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RRS *JAMES CLARK ROSS* CRUISE 81 18 DEC 2002 - 02 JAN 2003

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

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2003

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ABSTRACT <p>This report describes the eighth repeat hydrography section across Drake Passage, first established during the World Ocean Circulation Experiment. Thirty CTD/LADCP stations were carried out across the 753 km section from Elephant Island to Burdwood Bank, plus one test station and one station at the Rothera Time Series (RaTS) site, just off Biscoe Wharf at Rothera. 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 $\delta^{18}\text{O}$, for later analysis back at Southampton Oceanography Centre. The LADCP comprised a single downward-looking RD Instruments Workhorse ADCP. The CTD was a SeaBird 911<i>plus</i> with dual conductivity and temperature sensors. Various underway measurements included navigation, vessel-mounted ADCP, sea surface temperature and salinity, water depth and meteorological parameters.</p>	
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OVERVIEW

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

As a notable step towards addressing these objectives, Cunningham *et al.* (2003) was published earlier this year. Further publications are in preparation.

Last year's travel out to Stanley rather degenerated into comedy, as reported in Bacon (2002). We had high hopes of improved efficiency on this year's flight, since we were travelling with the RAF from Brize Norton. We were somewhat dismayed to find ourselves on the tedious end of two days' delay resulting from aircraft maintenance problems, necessitating acceptance of the RAF's hospitality in the oddly-named Gateway Hotel. There was a definite whiff of Dante about the place. We eventually departed on the afternoon of 17 December, arrived on board on the afternoon of the 18th, and sailed shortly after. An extra surprise awaited us on board, in that the entire shipboard computing system seemed to be well and truly up the creek. Johnnie Edmonston describes his travails over the next few days in section 8.

We were able to run a test station on the 21st, and the RaTS station off Biscoe Wharf, Rothera the following day. We docked soon afterwards, unloaded, and sailed again on the morning of the 24th. Christmas Lunch was consumed while underway to Port Lockroy, where we all had a pleasant run ashore to meet the penguins and other inhabitants on a chill, breezy and overcast day. We sailed north to start the section on the 27th, in splendid surroundings - a few miles off Elephant Island to the north-west, with Shackleton's landing spot in sight. The view was 270 degrees around, with Clarence and Cornwallis Islands, large grounded bergs on the shelf, and (what seemed to me) a huge tabular berg,

four and a half miles wide. Lots of snow, ice, jagged black rocks etc. We finished the section off Burdwood Bank during 1 January 2003, and docked back in Stanley early on the 2nd. Scientific work continued on board for a couple of days. Then there was an enforced wait in Stanley until our flight home on the 11th, returning to Brize Norton on the 12th.

The ships' track during the voyage is shown in figure 0.1. The weather, while not ideal for sightseeing, was perfectly adequately clement for scientific work, so there were no delays on that account. There was one brief engineering hiccup when the CTD underwater unit failed during station 26, necessitating recovery of the unit and its replacement with the backup. The station was repeated with a second cast.

The chaps from POL, Mike Meredith and Steve Mack, were along to service the moored POL bottom pressure recorders in Drake Passage. Accordingly, the southern one was interrogated northbound before the start of the section, the middle one after station 15, and the northern one between stations 31 and 32. These activities will be reported elsewhere.

We take this opportunity to publish, for future reference, a list of intended station positions (in addition to the list of actual positions). The list, Table 0.1, is given in south-to-north order with station numbers corresponding to those on this cruise. This is considered to be the definitive list of Drake Passage hydrographic section station positions.

1 CTD DATA ACQUISITION AND PROCESSING

Elizabeth Kent, Evan Mason and Sheldon Bacon.

1.1 Introduction

This section will describe the acquisition and processing of data from the Conductivity-Temperature-Depth (CTD) system used on Cruise JR81. 32 full depth stations were sampled: a test station, a station at the Rothera Time Series (RaTS) Station and 30 stations across the Drake Passage section (plus one failed cast on Station 26).

1.2 Configuration

The BAS CTD system was used: a SeaBird 911plus system with a 12 bottle frame and pylon. The system consisted of dual temperature and conductivity sensors, a pressure transducer, the LADCP (see Section 2) and an altimeter. Only 10 Niskin bottles were fitted to the frame, bottles 2 and 3 were removed to accommodate the LADCP battery. The BAS SBE35 high-precision thermometer was fitted to the CTD frame. Details of the sensor types, serial numbers and calibration dates are given in Table 1.1, calibration coefficients are given in section 1.9. Figure 1.1 shows pictures of the CTD system as used on the cruise.

1.3 Deployment

Before each deployment of the CTD, the LADCP workhorse had to be woken up and disconnected from the charger. The CTD Deck Unit was switched on while the CTD was on the deck to obtain deck pressure values. The CTD was then deployed from the midships gantry and hauled on the winch. Two of the ship's crew controlled the CTD as it left the deck and entered the water. The CTD was lowered to about 10 metres depth and left to soak for three minutes during which time the pumps automatically switch on. The pumps are water activated and so do not operate until 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). The soaking ensures the pumps are running when the cast starts and that the CTD system has had some time to adjust to the water temperature from the atmospheric temperature. Strong air-sea temperature differences were not encountered so a long soaking was not thought necessary. After soaking the CTD was brought to the surface, the wireout zeroed, and the CTD lowered to about 10 metres above the seabed. On JR67 there had been problems with 'false bottom' signals in the altimeter output but this has now been fixed by sending the altimeter to have its ping rate reduced (J. Fox, pers. comm.). This makes judgement of the depth off the seabed much easier. On several of the stations there was a problem with the winch spooling which meant that it was often necessary to stop the upcast, sometimes for periods of nearly an hour. More information on this is given in Section 1.9.

Water samples were taken on the upcast with the winch stopping at 10 separate depths to fire the 10 bottles for which there was room on the frame. The firing pattern was at staggered depths, alternating between stations, to allow easier contouring of the oxygen isotope samples (Figure 1.2). The CTD was stopped for about 10 seconds before each bottle was closed. The SeaBird Deep Ocean Standards Thermometer (SBE35) was set to record on each bottle firing and to report a 24 second average temperature. 24 seconds was chosen as it had previously been found to give the most consistent comparisons with the CTD measurements (M. Meredith, pers. comm.).

Following each cast the CTD was brought back onto deck, again with the help of the ship's crew, and lashed to the deck inside the water bottle annex. Salts were sampled from the 10 bottles, with a duplicate sample taken from the deepest bottle (bottle 1). Samples for later oxygen isotope analysis were taken from all bottles at all but stations 26 and 30 (as not quite enough sample bottles had been brought). The LADCP data were downloaded and the unit put onto charge. The CTD was then set up for the next station.

1.4 Data Acquisition

On JR67 a limiting factor was the ancient pc on which the data were logged. This has now been replaced with a much more suitable machine: a Viglen Contender P4 1.4 GHz which is attached to the Deck Unit. The Deck Unit was switched on whilst the CTD was on deck just before deployment and the control for the pylon usually 'homed'. When the pc is started up it opens Windows NT version 4 and logs onto the network with user 'ctd' and password 'bas_tardis'. Data were logged using the SeaBird *seasave Win32* software version 5.25 running within the Windows environment. Calibration data are entered in *seasave* using the 'new type instrument configuration' under the configure menu. Logging to the pc was normally started when the CTD was on the deck in order to obtain deck pressure values.

The pc screen display was set to show the temperature, conductivity and altimeter reading as a function of pressure and also to display spot values of the pressure, depth, temperature and altimeter reading. Data loss is indicated by a beeping of the Deck Unit (as happened on the aborted Station 26, renamed Station 26a), but usually few data were lost. Bottles were closed using the SeaBird software rather than by pressing the fire button on the Deck Unit. Logging was stopped when the CTD reached the surface. The raw data were logged as a binary file 81ctdNN.dat where NN is the station number.

The time variable recorded in the data file is datacycles after the start of logging, the sampling rate is 24Hz. The logging start time has to be obtained from the file header and derives from the pc clock. The time on the pc clock was therefore periodically synchronised with the ship's master clock. The pc is the only source of the raw data so in the event of a pc disk failure, any data which had not been promptly transferred to another file system would be lost. Data files were backed up to the pc network (N:) drive and copied to the UNIX system which was mounted as the U: drive where further

processing was carried out. The SeaBird *SBEDataPro* conversion utility was used to convert the logged binary data to ASCII files and also to apply the cell thermal mass correction using the standard coefficients ($\alpha = 0.03$ and $\beta = 1/7$).

1.5 Station History

Thirty-two stations were sampled during the cruise. Details are given in Table 1.2 and Figure 1.2 shows the positions of the bottles fired. Station 01 was a test cast taken on the southbound leg to a depth of nearly 3500m. Station 02 was at the Rothera Time Series (RaTS) Station to 391m. Stations 03 to 32 were the Drake Passage Section. There was found to be excessive rotation of the frame so a fin was added for stabilisation before Station 03 and was moved to a different upright before Station 11. On station 08 the SBE35 standards thermometer calibration slope and offset which had been input as 0 and 1 were corrected (see Section 1.10), this made an insignificant change to the values recorded. After Station 12 Niskin bottle 8 was found to be cracked and was replaced. After Station 17 there was orange slime on the LADCP and fin which was wiped off. On several of the deeper stations there was considerable spooling and respooling of the winch: Stations 10, 12, 15, 18, 23, 25 and 27 were particularly affected, more information is given in Section 9. The Underwater Unit failed at 1000m on the downcast of Station 26 (renamed Station 26a) which was repeated using the alternate Underwater Unit. On Station 26 the altimeter was not displayed to the screen as the channel had been changed and this had not been noticed. The depth off the bottom will therefore be greater for this cast than for the others. After the change of Underwater Unit the altimeter reading was found to drift slightly until the cable was changed before Station 29.

1.6 Data Processing

1.6.1 Data Processing Using the SeaBird Software on PC

Following each cast logging is stopped, the data are extracted from the SeaBird binary file 81ctdNN.dat, calibrated and output to ASCII format in a file 81ctdNN.cnv using the SeaBird *SBEDataPro* conversion utility. A bottle file 81ctdNN.bl is also logged which contains the bottle firing datacycle numbers extracted from the raw data file.

1.6.2 Conductivity Cell Thermal Mass Correction

The effect of the thermal mass of the conductivity cells was removed from the data using the standard SeaBird software *celltm*. The ASCII input file 81ctdNN.cnv was converted to 81ctdNN_ctm.cnv. The algorithm used was:

$$dt = t_i - t_{i-7}$$

$$ctm_i = -b * ctm_{i-7} + a * dcdt * dt$$

$$c_{cor,i} = c_{meas,i} + ctm_i$$

$$a = \frac{2\alpha}{7\Delta * \beta + 2}$$

$$b = 1 - \frac{2a}{\alpha}$$

$$dcdt = 0.8 * (1 + 0.006 * (t_i - 20))$$

where α , the thermal anomaly amplitude is set at 0.03 and β , the thermal anomaly time constant, is set at 1/7 (the SeaBird recommended values for SBE911plus pumped system). Δ is the sample interval (1/24 second), dt is the temperature (t) difference taken at a lag of 7 sample intervals. $c_{cor,i}$ is the corrected conductivity at the current data cycle (i), $c_{meas,i}$ the raw value as logged and ctm_i is the correction required at the current datacycle, $dcdt$ is a correction factor which is a slowly varying function of temperature deviation from 20°C.

1.6.3 Conductivity Advance

The temperature and conductivity sensors are separated in space within the pumped system and the seawater first passes the temperature sensor and then the conductivity sensor. Details are given in SeaBird Electronics Application Note 38, “Fundamentals of the TC duct and pump-controlled flow used on SeaBird CTDs”, December 1992. The default time separation of the temperature and conductivity measurements is 0.073 seconds (1.75/24 seconds). The Deck Unit is set up to advance the primary conductivity by this amount but the secondary conductivity is not shifted in time. As on JR67 the values for the conductivity advance were estimated by choosing the time shifts to minimise the noise in the derived salinities. Figure 1.3 shows the salinity before (Figure 1.3a) and after (Figure 1.3b) the optimal shifts of 1.0 for the primary sensor (a delay) and -1.0 for the secondary sensor (an advance) for Station 01. The values were checked again after the change of Underwater Unit on Station 26 and found still to be appropriate.

1.6.4 Deck Pressures

At the start of each cast the CTD was set logging on deck, we therefore have a record of the deck pressure. This information was extracted from the files and is plotted in Figure 1.4. There is little variation of the deck pressure apart from on Station 25 so no corrections to the pressure will be applied. Station 25 was just prior to the failure of the Underwater Unit on Station 26a.

1.6.5 Data Processing on the UNIX system.

After the thermal mass correction had been applied, the data were transferred to the UNIX machine *jruf* by copying to a mounted “U-drive” on the pc rather than by using ftp as had been done on JR67. This meant that the *dos2unix* command had to be used to strip out the pc line control characters which

caused parts of the UNIX processing system to fail. Once on the UNIX system the data is processed using pstar data format using c-shell scripts.

8lseactd0: reads in the ASCII file to pstar format using *pascin*. The start time is extracted from the ASCII file and is the pc clock time. The header time was set to the start of the cast. The water depth is extracted from the simrad file and latitude and longitude from the navigation file and inserted into the pstar header. The output file is 81ctdNN.raw. Figure 1.5 shows the raw data from a sample station, number 15.

8lseactd1: applies time shifts to conductivity sensors which are hard-wired into the script as +1 for the primary sensor and -1 for the secondary sensor. The input file is 81ctdNN.raw. Each conductivity variable is copied to a separate file along with the scan number variable using *pcopya*. The shift is applied to the scan number using *pcalib* and the files merged back onto the main file using *pmerg2*. Salinities and potential temperatures are then calculated using *peos83*. The output file is 81ctdNN.tsh.

8lseactd2: extracts data from 81ctdNN.tsh corresponding to the bottle firing times taken from the ASCII file 81ctdNN.bl. Data extracted for 3 seconds before the bottle close start datacycle and 5 seconds after the bottle close end datacycle. The bottle closing time is about 1.5 seconds meaning that just under 10 seconds of data are extracted. These 10 seconds of data are averaged using *pbins* to give a file containing a single datacycle for each bottle firing. These are appended using *papend* to give a pstar file of CTD data corresponding to each bottle firing 81ctdNN.btl. As 12 datacycles were required absent data was appended to the end of the file if less than 12 bottles were fired.

8lseactd3: extracts data from 81ctdNN.tsh corresponding to the 24 second measurement period of the SBE35. This is done in a different way to *8lseactd2*. 24 seconds of data after the bottle firing time are written to an ASCII file using *mlist*. The bottle number is added to the start of the file using the UNIX command *paste*. The data for each bottle are appended to the ASCII file which is then read into pstar using *pascin* and binned on bottle number using *pbins*. The output file is 81ctdNN.sbe35

8lseactd4: applies an automatic edit to the file 81ctdNN.tsh to remove data where the CTD is out of the water. This is assessed using the noise in the conductivity. The start and end of the file are binned into 5 second bins using *pbins*. The start of good conductivity data was defined as the first bin in which the standard deviation of conductivity was less than 0.05 mScm^{-1} and similarly for the end of good conductivity data. These

times were identified using *datpik* and conductivity and salinity data outside these times removed using *peditc*. The output is 81ctdNN.ed1.

81seactd5: applies an automatic edit to the file 81ctdNN.ed1 to remove data spikes. The differences of salinity and potential temperature from their 1 second filtered values were calculated for both the primary and secondary sensors. *pcopya* was used to duplicate these four variables, *pfiltr* to apply a 25 point running mean and *parith* to take the difference of the instantaneous and filtered quantities. *peditc* was then used to remove conductivity and salinity values where the absolute difference from the filtered salinity value was greater than 0.01 psu and to remove temperature and potential temperature where the absolute difference from the filtered temperature value was greater than 0.05°C. The output file from the automatic processing is 81ctdNN.ed2. This removed most of the data spikes and those that remained were removed with a version of *plxied* compiled with a larger buffer to accommodate the 24Hz data. The output file from the manual editing is 81ctdNN.ed3.

The conductivities were then calibrated using the values from Section 1.8 (primary conductivity +0.0035 and secondary conductivity +0.0002) and salinities, potential temperatures and potential densities calculated with *peos83* to give the master file 81ctdNN.24Hz. The downcast data cycles were extracted and the downcast averaged to 1db to give the file 81ctdNN.1db. The master file (81ctdNN.24Hz) was averaged to 1Hz using *pavrge* to give the file 81ctdNN.1Hz. The winch data was also read in as part of the CTD processing using the script *win0* which requires the station number and start and stop times for the cast.

These files were used to generate a 5db section across Drake Passage using *pgridp*. Figure 1.6 shows the salinity across the section and Figure 1.7 the difference in the two salinity measurements after calibration (primary minus secondary). There is some evidence for systematic differences between the two sensors after calibration, but these variations are below the target accuracy of 0.001 psu. Figure 1.8 shows the potential temperature for the section, differences between the two sensors were negligible.

1.8 CTD Calibration

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

1.8.1 Processing path

- i. an ascii file `sam81.names` was created, with 2 columns: variable name, and associated units. All variables required in subsequent processing were included.

- ii. a cshell script *pblankexec* was run to create a blank pstar sample file, called `sam81.blank`, containing 12 data cycles corresponding to the 12 positions on the BAS rosette.
- iii. for each cast, a cshell script *samblank.exec* was run, to create an empty copy of `sam81.blank` called `sam81nn`, where `nn` = cast number. Date, time, position and depth information is written into the header.
- iv. for each cast, a cshell script *samfir* was run, to paste variables from CTD file `81ctdnn.btl` into `sam81nn` (pressure, plus temperature, conductivity and derived salinity for each sensor pair).
- v. for each cast, a cshell script *sal.exec* was run, to retrieve an ascii file `sal81nn.txt` containing sample salinity data from the Mac iBook using the cshell script *getexcel.exec*, which converts the ascii file into a pstar file `sal81nn`.
- vi. for each cast, a cshell script *passal* was run, to paste sample salinity data from file `sal81nn` into `sam81nn`.
- vii. for each cast, a cshell script *botcond* was run, to calculate sample conductivity from bottle salinity, CTD pressure and (primary) temperature. Bottle minus CTD conductivity was calculated for each sample and for both CTD conductivity sensors. These operations all pertain to file `sam81nn`.

1.8.2 Comparison of bottle and CTD conductivities

Apart from the inevitable few outliers the conductivity calibration was of very good quality. There was no significant dependence of either sensor on pressure, temperature or time. Figure 1.9 shows the 107 sample minus CTD salinities for depths below 500 db. The primary conductivity was too low by 0.0035 ± 0.0010 mS/cm and the secondary by 0.0002 ± 0.0009 mS/cm. These adjustments are therefore to be applied to the sensors.

1.9 Calibration Equations and Coefficients

Temperature, ITS-90 Scale

$$T [^{\circ}\text{C}] = \frac{1}{g + h \ln(f_0/f) + i \ln^2(f_0/f) + j \ln^3(f_0/f)} - 273.15$$

where f is the frequency output of the temperature channel

Conductivity

$$C [\text{Siemens m}^{-1}] = \frac{(g + hf^2 + if^3 + jf^4)}{10 * (1 + \delta t + \epsilon p)}$$

where f is the frequency output of the temperature channel, t is the temperature in $^{\circ}\text{C}$ and p is the pressure in db.

