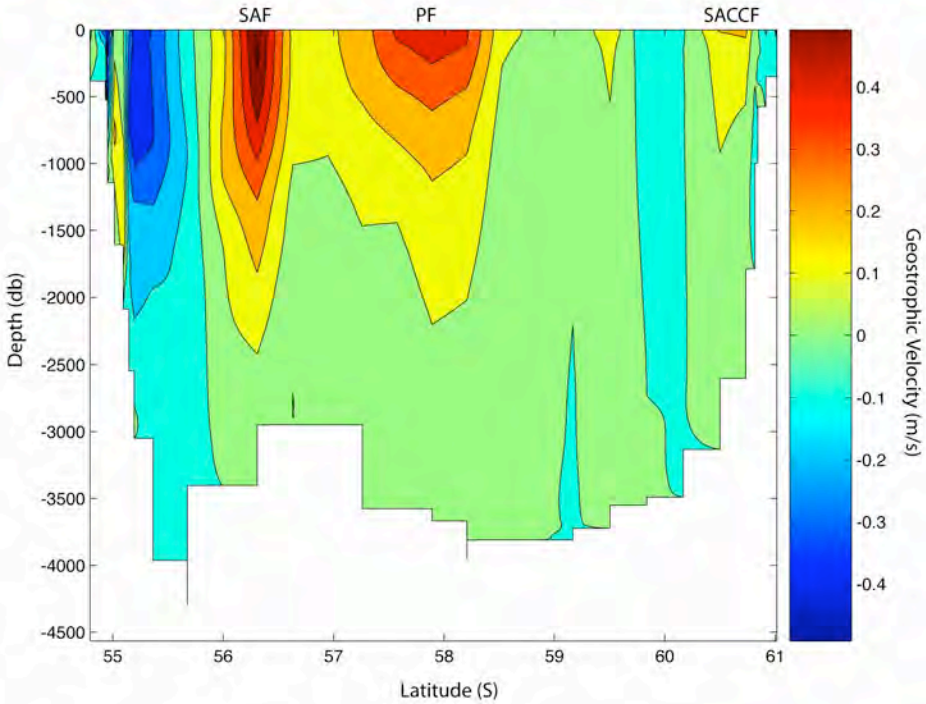

Figure 1.1: Geostrophic velocity plot, referenced to the deepest common level between station pairs. The locations of the Polar Front (PF), Sub-Antarctic Front (SAF) and Southern ACC Front (SACCF) are marked. The total geostrophic transport is 125.0 Sv.

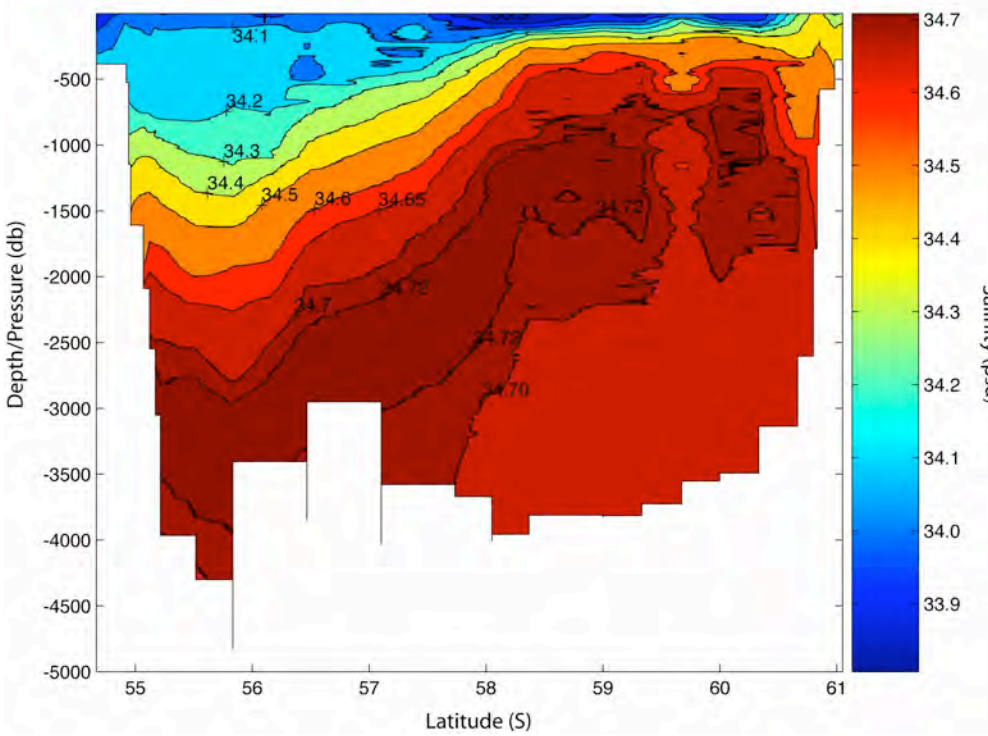

Figure 1.2: Plot of salinity (psu) from CTD stations on JR163.
This is a plot of the corrected salinity field.

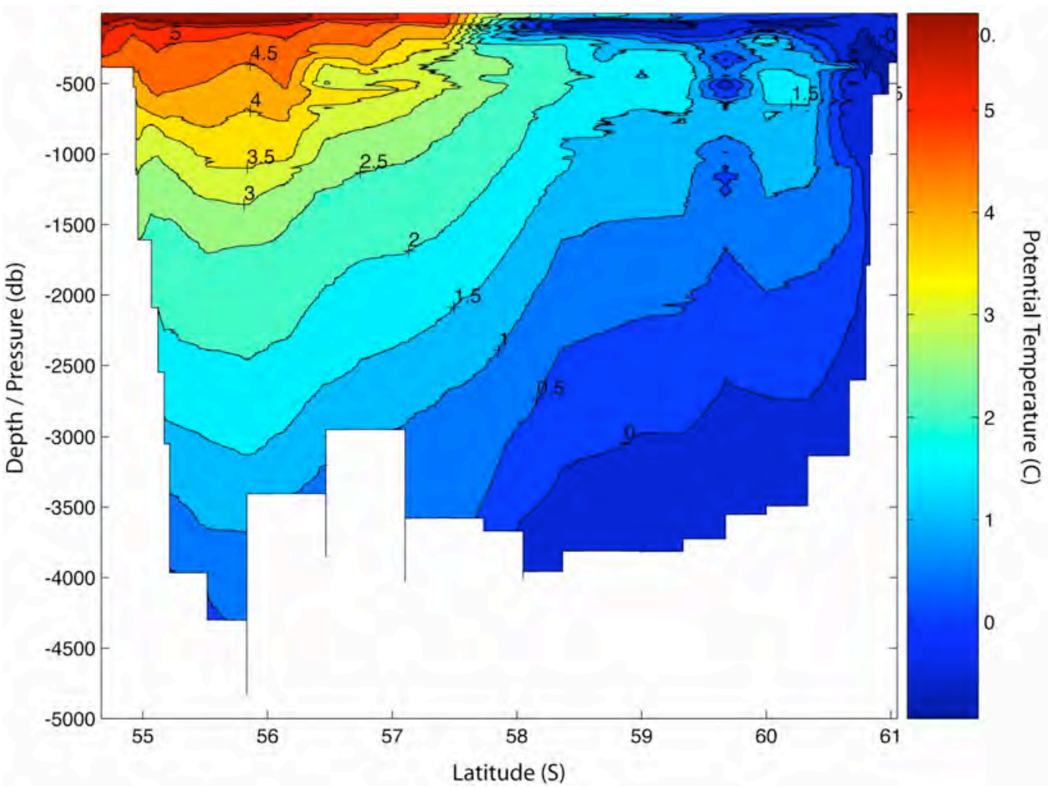

Figure 1.3: Plot of potential temperature (℃) from JR163. The contour spacing is 0.5 ℃

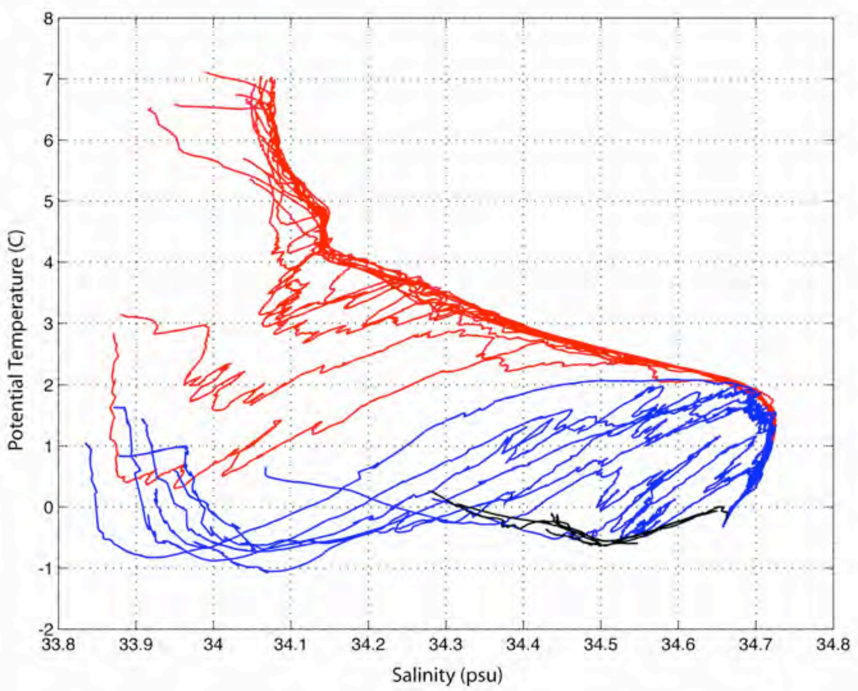

Figure 1.4: Potential temperature vs. Salinity plot from all stations of JR163. Lines in red are from stations north of the Polar Front, lines in blue are from stations in the Antarctic Zone (between the Polar Front and the Southern ACC Front), lines in black are from stations in the Continental Zone, south of the Southern Boundary/Southern ACC Front.

2. LADCP

Adam Williams

2.1 Introduction

Cruise JR163 planned to use two RDI Workhorse WH300 ADCP (WH) units to collect direct current velocity (LADCP) data. A single 300 kHz RDI WH unit (*DWH; serial number 4908*) was fixed in a downward-facing position mounted off-centre at the bottom of the CTD frame. A second WH unit was attached in an upward-facing position on the side of the CTD. After the problems experienced on the previous cruise JR161, a faulty connector pin was discovered between the upward-looking WH unit and the LADCP battery pack. It was decided to only use the downward-looking unit, but the other unit remained fixed to the CTD frame as the fault meant that it was not possible to blank the cables off when the unit was removed. A fin was added to the CTD frame to reduce spinning.

For the first seven stations, the LADCP was deployed as in the previous cruises (Shreeve, 2006, Stansfield and Meredith, 2008). Between stations, each ADCP was connected to a controlling PC in the Underway Instrument Control (UIC) room through a serial cable for delivery of pre-deployment instructions and post-deployment data retrieval. The battery package was recharged after each deployment, by connection to a charging unit via a power lead.

2.2 JR163 LADCP deployment

The sets of instructions for deployment and recovery (section 2.3) are based on the LADCP section of previous NOC cruise reports (including JR139, Stansfield and Meredith, 2008).