Pressure

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

where P is the pressure in psia, T is the pressure period in μ s and C is given by:

$$C = C_1 + C_2 U + C_3 U^2$$

and D is given by:

$$D = D_1 + D_2 U$$

U is the temperature in $^{\circ}$ C and T_0 is given by:

$$T_0 = T_1 + T_2 U + T_3 U^2 + T_4 U^3 + T_5 U^4$$

Date: 12/26/2002

ASCII file: D:\data\JR81\CTD_JR81_1.CON (CTD_JR81_2.CON after station 26a)
Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 3
Computer interface : RS-232C
Scans to average : 1
Surface PAR voltage added : No
NMEA position data added : No
Scan time added : No

1) Frequency channel 0, Temperature

Serial number : 032307
Calibrated on : 19-Jul-02
G : 4.33428016e-003
H : 6.44369554e-004
I : 2.36010224e-005
J : 2.26970388e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency channel 1, Conductivity

Serial number : 041913
Calibrated on : 19-Jul-02
G : -4.02687597e+000
H : 5.32198024e-001
I : -6.64099969e-004
J : 6.19114250e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency channel 2, Pressure, Digiquartz with TC - Stations 1 to 26a

Serial number : 75429
Calibrated on : 07-Jul-02
C1 : -4.398881e+004

C2 : -5.551403e-001
 C3 : 1.279490e-002
 D1 : 3.603000e-002
 D2 : 0.000000e+000
 T1 : 2.986716e+001
 T2 : -5.274889e-004
 T3 : 4.092900e-006
 T4 : 1.616590e-009
 T5 : 0.000000e+000
 Slope : 1.00000000
 Offset : -0.71340
 AD590M : 1.287416e-002
 AD590B : -8.793386e+000

3) Frequency channel 2, Pressure, Digiquartz with TC - Stations 27 to 32

Serial number : 67241
 Calibrated on : 30-Jun-2000
 C1 : -4.461418e+004
 C2 : 3.038386e-002
 C3 : 1.224130e-002
 D1 : 3.645500e-002
 D2 : 0.000000e+000
 T1 : 2.999608e+001
 T2 : -3.512191e-004
 T3 : 3.729240e-006
 T4 : 4.918760e-009
 T5 : 0.000000e+000
 Slope : 0.99992000
 Offset : -0.88150
 AD590M : 1.283280e-002
 AD590B : -9.474491e+000

4) Frequency channel 3, Temperature, 2

Serial number : 032191
 Calibrated on : 19-Jul-02
 G : 4.31967419e-003
 H : 6.38837657e-004
 I : 2.27990979e-005
 J : 2.17976156e-006
 F0 : 1000.000
 Slope : 1.00000000
 Offset : 0.0000

5) Frequency channel 4, Conductivity, 2

Serial number : 041912
 Calibrated on : 19-Jul-02
 G : -4.16212062e+000
 H : 5.36713913e-001
 I : -7.86598365e-004
 J : 6.80295512e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000

6) Voltage channel 0, Altimeter

Serial number : 2130.26993

Calibrated on : N/A
Scale factor : 15.000
Offset : 0.000

7) Voltage channel 1, Free

1.10 SeaBird SBE35 Deep Ocean Standards Thermometer

The BAS SBE35 high-precision thermometer was fitted to the CTD frame. The SBE35 was fixed vertically along an outer upright of the CTD frame, and thus was outside the ring of Niskin bottles and approximately 1 m above the level of the SBE911*plus*. On JR67 it was mounted with the sensor pointing up, away from the CTD sensors but on JR81 it was better positioned with the sensor pointing down and therefore slightly closer to the CTD sensors. Ideally the thermometer would be mounted on the bottom of the frame alongside the CTD sensors to give more sensitive comparisons. The SBE35 is a self-recording instrument that logs a temperature measurement to erasable/programmable read-only memory (EPROM) each time a Niskin bottle is closed; in this respect it is used as a replacement for digital reversing thermometers. Communication with the SBE35 for programming and data downloading is via SeaTerm, a terminal emulator running on the CTD pc and linked to the COM1 port of the computer.

Before programming, the SBE35.CON (configuration file) needs checking to ensure the calibration coefficients are current and accurately entered. Before Station 7 it was noticed that the slope and offset had not been correctly input and had values of 1 and 0 to allow for a fixed-point calibration on 21st January 2002. This calibration made an order 0.0001 difference to the values recorded and was applied to stations 01 to 06 in post-processing. On JR81, the values used were:-

```
SBE35 V 2.0      SERIAL NO. 0024
25-jan-02
A0 = 6.757077878e-03
A1 = -1.973003668e-03
A2 = 2.749250422e-04
A3 = -1.505277322e-05
A4 = 3.140739639e-07
SLOPE = 0.999982      (incorrect value of 1.00000 on stations 01 - 06)
OFFSET = -0.000136    (incorrect value of 0.00000 on stations 01 - 06)
```

where:-

$$\text{Temp (ITS-90)} = 1 / \{a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] + a_4[\ln^4(n)]\} - 273.15$$

and n = sensor output.

Values for a0 to a4 were determined by a linearization calibration on 14th September 2001 and the slope and offset by a fixed-point calibration on 21st January 2002.

The SBE35 is remotely programmed on the pc, this is a vast improvement over the situation on JR67 where the thermometer had to be disconnected and interrogated to download the data. The commands used were: DC (Display Coefficients, to display the calibration coefficients), DS (Display Status; shows date/time of internal memory, datacycles logged, number of measurements to be averaged per reading etc) and DD (Data Dump; writes stored datacycles to the file specified). Samplenum=0 was used to clear the EPROM for the next data acquisition. For JR81, the SBE35 was set to average 24 cycles per measurement. In a thermally quiet environment, the temperature noise standard deviation is $0.000029 \cdot \sqrt{8/n_{cycles}}$, equal to 0.000017°C in our case.

The SBE35 data were compared to the data from both the primary and secondary temperature sensors of the SBE911plus using data extracted in the 24 seconds after each was fired. Figure 1.10 shows the comparisons for all the 32 stations. Near the surface, as expected, the comparisons are quite noisy. Below 1000m the mean differences between both the CTD temperatures and the SBE35 were $0.001 \pm 0.001^\circ\text{C}$, the SBE35 being colder than both CTD sensors. No correction is applied as the nominal accuracy of both the standards thermometer and the CTD temperature sensors is 0.001°C . The difference between the two CTD temperature sensors is of order 0.0001°C .

1.11 Summary

The CTD system performed well on JR81. The main problems encountered were with the winch and the failure of the Underwater Unit that required Station 26 to be repeated. A fin was added to the frame to lessen rotation to improve the LADCP measurements. The comparisons with the sample conductivities showed no significant time, pressure or temperature dependence of the CTD conductivities which were recalibrated using constant offsets.

2 LADCP

David Berry and Sheldon Bacon

2.1 Introduction

Cruise JR81 was the fourth cruise to use a RDI Workhorse WH300 ADCP (WH) unit and a description of the set-up and operation can be found in cruise report JR67 (Bacon, 2002). During Cruise JR81 only one WH unit was deployed (S/N 1881) in a downward facing position on the CTD frame and a total of 33 CTD casts were made over 32 stations. Details of the stations and the operation of the CTD can be found in Section 1.

The procedures for the set-up and operation of the WH units listed in Bacon (2002) were followed on JR81 with only a few minor changes and the exception that no slave WH unit was deployed and any references to a slave WH unit were ignored. In this section we therefore only describe the changes to the set-up and operation of the WH unit. We also describe the initial processing of the data using software that originated from Eric Firing's group at the University of Hawaii.

2.2 JR81 LADCP Set-up

2.2.1 *Position of WH unit and battery pack*

Figure 1.1 shows the positioning of the WH unit and battery pack on the 12 bottle CTD frame. The WH unit has been fitted to its mounting bracket and set-up in a downward facing position on the outside of the CTD frame. It should be noted that the WH unit needs to be fitted to its mounting bracket before the bracket can be attached to the CTD frame. The battery pack has been mounted in a vertical position with one bracket attached to an inner support of the CTD frame and the other bracket attached to an outer support of the CTD frame.

2.2.2 *Cabling*

Since Cruise JR67 a new star cable that does not include diodes has been purchased. This allowed the battery pack to be connected to a Wynall intelligent charger through the star cable without the need for any additional cables as found on JR67. The new star cable initially produced some confusion as the old cable was also included in the equipment as a spare cable but was used in the initial set-up by mistake. This resulted in no voltage being seen from the battery pack when the battery pack, WH unit and charger were connected and the battery voltage tested. Only after some deliberation was it realised that the wrong cable was being used and the diodes were preventing a voltage being seen. After the star cable was changed the set-up was found to work correctly, with the battery pack able to be charged and the data from the WH unit could be transferred to the controlling PC without any problems.

2.2.3 WH configuration file

As described in Bacon (2002), the workhorse unit needs to be configured with the correct parameter settings. During cruise JR81 the parameter settings were the same as those used on JR67 for the master WH unit. The parameter settings used were;

Control System Commands

PS0
CR1 *Resets parameter set to factory defaults*
CF111101 *Sets various workhorse data flow control parameters*

Environmental Commands

EA00000 *Corrects for any misalignment between Beam 3 and heading reference*
EB00000 *Corrects for electric / magnetic bias between the ADCP heading value and the heading reference*
ED00000 *Sets the depth of the ADCP transducer*
ES35 *Sets a water salinity value for use in speed of sound calculations*
EX11111 *Sets the coordinate transformation processing flags*
EZ0111111 *Selects the source of environmental sensor data*

Timing Commands

TE00:00:01.00 *Sets a minimum interval of 1 second between data ensembles*
TP00:01.00 *Sets a minimum time of 1 second between pings*

Lowered ADCP Commands

LD1111100000 *Selects the data types collected by the ADCP:*
LF0500 *Moves the location of first depth cell away from the transducer head by 500cm to allow the transmit circuits time to recover before the receive cycle begins, thus blanking bad data close to the transducer head.*
LN016 *Sets 16 depth cells*
LP00001 *Sets the number of pings to average per ensemble. 1 ping per ensemble*
LS1000 *Sets the volume of water in each depth cell – 1000cm*
LV250 *Sets the radial ambiguity velocity to 250cm/s.*
LJ1 *Use normal receiver gain*
LW1 *Set narrow bandwidth for increased profiling range*
LZ30, 220 *Amplitude, correlation threshold*

Ping Synchronization Commands

SM1 *Sets the RDS3 master mode, enabling SA and SW commands*
SA001 *Sets the rough timing of the synchronization pulse. Send (wait for) pulse before a water ping.*
SW05000 *Sets the amount of time to wait after sending the pulse. 5000 x 0.1ms*

Control System Commands

CK *Stores present parameters to non-volatile memory.*
CS *Starts the data collection cycle.*

2.3 LADCP Deployment and recovery

The procedures for the deployment and operation listed in Cruise report JR67 (Bacon, 2002) were followed without any difficulties. Again, in following the instructions for the deployment and recovery of the WH unit the references to the slave unit were ignored. The software used to control the WH unit and to transfer data from the workhorse to the PC can all be found on the desktop of the controlling PC.

On the initial deployment of the CTD at the test station, station 001, it was found that the distribution of weight on the CTD frame caused the whole CTD package to spin. This spin can be seen in the initial plots of the processed data from the WH unit. Figure 2.1 shows the tilt and heading information from the WH unit for station 001. From the plot of the heading information, Figure 2.1.a, the spin can clearly be seen with a cyclical change in the heading of the WH unit from 0 degrees to 360 degrees about every 50m on the downcast. At station 002 a number of additional weights were added to the CTD frame but this failed to solve the problem of the spinning and a vane was added to the frame from station 003 onwards, solving the problem.

2.4 Initial data processing

Data must be processed as soon as possible after a CTD cast to check the instruments have worked correctly and that the data has been downloaded from the WH unit onto the controlling PC and UNIX system without any problems. The identification of the CTD frame spinning highlights the importance of processing the data as soon as possible.

2.4.1 Set-up

Before any data could be processed the software needed to be installed onto the Unix system. This was done using an installation CD provided by Brian King from SOC containing a copy of a working set-up. The steps in setting up the software were;

- 1 Copy the University of Hawaii source code from the CD to a suitable directory on the Unix system. The source code is found under the '/uh_src_y2k' directory on the CD and was copied to 'data/uh.src.y2k'.
- 2 Copy the archived working directory structure from the CD to the Unix system. The archived working directory structure can be found under '/LAD.SAMPLE/CLEAN.LAD.tar' on the CD. This was copied to 'data/CLEAN.LAD.tar'.
- 3 Unpack the directory structure using the command 'tar -xvf CLEAN.LAD.tar'
- 4 Rename the unpacked directory from 'CLEAN.LAD' to 'ladcp'
- 5 Set-up the environment variables for the LADCP processing. This was done by editing the set-up script 'LADall' found in the 'data/ladcp/' directory and setting the following environment variables

```

'setenv LADCP_PROCHOME users/mlsd/pstar/data/ladcp'
'setenv LADCP_PROGHOME users/mlsd/pstar/data/uh.src.y2k'
'setenv LADCP_CRUISEID jr0212'
'setenv LADCP_YEARBASE 2002'

```

- 6 Rename the cruise directories in 'data/ladcp/raw/' and 'data/ladcp/pro/' to an appropriate name for the cruise (generally the cruise id variable 'LADCP_CRUISEID'). The directories were renamed 'jr0212' for JR81.
- 7 Source the script containing the set-up commands. This was done by changing directory to 'data/ladcp/' and running the command 'source LADall'.
- 8 Create the symbolic links needed by the processing software. This was done by running the command 'source makelinks' in the 'data/ladcp/pro/jr0212/ladcp/proc' directory.
- 9 Ensure the version of 'data/uh.src.y2k/programs/ladcp/bin/sol/mergeb' is the correct one for the instrument being used. On JR81 this was set to the 30 degree version by creating a symbolic link with the command 'ln -s mergeb_30d mergeb'.

2.4.2 First – look processing

The initial steps of data processing on JR81 were as follows;

- 1 Transfer the data files J81MNNN.000 into data/ladcp/raw/jr0212/ladcp/ directory on the Unix file system and rename them to the form jNNN_CC.000 where NNN is the station number and CC is the cast number.
- 2 In the 'data/ladcp/pro/jr0212/ladcp/proc' directory run the script scan.prl with the command 'perl -S scan.prl NNN_CC' and check the start and end times for the downcast and upcast. The duration of the downcast and upcast should be similar. The minimum and maximum depths should also be checked.
- 3 Prepare the magnetic compass correction. This is done in two steps which are;
 - 3.1 Run the command 'putpos NNN CC latdeg latmin londeg lonmin' where latdeg and latmin are the Latitude of the station in degrees and minutes North respectively. Londeg and lonmin are the longitude of the station in degrees and minutes East.
 - 3.2 Start matlab and type the command 'magvarsm(NNN_CC)'.
- 4 Load the data into the CODAS database (data format / database used by the UH software). This is done with the command 'perl -S load.prl NNN_CC'.
- 5 Merge the ping files to create a shear profile. This is done with the command 'perl -S domerge.prl -c0 NNN_CC'.
- 6 Plot and check the data in matlab with the following commands

- 6.1 `plist = NNN.CC` *set the station and cast number to process*
- 6.2 `do_abs` *run the matlab processing script 'do_abs.m'*

Following these steps should generate five plots showing the various velocity components and information about the sensor such as its heading, tilt and angle. However when these steps were followed no plots were seen due to a feature of matlab. When the script 'do_abs' was run five postscript files containing the plots were generated and it was found that the generation of these files prevented the figures being displayed on the screen. Putting a pause command in the matlab scripts before the command to save the plots solved this problem.

2.5 Secondary processing (absolute velocities)

Before the LADCP data can be processed any further the navigation and CTD data for the cast need to be copied to the appropriate directories and converted to ascii format. The navigation data should be copied to 'data/ladcp/raw/jr0212/gps' and the CTD data to 'data/ladcp/raw/jr0212/ctd'. The navigation data also needs to be averaged onto 30 second time steps before it is converted to ascii format. This is done using the pstar program pavrge. Both the 30 second navigation and CTD files can then be converted to ascii format using the pstar command 'mlist'. Help with the pstar commands 'mlist' and 'pavrge' can be found by typing the command name then '-help' at the command line, i.e. 'pavrge -help'. Once the files have been converted to ascii format the absolute velocities can be calculated with the following steps.

- 1 Change to the raw navigation data directory ('data/ladcp/raw/jr0212/gps') and update the 'sm.mat' files using matlab with the following commands
 - 1.1 `sm = load('gps.asc')` *load in the ascii navigation data file*
 - 1.2 `save sm.mat` *save the navigation data in 'sm.mat'*
- 2 Change directory to the processed CTD data directory ('data/ladcp/pro/jr0212/ladcp/proc/Pctd') and add the CTD data to the profile in matlab using the following command
 - 2.1 `ctd_in(NNN,CC)`
- 3 Change directory to 'data/ladcp/pro/jr0212/ladcp/proc/Fitd' and fit the LADCP vertical velocity profile to the CTD vertical velocity profile using the following commands in matlab
 - 3.1 `plist = NNN.CC` *set the station and cast number to process*
 - 3.2 `fd` *run the matlab processing script 'fd.m'*
- 4 Add the CTD data to the CODAS database and merge the ping files in the database to create a shear profile
 - 4.1 Change directory to 'data/ladcp/pro/jr0212/ladcp/proc'
 - 4.2 `perl -S add_ctd.prl NNN_CC` *add the CTD data to the CODAS database*
 - 4.3 `perl -S domerge.prl -c1 NNN_CC` *merge the ping profiles using the CTD data (-c1)*

5 Plot and check the data in matlab with the following commands

5.1 `plist = NNN.CC` *set the station and cast number to process*

5.2 `do_abs` *run the matlab processing script 'do_abs.m'*

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

3 NAVIGATION

David Webb

The navigation systems used during JR81 were the same as those used during JR67. As a result the methods used to process the navigation data was essentially the same as that described by Elizabeth Hawker, Brian King and Mike Meredith in section 3 of the JR67 Cruise Report (Bacon, 2002).

The primary sources of information on the ships position, its pitch and roll and its heading were obtained from the Trimble 4000 GPS receiver; the Ashtech ADU-2 GPS receiver, and the Sperry Mk 37 Model D Gyrocompass. Data was also logged from the Ashtech GG24 GLONASS/GPS receiver and from the SEATEX SEAPATH 200 unit, which provides the heading data used by the EM120 Swath Bathymetry System. A Racal Satcom received GPS SV range correction data via the INMARSAT B satellite from a fixed antenna located in the Falkland Islands. This data was piped to all of the GPS receivers to allow them to operate in differential mode (DGPS). Support for this hardware was provided by Jim Fox from BAS.

Data from the each of the instruments was collected by the ship's SCS data acquisition system and transferred to the RVS level C data storage system. It was then processed further on the ship's Unix system by the science team using Pstar software, based on that described in the JCR67 Cruise Report (Bacon, 2002). Support for the Unix system, a set of PC workstations and the ship's TCP/IP network was provided by Johnnie Edmondston from BAS.

The Unix processing was carried out using a series of c-shell scripts. These in turn called the series of Pstar programmes that carried out the main data processing. Processing was carried out in 12-hour chunks, from 0000 to 1159 GMT (*am*) and from 1200 to 2359 GMT (*pm*). In their original form the scripts needed typed input of the Julian day number for the year and a flag to indicate whether *am* or *pm* data is to be processed.

3.1 Changes to the scripts

The JR81 cruise started in December 2002 and finished in January 2003. Previously the year number had been hardwired into the Unix scripts, but this time we decided to make the year number one of the input parameters. This simplified both the processing of the data near the year-end and reprocessing of the data at a later time.

For efficiency, the scripts were also modified so that all parameters could be entered on the command line. A command of the form "scriptname -h" will list the parameters needed by each script.

3.2 Trimble 4000

The primary source of positional information on JR81 was the Trimble 4000 receiver working in differential mode. The UNIX script *gpsexec0*, stored in the Pstar exec directory, processed the data.

The script first created a raw data file by calling the Pstar programmes *datapup*, to transfer the data from the RVS database to a Pstar binary file; *pcopya*, to reset the raw data flag on the binary file, and *pheadr*, to set up the Pstar dataname and the rest of the header parameters. The script then called the programme *datpik*, to remove data with a dilution of precision (hdop) greater than five. The script created two new output files for each 12 hour period, 81gps[jday][a/p].raw before the *datpik* stage and 81gps[jday][a/p] and afterwards. The script also appends the processed data to the master file 81gps01.

Here and elsewhere [jday] represents the three digit Julian day for the year, (such that January 1st of each year has a jday value of 001), and [a/p] has the value "a" for the am data and "p" for the pm data. The number "81", also used in the filenames, is the cruise number. It is obtained by the scripts from the Unix environment variable CRUISE. This variable is defined in the '.cshrc' script found in the Pstar home directory and needs to be changed at the start of each cruise.

3.3 Ashtech GLONASS (GG24)

The Ashtech GG24 records data from both the American GPS and the Russian GLONASS satellite clusters (extending the constellation of available satellites to 48). Data was processed using the UNIX script *ggexec0* creating, as with *gpsexec0*, an output file of the form 81glo[jday][a/p].raw. It also carries out some basic quality control and stores the good data in the file 81glo[jday][a/p].

3.4 Ashtech ADU-2

The Ashtech ADU-2 GPS is used to correct errors in the heading of the ship's gyrocompass before using the gyro information to process ADCP data. This is necessary as the gyrocompass can oscillate for several minutes after any ship manoeuvre due to an inherent error. Four UNIX scripts were used to process the Ashtech data.

ashexec0 This exec used the Pstar programme *datapup* to read in data from the RVS data stream into a Pstar file; *pcopya* to set the raw data flag and *pheadr* to set the other header information. The output file created was 81ash[jday][a/p].raw.

ashexec1 This exec combined the data from the Ashtech and gyro files into a new file. It used the Pstar programme *pmerge* to merge in data from the master gyro file and *parith* and *prange* to calculate the difference between the gyro and Ashtech headings, forcing the result to lie within the range of -180 to +180 degrees. A time shift of -0.9s was applied to the Ashtech data in order to obtain the best agreement with the gyro data (see section on Navigation Timebases). The output file created was 81ash[jday][a/p].mrg.

ashexec2 This exec carried out quality control functions. First it called the Pstar programme *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°;

It then called:

pmdian to remove outliers in an “a-ghdg” of greater than 1° from a 5 point mean;
pavrge to set the data file to a 2-minute time base;
phisto to calculate the pitch limits;
datpik to reject further bad data:
pitch outside the limits calculated by phisto;
mrms outside the range 0 to 0.004;
pavrge to reset the data file to a 2-minute time base;
pmerge to remerge in the heading data from the master gyro file;
pcopya to change the order of the variables.

The output files were 81ash[jday][a/p].edit and 81ash[jday][a/p].ave.

ashedit.exec This exec was used to manually remove obvious outliers from “a-ghdg” and to interpolate gaps in the data. The output file created was 81ash[jday][a/p].ave.dspk.

ashtec_67plot was then used to plot out the final interpolated “a-ghdg” with the original and gyro data.

3.5 Ashtech ADU2 parameter settings.

The Ashtech ADU2 parameter settings, which include a specification of the antenna geometry, were investigated by J Robst and Brian King during cruise JR67 (Bacon, 2002). A number of sets of parameters were available but when they started it was not clear which was the final definitive set.

They finally decided on a set of parameters prepared by Richard Bridgeman. In the form of the output from the Ashtech \$PASHQ command these are:

```
$PASHQ, PAR

POS:0 FIX:0 UNH:0 PDP:40 HDP:04 VDP:04
ELM:10 RCI:000 MSV:4 SIT:??? SAV:Y PDS:ON
ONE SECOND UPDATE: Y ALT:+00.00
OUT MBN PBN AT2 SNV PSA DSO BIN RTCM
PRT A:
PRT B:
NMEA: GL... HDT
PRT A:
```

```

PRT B:
NMEA: GSA...SA4
PRT A:
PRT B:
PER:000

```

Antenna definition

```

1 Port Aft
2 Port Fwd
3 Starboard Fwd
4 Starboard Aft

```

```
$PASHQ,3DF
```

```

V12: +002.955 +004.751 +000.000
V13: +011.499 +004.754 +000.000
V14: +013.227 +000.000 +000.000
OFFSET ANGLE: +000.00 +00.00 +000.000
MAX CYC: 0.200 SMOOTHING; N
MAX BRMS: 0.035 MAX ANGLE: 10
MAX MRMS: 0.005 SRCHRAT: 0.5
HKF: 999 000 1.0E-2 1.0E+0
PKF: 020 000 4.0E-2 1.0E+0
RKF: 020 000 4.0E-2 1.0E+0
STATIC: N

```

3.6 SeaTex

The SeaTex system was not used during JR81.

3.7 Gyrocompass

The gyrocompass provides the most continuous stream of data on the ship's heading. It was used in the processing of data from the meteorological instrumentation, to give the true wind velocity vector, and for processing the Acoustic Doppler Current Profiler (ADCP) data. It was also used when generating the bestnav data stream to derive positional information by dead reckoning in the absence of GPS data coverage.

In the Unix system, a Pstar version of the gyrocompass data was produced using the script *gyroexec0*. This calls the Pstar programmes *datapup* to transfer data from the RVS to Pstar binary files; *pcopya* to set the raw data flag; *pheadr* to specify the remaining header data; and *datpik* to force all heading data to lie between 0 and 360 degrees. The RVS SCS system can provide duplicate time stamps in the gyro data hence *gyroexec0* also calls a Pstar program *pcopym* to exclude this data from the processed data stream.

The script produces one new output file 81gyr[jday][a/p].raw. It also appends the data to a master gyro file 81gyr01.

3.8 Bestnav

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

In the Unix system, the script *navexec0* was used to convert the data to Pstar format working in 12-hour chunks, appending the new data to a master file *abnv811*. The script calls the Pstar programmes *datapup*, to input the RVS data and form a Pstar binary file; *pcopya* and *pheadr* to set the header information; *posspd* to calculate east and north velocities; *pdist* to calculate distance run; *pcopya* to remove the RVS distance variable; and *papend* to append the data to the master file.

A second script *navexec1* averages and filters the navigation data. This takes as input the data in the master navigation file *abnv811* and smoothes and despikes it, putting the resulting data in *abnv811.av*.

3.9 Navigation (heading) timebases

During the JR67 cruise, Elizabeth Hawker, Brian King and Mike Meredith report finding a small but puzzling difference between the time stamps used by the Ship's gyro (GYR), the Ashtech ADU2 (ASH) and the Seatex (STX) data streams (Bacon, 2002). The offsets are less than a second and so may be a result of the averaging or processing occurring within the individual instruments and their associated electronics.

On JR81, the Seatex data was not used. When the raw Ashtech and gyro data were plotted on similar scales, the Ashtech signal was seen to be delayed by about a second. On the basis of the more accurate earlier study by Hawker et al., the lag was taken to be 0.7 seconds. Thus during the processing of the Ashtech data, the Ashtech time stamp was *advanced* by 0.7 s.

4 VM-ADCP

Mike Meredith

4.1 Configuration

RRS *James Clark Ross* has an RD Instruments 153.6 kHz Acoustic Doppler Current Profiler (ADCP) unit sited in a sea chest that is recessed within the hull to afford protection from sea ice. Since summer 2000, the fluid in the sea chest has been a mixture of 90% deionised water and 10% ethylene glycol. The underside of the seachest is closed by a 33 mm thick window of Low Density PolyEthylene (LDPE). The orientation of the transducer head is offset by approximately 45° to the fore-aft direction.

For cruise JR81, the VMADCP was configured in a similar manner to previous SR1b transects. Data were recorded in 64 x 8 m bins, and in ensembles of 2 minute duration. The 'blank beyond transmit' was set to 4 m such that the centre depth of the first bin was 14 m, given the approximate transducer depth of 6 m. The system uses 17.07 firmware and version 2.48 of RDI Data Acquisition Software (DAS) run on an IBM-type PC. The two minute ensembles of data are passed directly to the Level C. Data are available in the PC PINGDATA files in the instance of any problems with the ship's Level C system.

A difference from previous cruises is that the logging PC had been recently upgraded (by Jim Fox, BAS ETS) from a very old Viglen 286 machine, to a Pentium. This upgrade is very welcome, since it was only a matter of time before the 286 became unserviceable. During JR81, data were logged to the new machine on the D: drive (local) and the G: drive (networked). These were partitioned to be sufficiently small to enable correct operation of the logging software. Although somewhat archaic, the DAS software is preferred to the more recent Transect. Connection between the ADCP unit and logging PC was made via the computer's serial port.

The VMADCP was operated in two modes during JR81. Data in bottom tracking mode were collected in shallow waters (shallower than approximately 500m), generally over Burdwood Bank and the Antarctic Peninsula shelf. Data in water track mode were collected where water depth was sufficient to preclude useful bottom tracking, typically in depths greater than 500m. Two ADCP PC configuration files were created to enable toggling between the two modes (JR81WAT.CNF and JR81BOT.CNF). Because of the change in logging PC, changes to the configuration files were needed compared with previous cruises; the corresponding earlier configuration files no longer work.

Changes to the configuration files (compared with JR70, the last time the ADCP was used extensively and data rigorously processed) were:

- 1 DR, SD, WHOLE 7 (change secondary drive to G:)
- 2 DR, PD, WHOLE 4 (change primary drive to D:)

- 3 AD, PS, BOOLE YES (change Parallel/Serial Profiler Link to Serial)
- 4 The options under Serial Device Menu were altered to be as follows:

	Port	Stop Bits	Length	Parity	Baud Rate
Profiler	1	1	8	Odd	9600
Loran Receiver	0	1	8	None	1200
Remote Display	0	2	8	None	9600
Ensemble Output	2	1	8	None	9600
Aux 1	0	1	8	None	1200
Aux 2	0	1	8	None	1200

4.2 Routine Data Processing

The JR81 VMADCP data were processed in 12 hour sections, specifically 0000 to 1159 hrs and 1200 to 2359 hrs of each day. A sequence of unix scripts calling Pstar routines were used for the data processing:

4.2.1 Read data into PSTAR (81adpexec0)

Data were read from the RVS Level C system into Pstar creating two output files 81adp[jday][a/p] and 81bot[jday][a/p], containing water track and bottom track data respectively.

4.2.2 Temperature correction (81adpexec0.1)

The VMADCP DAS software assumes that the fluid surrounding the transducers is ambient seawater. A speed of sound is derived using the temperature measured at the transducer head and an assumed salinity of 35. A correction must be made to this to take into consideration the difference between the speed of sound in seawater and the mixture of 90% deionised water and 10% ethylene glycol.

The required modification was derived on JR55 by Meredith and King, and has been employed on subsequent cruises. Measurements of the variation in sound speed versus temperature were obtained from RDI and used to derive an equation for the speed of sound through the mixture as a function of temperature,

$$c = 1484 + 3.6095 \times T - 0.0352 \times T^2, \quad (1)$$

where the individual velocity measurements were given to an accuracy of 0.01%, and the environmental conditions were known to within ± 35 kPa pressure and $\pm 0.5^\circ\text{C}$ temperature.

This equation was used to derive a correction term to adjust the assumed speed of sound such that it was appropriate for the fluid mixture within the sea chest,

$$(1484 + 3.6095 T - 0.0352 T^2) / (1449.2 + 4.6 T - 0.055 T^2 + 0.00029 T^3) . \quad (2)$$

This correction term was applied to both the raw water and bottom tracked velocities measured on JR81.

On JR55, a residual dependence of A on temperature was also found, due probably to the speed of sound in the fluid in the sea chest being imperfectly known. No significant difference in this temperature dependence was found on JR81, thus a residual correction of

$$1 - 0.00152 T \quad (3)$$

was applied.

The output files created were 81adp[jday][a/p].t and 81bot[jday][a/p].t.

4.2.3 Clock Correction (81adpexec1)

The VMADCP data stream was time stamped by the Pentium PC clock running the DAS software. Although the PC clock is GPS-synchronized over the network at the time of login, there was a surprisingly large subsequent drift during the duration of the cruise. This results in there being a timing error associated with the raw data. The drift observed was comparable to that found during previous cruises, when the 286 PC was in operation. This suggests that the clock drift may derive from software problems rather than hardware problems. Jim Fox (BAS ETS) has been made aware of the problem, and is going to investigate methods of routinely synchronizing the PC clock whilst running the DAS software.

During JR81, the time difference was measured at approximately 4 hour intervals, and a correction applied to the data. This created the files 81adp[jday][a/p].corr, 81bot[jday][a/p].corr and clock[jday][a/p].

4.2.4 Gyrocompass error correction (81adpexec2)

The VMADCP measures the water velocity relative to the ship. To calculate true east and north water velocities over ground, we need to include information on the ship's heading and speed. The ship's gyrocompass provides near-continuous measurements of heading, however it can oscillate for several minutes after a manoeuvre. The gyro heading can be corrected using data from the Ashtech ADU-2. However, the Ashtech system does not provide continuous data, and hence a correction can only be applied on an ensemble by ensemble basis. The two-minute averaged Ashtech-minus-gyro heading correction ("a-ghdg") was manually despiked and interpolated (see section on navigation). The required correction was then applied to the data creating the output files 81adp[jday][a/p].true and 81bot[jday][a/p].true.

4.2.5 Calibration (81adpexec3)

Two further corrections are applied to the VMADCP data:

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

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

A and ϕ were calculated using

$$A = U_{\text{gps}} / U_{\text{VMADCP}} \quad (4)$$

$$\phi = \phi_{\text{gps}} - \phi_{\text{VMADCP}} \quad (5)$$

where U_{gps} and U_{VMADCP} , and ϕ_{gps} and ϕ_{VMADCP} are the 20 minute averaged speeds and headings, derived from the GPS and bottom track VMADCP data respectively.

The direction of ϕ was reversed to put it in the correct orientation and it was put in the range $-180^\circ < \phi < 180^\circ$. Outliers were excluded, and values of A and ϕ derived:-

$$A = 1.0285 \text{ and } \phi = -1.275 \text{ .}$$

These values compare to:

$$A = 1.0269 \text{ and } \phi = -1.55 \text{ (Meredith and King, JR55)}$$

$$A = 1.0253 \text{ and } \phi = -1.48 \text{ (Meredith, JR57)}$$

$$A = 1.0314 \text{ and } \phi = -1.81 \text{ (Hawker, King and Meredith, JR67)}$$

$$A = 1.0290 \text{ and } \phi = -1.55 \text{ (Meredith, JR70)}$$

The data were reprocessed using the new values for A and ϕ to produce calibrated water velocities relative to the ship, creating the output files 81adp[jday][a/p].cal and 81 bot[jday][a/p].cal.

4.2.6 Derivation of absolute velocities (81adpexec4)

Ship's velocities between ensembles were derived by merging in position information from the RVS navigation data. The absolute water velocities were then derived by removing the ship's velocities from the VMADCP data. These final velocities were output to the files 81adp[jday][a/p].abs and 81bot[jday][a/p].abs.

4.3 Offline Data Processing

Once final absolute velocity files had been obtained, they were appended into single files (81adp_abs.all for water-tracked data and 81bot_abs.all for bottom-tracked data). These files were merged, so that the heading variable in the bottom-tracked file was available alongside the water-tracked velocity data. This resulting file was then manually scanned for good data, i.e. a record was made of good data cycles. Obviously bad data was generally obtained during periods when the ship was maneuvering; periods on-station or steaming with constant heading showed much higher data quality. The good data cycles were extracted into file 81adp_abs.all.good. These data are plotted in Figure 4.1.

4.4 Summary

The VMADCP again performed well, and routinely obtained bottom track data from depths in excess of 500m. Water-tracked data were obtained down to approximately 400m maximum. Data quality was undoubtedly helped by the generally favourable weather conditions. The installation of new ADCP logging PC is a very welcome development, and should lessen the chances of data loss for future cruises. There still appears to be a significant drift between the PC clock (when running the RDI DAS software) and the ship's master clock. Although this is removed in post-processing, it would clearly be preferable to have this problem removed at source.

5 WATER SAMPLES

Sheldon Bacon

5.1 Sample salinity

BAS Guildline Autosol 8400B salinometer s/n 65763 was employed during the cruise for measurement of sample salinity. The salinometer was set up as previously in the Bio Lab on the Upper Deck, with salinometer bath temperature set to 24°C, and the ship's air conditioning used to maintain the laboratory at an ambient temperature of 21-22°C, from which there were no significant deviations. An SOC-supplied peristaltic sample intake pump was used because, as noted in section 9 below, the BAS one was in bad repair.

The Autosol was standardised using batch P140 IAPSO Standard Seawater supplied by Ocean Scientific International Ltd. of Petersfield, Hampshire, UK. A total of 18 bottles of P140 were consumed during the cruise.

Water samples for analysis of salinity were drawn from each Niskin into 200 ml glass sample bottles which were then sealed with clean, dry, disposable plastic stoppers and screw-on caps. The neck of the sample bottle is dried before insertion of the cap. A replicate sample was drawn on most stations from the deepest bottle. Full crates of sample bottles were taken to the Bio Lab to equilibrate. Most of the analysis was performed by EM, DJW and DB, with some samples analysed by ECK and SB.

For the 31 replicate sample pairs, two were outliers; the mean difference between the remaining 29 pairs was 0.0001, the standard deviation of the difference about the mean was 0.0009.

The salinometer standardisation history is shown in figure 5.1, in which the first analysed bottle of P140 is used as a pseudo-standard to reference subsequent measurements of P140 salinity. Any apparent salinity drift is thus a measure of the stability of the salinometer. On this occasion the instrument was very stable, the drift being equivalent to ± 0.001 in salinity, which is actually manifested as a slight trend over the week during which the measurements were made. We are satisfied with the performance and quality of the salinometer's results.

5.2 Oxygen Isotope Samples

Samples were drawn for later analysis back at SOC for oxygen isotope anomaly $\delta^{18}\text{O}$. Sample bottles were provided by Prof. Eelco Rohling of the School of Ocean and Earth Sciences at SOC. All bottles were sampled on all stations, except for stations 26 and 30, where no samples were drawn. This is because we did not bring quite enough bottles for the whole section. However, these stations were in a region of steep topography and very close to the adjacent stations, and we believe that all water masses have been adequately sampled.

6. UNDERWAY

David Webb

The underway data comes 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. Other parameters sampled include the temperature of the conductivity sensor and the flow rate of the uncontaminated water supply.

Data from these sensors feeds into the ship's oceanlogger data system. From there it is transferred to the ship's SCS scientific data collection system and thus to the unix and PC computer network.

Underway data first became available on day 353 and was then collected continuously until the end of the cruise. However between 1319Z on day 356 and 1115Z on day 360, the uncontaminated water supply was switched off because of the presence of sea ice. The oceanographic measurements made during this period should be ignored.

Although data from the ship's anemometer takes a different route into the ship's SCS scientific data collection system it was processed together with the other meteorological data.

6.1 Data Capture and Processing

The data from the ocean logger and anemometer data streams was processed in 12-hour chunks, using scripts based on those used during JR67. The primary changes made were the same as those described in the navigation section and arose because JR81 ran over a year end. To make the process more efficient, the standard unix processing scripts, which call a series of pstar programmes, were also modified so that their parameters can be entered on the command line. The parameters involved, used to access the data and generate filenames, are the two digit year number, the three digit day number and whether the processing is for am or pm.

The unix execs used to process the underway data streams are:

- 8loclexec0*: Reads the ocean-logger and anemometer data streams and stores them into a single pstar type file.
- 8loclexec1*: Splits the data into separate ocean data and meteorological data files. It also de-spikes the conductivity data and calculates a raw salinity value.
- twvelexec*: Merges the met data file with gyrocompass and navigation data streams in order to calculate ship motion and true wind velocity.

6.2 Salinity

Sea surface salinity (SSS) is calculated from the ship's thermosalinograph measurements of conductivity (variable *cond*) and water temperature (variable *saltemp*). Calibration of SSS remains to be done.

6.3 Sea Surface Temperature

Sea surface temperature (SST) is measured at the hull intake sensor. Calibration / validation of SST remains to be done.

6.4 Air Pressure

We could find no significant systematic difference between the two air pressure measurements. Random differences had a r.m.s. value of less than 0.1 mb.