Connect the communications and battery leads for both instruments.
Go to controlling PC:

A) MASTER (downward-looking workhorse DWH)

1. Open BBTALK window for COM1
   Press <**F3**> to create log file for all output: filename of the form **c:\ladcp\jr163\log_files\WHM###m.txt**
   where ### is ctd cast number, and m refers to master status
2. Press <**END**> to wake up DWH
   If this fails, check communications lead

3. Type **TS?** <**ENTER**> to check DWH clock against scientific clock
gives time in form YYMMDDhhmmss
Type **TSYYMMDDhhmmss** <**ENTER**> if required to reset DWH clock
4. Type **RS?** <**ENTER**> to check available memory of DWH
If you need to clear memory, type **RE ErAsE** <**ENTER**>
Only clear if backed up to UNIX drive
5. Type **PA** <**ENTER**> to run diagnostic checks
6. If batteries were recharged, switch off battery charge unit and check battery voltage.
7. Press <**F2**> select DWH master configuration file
8. Press <**F3**> to stop log file

The master DWH should now be pinging.

B) SLAVE (upward-looking workhorse UWH)

Repeat steps 1 - 8 in adjacent window noting:

1. UWH log file should be called **c:\ladcp\jr163\log_files\WHS###s.txt** (s refers to slave)
7. Select slave UWH configuration file

Detach communication and charger cables and fit blanks to cable ends.

2.3 JR163 LADCP recovery

Remove Blanks and attach communications and charger cables.

1. Open BBTALK COM1 window (for master) and COM2 window (for slave)
Press <**END**> in both windows to wake up the LADCPs
2. Check battery voltage and switch on charger if needed.
3. type **RA?** <**ENTER**> to check number of deployments
Reset Baud rate to 115200 to allow for faster recovery of the data by typing **CB811**
To transfer data to PC:
Go to FILE, RECOVER RECORDER
Select c:\ladcp\jr161\master\ for DWH and c:\ladcp\jr161\slave for UWH as destination files
Reset Baud rate by typing **CB411**
Type **CZ** <**ENTER**> once data are transferred to power down LADCPs
4. Rename the default filenames to
c:\ladcp\jr161\master\jr161m###.000 and
c:\ladcp\jr161\slave\jr161s###.000

2.4 LADCP problems

Cruise JR161 experienced a number of problems with the LADCP deployment and data recording. They were not obtaining full casts, with the LADCP stopping recording on deeper casts. The discovery of a faulty connector between the upward-looking WH unit and the LADCP battery were thought to be the cause of the problems, so it was decided to use the downward-looking WH unit deployed on its own. Deployment and recovery seemed to be working properly for the first six stations, but on station 7, the LADCP returned with no data. A deck test was performed and the unit seemed to be working properly. When it came to be deployed for the next station, the unit failed the diagnostic checks performed before each deployment. The connector leads were changed with the upward-looking WH unit and the input port was switched from COM1 to COM2. This did not resolve the problem and the setup was returned to the original configuration. After a short delay, the WH unit passed all of the diagnostic tests and appeared to be working normally.

The initial analysis of the data used the processing steps outlined in Stansfield and Meredith (2008) and Shreeve (2006). It appeared that the LADCP was not recording complete down and up casts. Analysis of the raw data on the RD VM_DAS ADCP software showed that the data for full casts were in fact there and that the processing software was not correctly identifying the up and down casts. This may be due to the vertical looping motion of the CTD on the up cast when the package is stationary but the ship is rolling in large swell.

Brian King (connecting remotely from the NOC) performed an analysis of the data from cruise JR161 during JDAY 341 and determined that during that cruise, one of the four beams on each instrument had begun to fail and was now broken. This effectively meant that there was no use in continuing to deploy the instruments as they were not returning any usable data. It was decided to end all activities associated with the LADCP due to this fault, and that all previously recorded data were also of no use for the purposes of this cruise. All LADCP operations were suspended after station 8.

3. NAVIGATION

Sara de la Rosa Hohn

3.1 Introduction

During JR163 data from three of the scientific navigational instruments on *RRS James Clark Ross* were routinely processed. Primary positional, attitude and heading information were obtained from the *Trimble 4000* GPS receiver; Ashtech ADU-5 GPS receiver, and the Sperry Mk 37 Model D Gyrocompass, respectively. The SEATEX SEAPATH 200 unit, which provides heading data for the EM120 Swath System was also active for logging data, but was not processed onboard. A Racal Satcom received GPS SV range correction data via INMARSAT B from a fixed antenna in the Falkland Islands. This was passed to the *Trimble* and other GPS receivers to allow them to operate in differential mode (DGPS). All the instruments are logged to the SCS system and transferred to the RVS level C system. A series of UNIX scripts were used to process the navigation data in 12-hour periods from 0000 to 1159 (am) and 1200 to 2359 (pm). Each script requires the cruise number, the day of year number (JDay), and whether am or pm data are to be processed, or the full day.

The primary source of positional information on JR163 was the Trimble 4000 receiver in differential mode. Pstar script *gpsexec0* was used to process the data. This called *datapup* to transfer the data from RVS to pstar binary files; *pcopya* to reset the raw data flag on the binary file; *pheadr* to set up the pstar dataname and header; and *datpik* to remove data with a dilution of precision (hdop) greater than five. Two output files were created for each 12 hr period,163gps[jday].raw and 163gps[jday], before and after the *datpik* stage respectively. The processed data were then appended to a master file 163gps01.

3.2 Ashtech ADU-5

The Ashtech ADU-5 GPS is used to correct errors in the heading of the ship's gyrocompass prior to input of the data into the ADCP processing stream. This is necessary as the gyrocompass can oscillate for several minutes after a manoeuvre due to an inherent error.

The Ashtech data must be processed and merged with the gyro data in order to correct the latter data for gyrocompass oscillations. Four UNIX scripts were used to process the Ashtech data in order to be able to correct the gyrocompass error as required.

Ashexec0 This exec used *datapup* to read in data from the RVS data stream in daily chunks; *pcopya* to reset the raw data flag and *pheadr* to set the header information. The output file created was 163ash[jday].raw.

Ashexec1 This exec used *pmerge* to merge in data from the master gyro file; and *parith* and *prange* to calculate the difference between the gyro and Ashtech headings was forced within the range +/- 180 degrees. A timeshift of –0.9s was applied to the Ashtech data in order to obtain the best agreement with the gyro data. An output file 163ash[jday].mrg was created.

Ashexec2 This exec was used to edit the merged data file using the PSTAR programmes: *datpik* to reject all data outside the limits given by:

heading outside 0°and 360°;
pitch outside –5°to 5°;
roll outside –7°to 7°;
attf outside –0.5 to 0.5;
mrms outside 0.00001 to 0.01;
brms outside 0.00001 to 0.1;
heading difference ("a – ghdg") outside –5°to 5°;

The output files were 163ash[jday].edit and 163ash[jday].ave.

3.3 Gyrocompass

Data obtained from the gyrocompass give the most continuous information available on the ship's heading. Data were processed using *gyroexec0.*, which called the following routines:

datapup to transfer data from the RVS to pstar binary files;
pcopya to reset the raw data flag;
pheadr to set up the pstar header and dataname;
datpik to force all heading data to lie between 0 and 360 degrees.

One output file was created 163gry[jday].raw, and the data appended to a master file 163gyr01.

The RVS SCS system can provide duplicate time stamps in the gyro data hence *gyroexec0* also calls a pstar program *pcopym* to exclude these data from the processed data stream.

In a previous cruise report, correlation plots between the SEATEX and Ashtech data versus Gyrocompass have shown that the accuracy of the Ashtech dataset is much better than the accuracy of the SEATEX Seapath 200 unit.

4. VESSEL-MOUNTED ADCP (VM-ADCP)

Adam Williams

4.1 Introduction

A 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP was used during this cruise similar to JR139 (Stansfield and Meredith, 2008) and JR161 (Shreeve, 2006). The OS75 is, in principle, capable of profiling to deeper levels in the water column, and can also be configured to run in either narrowband or broadband modes.

4.2 Instrument and configuration

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

The OS75 transducer on the *JCR* is aligned at approximately 60 degrees relative to the centre line. This differs from the recommended 45 degrees. Shortly after sailing for JR139, the hull depth was measured by Robert Patterson (Chief Officer), and found to be 6.47m. Combined with a value for the distance of the transducer behind the seachest window of 100-200mm and a window thickness of 50mm, this implies a transducer depth of 6.3m. This is the value assumed for JR163, but note that the ship was very heavily laden during cruise JR139, and for other cruises it may be shallower.

During the trials cruise, it was noted that the OS75 causes interference with most of the other acoustic instruments on *JCR,* including the EM120 swath bathymetry system. To circumvent this, the ADCP pinging was synchronised with the other acoustic instruments using the SSU, however this acts to reduce the ping-rate. As noted by Dr. Sophie Fielding, when in deep water the swath can take 20 to 30 seconds from ping to end of listening, as a result this means the ADCP only pings once every 25 or so seconds. A further problem is that the ADCP appears to “time out” after every other ping when it has to wait a long time between pings (i.e when running in deep water alongside the EM120). This results in it rebooting and waking the

ADCP instrument up every other ping, which simply exacerbates the problem. A fix is promised by BAS AME, but requires a firmware upgrade from RDI that is not presently available. To circumvent these problems, only the single-beam echosounder (EA600) was run alongside the OS75 during JR139.
The heading feed to the OS75 is the heading from the Seapath GPS unit. This differs from the previous ADCP setup on *JCR,* which took a heading feed from the ship's gyrocompass and required correction to GPS heading (from Ashtech) in post-processing.

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The logging PC also had Version 1.13 of the RDI WinADCP software installed and running, to act as a real-time monitor of data. The OS75 ran in two modes during JR163: narrowband with bottom-tracking on and narrowband with bottom-tracking off. Narrowband profiling with bottom-tracking on was enabled with sixty-five 16m bins, and with bottom-tracking off with seventy 16m bin; in both cases an 8m blanking distance was used. (Note that this blanking distance is larger than the 2m initially used by the RDI technician during the trials cruise. This change was adopted following advice from Dr. Mark Inall and Dr. Deb Shoosmith, who voiced concerns over the quality of data in the top bin). The time between pings was set to 2 seconds, again following advice from Dr E. Hawker and Dr. Deb Shoosmith. Salinity at the transducer was set to zero, and Beam 3 misalignment was set to 60.08 degrees (see above discussion). The full configuration files for each of the modes used are given in Appendix A.

4.3 Output formats

The ADCP writes files to a network drive that is samba-mounted from the Unix system. (Should the network fail, there is an alternative write path to the local ADCP PC hard drive to preserve data until the link is restored). When the Unix system is accessed (via samba) from a separate networked PC, this enables post-processing of the data without the need to move files.

Output files are of the form JR163_XXX_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte.

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

.N1R (NMEA telegram + ADCP timestamp; ASCII)

.ENR (Beam coodinate single-ping data; binary)

.VMO (VmDas configuation; ASCII)

.NMS (Navigation and attitude; binary)

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

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

.ENX (Earth coordinate single-ping data; binary)

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

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

4.4 Post-processing of data

OS75 data were processed on JR163 using Matlab code originated by IFM Kiel. This was adapted by Dr. Mark Inall and Dr. Deb Shoosmith for use with the *JCR* system. The master file for the processing is "OS75_JCR_FINAL_JR163.m", which calls a lengthy sequence of routines to execute the following steps:-

1) Read RDI binary file with extension .ENX and ASCII file with extension .N1R into Matlab environment.
2) Remove missing data and data with bad navigation.
3) Merge Seapath attitude data with single-ping ADCP data.
4) Correct for transducer misalignment and velocity scaling error (calculated during first run-through of code, applied during second).
5) Derive ship velocity from Seapath navigation data.
6) Perform quality control on data, such that only the four-beam solution is permitted. Other screening is performed based on maximum heading change between pings, maximum velocity change between pings, and the error velocity.
7) Average data into ensembles of pre-defined length (120 seconds for JR163).
8) Calculate transducer misalignment and velocity scaling error (computation done on first run-through of code, to be applied during second).
9) Set to missing any velocities from depths deeper than 86% of the bottom-tracking depth.
10) Determine absolute velocities from either bottom-track ship velocity or Seapath GPS (usually the latter).