6.5 Humidity

During the cruise the humidity sensors both worked well and gave very similar results. Analysis of the differences between the two sensors showed that below 98% humidity sensor 2 reads on average 1% higher than sensor 1. The difference signal also showed additional random noise with an amplitude of order 1%. (See figure 6.1)

6.6 Air Temperature

There is a slight difference between the two air temperature measurements. The offset is about 0.25 deg C, with random noise of about 0.1 deg C. (See figure 6.2). Some of the reasons for the differences are discussed in the previous cruise report (Bacon 2002).

6.7 Total Incident Radiation (TIR)

There is a slight difference in the sensitivity of the two instruments measuring total incident radiation, the second giving a reading which is about 3% lower than the first. (See figure 6.3).

6.8 Photosynthetically Active Radiation (PAR)

There was no measurable systematic difference in the two measurements of photosynthetically active radiation. The random difference are generally less than 0.5% of the measured signal. (See figure 6.4)

6.9 Anemometer - winds

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

6.10 Flow meter

During the cruise, when the flow meter was switched on, it indicated flow rates between 0.6 and 0.8 l/min with an average near 0.7 l/min.

6.11 Data Processing

Daily plots of the main ocean logger data streams were produced with a new pstar script *pl_ocl*. This takes two inline parameters, the first being the number of the plot description file (in directory data/olog) and the second the Julian day to plot. The script can also be used to produce plots of the whole cruise dataset.

The five plot description files, *plot1.pdf* to *plot5.pdf*, produce standard daily plots of the main oceanographic variables, the main meteorological variables and comparison plots of the data streams where duplicate sensors are installed.

Three standard scripts, *pl_ocl1* to *pl_ocl3*, in directory *~pstar/exec*, were developed to further aid the analysis of duplicate data streams. These plot the difference in the data as a function of time, plot one of the variables against the other, and plot the difference against one of the variables.

Overall the data processing software was straightforward, if tedious, and appeared to be robust. The minor irritations were the lack of a fortran licence for the fortran compiler, a uniras licence for only one machine and, apparently, a one user only matlab licence. (In future this should not be allowed to happen - the SOC processing software depends too much on all three systems.) The main computer system failed badly at the beginning of the cruise and both Johnny Edmonston and Jim Fox are to be commended for their hard work in overcoming this and for their high level of computer support during the cruise.

6.12 Southern Ocean Fronts

There was little evidence for the classic series of Southern Ocean fronts in the underway data. During the main section, a strong Antarctic Convergence was observed near 55° 50' S, with temperatures and salinities around 3.4 °C and 34.0, in the region to the south of the front, and 6.8 °C and 33.7, in the region to the north (figures 6.5 and 6.6). Within each of these region, the temperature variations were generally less than 0.1 °C. Salinity variations were less than 0.05.

To the south of the main front, we observed what appears to be detached pool of the northern water. Within the pool, temperatures are near 6.8 °C and salinities near 34.0. At its northern edge the pool is separated from the 3.4 °C water by two strong fronts, within which there is a third, almost uniform, water type with temperatures near 5.7 °C and salinity near 33.9.

To the south of the pool, the temperatures again drop in two stages to a cold water mass, with temperatures near 3.2 °C and salinities near 33.73. This time the intermediate water is colder, has temperatures near 4.3 °C and is a lot less uniform.

The fluorometer data indicates increased productivity in an extensive region to the north of the main Antarctic Convergence and at the southern edge of the Burdwood Bank. It also shows similar increased productivity in the fronts immediately to the north and south of the warm pool region and in the northernmost intermediate water property region.

Although the changes in atmospheric properties were not so dramatic as those in the ocean, there was a significant increase in air temperature as the ship crossed the Antarctic Convergence. Temperatures increased from near 4.2 °C south of the front to 6.4 °C in the north. Further south air temperatures were fairly uniform near 6.1 °C over the 'pool' and then dropped to 0.5 °C and less further south. Many of these features were also seen in the southward passage leg (figures 6.7 and 6.8).

The larger scale meteorology has not been analysed with any expertise but during the period of the main section, local winds were generally light and the sea state light to moderate. This seems partly to have been a result of South America and the Antarctic Peninsula blocking the path of depressions. When strong pressure gradients and winds did occur they appeared to be concentrated further north, noticeably at the latitude of the Falklands.

6.13 ashedit.exec

The Ashtech heading information is used to correct the gyro log. The unix script 'ashedit.exec' allows us to remove outliers in the differences between the Ashtech and gyro data, where the Ashtech itself may be introducing errors. Here we describe the actions that need to be taken.

- 1 The script generates a uniras plot showing the ashtech and gyro data as red and white lines (ranges 0 to 360 degrees) and their difference shown as green crosses using an expanded scale (range -5 to +5). To the right of the plot are a series of action buttons. The aim is to use these buttons to edit out outliers in the difference data.
- 2 First choose the type of point to remove. This is done by clicking on the 'choose' button. New buttons are displayed. Click on 'Green' and then 'Done'.
- 3 This leaves the original plot. Choose one or more neighbouring outliers to remove. Clicking to the top left and bottom right of the outliers generates a white box enclosing them. All the green crosses within the box will be removed so make sure that there are no good data points within the box.
- 4 The initial set of buttons reappears. Click on 'without' and then 'edit'. This produces a new set of buttons. Click on 'a-ghdg' and then 'done'. The data is removed from the file and the original set of buttons is again displayed.
- 5 To remove more outliers, repeat the process from 2 above. Otherwise click on the 'quit' button and press 'return' on the keyboard (otherwise uniras hangs). The exec then plots out the new

data file. Click on the plot, to ensure that keyboard input is sent to uniras and press the 'return' key. The exec then writes out the new edited file and ends.

7 ECHO-SOUNDER

Sheldon Bacon

The RRS *James Clark Ross* is equipped with two echo sounders, the EA500 and the EM120. The latter is a swath bathymetry system. Proper synchronisation between the two has now been achieved so that they can be run simultaneously; see comments in section 9 below. Logging and processing are similar for both: raw data with assumed sound speeds of 1500 m/s are logged by the SCS onto the respective simulated level C streams, retrieved twice daily using pstar scripts, edited with a median filter and ‘zero stripper’, merged with navigation, and depth corrected with Carter’s Tables.

We compared the bathymetric depth derived from the EA500 with that calculated from the maximum depth of the CTD on each station (converting maximum pressure [dbar] to depth [m]) plus the minimum height off bottom measured by the altimeter (m); see table NN. While there is a lot of scatter, excluding differences of (EA500 minus station depth) of more than ± 20 m produces a mean difference of 5 m (sd 8 m). The EA500 depths do not include the depth below the ship’s waterline of the transducer head, which is approximately 5 m, so these measurements are fairly consistent. There is a mean difference between EA500 and EM120 bathymetry of between 5 m and 15 m. Now the distribution of the difference is heavily skewed such that $\text{depth (EM120)} > \text{depth (EA500)}$, so that the calculated mean difference is dependent on the window outwith which one elects to exclude data as bad. The modal difference is 5 m ($\text{EM120} > \text{EA500}$), which is what would be expected from the transducer depth being included in the EM120 processing and not in the EA500.

Figure 7.1 compares the bathymetry derived from the EA500 with that derived from the centre beam of the EM120. Since the swath system uses narrower beams than the EA500, a better record of true under-ship bathymetry seems to be obtained. The difference between the two becomes very noisy in the vicinity of rough or steep topography, which is in accord with our belief that the wider EA500 beam provides a depth record ‘contaminated’ by side echoes from adjacent topographic features. The centre-beam EM120 data stream thus appear to be better for routine recording of bathymetry, although one must bear in mind the swath bathymetry system’s greater sensitivity to rough weather.

8 COMPUTING

Johnnie Edmonston

8.1 Introduction

This report covers IT support work carried out on RRS James Clark Ross during the JR81/85 cruises between 18th December 2002 and 3rd January 2002.

8.2 Data Acquisition Systems.

8.2.1 SCS

Continuous data acquisition on the SCS was started at 13:14 GMT on December 20th (jday 353) and the system ran problem free for the rest of the cruise. The following instruments were logged:

Glonass

Ashtech-ADU2

Trimble

Anemometer

TSSHRP

Oceanlogger

Emlog

BASSTCM

Dopplerlog

Simrad-ea500

Simrad-em120

Winch

Data for the gyro and new_stcm was logged to the server via the Java applications “gyro” and “AtoSCS”.

Data acquisition was stopped at 20:00 GMT on 1st January 2003 (Jday 001).

8.2.1.1

The SCS real time plot doesn't work, on either the SCS machine in the computer office or the UIC.

When trying to execute any of the real time plots: the message:

Debug Assertion failed

program: x:\RTTimeSeries.exe

Line:43

Clicking on “Ignore” results in the message:

An unsupported operation was attempted

8.2.2 Level C

scs2levc was run on JRUF throughout the cruise to convert the SCS data to Level C format. This ran without problems. “bestnav”, “bestdrf” and “relmov” were run on JRUF to create their respective data streams and ran without problem throughout the cruise. The following streams were logging from the date (jday) and time shown:

Stream name	jday	time started
gps_nmea	353	1148
gps_as	353	1721
gps_glos	353	1148
gyro	353	1233
dop_log	353	1148
em_log	353	1148
sim500	353	2257
oceanlog	353	1148
stcm	353	1148
adcp	353	1423
winch	353	1605
anemom	353	1148
em120	353	2303
relmov	353	1233
bestdrf	353	1148
bestnav	353	1148

8.3 Unix

8.3.1 JRUF

Upon arrival to the ship at 0800L on 19th December jrui, and jruh were sitting part way through the boot process halting after the line:

starting rpc services: rpcbind keyserv done

JRUF was sitting part way through the boot process with an error message on screen regarding file system corruption of lun0.

fsck was run and a number of inconsistencies resolved.

JRUF would then boot part way, then would also halt after the line:

starting rpc services: rpcbind keyserv done

It was assumed that that main problem lay with JRUF, as JRUF is the DNS server and holds the NIS mappings for all other unix machines on the LAN.

JRUF would boot into single user mode:

```
stop a
boot -s
```

It transpired that the boot process was being interrupted by the failure of LDAP on JRUF. Volumes were not being mounted, and services thus not being run. i.e. LDAP and shared mountpoints.

The boot process would continue by commenting out the line:

```
/usr/sbin/ifconfig -aud4 netmask + broadcast +
```

from the script:

```
S72inetsvc in /etc/rc2.d,
```

although no network services were able to run.

The LDAP version was changed to the previous version by going to the full path of the LDAP installation:

```
/jra1000/lun0/packages/solaris/openldap
```

deleting the symbolic link current which pointed to version 2.1.5 and created a new one to point to 8.2.1.3

LDAP could then be started manually by running slapd from:

```
jra1000/lun0/packages/solaris/openldap/current/libexec
```

Once LDAP was running, DNS was run from: jra1000/lun0/packages/solaris/openldap using the “named” script. Once LDAP and DNS were running /usr/sbin/ifconfig -aud4 netmask + broadcast + could be run manually and all services appeared to be running correctly. JRUF rebooted successfully and all unix hosts connected. DNS ran correctly, verified by ping, tracert and ipconfig from windows machines.

8.3.1.1 Uniras licence manager

The uniras licence manager wasn't running, although the current version is 6.5, it transpired that running v7.0 licence manager served licences which ran on 6.5.

8.3.2 *Workshop licence manager*

The Sun workshop licence manager could not be started using a current licence. This became apparent when trying to compile Fortran code and an error message being returned saying the licence server isn't running.

The process I carried out was:

1. I de-tarred the licenses.tar file into /nerc/packages/workshop/licenses
2. edited the licenses_combined and
3. licenses_combined.DUP to reflect JRUF in the licence info
4. added the line licdir=/nerc/packages/workshop/licenses to the startup file S85lmgd
5. created a /etc/opt/licenses directory and copied suntechd (binary) into it

Note: the licenses_combined file referred to suntechd in the /etc/opt/licenses directory.

S85lmgd kicks off fine, says it is running and doesn't complain about the licence file.

It is when the suntechd is called into run that error is returned. The log file from /var/adm/SUN_Workshop_license.log says thus:

23:28:27 (lmgrd) FLEXlm (v4.1) started on JRUF (Sun) (12/29/102)

23:28:27 (lmgrd) FLEXlm Copyright 1988-1994, Globetrotter Software, Inc.

23:28:27 (lmgrd) License file: "/nerc/packages/workshop/licenses/licenses_combined"

23:28:27 (lmgrd) Starting vendor daemons ...

23:28:27 (lmgrd) Started suntechd

23:28:27 (suntechd) Wrong hostid, exiting (expected 723770da, got 80a1326c).

23:28:27 (lmgrd) Please correct problem and restart daemons

Unfortunately suntechd is a binary with no apparent readme's or document nearby..

8.3.3 *EM120*

The EM120 unix workstations was run both Southbound and Northbound and appeared to be functioning well. No calibration or sound velocity profiles were carried out, a fixed sound velocity of 1500m/s was used.

8.3.4 *JRLA*

The RO was unable to add users to the AMS during the period of disruption with JRUF. The IP address of JRLA was added to the hosts file of the RO's local machine until the issues with JRUF were resolved, allowing the addition of new arrivals for the Southbound Drakes Passage voyage. An upgrade to AMS interface to allow easier upload and download of data files was carried out.

8.4 **Netware Systems**

8.4.1 *Compaq console*

The new Compaq console on JRNA is non-functional, this is believed to be a physical fault within the screen of the unit itself. There is a small melted patch on the lid, roughly central, one inch from the furthest edge. The keyboard and mouse from the admin machine adjacent to JRNA are currently connected to JRNA until a replacement can be fitted.

8.4.2 *JRNA*

JRNA had its disks moved over to the spare server by the RO onboard who had believed the DNS problems were due to a physical fault within JRNA. The disks were placed back in the original JRNA and the server restarted. JRNA ran on synthetic time until a DSREPAIR was run. No Netware problems were observed during the period when JRUF was out of action. Although users were unable to access the intranet this was due to there being no DNS resolution. All file and print services, drive mappings and GroupWise ran problem-free throughout the cruise.

8.4.3 Print Server

A new jet-direct print server was installed in the engine control room to allow users to access the HP1200 installed there. previously that printer was shared through win2000 printer share, but that was proving problematic for the crew.

8.5 PC's

All PC's onboard the ship functioned with no major problems.

An outbreak of the W32/Bugbear virus is currently being dealt with. A batch file which executes a removal tool has been placed in the login script of all users, which will remove all locally occurring incidences of the virus. Sweep on JRNA has been detecting the virus, and all occurrence of bugbear on the NetWare network have been eliminated.

All PC users were asked to log out of the network whilst sweep deleted the virus. All users still have the batch file in their login. The batch file closes itself down when its finished.

The network is now completely clear of Bugbear. The bugbear removal tool will remained in operation until 2nd January 2003.

8.6 Additional notes and recommendations

8.6.1 Apple laptops

3 Apple laptops in the possession of SOC scientists were connected to the JCR network.

2 required fixed IP addresses, the other acquired one automatically from the DHCP server.

All Apple laptops were able to telnet into JRUF as pstar after being added to /etc/allowed

8.6.2 UPS

The problems at the beginning of the cruise could have been avoided if the servers in question hadn't experienced an unexpected and lengthy power outage. There were apparently two power outages. The first was totally unexpected, the second apparently was not, although the RO was under the impression it was only going to be for 10 minutes, it turned out to be 2 hours. By which time the UPS on JRUF had run out of power and the server dropped. The UPS timeouts were: JRNA: 10mins; JRUF: 15mins; LAN: 19mins. It may be prudent in future to have both intelligent UPS's on board that all servers may be brought down safely.

8.6.3 Matlab

A second Matlab licence would have been useful for this cruise, the science compliment on board made considerable use of Matlab and a second licence would have been welcomed.

8.6.4 Samba

A samba drive mapping was made on the ctd machine to the pstar home directory.

9 TECHNICAL SUPPORT

Jim Fox

The table below summarises instruments and equipment utilised by JR81, with serial numbers and, where appropriate, comments on performance.

INSTRUMENT	COMMENTS
Salinometer	
AutoSal (labs on upper deck) S/N 65763	Installed at start of cruise (from service) – no problems. Peristaltic pump speed switch needs fixing – only one speed selectable (just).
GPS	
DGPS Trimble 4000 DS (bridge – port side)	No problems
DGPS Ashtech ADU2 (bridge – port side)	No problems
DGPS Ashtech Glonass GG24 (bridge – starboard side)	No problems
Acoustic	
ADCP (aft UIC)	No problems other than occasional comms ack error between PC and hardware – happens very infrequently and no easy solution. Clock still drifts slowly – needs DOS time synching.
EM120 (for'd UIC)	No problems – recently new software seems to work ok – auto line incrementing has been improved – didn't try with SVP, but is supposed to handle more than 1000 points now
SSU (for'd UIC)	EA500 had lost / reset many of its settings including comms with SSU – eventually sorted so EA and EM were synched properly on 27/12/02. Recently new software seems to work ok.
Oceanlogger	
Main logging system	No problems
Barometer (logger rack) #V145002	No problems
Barometer (logger rack) #V145003	No problems
Air humidity & temp (for'd	In need of calibration; two temp sensors have about 0.2°C offset

mast) #15619015	most of the time
Air humidity & temp 2 (for'd mast) #15619025	See above
Thermosalinograph SBE45 (prep lab) #4524698-0016	No problems
Fluorometer (prep lab)	No problems
TIR sensor (pyranom) (for'd mast) #990684	No problems
TIR sensor (pyranom) (for'd mast) #990685	No problems
PAR sensor (for'd mast) #990069	No problems
PAR sensor 2 (for'd mast) #990070	No problems
Flow meter (prep room) #45/59462	No problems
Uncontaminated seawater temp (transducer space)	No problems
CTD (all kept in cage / sci hold when not in use)	
Deck unit 1 SBE11plus S/N 11P15759-0458	No problems
Underwater unit SBE9plus #09P15759-0480 Press #67241	Swapped for 541 on 31/12/02 – working fine (termination redone at same time).
Underwater unit SBE9plus #09P20391-0541 Press #75429	Failed on 31/12/02. Looks like it was 2-pin (power & comms) bulkhead conn – replaced and is now talking ok. Kept on board since might be needed on next cruise – send back to Seabird at end of season for service. Also needs one of temp/cond cons replacing due to corrosion.
Temp sensor SBE3plus #03P2191	No problems
Temp sensor SBE3plus #03P2307	Left on for whole cruise but had corroded pin so replaced with 32366 at end of cruise; cable replaced – needs repair. Will hand carry back for repair. No spare sensor on board now.
Cond sensor SBE4C #041912	No problems

Cond sensor SBE4C #041913	Left on for whole cruise but had split o-ring so replaced with 42289 at end of cruise – needs new o-ring. Will carry back for repair. No spare sensor on board now.
Standards Thermometer SBE35 #3527735-0024	No problems
Altimeter PA200 #2130.26993	A little noisy. Good readings with S/N 541 but reading slightly under 100m increasing with pressure (as if poor connection) with S/N 480; cable replaced towards end of cruise and reading improved.
Carousel & pylon SBE32 #0248	No problems
CTD swivel linkage	No problems – very successful
CTD swivel	No problems – very successful
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc.	Spooling gear misbehaving caused frequent stoppages and delays on a number of CTD casts. It is thought that the problem is due to a newer section of cable used on deep casts which has not been used since refit and requires ‘wearing in’ with respect to spooling on the drum. Other possibilities include wear of the spooling gear, age of the wire and progressive stretching. Fitted LADCP to CTD frame – see end of report for details. Bottle #8 replaced – cracked bottom lip.

ETS UNSUPPORTED INSTRUMENTS BUT LOGGED

EA500 (bridge)	At some point before boarding, many settings had been reset causing Ethernet comms with SSU to be non-functional. Settings were set to correct vals after correspondence with Simrad – and noted in SSU directory.
TSS HRP motion sensor	20/12/02 PSU board (DCDC converter) failed. Radio op had spare board – replaced – fixed 23/12/02
Anemometer	No problems reported
Gyro	No problems reported
DopplerLog	No problems reported
EMLog	No problems reported
Winch	No problems other than spooling gear (see CTD)

Additional notes and recommendations for change / future work

RDI 300kHz Workhorse LADCP: Transducer head and battery pack fitted to BAS 12-bottle frame. 2 bottles were removed to make room for the battery pack. See figure 1.1 for mounting. Swivel essential due to unbalancing of the frame. Fin was very useful to dramatically reduce spinning (for the benefit of LADCP data). Battery pack weight 40kg out of water, head 20kg out of water; but provided buoyancy in water so 40kg of extra weights were needed to keep good tension on the wire when lowering. LADCP head mounting had been constructed for 24-bottle frame, not 12-bottle – wrong curvature of lower fixings - used padding. Recommend customers provide special mounting to mount head inboard (just enough room under bottles) – this will reduce imbalance and resistance to water while lowering.

REFERENCES

- Bacon, S., 2002: RRS *James Clark Ross* Cruise 67, 19 Nov – 17 Dec 2001. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b – Burdwood Bank to Elephant Island. Southampton Oceanography Centre Cruise Report, No. 38., 118 pp.
- Cunningham, S. A., S. G. Alderson, B. A. King and M. A. Brandon, 2003: Transport and variability of the Antarctic Circumpolar Current in Drake Passage. *J. Geophys. Res.* **108** 10.1029/2001JC001147.
- ETOPO5, 1988: Data Announcement 88-MGG-02, Digital relief of the Surface of the Earth. NOAA, National Geophysical Data Center, Boulder, Colorado, 1988.

TABLES

Table 0.1: Definitive Drake Passage station position list, in south to north order.

station number	lat °S	lat min	lon °W	lon min	nominal depth	comments
3	61	03.00	54	35.23	400	1 st section stn
4	60	58.86	54	37.80	600	
5	60	51.02	54	42.66	1000	
6	60	49.99	54	43.30	1500	
7	60	47.97	54	44.55	2500	
8	60	40.00	54	49.49	3100	
9	60	20.00	55	01.88		
10	60	00.00	55	14.28		
11	59	40.00	55	26.67		
12	59	20.00	55	39.07		
13	59	00.00	55	51.47		
14	58	41.00	56	03.24		
15	58	22.00	56	15.02		
16	58	03.00	56	26.79		
17	57	44.00	56	38.57		
18	57	25.00	56	50.35		
19	57	06.00	57	02.12		
20	56	47.00	57	13.90		
21	56	28.00	57	25.67		
22	56	09.00	57	37.45		
23	55	50.00	57	49.23		
24	55	31.00	58	01.00		
25	55	12.86	58	12.24	3500	
26	55	10.25	58	13.86	3000	
27	55	07.27	58	15.71	2500	
28	55	04.18	58	17.62	2000	
29	54	57.66	58	21.67	1500	
30	54	56.62	58	22.31	1000	
31	54	55.34	58	23.10	600	
32	54	40.00	58	32.61	250	Last section stn

Table 1.1: CTD Sensors Used on JR81.

Instrument	Type	Serial Number	Calibration Date
Underwater Unit Stations 01 - 26a Stations 26 - 32	SBE 9 plus	09P20391-0541 09P15759-0480	-
Deck Unit	SBE 11 plus	11P15759-0458	-
Primary Temperature	SBE 3 plus	2307	19-Jul-02
Primary Conductivity	SBE 4C	1913	19-Jul-02
Secondary Temperature	SBE 3 plus	2191	19-Jul-02
Secondary Conductivity	SBE 4C	1912	19-Jul-02
Pressure Transducer Stations 01 - 26a Stations 26 - 32	Series 410K-105 Digiquartz pressure transducer.	75429 67241	7-Jul-02 30-Jun-00
Altimeter	Tritech	2130.26993	-
Frame	BAS 12 bottle with fin		-
Pylon	SBE 32	90194U 3220391-0128	-
Niskin Bottles			-
Primary Pump Stations 01 - 26a Stations 26 - 32	SBE 5 T	52395 52400	
Secondary Pump Stations 01 - 26a Stations 26 - 32	SBE 5 T	51813 51807	
Swivel	Focal Instruments, Model 196	196111	
Standards Thermometer	SBE35	3527735-0024	
SeaSave	Version 5.25		
SeaTerm	Version 1.26		
SBEDataPro	Version 5.25		

Table 1.2: JR81 CTD Stations. The three lines for each station represent the start, maximum depth and end of the station. Depth (m) is the EA500 value corrected for speed of sound using Carter's Tables. Wout is Wire Out (m), the maximum length of winch cable deployed for each station. Pmax is maximum pressure (dbar) for each station; Dcalc is the calculated equivalent depth (m) of Pmax. Ddiff is depth difference (m), calculated as water depth (Depth) minus calculated depth (Dcalc) minus minimum altimeter height off bottom (alt, m). Numbered notes are at the end of this table.

Stn #	Day JDAY	Time hhmmss	Latitude deg min			Longitude deg min			Depth m	Wout Pmax Dcalc	Ddiff Alt Notes
001	355	131508	62	46.824	S	67	02.808	W	3423	3402	1.4
	355	145220	62	46.830	S	67	02.796	W	3422	3474	8.6
	355	160938	62	46.830	S	67	02.802	W	3421	3412	Note 1
002	356	201156	67	34.932	S	68	08.106	W	374	367	-3.3
	356	202017	67	34.932	S	68	08.100	W	374	372	9.3
	356	204226	67	34.932	S	68	08.106	W	374	368	Note 2
003	361	113606	61	03.000	S	54	35.250	W	352	348	-5.7
	361	114514	61	03.000	S	54	35.250	W	352	354	7.7
	361	120850	61	03.000	S	54	35.250	W	352	350	Note 3
004	361	130346	60	58.860	S	54	37.806	W	578	569	-3.5
	361	131656	60	58.860	S	54	37.806	W	577	578	8.5
	361	134221	60	58.860	S	54	37.806	W	579	572	
005	361	144852	60	51.024	S	54	42.648	W	953	978	-35.1
	361	151306	60	51.018	S	54	42.636	W	956	994	9.1
	361	154431	60	51.006	S	54	42.630	W	957	982	
006	361	165319	60	49.980	S	54	43.290	W	1618	1758	-144.0
	361	173102	60	49.980	S	54	43.296	W	1631	1791	7.6
	361	181517	60	49.980	S	54	43.296	W	1617	1767	
007	361	185810	60	47.958	S	54	44.544	W	1652	2561	-939.5
	361	194724	60	47.958	S	54	44.544	W	1643	2615	8.5
	361	204626	60	47.958	S	54	44.544	W	1644	2574	
008	361	220409	60	39.996	S	54	49.422	W	3087	3060	-15.0
	361	230038	60	39.792	S	54	48.396	W	3064	3126	6.0
	362	000645	60	39.546	S	54	47.586	W	3041	3073	
009	362	022244	60	20.016	S	55	01.878	W	3436	3419	-2.5
	362	032353	60	20.142	S	55	02.304	W	3441	3497	7.0
	362	043411	60	20.376	S	55	02.802	W	3442	3436	
010	362	065950	59	59.988	S	55	14.280	W	3499	3478	-0.8
	362	080354	59	59.544	S	55	14.604	W	3502	3555	11.0
	362	102539	59	57.948	S	55	15.768	W	3512	3492	
011	362	122727	59	39.978	S	55	26.724	W	3673	3648	-1.5
	362	133345	59	39.978	S	55	26.724	W	3673	3734	8.5
	362	145912	59	39.972	S	55	26.724	W	3674	3666	
012	362	171302	59	19.998	S	55	39.054	W	3755	3733	0.6
	362	184855	59	19.998	S	55	39.054	W	3754	3814	8.4
	362	200646	59	19.998	S	55	39.048	W	3754	3745	
013	362	221223	59	00.036	S	55	51.624	W	3774	3750	4.5
	362	231722	58	59.988	S	55	52.188	W	3774	3835	4.5
	363	003514	58	59.892	S	55	53.280	W	3767	3765	
014	363	023456	58	40.938	S	56	03.288	W	3754	3731	-2.4
	363	033959	58	40.938	S	56	03.288	W	3752	3816	7.9
	363	050003	58	40.938	S	56	03.288	W	3753	3747	

015	363	070152	58	22.002	S	56	15.000	W	3886	3864	-3.9
	363	080916	58	22.002	S	56	15.000	W	3888	3957	8.8
	363	095230	58	22.002	S	56	15.000	W	3886	3883	Note 4
016	363	171058	58	02.976	S	56	26.796	W	3690	3939	-11.9
	363	181829	58	03.000	S	56	26.766	W	3954	4032	8.9
	363	194943	58	03.000	S	56	26.766	W	3954	3957	
017	363	215417	57	43.896	S	56	38.580	W	3456	3454	-13.4
	363	225311	57	43.998	S	56	38.574	W	3460	3530	5.7
	364	000924	57	43.998	S	56	38.574	W	3457	3468	
018	364	021151	57	24.996	S	56	50.304	W	3437	3463	-12.0
	364	031017	57	24.858	S	56	49.698	W	3474	3541	7.0
	364	045608	57	24.684	S	56	48.822	W	3468	3479	
019	364	071202	57	05.988	S	57	01.716	W	3904	3746	-74.7
	364	081511	57	06.726	S	57	00.630	W	3661	3791	13.0
	364	094450	57	07.608	S	56	59.274	W	3654	3723	
020	364	121950	56	47.154	S	57	13.512	W	3062	3279	-93.0
	364	131759	56	47.700	S	57	12.390	W	3203	3337	16.0
	364	142837	56	48.678	S	57	11.856	W	3053	3280	
021	364	164321	56	27.984	S	57	25.668	W	3709	3882	-18.0
	364	175407	56	28.464	S	57	25.356	W	3885	3968	8.3
	364	192451	56	29.208	S	57	25.308	W	3887	3895	
022	364	214900	56	09.000	S	57	37.452	W	3359	3384	-17.1
	364	224635	56	09.546	S	57	37.956	W	3383	3450	9.1
	365	000102	56	10.410	S	57	38.682	W	3417	3391	
023	365	020546	55	50.046	S	57	49.176	W	4750	4747	17.4
	365	032909	55	50.400	S	57	48.210	W	4775	4847	8.6
	365	052752	55	50.544	S	57	47.058	W	4799	4749	
024	365	074954	55	30.984	S	58	00.912	W	4223	4203	-6.5
	365	090409	55	30.780	S	57	58.854	W	4201	4279	9.5
	365	103811	55	30.576	S	57	56.676	W	4170	4198	
025	365	124122	55	12.864	S	58	12.234	W	3818	4747	-40.5
	365	134746	55	12.858	S	58	10.416	W	3861	3966	7.6
	365	151012	55	12.858	S	58	07.782	W	3946	3894	
026	365	205154	55	10.248	S	58	13.770	W	2962	2926	
	365	214857	55	10.080	S	58	12.138	W	2920	2986	
	365	225221	55	09.864	S	58	09.978	W	2926	2938	Note 5
027	001	000842	55	07.272	S	58	15.714	W	2513	2506	-10.4
	001	005400	55	07.146	S	58	14.400	W	2511	2550	9.6
	001	014818	55	06.990	S	58	12.870	W	2492	2512	Note 6
028	001	022811	55	04.176	S	58	17.634	W	2057	2036	-113.6
	001	030452	55	04.194	S	58	16.656	W	2028	2072	98.6
	001	035148	55	04.194	S	58	15.570	W	2020	2043	
029	001	045913	54	57.762	S	58	21.684	W	1596	1584	-3.1
	001	052645	54	57.870	S	58	20.670	W	1584	1599	9.1
	001	060749	54	58.044	S	58	19.038	W	1540	1578	
030	001	064601	54	56.652	S	58	22.176	W	1138	1271	-9.0
	001	070759	54	56.682	S	58	21.210	W	1250	1264	10.0
	001	074618	54	56.820	S	58	19.812	W	1403	1249	
031	001	082718	54	55.338	S	58	23.016	W	506	565	-22.5
	001	083851	54	55.380	S	58	22.680	W	557	572	13.5
	001	090219	54	55.494	S	58	21.666	W	672	566	
032	001	122617	54	39.996	S	58	32.628	W	382	379	-10.5
	001	123605	54	39.996	S	58	32.628	W	379	385	9.0
	001	125652	54	39.996	S	58	32.628	W	379	381	Note 7

Notes to Table 1.2:

Note 1: Test Station.

Note 2: Rothera Time Series (RaTS) Station.

Note 3: First station on Drake Passage section, off Elephant Island. POL south mooring interrogated beforehand.

Note 4: POL middle mooring interrogated afterwards.

Note 5: Second cast on this station. The underwater unit failed on the first cast. See section 1. Also, last station of year 2002, day 365.

Note 6: First station of year 2003, day 001.

Note 7: Last station of Drake Passage section, south side of Burdwood Bank. POL north mooring interrogated beforehand.

FIGURES

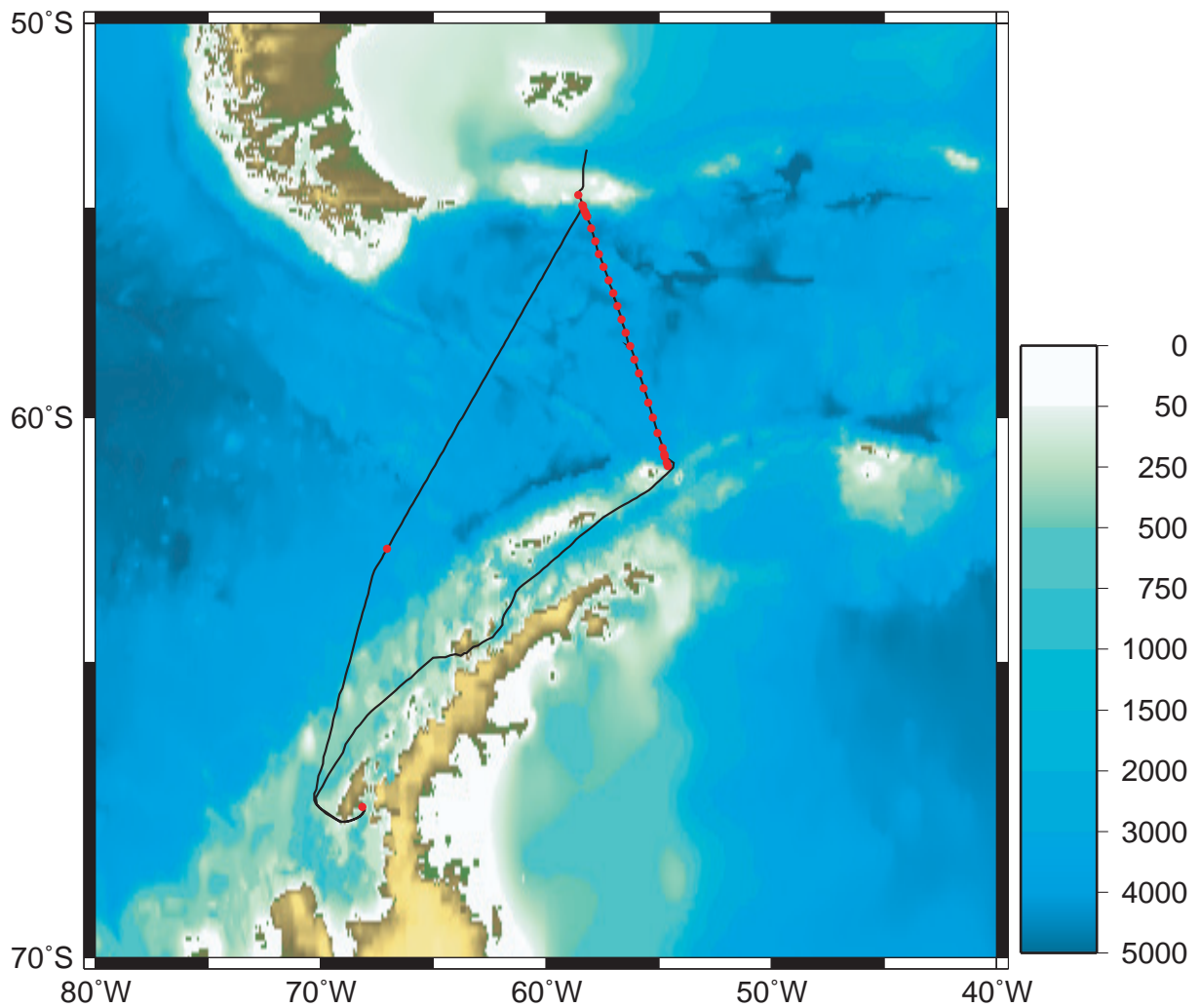


Figure 0.1: Cruise track for RRS *James Clark Ross* cruise 81 (black line) showing CTD station positions (red dots). The bathymetry is from the ETOPO5 (1988) data set. The scale bar shows depths in metres.

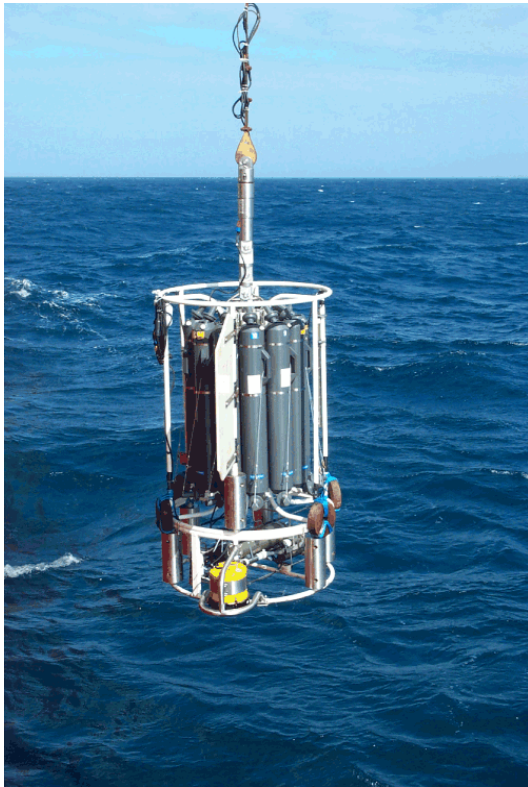


Figure 1.1a: above left: CTD frame being deployed. Note the LADCP and protective frame mount, the stabilising fin, the extra weights and the swivel. The battery pack is on the opposite side.

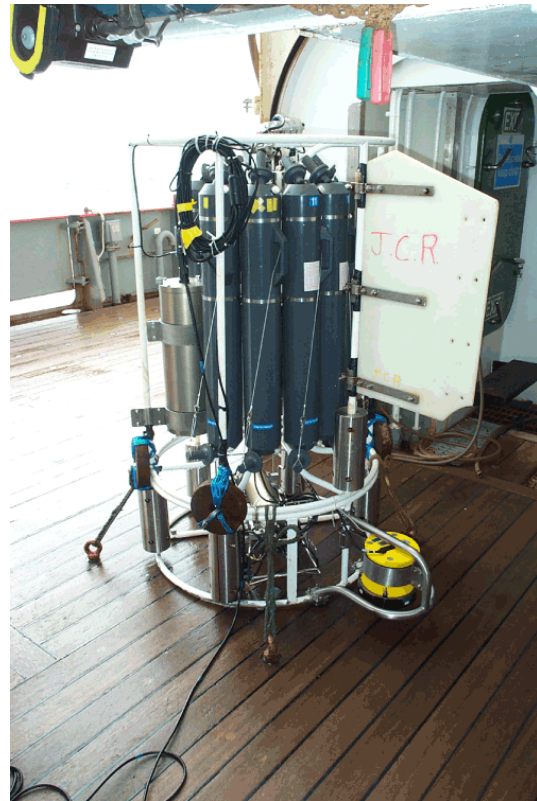


Figure 1.1b above right: CTD frame on deck, showing position of battery pack.



Figure 1.1c: Detail of LADCP frame mount. There are three attachment points to the CTD frame for the LADCP frame; the LADCP mounting bracket is attached on the right to the LADCP frame and on the left to the CTD frame.



Figure 1.1d: Detail of the LADCP battery pack. The upper mounting bracket attaches to a CTD frame inner spar, and the lower to an outer spar.