4.4.1 Output Files

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

1) JR163_000_000000_A_hc.mat, where A is the highest number of the user-incremented files. (This is the number that VmDas increments every time logging is stopped and restarted). This contains structured arrays “c” (ensemble-averaged data), and “b” (absolute velocities)
2) JR163_00A_00000Bd.mat, where A is as above, and B is the number VmDas increments every time filesize exceeds 10 Mbyte. This contains single-ping data in structured array “d”.
3) JR163_00A_00000Bd_ATT.mat. As (2), but containing ship’s attitude data rather than ADCP data.
4) JR163_00A_000000_ATT.mat. As (3), but for the whole section of data in the user-incremented series A

4.5 JR163 data

The data were collected in a series of files for the section, due to the required changes in configuration file when the VM-ADCP needed to be changed from bottom-tracking to normal mode. Figure 4.1 shows the zonal and meridional velocities from the central part of the transect across Drake Passage. There is a large westward flow to the north of the passage that is also found in the geostrophic velocity field (figure 1.1). The Sub-Antarctic Front is also very clearly found in the zonal velocity field centred on 56.5 °S latitude. The structure of the Polar Front is less pronounced, with eastward flow over a large meridional distance. This is in broad agreement with the geostrophic profiles, which depicted a strong and localised Sub-Antarctic Front with a core that extends deep into the water column, and a broader, shallower Polar Front.

There were a few issues with the data collection during the section. Some data were lost on the initial crossing over the continental slope on the south side of Burdwood Bank due to the sharp topography and a delay in changing the sampling mode from bottom-tracking to deep water tracking. In the southern third of the section the VM-ADCP detected bad values during the periods of steaming between stations, causing a loss in spatial coverage; the data quality was still good during the periods when casts were being taken.

The VM-ADCP was kept running throughout the journey through the Bransfield Strait and towards Rothera. This was generally of a high quality, with a few periods lost due to sudden changes in the topography requiring a change of the sampling mode.

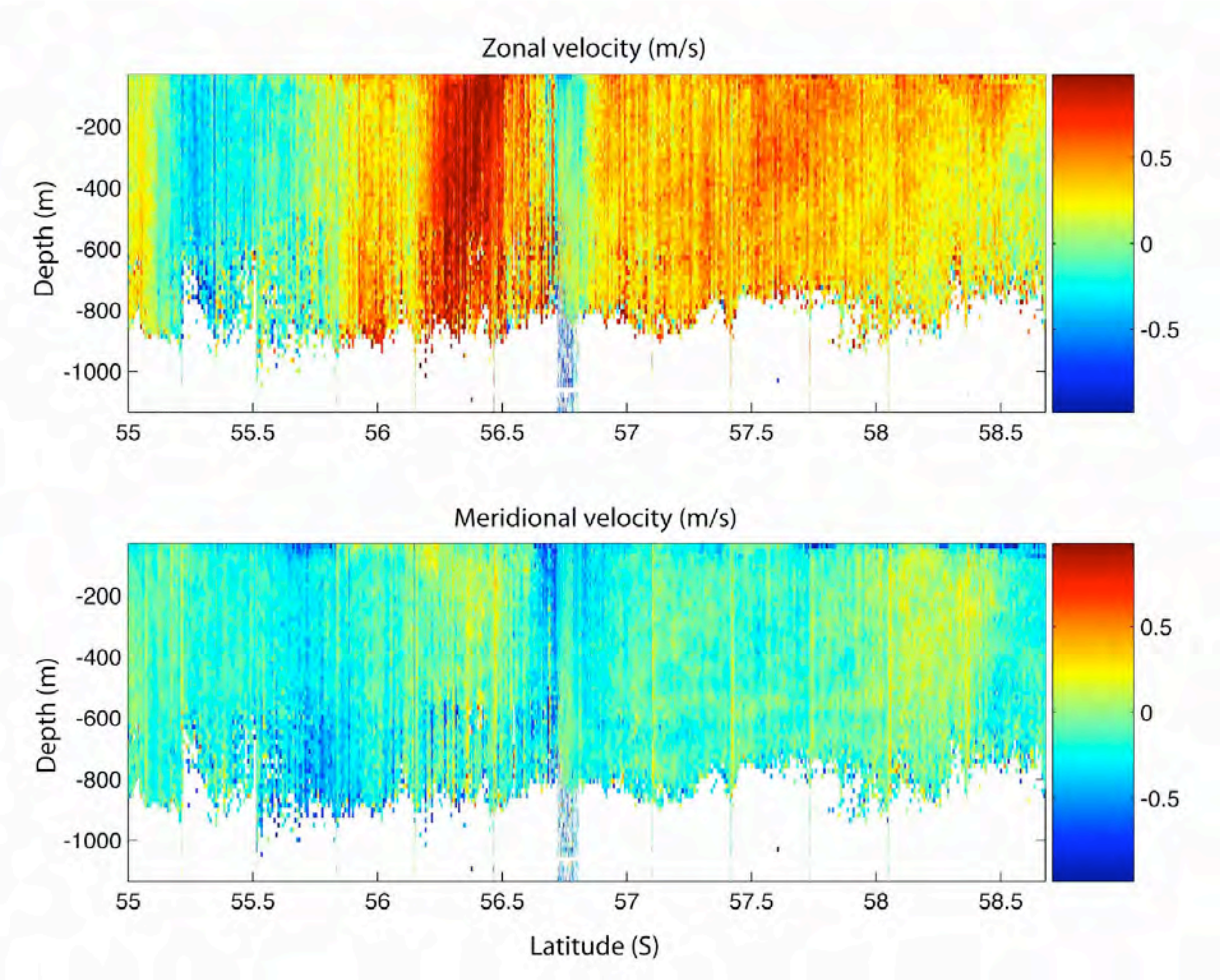

Figure 4.1: (Top) Zonal velocities from the VM-ADCP between 55-58.9°S. (Bottom) Corresponding meridional velocities from the VM-ADCP.

4.6 VM-ADCP Calibration files

1. Deep water- bottom tracking mode off

```
;----------------------------------------------------------------------------\

; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    low resolution, Long range profile(Narrowband)  deep water
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;----------------------------------------------------------------------------/
; Restore factory default settings in the ADCP
cr1
; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611
; Set for narrowband single-ping profile mode (NP), seventy (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)
; Switch Narrowband ON   NP1
NP1
nn70
ns1600
nf0800
; Switch Broadband  OFF   WP0
WP000
WN065
WS800
WF0200
WV390
; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX);
 Bottom track OFF
BP00
BX12000
; output velocity, correlation, echo intensity, percent good
WD111100000
; One and half seconds between bottom and water pings
TP000150
; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200
; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001
; Output beam data (rotations are done in software)
EX00000
; Set transducer misalignment (hundredths of degrees)
EA6008
; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00063
; Set Salinity (ppt) [salinity in transducer well = 0]
ES0
; Set to trigger by SSU
CX1,3
; save this setup to non-volatile memory in the ADCP
CK
```

2. Bottom tracking mode on

```
;-----------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    low resolution, Long range profile(Narrowband)  1000 m
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;-----------------------------------------------------------------------------/
; Restore factory default settings in the ADCP
cr1
; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611
; Set for narrowband single-ping profile mode (NP), sixty five (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)
; Switch Narrowband ON  NP1
NP1
nn65
ns1600
nf0800
; Switch Broadband  OFF  WP0
WP000
WN065
WS800
WF0200
WV390
; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX) (decimeters)
BP01
BX12000
; output velocity, correlation, echo intensity, percent good
WD111100000
; Two seconds between bottom and water pings
TP000200
; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300
; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001
; Output beam data (rotations are done in software)
EX00000
; Set transducer misalignment (hundredths of degrees)
EA6008
; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00063
; Set Salinity (ppt) [salinity in transducer well = 0]
ES0
; Set Trigger In/Out [ADCP run through SSU
; CX0,0
CX1,3
; save this setup to non-volatile memory in the ADCP
CK
```

5. UNDERWAY

Chris Atkinson

5.1 Introduction

The underway data come from the meteorological sensors, situated on the forward mast, and the 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 (PAR). Other parameters sampled include the temperature of the conductivity sensor and the flow rate of the uncontaminated water supply.

Data from these sensors feed into the ship's oceanlogger data system. From there they are transferred to the ship's SCS scientific data collection system and thence to the UNIX and PC computer network.

Underway data first became available on day 341, shortly after departing the Falkland Islands, and were then collected continuously until day 349 when the water supply was switched off due to the presence of sea-ice. Data from here to Rothera were sporadic and have not been analysed. Although data from the ship's anemometer take a different route into the ship's SCS scientific data collection system they were processed together with the other meteorological data.

During the cruise, when the flow meter was switched on, the average flow rate was usually about 0.6 l/min. For a short period on day 342 and an extended period on day 343, flow rate to the thermosalinograph and fluorometer became erratic due to the presence of air in the system. Flow rate was returned to 0.6 l/min by the afternoon of day 343 and remained satisfactory until the supply was switched off. During the periods of erratic flow, measurements of water temperature, salinity and fluorescence were discarded. At this point, underway water samples were taken from the ships uncontaminated water supply every hour to provide replacement salinity measurements.

5.2 Data capture and processing

Data were processed in 24-hour sections using pstar. The scripts are based on those used during the previous JR94 and JR115 cruises (see Hawker et al., 2005, Sparrow and Hawker, 2005).

The executables for processing the data are described below:

oclexec0: Reads the ocean-logger and anemometer data streams and stores them in a single pstar type file called 163oclXXXd.raw (where XXX = JDay).

oclexec1: Splits the data into separate ocean data and meteorological data files. It also performs some initial de-spiking of the conductivity data and calculates a raw salinity value. This creates a file called 163oclXXXd (and a meteorological file 163metXXXd.raw).

twvelexec: 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. This creates a file called 163metXXXd.

Data were then further de-spiked and plotted using MATLAB and the differences between duplicate meteorological instruments calculated.

5.3 Oceanographic parameters

Sea surface salinity (SSS) was calculated from the ship's thermosalinograph (TSG) measurements of conductivity and water temperature. In addition, water samples were taken every 4 hours from the ship's uncontaminated water supply. The salinity from the TSG was comparable to that of the water samples (Fig. 5.1) with the offset small and essentially random though showing a faintly negative trend as the ship progressed south. The offset had a mean and standard deviation (s.d.) of –0.0006 and 0.004, respectively. This s.d. is attributed mostly to inaccuracies in recording of underway sample time as s.d. of underway salinity ranged from 0.003-0.006 over a few minutes.

After moving off the continental shelf edge, salinity values of approximately 34.0-34.1 were recorded between 54°S and 57.5°S (Fig. 5.2). Here, salinities dropped sharply across the Polar Front to values of around 33.8-33.9 between 57.5°S and 61°S. Moving onto the Antarctic continental shelf, salinities increased sharply again to 34.4, before showing erratic values of between 34.0-34.1 along the Antarctic Peninsula (likely associated with formation and melting of patchy sea-ice).

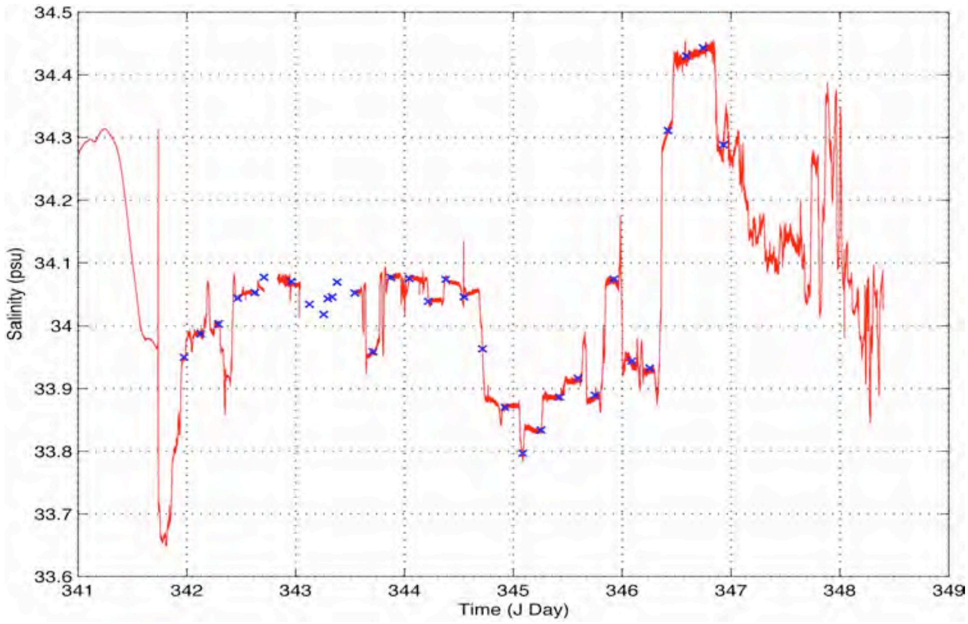

Figure 5.1: Plot of TSG salinity (red line) and surface water sample salinities (blue crosses) against JDay.

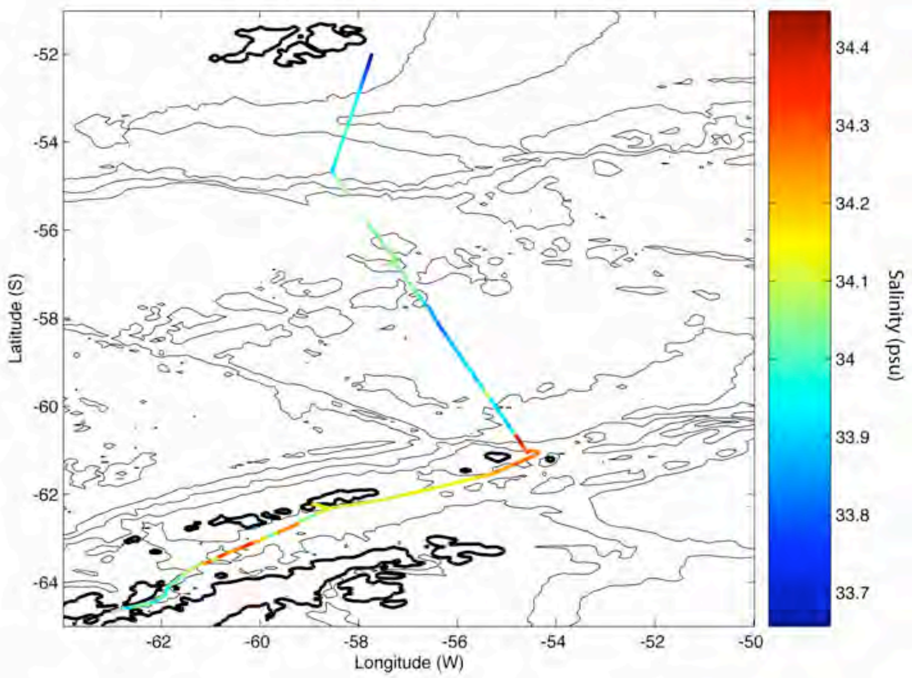

Figure 5.2: Plot of TSG Sea Surface Salinity for JDays 341-349.

North of the Polar Front, temperature decreased steadily from 8°C to 5°C between 53°S and 57.5°S (Fig. 5.3). At the Polar Front, temperatures decreased sharply to 3°C before dropping gradually again to 0°C at 61°S. Along the peninsula, a slight increase in SST was recorded associated with warm weather and increased surface air temperature on day 347.

Fluorescence estimates the amount of phytoplankton in the water, giving an indication of primary production. Around the continental shelf edges (53.5°S, 55°S and 60.5°S), fluorescence showed values of typically 0.4 µg/l to 0.5 µg/l (Fig. 5.4). Notably, a sizeable peak of 1.5 µg/l was observed centred around 53.5°S. Between 55°S and 60.5°S, values were at their lowest, typically 0.1 µg/l to 0.2 µg/l with erratic spikes of up to 0.5 µg/l including at the Polar Front. Along the Antarctic Peninsula, values were mostly greater than 0.4 µg/l, showing peak values up to 0.7 µg/l at the western edge of the Bransfield Strait shortly before measurements stopped.

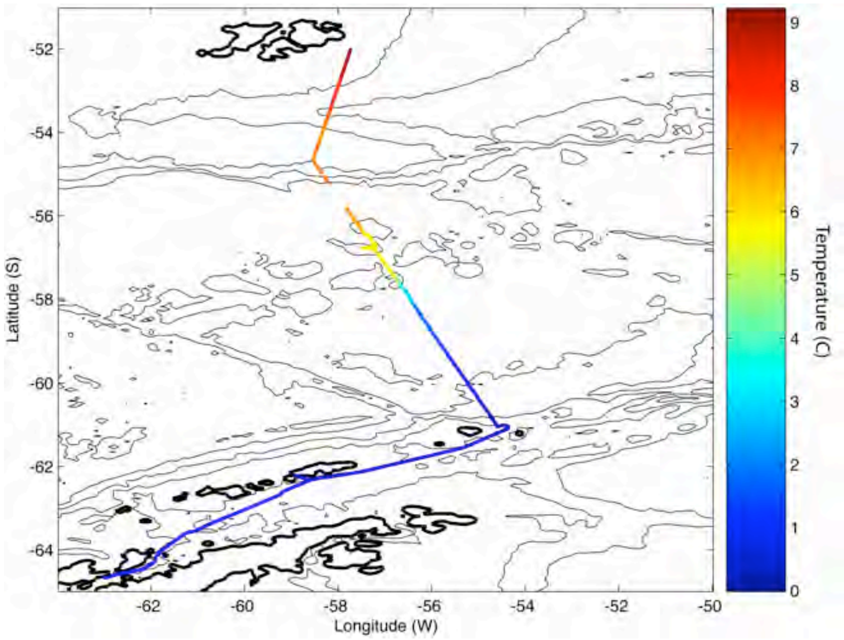

Figure 5.3: Plot of TSG Sea Surface Temperature for JDays 341-349.

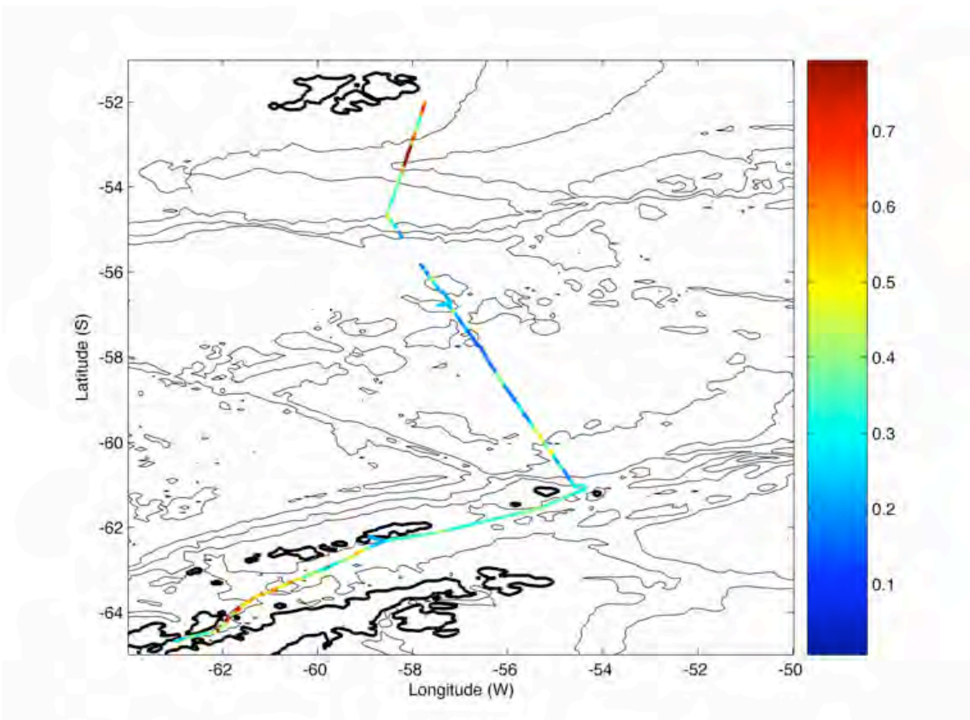

Figure 5.4: Plot of surface fluorometer readings for JDays 341-349.

5.4 Meteorological parameters

From 52°S to 65.5°S, air temperature steadily decreased from 11°C to -1°C (Fig. 5.5a) approaching the cold continental air. Along the Antarctic Peninsula, temperatures also showed variation of +/- 2°C about 0°C. Between 55°S and 57°S a peak of air temperature between 5°C to 8°C was observed that overlaps with a northward increase in SST. Typically the surface air temperature matches little of the SST spatial variability, including across the oceanic Polar Front. The difference between the two air temperature instruments ranged typically from 0 to 0.5°C with a mean offset of 0.13°C and s.d. of 0.15.

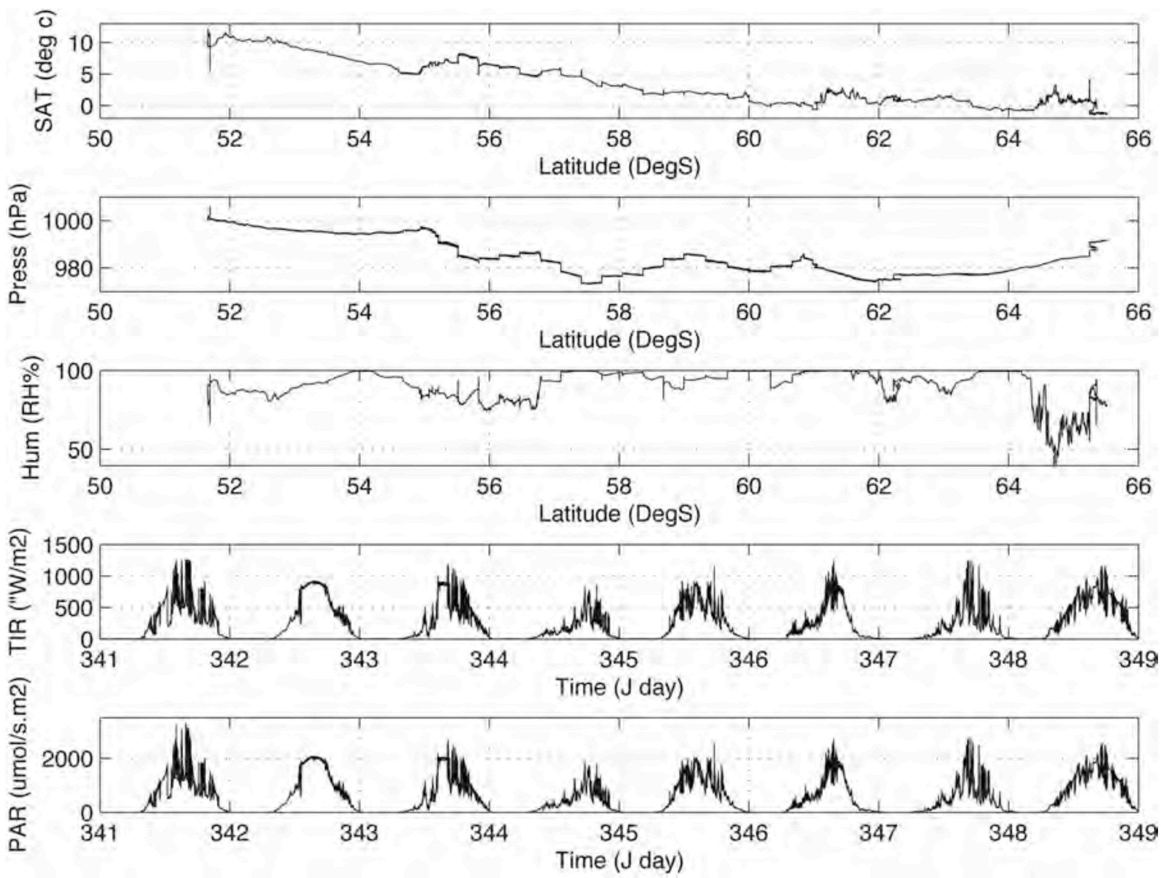

Figure 5.5. From top to bottom (a-e), plots of Surface Air Temperature, Surface Pressure and Humidity against latitude for JDays 341-349 and plots of Total Incident Radiation and Photosynthetically Active Radiation against JDay.