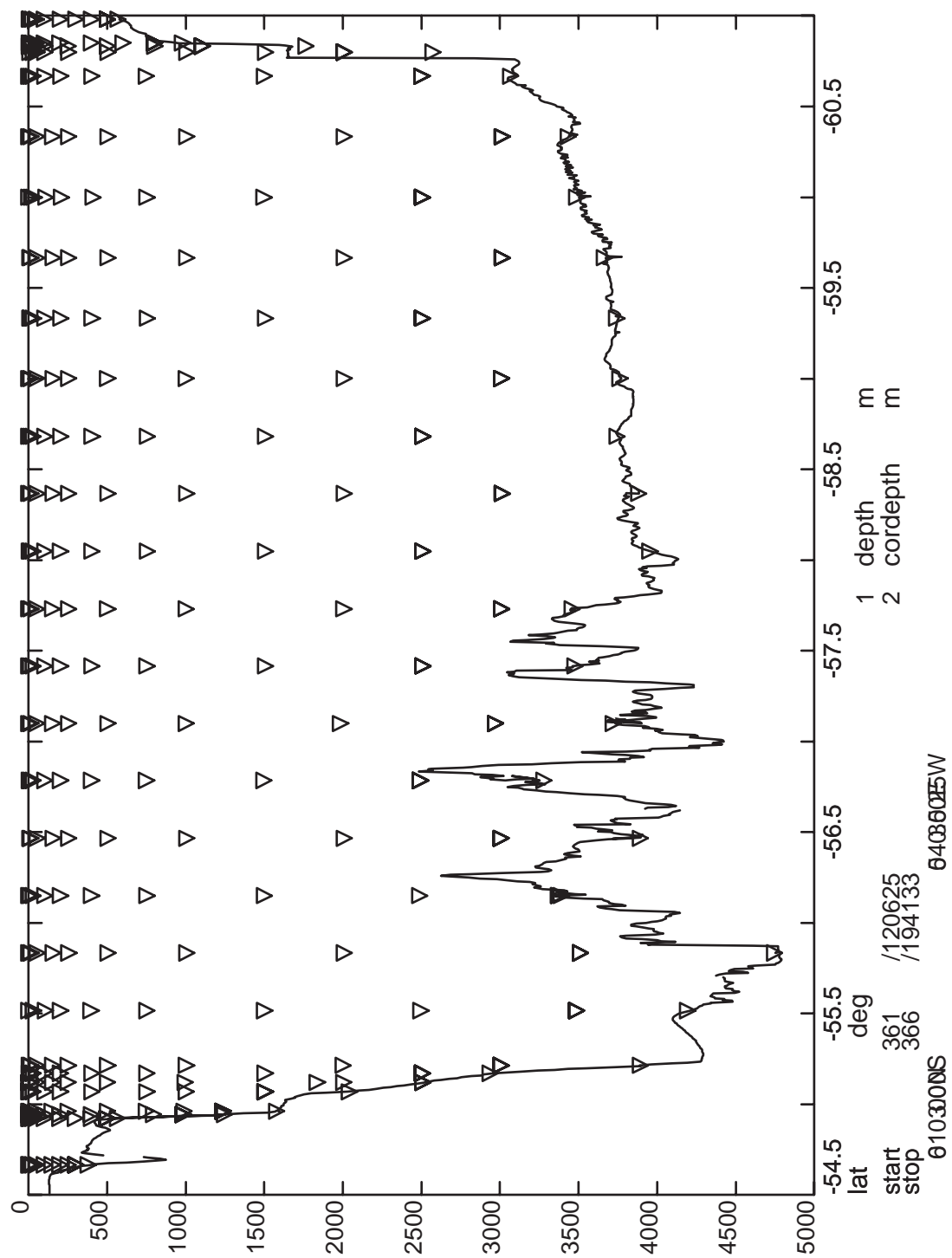


Figure 1.2: Plot of positions of bottle firings across Drake Passage.

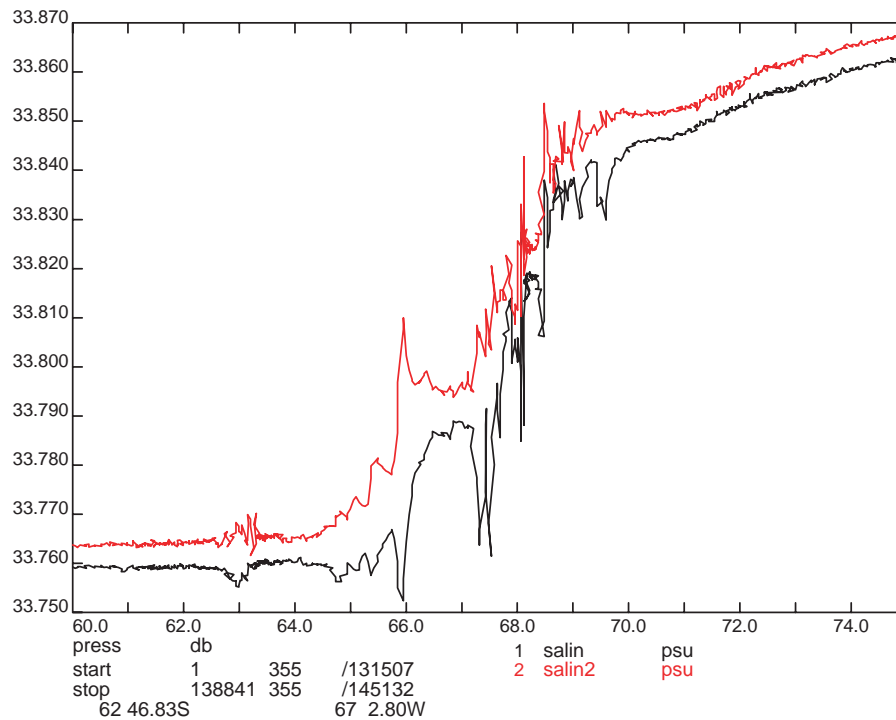


Figure 1.3a: Salinity as measured on Station 01. A 15 m section of the cast has been chosen which most clearly shows the spikes in salinity resulting from the misalignment of the conductivity and temperature sensors.

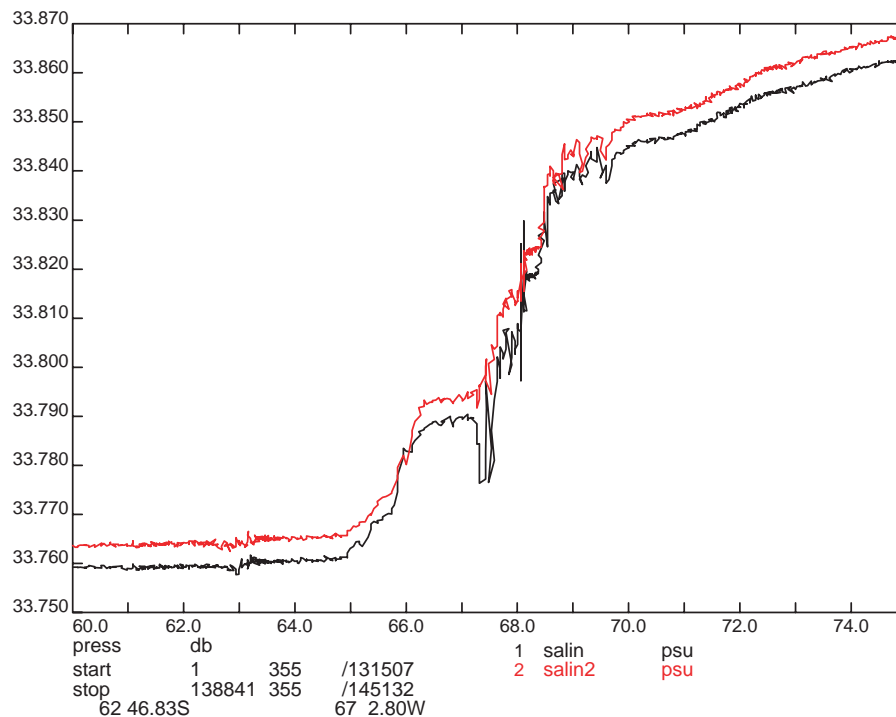


Figure 1.3b: As Figure 1.3a but after the misalignment has been reduced by delaying the primary conductivity by 1 datacycle (1/24 seconds) and advancing the secondary conductivity by 1 datacycle.

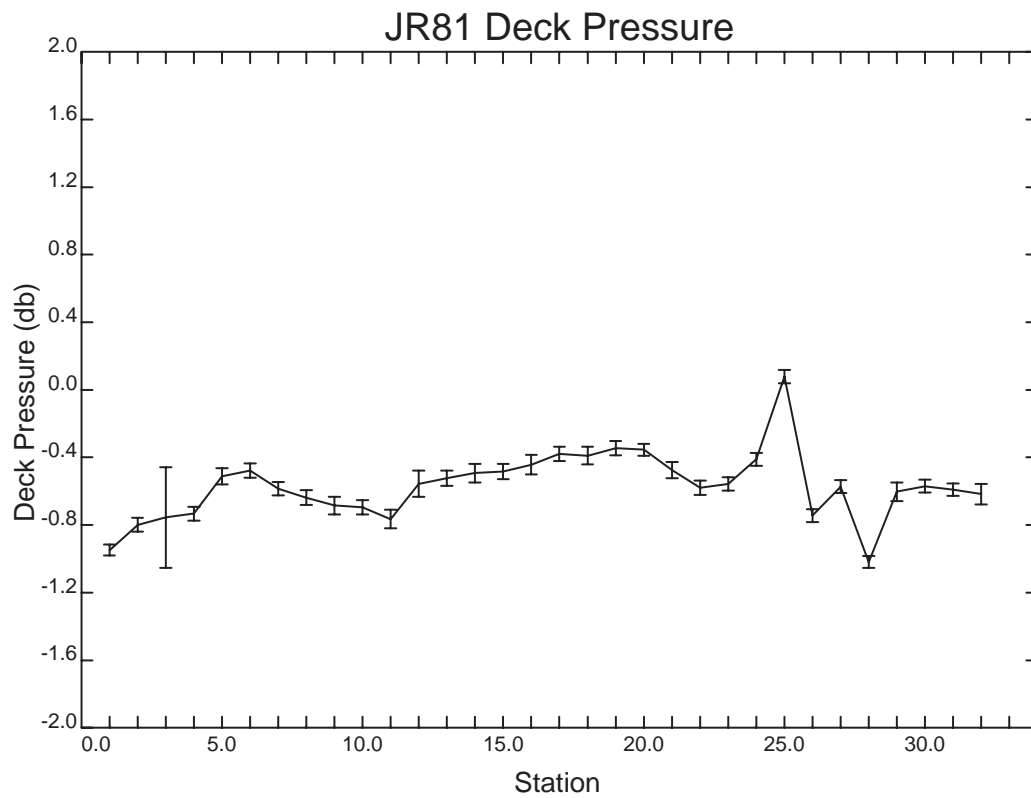


Figure 1.4: Deck Pressures using 30 seconds of data extracted from the CTD 10 seconds after the start of data collection. The increase on Station 25 occurred just before the failure of the Underwater Unit. All other variations are small.

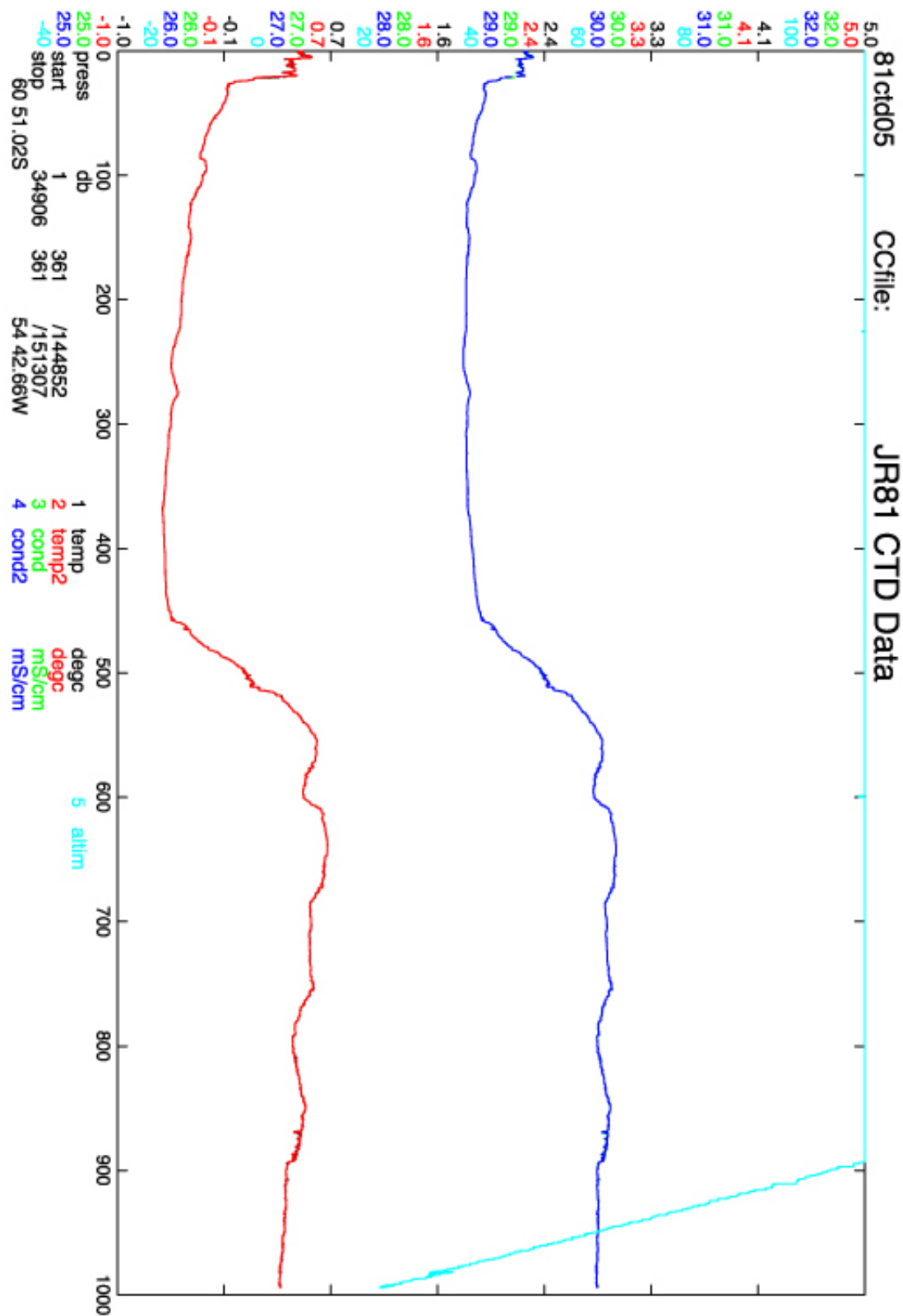


Figure 1.5: Raw data from the downcast of Station 15. Conductivity time shifts and the editing procedures as described in the text have been applied.

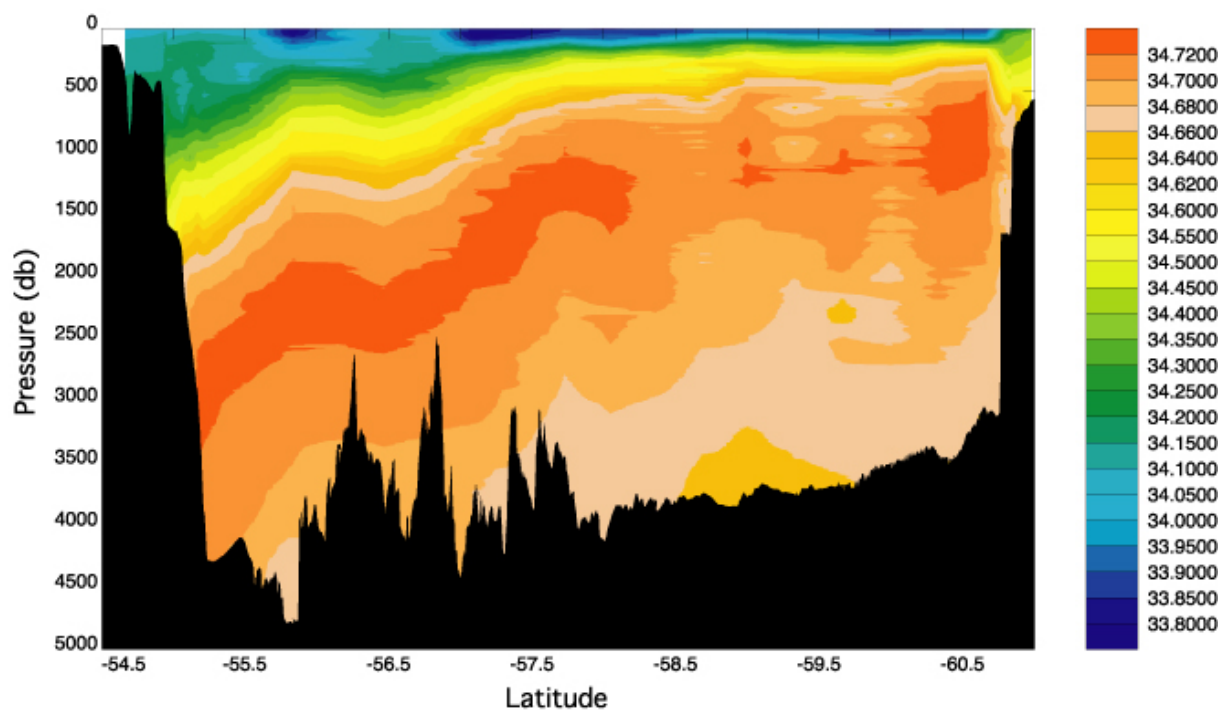


Figure 1.6: Calibrated salinity in psu averaged to 5db.

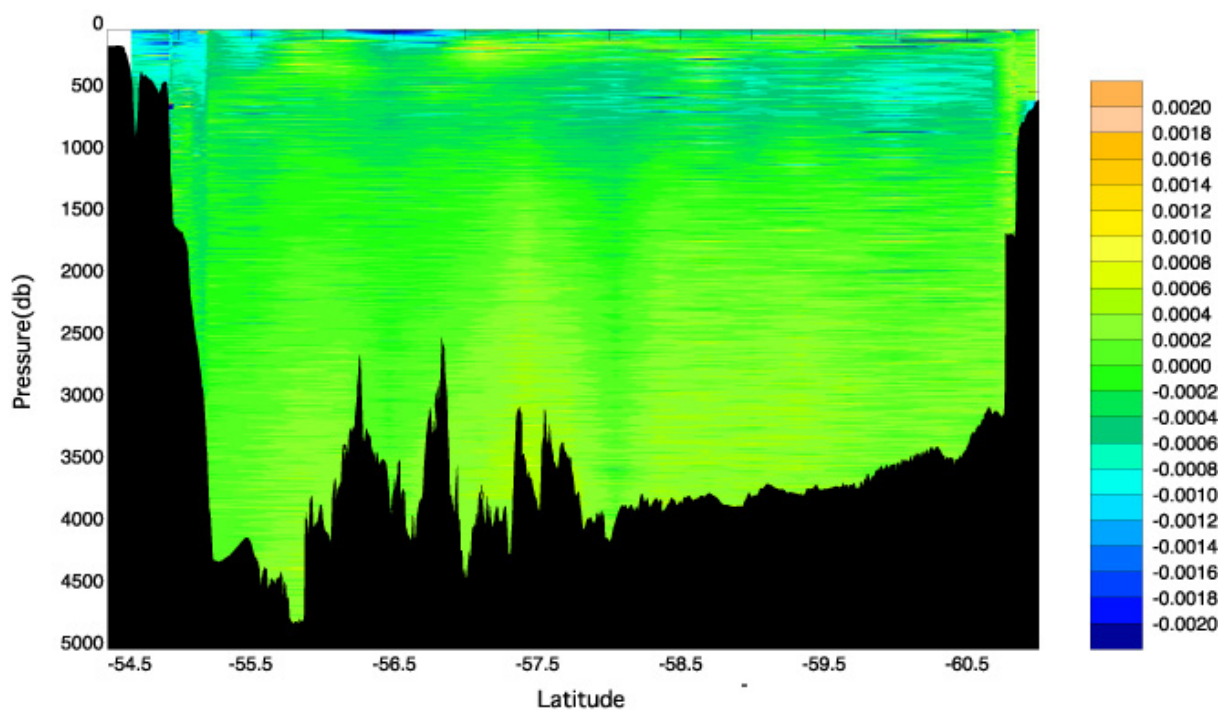


Figure 1.7: Salinity Difference (psu), primary – secondary conductivity after calibration averaged to 5 db.