From 52°S to 62°S, air pressure (Fig. 5.5b) broadly decreased from 1000 hPa to 975 hPa before increasing rapidly to 992 hPa between 62°S and 65°S. Some synoptic variation is observed, particularly increases of 10 hPa at 59°S and 61°S associated with local weather, however the sub-polar low marking the Antarctic front is clear. The difference between the two instruments was between –0.3 and +0.3 hPa throughout the section.

From 52°S to 64.5°S, humidity (Fig. 5.5c) ranged erratically from 80% to 100%. From 64.5°S to 65.5°S humidity showed lower values of between 35% and 90%. This change in range coincides with the Antarctic Front separating cold continental air and the warmer moister polar maritime air. The difference between the instruments ranged typically over 0-5 RH%, with mean offset of 1.8% and s.d. of 2.3%.

Total Incident Radiation (TIR, Fig. 5.5d) showed near-zero values at night with values increasing to a peak around midday. The maximum daily values of TIR varied from 800 W/m^2 up to 1250 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 ranged between –200 W/m^2 to 150 W/m^2 while night-time offset was between 0 W/m^2 and 0.3 W/m^2. Mean and s.d. of the offset were –3.8 W/m^2 and 8.65. A similar pattern was observed for Photosynthetically Available Radiation (PAR, Fig. 5.5e) as for TIR. Maximum values of PAR varied from 1700 µmol/s.m^2 to 3200 µmol/s m^2. During the day the difference between the two instruments ranged between –400 µmol/s m^2 to 400 µmol/s m^2 while night-time offset was 3 µmol/s m^2. Mean and s.d. of the offset were 10.6 and 18.1 µmol/s m^2.

Across the section, winds were predominantly northwesterly to westerly (Fig. 5.6), whilst along the Antarctic Peninsula, they were northwesterly with some easterlies recorded leaving the Bransfield Strait. Wind speeds were relatively constant averaging 9.5 ms^{-1} and reaching a maximum of 20 ms^{-1}.

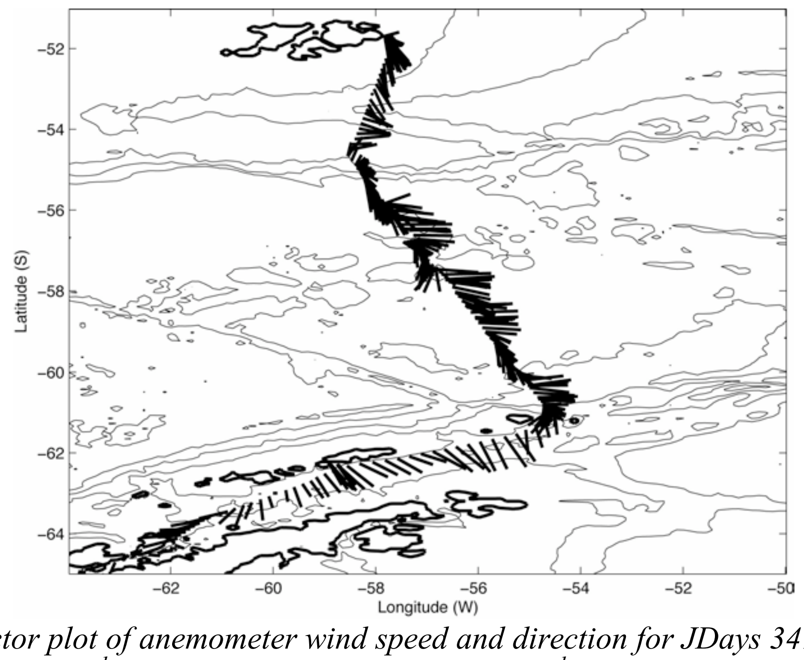

Figure 5.6: Vector plot of anemometer wind speed and direction for JDays 341-349. Average wind speed was 9.5 ms^{-1} and reached a maximum of 20 ms^{-1}.

5.5 Southern Ocean fronts and water masses

As discussed above, the Polar Front was observed near 57.5°S in both sea surface temperature and sea surface salinity data. This coincides with steeper slopes in both temperature and salinity fields observed by the CTD data in the upper 1000m of the water column. No evidence of the Sub Antarctic Front was observed.

Three principal water masses were observed in the underway data. The first of these water masses is Sub-Antarctic Surface Water, with salinities between 33.85 and 34.1 and temperatures between 5°C and 7°C. This water mass 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 33.8 and 34 and temperatures between 0.5°C to 2°C. The second is Continental Shelf Water, observed south of 61°S, with salinities between 33.9 and 34.45 and temperatures between 0°C and 1.5°C.

6. ECHO-SOUNDER

Stéphanie Contardo

6.1 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 one transducer mounted on the hull to starboard. The EM120 was switched off because of some interference it caused to other instruments. The EA600 was used to produce a bathymetry profile.

6.2 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 twice-daily pstar files using the pstar script *163sim*. Initial processing was done by running the script *163sim* from 'pstar/data/sim'. 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 the raw file '163simXXXd.raw' and the filtered data file '163simXXXd', 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.

A plot of the bathymetry along the ship track was done using the Matlab program bathy_map_jr163.m, which merges the bathymetry data with gps navigation data (Fig. 6.1).

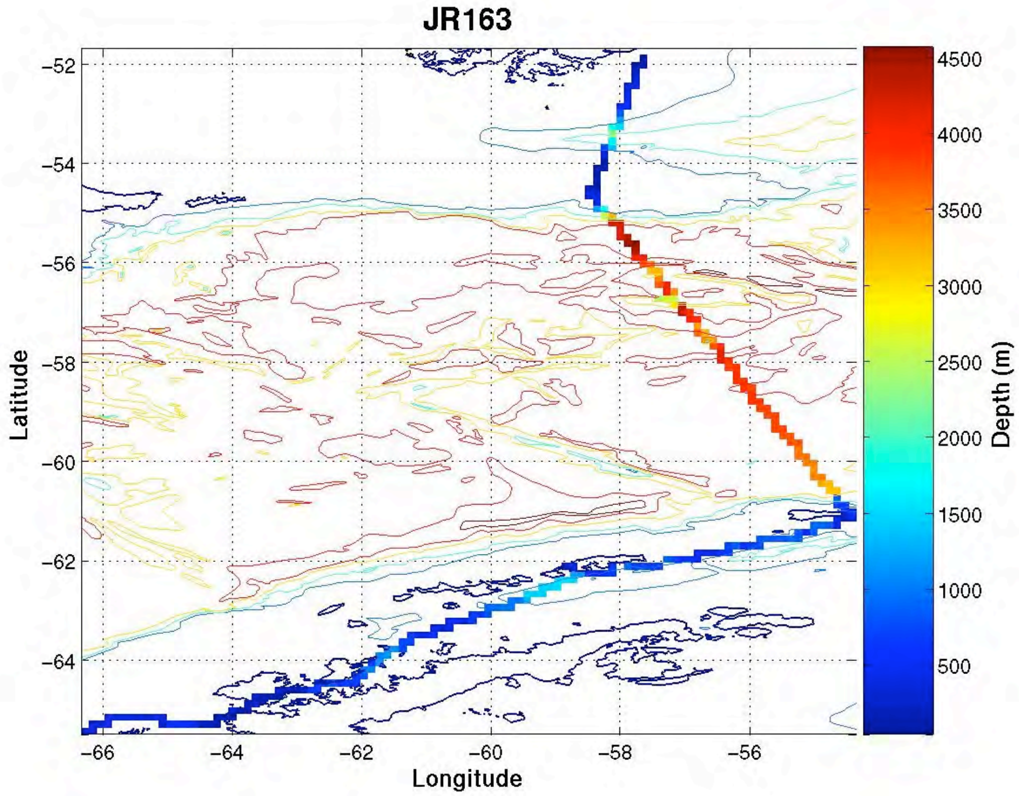

Figure 6.1: Bathymetry measured using EA600 along cruise track plus GEBCO bathymetry contours.

Figure 6.2: Bathymetry measured using the EA600 along cruise track, for the duration of the cruise.

7. WATER SAMPLES

Patrick Holligan

7.1 Oxygen isotopes

As well as salinity samples, samples for oxygen isotope analysis were taken from every bottle on every CTD station. As of Jan. 2008, these are still at BAS awaiting collection by NOCS.

7.2 Biological samples

The objective of the biological work on the cruise was to investigate the cause of high reflectivity seen in satellite ocean colour images of the Southern Ocean during summer (December - February).

On the transect from the Falkland Islands to Elephant Island at the northern tip of the Antarctic Peninsula water samples were collected from CTD bottles (31 stations, with typically 3 depths per station for chlorophyll samples and one sample for others). Also there was intermediate sampling from the underway pumped supply. The samples were filtered for determinations of chlorophyll-a (Chl), particulate organic carbon (POC), particulate inorganic carbon (PIC) and biogenic silica (BSi). Chlorophyll was determined on board, and the other filters were stored for analysis in the UK. Also phytoplankton samples were collected on filters and in water preserved with buffered formalin (F) and lugols solution (L) for examination respectively by scanning electron microscopy (SEM) and by light microscopy. Full details of the sampling are provided in Table 7.1; the total numbers of samples obtained were as follows:

Chl	131	POC	53 (-80C)	SEM	50
(analysed		PIC	56	F	40
on ship)		BSi	56 (-80C)	L	6

Satellite images for the period of the cruise (Fig. 7.1) showed that the Antarctic Convergence was at about 58˚S along the cruise track. Chlorophyll levels were low (<0.5 mg m^{-3}) along and just to the south of the convergence, and up to 2 mg m^{-3} at either end of the transect. Reflectance values were generally relatively low along the transect compared to those for Falklands shelf water. Of particular interest is the eddy-like feature just to the east of the transect line at about 58˚S which indicates the presence of mineralised plankton in cold water south of the convergence.

Table 7.1: Location and time of all samples taken for subsequent biological analysis. NT indicates sample from underway non-toxic supply, with intake at 5m depth

Date	Time (ship)	Sta.	Lat (S)	Long (W)	Water dep. (m)	Temp (˚C)	Sal. (psu)	Fluor.	Sample dep. (m)	Chloro. no.	Chloro. vol.	PIC no.	PIC vol	BSi no.	BSi vol.	POC/C no.	POC/C vol.	SEM no.	SEM vol.	Lugol/ Form no.
7-Dec	1513	u/w	51 47.5	57 40.3		9.19	33.66	0.377	NT	1	100									
	1539	u/w	51 53.4	57 42.0		9.16	33.66	0.510	NT	2	100	1*	150	1*	150					
											* very slow to filter due to suspended particle									
	1721	u/w	52 17.1	57 48.9		8.87	33.69	0.677	NT	3	100									
	1739	u/w	52 21.1	57 50.1		8.85	33.74	0.513	NT	4	100	2	250	2	220					
	1927	u/w	52 45.7	57 57.5		8.38	33.83	0.660	NT	5	100	3	250	3	250					
	2053	u/w	53 05.2	58 03.3		8.01	33.98	1.740	NT	6	100	4	250	4	250	1	400			
	2140	u/w	53 15.9	58 06.8		8.21	33.99	1.480	NT	7	100	5	250	5	250	2	500	1	275	L1
8-Dec	15	CTD1	53 30.4	58 11.0	2345	7.57	33.99	?	5	8	100	6	250	6	250	3	500			
									25	9	100									
									100	10	100									
	200	u/w	53 50.7	58 43.0?		7.14	34.01	0.311	NT	11	100	7	250	7	250	4	500	2	250	
	400	u/w	54 18.5?	58 25.9		7.25	34.00	0.342	NT	12	100	8	250	8	250	5	500			
	630	CTD2	54 00.0	58 32.6	387	6.81	33.91	0.441	5	13	100	9	250	9	250	6	500	3	250	
									25	14	100									
									100	15	100									
	830	CTD3	54 55.4	58 23.1	514	6.95	34.04	0.320	5	16	100	10	250	10	250	7	500	4	250	
									50	17	100									
									150	18	100									
	1215	CTD4	54 56.6	58 22.3	1114	7.21	34.05	0.280	5	19	100	11	250	11	250	8	500	5	250	
									50	20	100									
									100	21	100									
	1416	CTD5	54 57.6	58 21.7	1608	7.30	34.06	0.270	5	22	100	12	500	12	250	9	500	6	500	F1
									50	23	100	13	500	13	250	10	500	7	400	F2,L2
									100	24	100									
	1650	CTD6	55 04.2	58 17.6	2078	7.33	34.08	0.174	5	25	100	14	500	14	250	11	500	8	500	F3
									50	26	100									
									250	27	100									
	1923	CTD7	55 07.3	58 15.7	2539	7.07	34.07	0.200	5	28	100	15	500	15	250	12	500	9	350	
									25	29	100									
									50	30	100									
	2205	CTD8	55 10.3	58 13.8	3001	7.17	34.06	0.210	5	31	100	16	500	16	250	13	500	10	500	F4
									50	32	100									
									100	33	100									
9-Dec	110	CTD9	55 12.9	58 12.2	3838	(flow through		0.24?	5	34	100	17	500	17	250	14	500	11	500	F5
						system not			50	35	100									
						working)			100	36	100									
	205	u/w				7.08	33.72	?	NT	37	100	18	500	18	250	15	500	12	430	
	600	CTD10	55 31.0	58 01.3	4226	6.98	34.06	0.225	5	38	100	19	500	19	250	16	500	13	500	F6
									50	39	100									
									200	40	100									
	1050	CTD11	55 50.1	57 49.1	4743	6.85	34.05	0.227	5	41	200	20	500	20	250	17	500	14	500	F7
									50	42	200									
									200	43	200									
	1159	u/w	56 00.7	57 42.4		6.84	34.05	0.165	NT	44	200	21	500	21	250	18	500	15	500	F8
	1511	CTD12	56 09.1	57 36.0	3500	6.84	33.98	0.332	5	45	200	22	500	22	250	19	500	16	400	F9,L3
									25	46	200									
									28	47	200	23	500	23	250	20	500	17	360	F9A, L4
									50	48	200									
									200	49	200									
	1620	u/w	56 20.5	57 29.8		6.67	33.96	0.256	NT	50	200	24	500	24	250	21	500	18	500	F10
	1945	CTD13	56 28.1	57 21.4	3738	5.89	34.08	0.260	5	51	200	25	500	25	250	22	500	19	500	F11
									25	52	200									
									50	53	200									
	2055	u/w	56 38.7	57 14.6		5.77	34.05	0.230	NT	54	200	26	500	26	250	23	500	20	350	F12
10-Dec	444	CTD14	56 48.3	57 06.2	2900	5.91	34.04	0.223	5	55	200	27	500	27	250	24	500	21	500	F13
									25	56	200									
									100	57	200									
	542	u/w	56 59.1	57 14.3		5.89	34.04	0.370	NT	58	200	28	500	28	250	25	500	22	500	F14
	852	CTD15	57 06.2	57 01.9	3908	5.72	34.07	0.205	5	59	200	29	500	29	250	26	500	23	500	F15
									50	60	200	&29 A-D	500							

									200	61	200	(replicate PIC samples)								
	940	u/w	57 13.3	56 57.4		5.51	34.04	0.185	NT	62	200	30	500	30	250	27	500	24	500	F16
	1300	CTD16	57 25.0	56 58.0	3566	5.77	34.05	0.211	5	63	200	31	500	31	250	28	500	25	500	F17
									75	64	200									
									200	65	200									
	1350	u/w	57 33.1	56 44.5		5.14	34.01	0.175	NT	66	200	32	500	32	250	29	500	26	500	F18
	1729	CTD17	57 44.1	56 36.0	3743	3.31	33.88	0.154	5	67	200	33*	500	33	250	30	500	27	500	F19
									50	68	200	*no borate rinse								
									200	69	200	(& 33 A-H PIC samples - see notes)								
	1830	u/w	57 40.0	56 30.3		3.08	33.86	0.155	NT	70	200	34	500	34	250	31	500	28	500	F20
	2145	CTD18	58 03.1	56 26.0	3963	3.12	33.87	0.218	NT	71	200	35	500	35	250	32	500	29	500	F21
									(water bottles failed to fire)											
	2235	u/w	58 10.7	56 21.6		1.95	33.82	0.169	NT	72	200	36	500	36	250	33	500	30	500	F22
11-Dec	300	CTD19	58 22.0	56 15.0	3922	1.34	33.83	0.200	5	73*	200	37	500	37	250	34	500	31	500	F23
									50	74	200									
									200	75	200									
										(& 76-83 replicates)										
	327	u/w						0.420	NT	84	200									L5
	353	u/w	58 31.3	56 09.2		1.86	33.89	0.400	NT	85	200	38*	280	38	250	35	500	32	275*	F24, L6
											(*0.4μ filters very slow-and at following stations)									
	710	CTD20	58 41.0	56 03.2	3788	1.92	33.89	~0.280	5	86	200	39	300	39	250	36	500	33	300	F25
									50	87	200									
									200	88	200									
	802	u/w	58 49.0	55 58.2		1.83	33.90	0.173	NT	89	200	40	285	40	200	37	500	34	245	F26
	1130	CTD21	59 00.0	55 51.4	3809	1.67	33.92	0.169	5	90	200	41	250	41	250	38	500	35	250	F27
									25	91	200									
									40	92	200									
	1215	u/w	59 08.6	55 45.8		1.46	33.97	0.280	NT	93	200	42	250	42	250	39	500	36	250	F28
	1542	CTD22	59 20.0	55 39.1	3793	1.18	33.89	0.250	5	94	200	43	300	43	250	40	500	37	300	F29
									25	95	200			(& 43 A-D BSi replicates)						
									29	96	200	44	250	44	250	41	500	38	250	F30, L7
									200	97	200									
	1642	u/w	59 30.6	55 32.3		1.14	33.93	0.219	NT	98	200	45	250	45	250	42	500	39	250	F31
	2000	CTD23	59 40.7	55 25.4	3717	0.94	34.07	0.500	5	99	200	46	250	46	250	43	500	40	250	F32
									25	100	200									
									200	101	200									
	2050	u/w	59 49.3	55 20.6		0.85	34.05	0.480	NT	102	200	47	250	47	250	44	500	41	250	F33
12-Dec	0	CTD24	60 00.0	55 14.3	3540	0.80	33.94	0.410	5	103	200	48	250	48	250	45	500	42	220	F34
									25	104	200									
									50	105	200									
	52	u/w				0.67	33.90	0.393	NT	106	200	49	250	49	250	46	500	43	250	
	358	CTD25	60 20.0	55 01.9	3479	0.47	33.93	0.393	5	107	200	50	250	50	250	47	500	44	250	F35
									25	108	200									
									100	109	200									
	750	CTD26	60 40.0	54 48.5	3130	0.27	34.32	0.203	5	110	200	51	250	51	250	48	500	45	250	F36
									25	111	200			(& 51 A-C blanks for BSi)		(& 48 A-C blanks for POC)				
									50	112	200									
									2500	113, 114, 115	200		Blanks = filter & 2ml water from 2500m							
	1031	CTD27	60 48.0	54 44.5	2599	-0.02	34.43	0.182	5	116, 117	200	52	250	52	250	49	500	46	250	F37
									50	118	200			(& Bsi 52 A-D: 50,100,200 and 350 ml)						
									150	119	200									
	1515	CTD28	60 50.0	54 43.3	1644	0.12	34.44	0.159	5	120	200	53	250	53	250	50	500	47	~250	F38
									50	121	200									
									100	122	200									
	1705	CTD29	60 51.0	54 42.7	975	0.08	34.44	0.197	5	123	200	54	500	54	250	51	500	48	500	F39
									50	124	200									
									100	125	200									
	1845	CTD30	60 58.9	54 37.8	594	0.47	34.28	0.341	5	126	200	55	300	55	250	52	500	49	300	F40
									25	127	200									
									50	128	200									
	2005	CTD31	61 03.0	54 35.2	367	0.25	34.34	0.251	5	129	200	56	360	56	250	53	500	50	~300	
									25	130	200									
									50	131	200									

Measured surface chlorophyll concentrations ranged from >2mg m^{-3} on the shelf south of the Falklands to ~0.1 mg m^{-3} in the central Drake Passage close to the Antarctic convergence, and agree well with the satellite data (Fig. 7.1). Calibration data for the CTD fluorometer are shown in Fig 7.2, and are subject to correction against laboratory determination of the chlorophyll standard used on the ship.

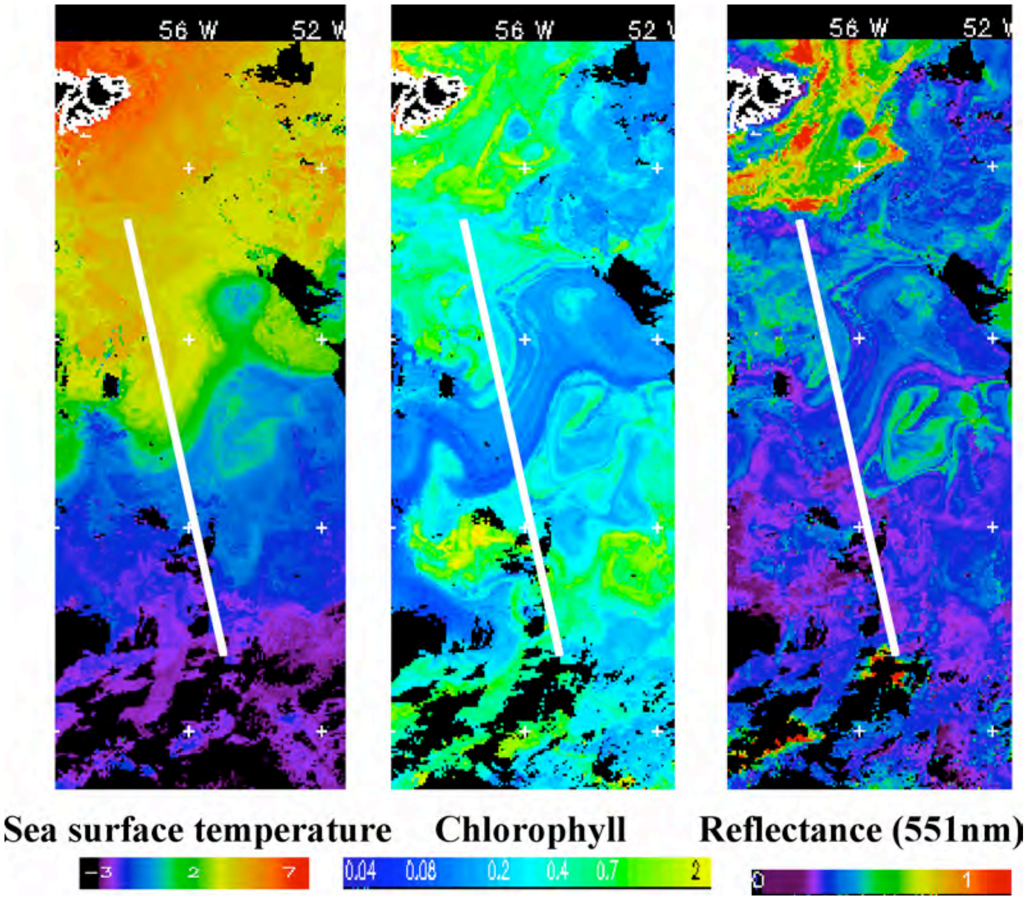

Figure 7.1: MODIS data for 6-12 December 2006 White lines indicate transect

The relationship between measured chlorophyll values and CTD transmissometer values is shown in Fig. 7.3. Much of the variability in transmission appears to be attributable to chlorophyll-containing particles, and it is likely that the remainder is a function of the particle type – i.e. cell size and the presence of mineral phases.