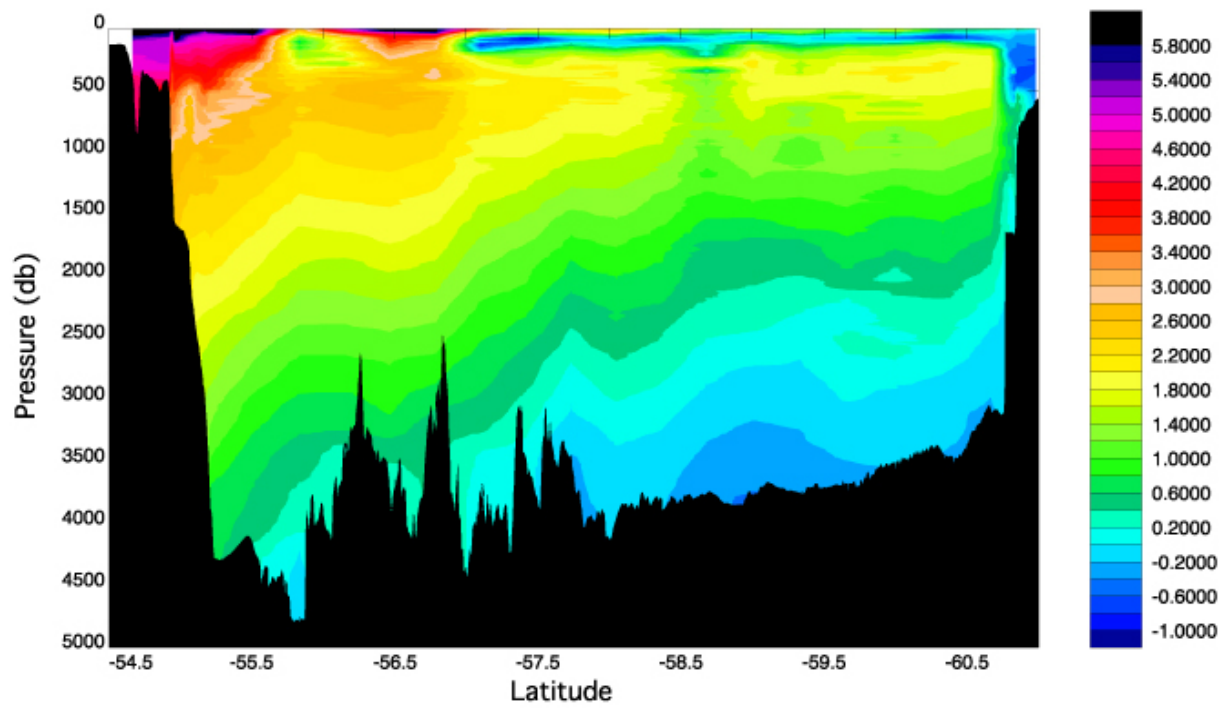


Figure 1.8: Potential Temperature (°C) averaged to 5db.

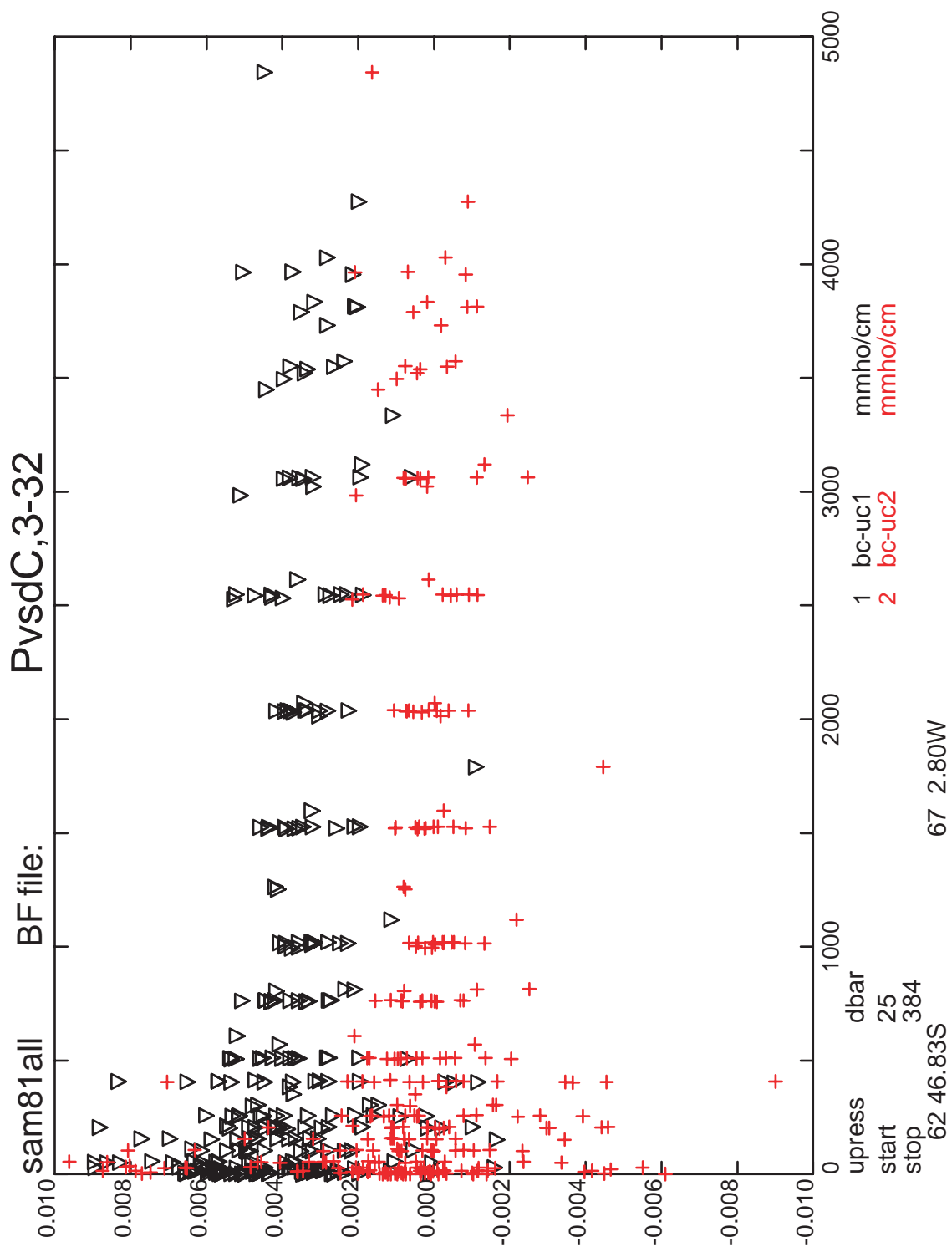


Figure 1.9: Sample (bc) minus pre-calibration CTD upcast (uc) conductivities vs. pressure for primary (black triangles) and secondary (red pluses) CTD sensor pairs.

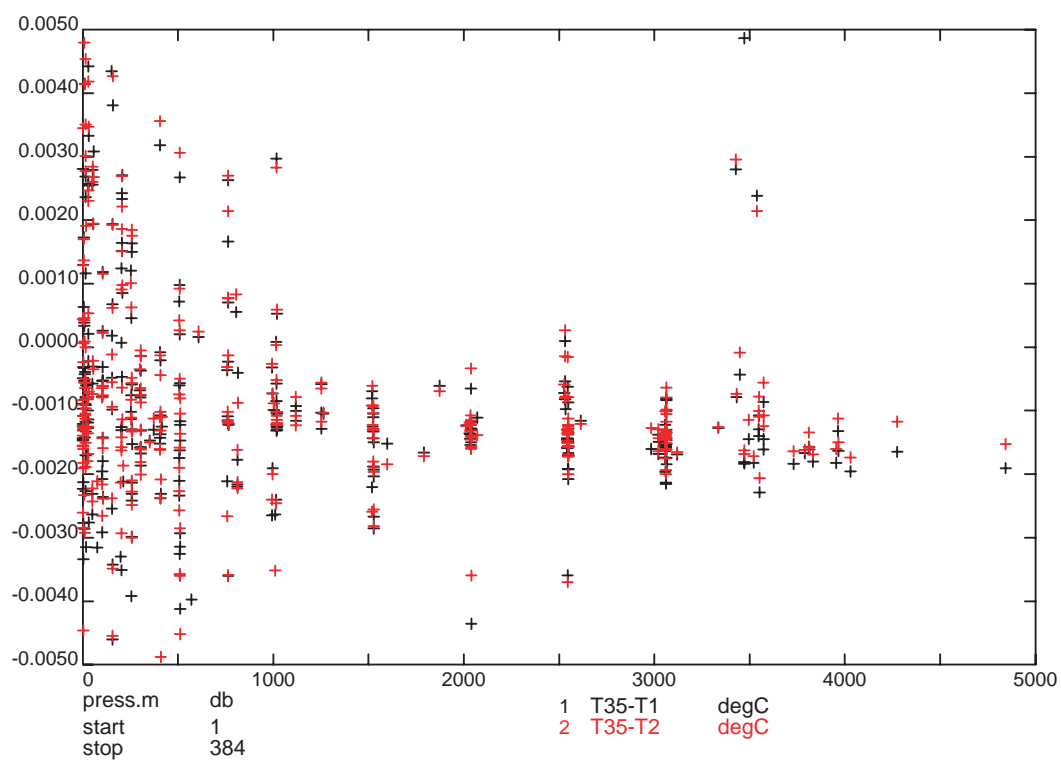


Figure 1.10: SBE35 – CTD temperature difference in °C as a function of pressure for all stations.

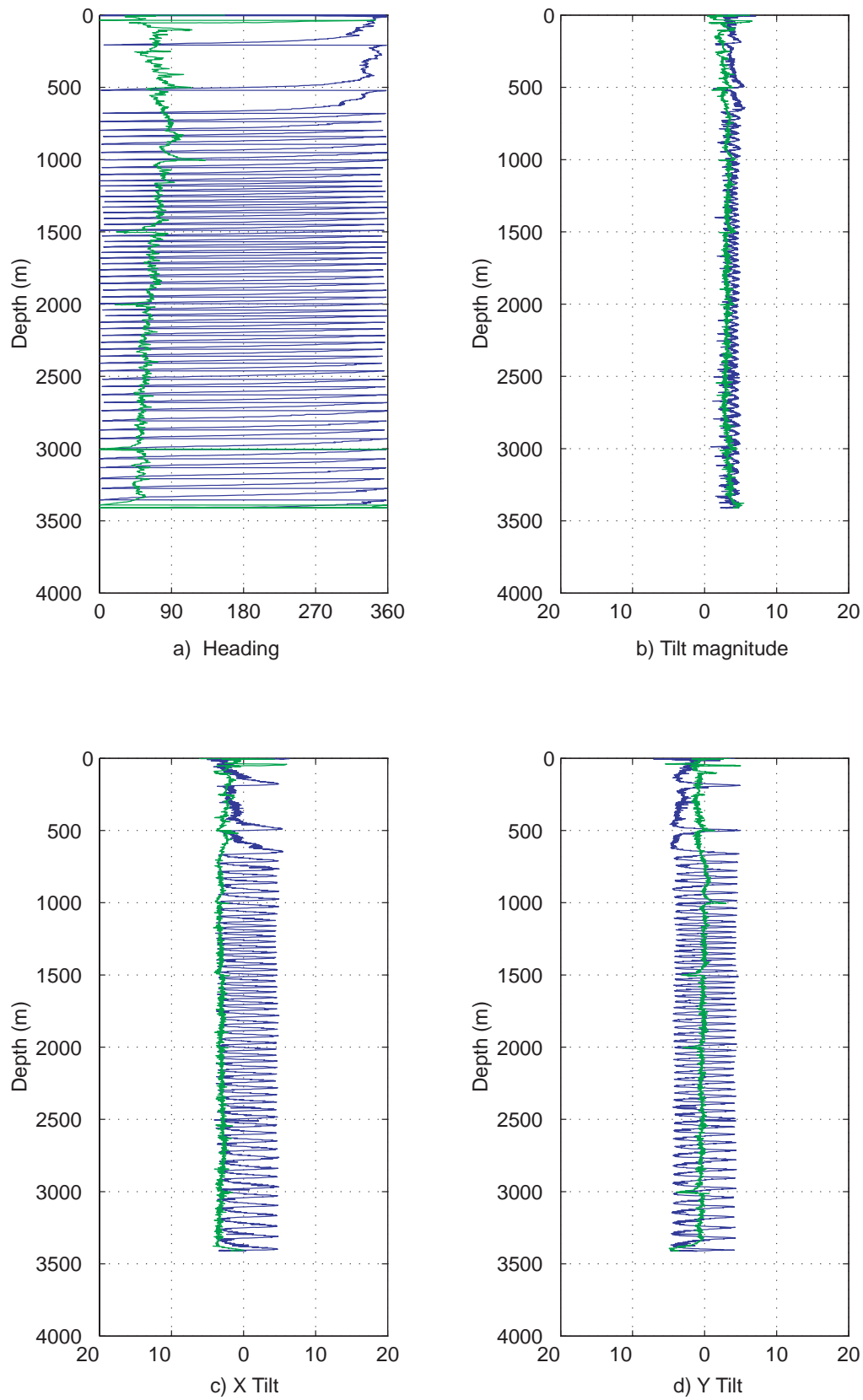


Figure 2.1: LADCP tilt and heading for station 1.

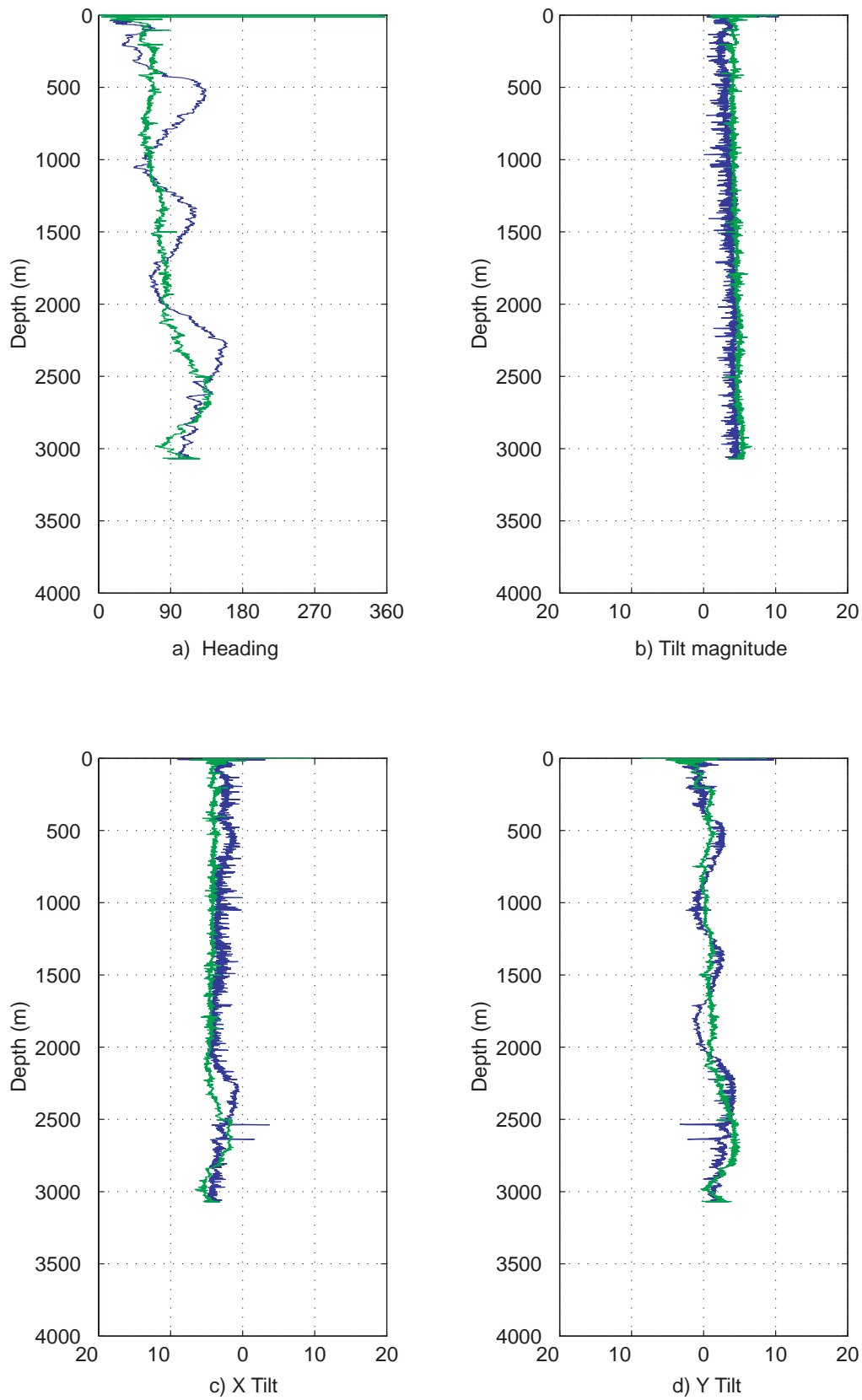


Figure 2.2: LADCP tilt and heading for station 8.

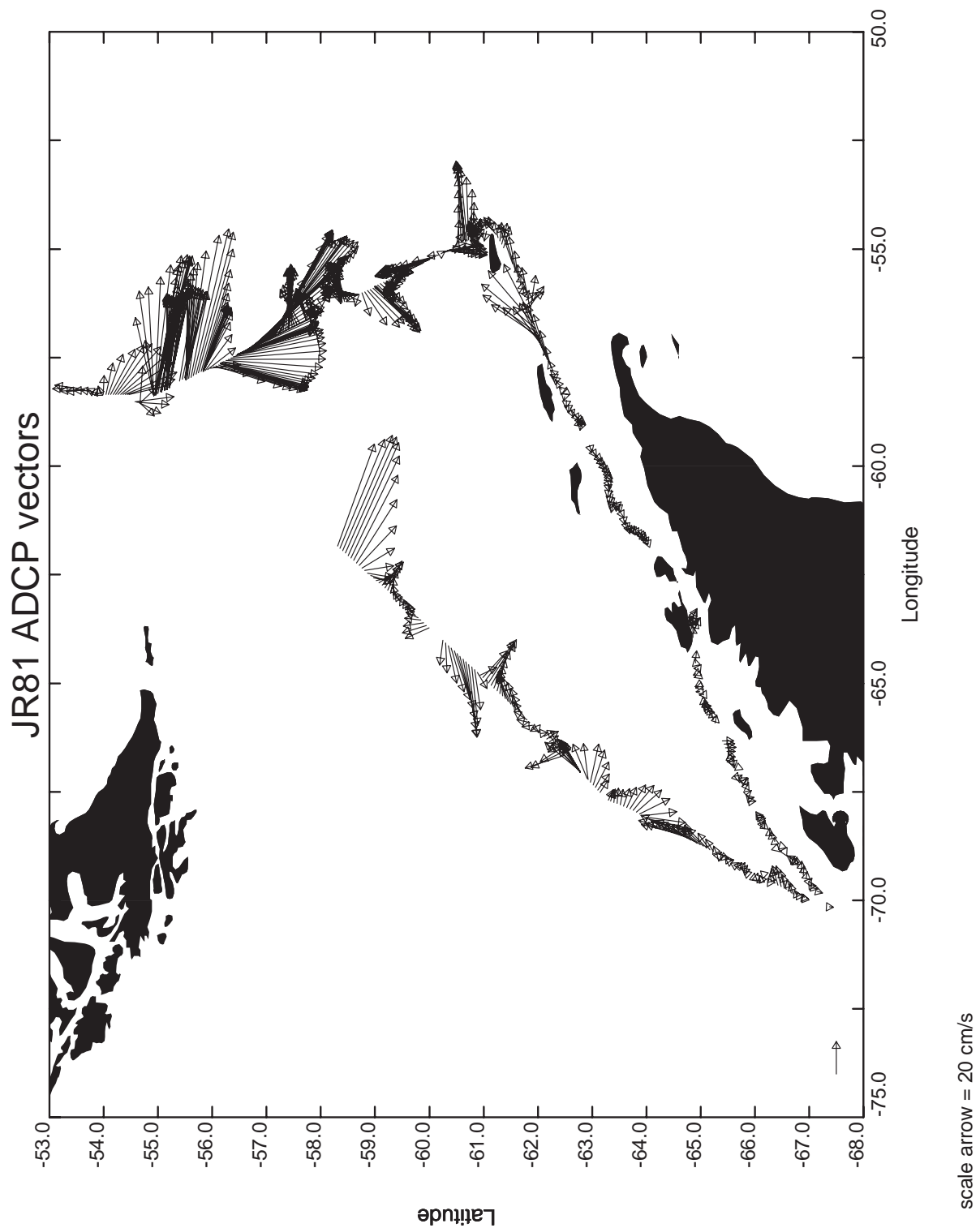


Figure 4.1: Vessel-mounted ADCP vectors from 14 m depth for the duration of cruise JR81. Individual 2 minute ensemble vectors were smoothed with a 30-minute running mean filter, and then averaged in 15 minute blocks for display.