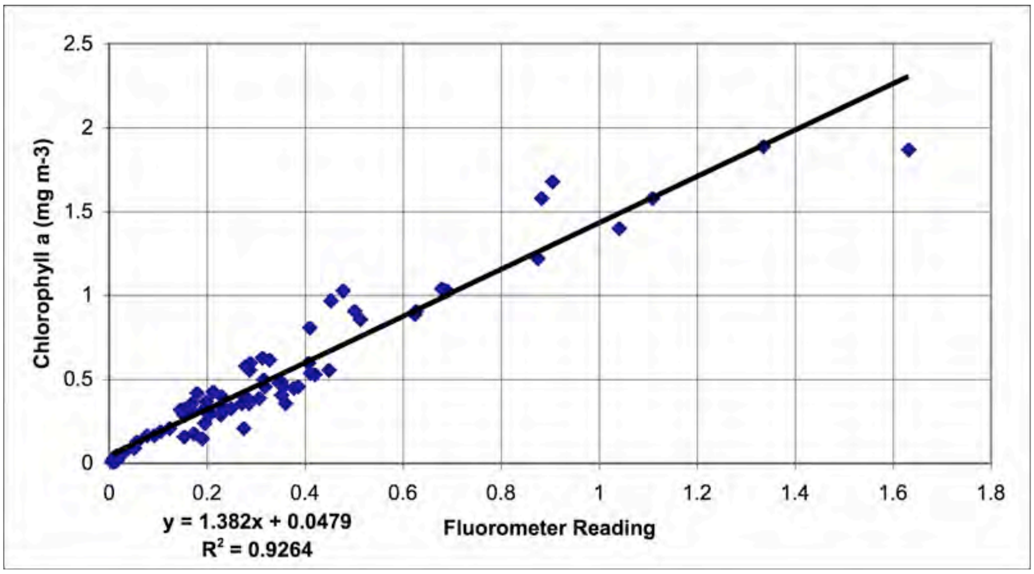

Figure 7.2: Calibration of CTD fluorometer

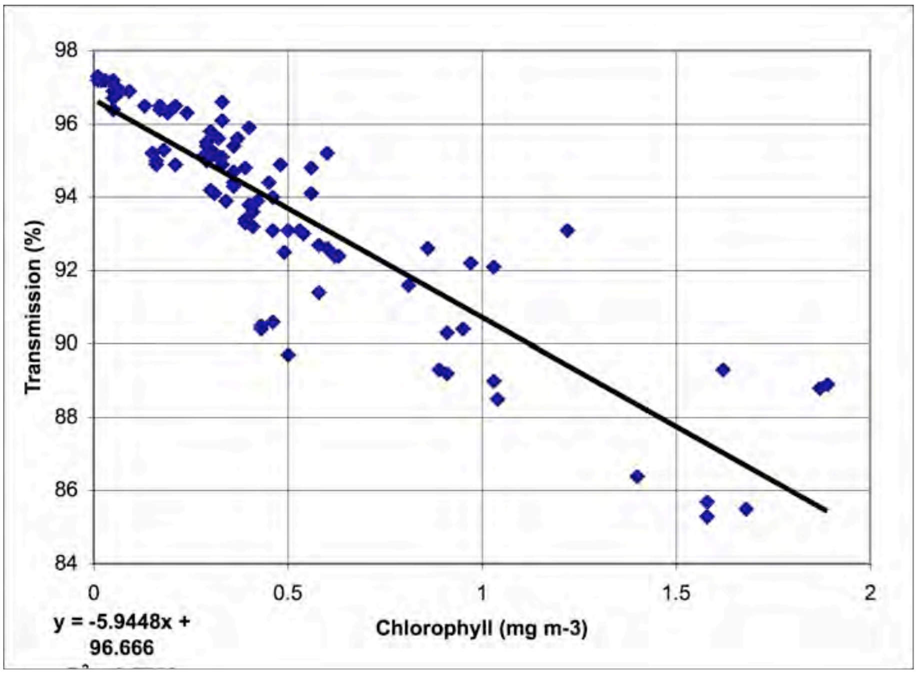

Figure 7.3: Relationship between chlorophyll concentration and transmission.

Further interpretation of the satellite reflectance data and the CTD transmission data will depend on analyses of the POC, PIC and BSi samples and on examination of the phytoplankton types by microscopy. As of Jan. 2008, this work is still to be carried out at NOC.

8. UNIX COMPUTING

Adam Williams

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 excellently supported by Doug Willis, who assisted with networking and a number of other computer-related issues.

Pstar: A copy of the JR115 pstar exec directory was brought from NOC. 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. Brian King set up the majority of the scripts remotely from the NOC before the cruise began. The main issues related to the new data management system on the JCR, requiring some adaptation of previous methods.

Each time the ship leaves port, a new leg is started (defined as the current leg), and a data directory is set up on the BASnet network. This system means that all data are automatically backed up in Cambridge, improving the safety and security of all data. All instruments are connected to this system, with directories for each instrument. The pathways for the data processing scripts had to be adjusted so that the processing was carried out in the data area, and not as in previous cruises, under the pstar directory.

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 Brian King before the main section work began.

Laptops: One laptop was brought to aid with computer processing. A Mac iBook G4 was used for calculating and transferring sample salinities and TSG bottle times and numbers.. A unix directory was mounted using samba so that files could be transferred to unix by drag and drop.

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

9. TECHNICAL SUPPORT

Mark Preston (Summarised from BAS Technical Report by Adam Williams)

9.1 Autosal- salinometer (S/N 65763)

Continued problems with bubbles still being experienced with the salinometer. Both new and old peristaltic pumps can at times generate air bubbles. This has caused problems with the stability of salinity measurements. Investigations continue.

9.2 Acoustics: EK120 Echosounder

Computer failed to find an echosounder on one occasion. Investigation in the tween deck found the breaker on the top RHS of the EK120 cabinet was off. Restoring this solved the problem. No reason was found for the breaker to trip.

9.3 Acoustics: EA600 Echosounder

38 kHz was used briefly to help locate a mooring.

9.4 CTD swivel S/N 196111

Swivel failed mid cast. Electrical measurements on deck showed insulation resistance down to low number of Megaohms. Needs repairing.

9.5 CTD Swivel linkage

Both CTD swivel linkages do not fit both swivels properly. Swivels and linkages need measuring and adjusting.

10. INFORMATION COMMUNICATIONS TECHNOLOGY

Doug Willis and Manos Tsentides

10.1 Personal Computers

Due to the ship being almost full a large variety of laptops were setup for use on the JCR LAN. This included several Apple Mac's. All were setup with antivirus and non-BAS machines had personal firewalls enabled. Laptops that didn't have antivirus had free versions of Comodo or AVG installed and configured for auto-updates (Clam AV for the Macs).

PCs in the Data Prep room still had MS Office SR1 installed. All were updated to SR3, some needed a complete reinstall of Office for the SR3 update to complete.

XP PCs needed MS patch 884897 installing before the new colour laser printer was installed via iPrint (located in **Y:\MS KB884897**). This was necessary for the printer driver to be fully functional. Search for MS KB884897 article on Microsoft's website for more info. The patch was installed manually and not via login script. Informed Mike Glostein of this issue with respect to crew PCs.

10.2 Netware

Installed new Colour Laserjet 4700dn printer into iPrint to replace the faulty HP4550. The new printer has a printer driver profile that has duplex printing enabled by default and the correct memory configured. See Personal Computer section above for printer driver issue on XP PCs.
Old HP4550 printer agent deleted and hardware boxed up ready for return to Cambridge for disposal (tied down in UIC due to lack of space in hold).

JRNA NSS errors on SYS volume probably caused by a known bug in the version of OFM being used. This caused the SYS volume to temporarily go offline one evening. Upgraded Backup Exec from build 1127 to 1158.4 and installed new 9.4.401m version of OFM which resolves this issue. Scheduled reboot of server with RO for changes to take effect. Minor backup issues resolved (see Leg 20061205 report on JCR Wiki for detail). Backup now reliable.

Investigated using Backup Exec to backup SCS server using remote agent recently purchased but not possible now that the SCS server is on a different network.

10.3 Unix

Set-up the UNIRAS license server on *jrub* and acquire the updated license file from Cambridge.

Add the pstar & ladcp user IDs to the di group so that they have write permissions to their data areas on /data/cruise/jcr/current/ and added the pstar & ladcp directories to the newleg script.

10.4 SCS Logging System / Data Logging

The SCS logging system performed reasonably well throughout the cruise, though it is starting to show its age in several areas.

The Ashtech GPS occasionally stopped outputting heading information (approx every 5 days) and required power cycling.

Sometimes the EA600 stopped outputting depth data over the serial port, mostly this just required the software to be shutdown & restarted, however sometimes the machine on the bridge needed to be power cycled, occasionally repeatedly. The RO (Mike Glostein) is discussing with Simrad.

The RVS utilities are showing a problem connecting to the data files with a message "---- Failed to attach ---" being shown against the data stream when running *lookd* on any system other than *jrua*. This may be an indication that the RVS utilities need updating to handle current NFS protocols as this fault seems to have started following the upgrade to a network storage solution for the ship.

The RVS data streams are no longer updating in real time but show a delay of up to two minutes between the current data file and the SCS logging system. This was not a problem as the data were analysed in the pstar system in one-day segments.

Several times during the cruise the RVS files were updated with a record dated in the future and this stopped the streams from being updated. To work around the problem the files affected were re-created and the *scs2levc* routine was re-run on the files in question.

Data Acquisition Events	
Date / Time	**Event / Reason**
06/12/2006 14:14	Records were added to the *rvs* data files with a future date. This stopped the streams from being updated. After checking the SCS source files no corruption was found. The *rvs* data files were recreated and the *scs2levc* program was restated.
07/12/2006 13:25	The EA600 stopped reporting the depth to the SCS system. This required that the EA600 system on the bridge be restarted.
07/12/2006 18:46	The EA600 stopped reporting the depth. The system was powered down and restarted. The depth was once again reported to the SCS system. There is a gap in the EA600 data between 17:24 and 18:46.
10/12/2006 10:14	The Ashtech ADU5 stopped reporting the heading. This required power cycling of the machine. There is a gap in the data between 10:10:17 and 10:21:29.

10.5 Network

No problems reported.

10.6 Recommendations

Investigate replacing or upgrading the RVS & pstar utilities as they are showing their age and are becoming unstable on current systems.

Plan upgrade of GroupWise to at least version 6.5.4. This will require all GW clients to be upgraded to 6.5.4 or 6.5.7.

REFERENCES

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Hawker, E.J., King, B.A., Sparrow, M. and et al, . (2005) RRS James Clark Ross Cruise 94, 01 Dec-15 Dec 2003. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 56pp. (Southampton Oceanography Centre Cruise Report, 55) Available at: http://eprints.soton.ac.uk/15510/

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Sparrow, M., Hawker, E.J. and et al, . (2005) RRS James Clark Ross Cruise 115, 01 Dec-19 Dec 2004. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 80pp. (Southampton Oceanography Centre Cruise Report, 56) Available at: http://eprints.soton.ac.uk/15511/

Stansfield, K. and Meredith M, (2008) RRS James Clark Ross Cruise 115, 05 Dec-12 Dec 2005. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Southampton, UK, Southampton Oceanography Centre, 80pp. (National Oceanography Centre Cruise Report, 24) Available at: http://eprints.soton.ac.uk/50065/

Appendix A SCS Data Streams

The ships data logging system records the following data.

Anemometer: MWV - Mean Wind direction and Velocity

```
$IIMWV,237,R,28.0,N,A*1F
```

Filed	Description
1	$IIMWV
2	Direction in degrees
3	R- Relative wind measurement
4	Wind speed in unit specified by the next digit
5	Units (M=m/s, N=knots, P=mph, K=kph)
6	Valid flag (A=Valid, V=Invalid)
7	Checksum delimiter

Ashtech: PAT – Position and Attitude

```
$GPPAT,134205.00,5141.50394,S,05749.34375,W,00029.10,98.2665,001.20,000.84,
0.0020,0.0220,0*4B
```

Field	Description
1	$GPPAT
2	Time in HHMMSS.hh (hh 0 hundredths of seconds)
3	L atitude (absolute value)
4	Latitude sense (N, or S)
5	Longitude (absolute)
6	Longitude sense (E or W)
7	Altitude (meters)
8	Heading (degrees)
9	Pitch (degrees)
10	Roll (degrees)
11	Attitude phase RMS error (meters)
12	Attitude baseline length error (meters)
13	Attitude Flag (0, for good data, 1 for bad)
14	Checksum

EA600: DBS – Depth below surface

```
$SDDBS,0.00,f,0.00,M,0.00,F*31
```

Field	Description
1	SDDBS
2	Depth
3	Feet (f)
4	Depth
5	meters (M)
6	Depth
7	fathoms (F)
8	Checksum

Em120: DPT – Depth below transducer

```
$EMDPT,542.43,0.0
```

Field	Description
1	$EMDPT
2	Depth in metres
3	Offset from transducer

Emlog: VHW - Water speed and heading

```
$VMVHW,,,,,-00.01,N,,
```

Field	Description
1	$VMVHW
2	Heading degrees True
3	Heading degrees. Magnetic
4	Speed through the water (knots)
5	Speed KPH

Emlog: VLW – Dual Ground/Water Distance

```
$VMVLW,6870.2,N,721.51,N
```

Field	Description
1	Total Cumulative Distance
2	Always Transmitted as “N”
3	Distance Since Last Reset
4	Always Transmitted as “N”

Furano: GGA - Global Positioning System Fix Data

```
$GPGGA,134211,5141.5113,S,05749.3426,W,1,10,1.4,23,M,13,M,,
```

Field	Description
1	$GPGGA
2	Time in UTC (hhmmss)
3	Latitude
4	Latitude sense (N,S)
5	Longitude
6	Longitude (E,W)
7	Fix quality: 0 = invalid,1 = GPS fix,2 = DGPS fix
8	Number of satellites being tracked
9	Horizontal dilution of position
10	Altitude, Metres, above mean sea level
11	Altitude unit (M) Metres
12	Height of geoid (mean sea level) above WGS84 ellipsoid
13	Height unit (M) Metres
14	(empty field) time in seconds since last DGPS update
15	(empty field) DGPS station ID number
16	Optional checksum

Furano: GLL - Geographic position, Latitude and Longitude

```
$GPGLL,5141.5115,S,05749.3423,W,134220,A
```

Field	Description
1	$GPGLL
2	Latitude
3	Latitude sense (N,S)
4	Longitude
5	Longitude sense
6	Time of fix UTC (hhmmss)
7	Data valid

Furano: RMC - Recommended minimum specific GPS/Transit data

`$GPRMC,134222,A,5141.5115,S,05749.3423,W,0.0,262.5,051206,4,E*6C`

Field	Description
1	GPRMC
2	Time of fix in UTC
3	Navigation receiver warning A = OK, V = warning
4	Latitude
5	Latitude sense (N,S)
6	Longitude
7	Longitude Sense (W,E)
8	Speed over ground, Knots
9	Course Made Good, True
10	Date of fix (ddmmyy)
11	Magnetic variation 20.3 deg
12	Magnetic variation (E,W)
13	mandatory checksum

Furano: VTG - Track made good and ground speed

`$GPVTG,,T,296.2,M,0.0,N,0.1,K`

Field	Description
1	$GPVTG
2	True track made good
3	Always transmitted as T
4	Magnetic track made good
5	Always transmitted as M
6	Ground speed
7	Ground speed units ,(N) knots
8	Ground speed
9	Ground speed units (K) Kilometers per hour

Furano: ZDA - UTC Date / Time and Local Time Zone Offset

`$GPZDA,134243,05,12,2006,0,0`

Field	Description
1	$GPZDA
2	Time of fix UTC (hhmmss.ss)
3	Day, 01 to 31
4	Month, 01 to 12
5	Year
6	Local zone description, 00 to +/- 13 hours
7	Local zone minutes description (same sign as hours)
8	Optionsl checksum

Glonass:

$PASHR,POS,0,10,134217.00,5141.513208,S,05749.349999,W,+00046.007,,000.00,000.02,-000.05,01.6,00.9,01.3,00.8,GJ00*04

Field	Description
1	$PASHR
2	POS
3	Position fix type
4	Number of satellites used in position computation
5	Current UTC Time hhmmss.ss
6	Latitude
7	Latitude sector (N,S)
8	Longitude
9	Longitude sector (E,W)
10	Altitude above mean sea level (m)
11	Reserved
12	True track/true course over ground (deg)
13	Vertical velocity (m/s)
14	PDOP
15	HDOP
16	VDOP
17	TDOP
18	Firmware version
19	Checksum

Gyro: HDT – True heading

```
$HEHDT,099.4,T*2B
```

Field	Description
1	$HEHDT
2	Heading
3	True.(T)
4	Checksum

Oceanlogger: OL2 – BAS Ocean logger

```
$OL2, 2006  339
13:41:56,11.500000,80.550000,1870.995671,819.024390,11.800000,77.890000,183
6.186770,827.875000,1007.970000,1007.990000,18.224800,4.492080,33.978600,15
15.284000,1.039000,23.400000,0.005250,13.980000,
```

Field	Description
1	$OL2
2	time
3	Air temprature 1
4	Humidity 1
5	Par 1
6	Tir 1
7	Air temprature 2
8	Humiditu 2
9	Par 2
10	Tir 2
11	Pressure 1
12	Pressure 2
13	Sal temp
14	Cond
15	Sal
16	Water velocity
17	Fluor
18	Fstemp
19	Flow
20	sst

Seatex: GGA - Global Positioning System Fix Data

```
$INGGA,134224.51,5141.50583,S,05749.34996,W,2,07,1.2,14.4,M,,M,8.0,0201*7C
```

Field	Description
1	$INGGA
2	Time in UTC (hhmmss)
3	Latitude
4	Latitude sense (N,S)
5	Longitude
6	Longitude (E,W)
7	Fix quality: 0 = invalid,1 = GPS fix,2 = DGPS fix
8	Number of satellites being tracked
9	Horizontal dilution of position
10	Altitude, Metres, above mean sea level
11	Altitude unit (M) Metres
12	Height of geoid (mean sea level) above WGS84 ellipsoid
13	Height unit (M) Metres
14	(empty field) time in seconds since last DGPS update
15	(empty field) DGPS station ID number
16	Optional checksum

Seatex: GLL - Geographic position, Latitude and Longitude

```
$INGLL,5141.50580,S,05749.34997,W,134231.51,A*1F
```

Field	Description
1	$INGLL
2	Latitude
3	Latitude sense (N,S)
4	Longitude
5	Longitude sense
6	Time of fix UTC (hhmmss)
7	Data valid

Seatex: HDT – True heading

```
$INHDT,98.15,T*20
```

Field	Description
1	$INHDT
2	Heading
3	True.(T)
4	Checksum

Seatex: PSXN,20

```
$PSXN,20,0,0,0,0*3B
```

Field	Description
1	$PSXN
2	20
3	Horizontal position & velocity quality: 0=normal, 1=reduced performance, 2=invalid data
4	Height & vertical velocity quality: 0=normal, 1=reduced performance, 2=invalid data
5	Heading quality: 0=normal, 1=reduced performance, 2=invalid data
6	Roll & pitch quality: 0=normal, 1=reduced performance, 2=invalid data
7	Checksum

Seatex: PSXN,22

```
$PSXN,22,-1.76,-2.17*3D
```

Field	Data
1	$PSXN
2	22
3	gyro calibration value since system start-up in degrees d.dd
4	short term gyro offset in degrees d.dd
5	Checksum

Seatex: PSXN,23

```
$PSXN,23,0.11,0.86,98.09,0.00*0E
```

Field	Data
1	$PSXN
2	23
3	roll in degrees, positive with port side up d.dd
4	pitch in degrees, positive with bow up d.dd
5	Heading, degrees true d.dd
6	heave in meters, positive down m.mm
7	Checksum

Seatex: VTG - Track made good and ground speed

```
$INVTG,223.58,T,,M,0.0,N,,K*60
```

Field	Description
1	$INVTG
2	True track made good
3	Always transmitted as T
4	Magnetic track made good
5	Always transmitted as M
6	Ground speed
7	Ground speed units ,(N) knots
8	Ground speed
9	Ground speed units (K) Kilometers per hour

Seatex: ZDA - UTC Date / Time and Local Time Zone Offset

```
$INZDA,134224.51,05,12,2006,,*72
```

Field	Description
1	$INZDA
2	Time of fix UTC (hhmmss.ss)
3	Day, 01 to 31
4	Month, 01 to 12
5	Year
6	Local zone description, 00 to +/- 13 hours
7	Local zone minutes description (same sign as hours)
8	Optionsl checksum

Tsshrp:

```
:003D3C  0000U-0531  0141
```

Field	Description
1	Start of packet
2	Horizontal acceleration length 2
3	Vertical acceleration length 4
4	Space character
5	Heave length 5 with leading character either space or -
6	Status flag (u,U,g,G,h,H,f,F)
7	Roll length 5 with leading character either space or -
8	Space character
9	Pitch length 5 with leading character either space or -

WINCH – BAS winch control system

```
$WINCH,06,342,01:52:52,5,7,-11,0.05,348,0,5
```

Field	Description
1	$WINCH
2	Year
3	Jday
4	Time
5	Cable type
6	Cable out
7	Rate
8	Tension
9	Back Tension
10	Compensation
11	Angle

Appendix B - SCS Data to RVS Data Streams

SCS Data File	RVS data Stream
Glonas.aco	Gps_glos
Ashtech.aco	Gps_ash
Furuno-gga.aco	Gps_nmea
Seatex-gga.aco	Seatex
Anemometer.aco	anemomter
Tsshrp.aco	Tsshrp
Oceanlogger.aco	Oceanlogger
Emlog-vhw.aco	Emlog
Ea600.aco	Sim500
Winch.aco	Winch
Gyro.aco	Gyro
Em120.aco	Em120