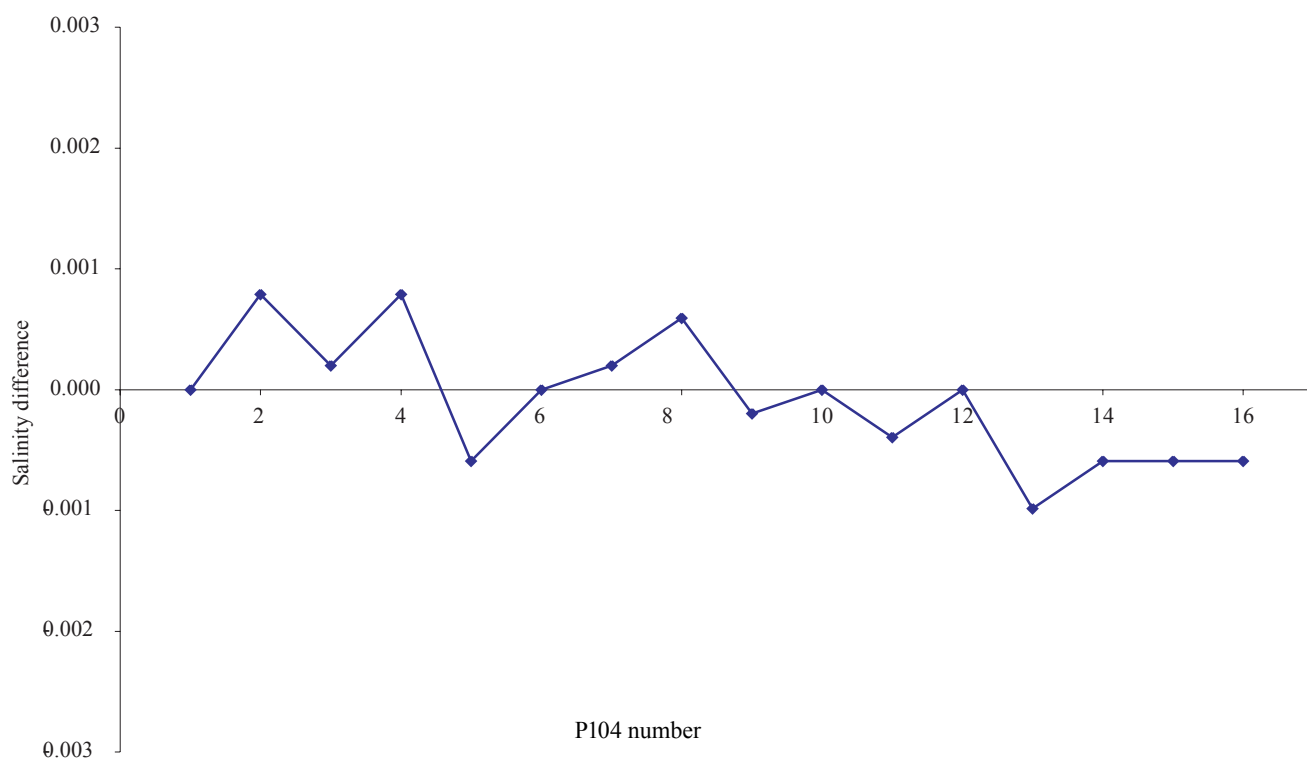


Figure 5.1: BAS 8400B salinometer standardisation history.

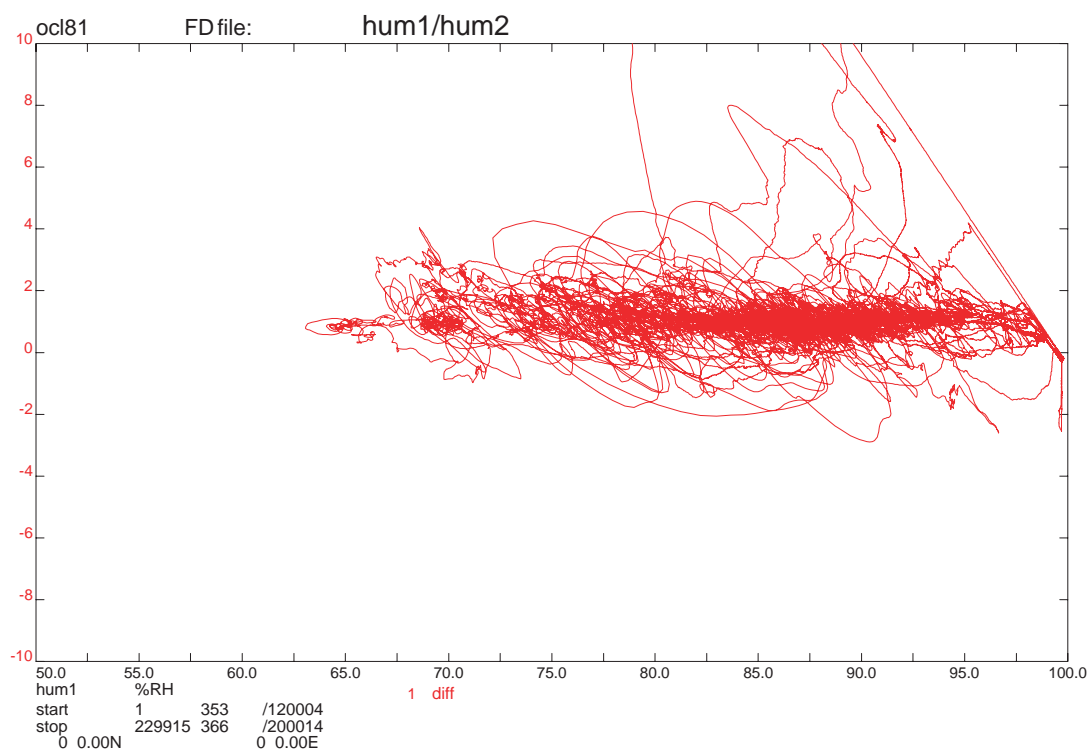


Figure 6.1: Difference between the two humidity measurements as a function of humidity. Below 98% humidity sensor 1 reads on average 1% higher than sensor 2.

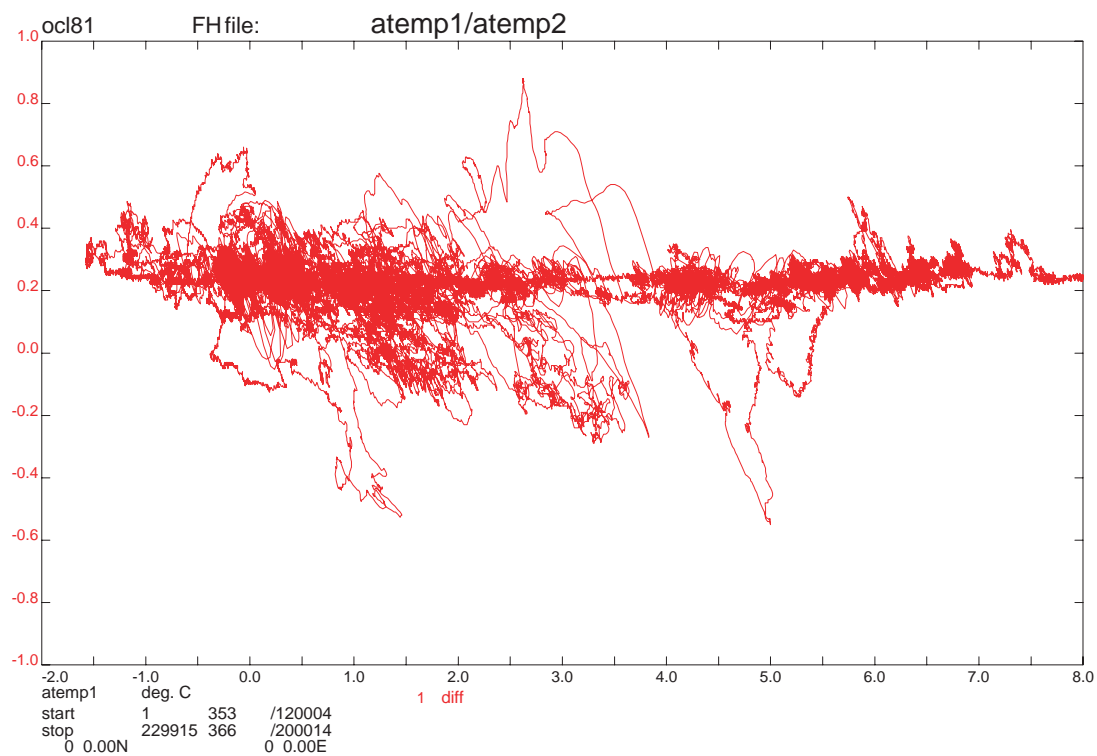


Figure 6.2: Difference between the two temperature measurements as a function of temperature. The offset is about 0.25 °C, with random noise of about 0.1 °C.

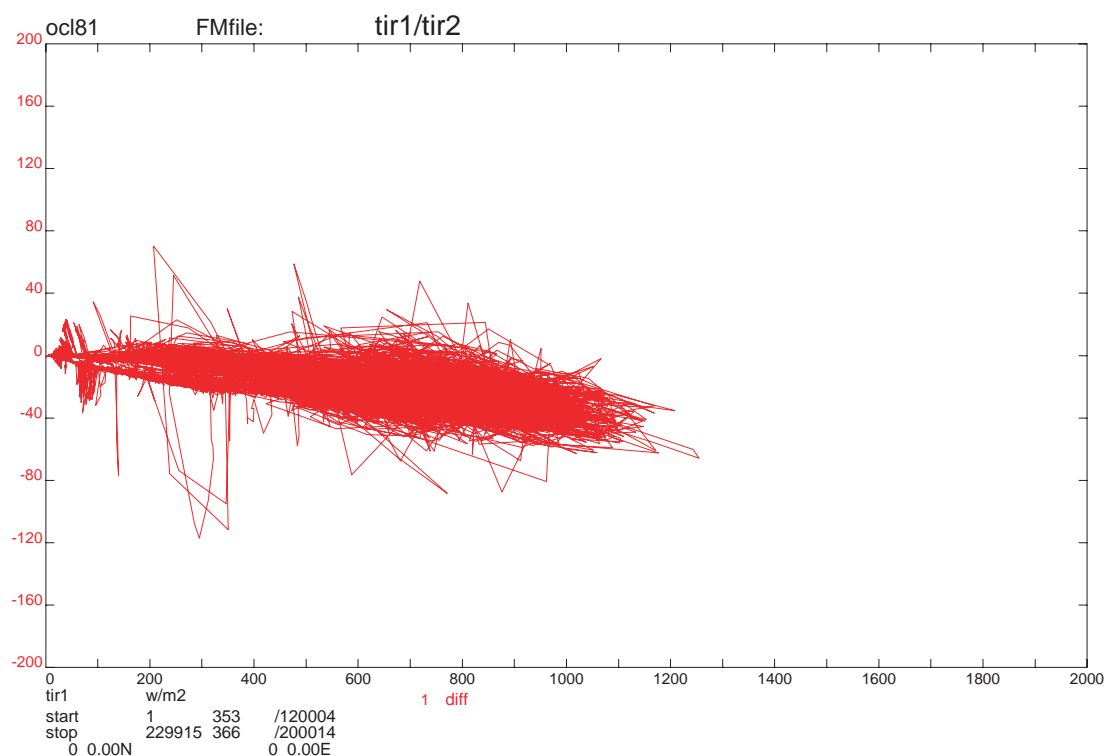


Figure 6.3: Difference between the two measurements total incident radiation. This shows that the second instrument gives a value that is about 3% lower than the first.

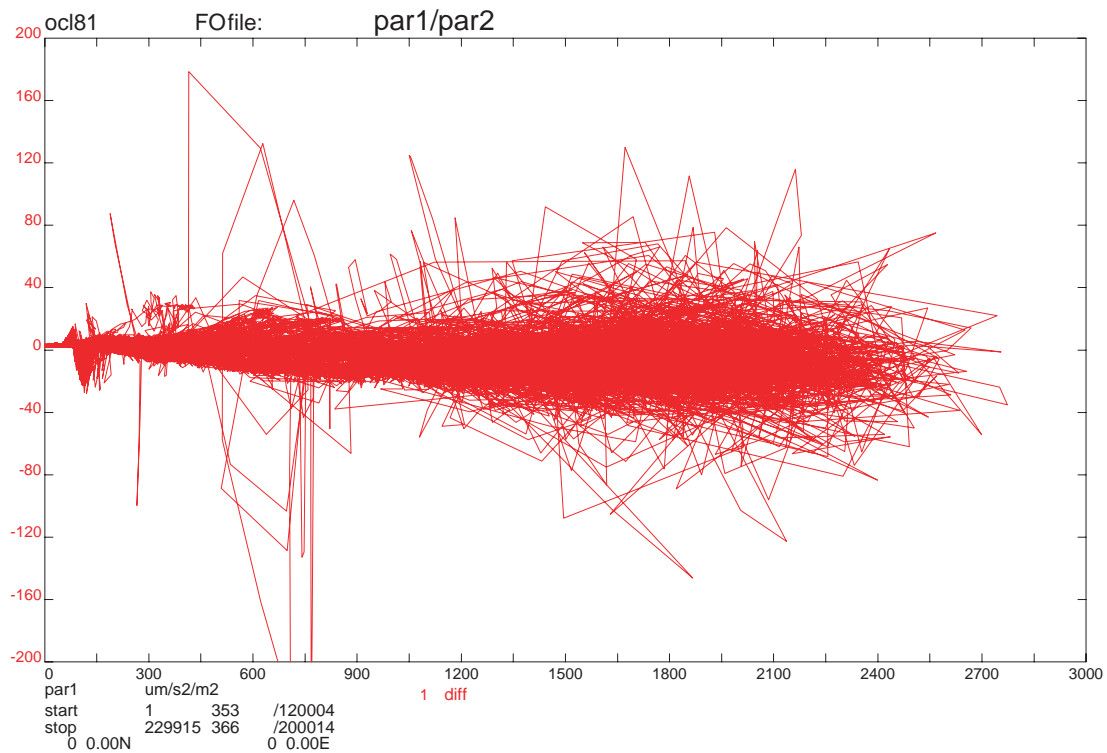


Figure 6.4: Differences between the two measurements of photosynthetically active radiation. There was no measurable systematic difference. The random differences are generally less than 0.5% of the measured signal.

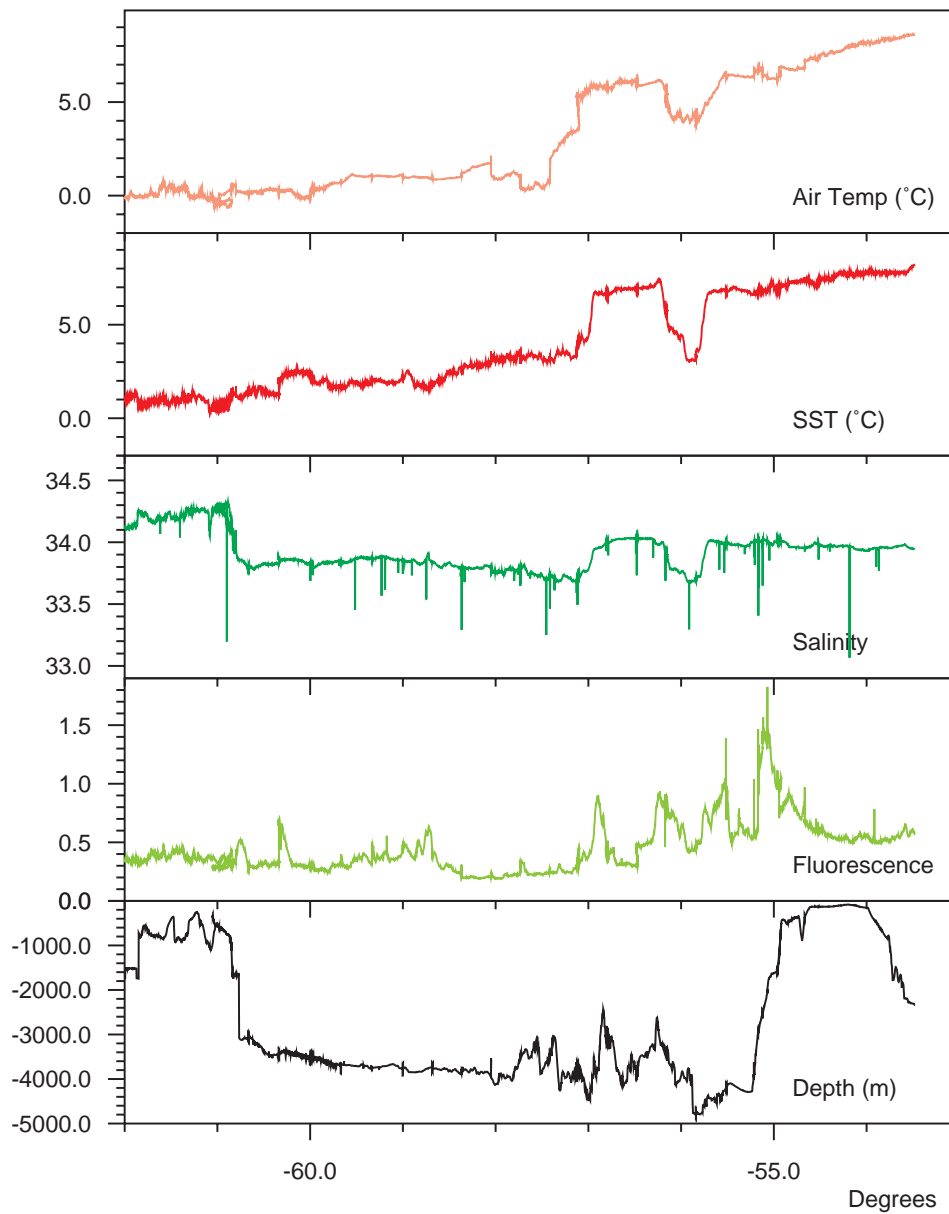


Figure 6.5: Underway measurements of air temperature (°C), sea surface temperature (°C), salinity, fluorescence (ug/l) and depth (m), during the later northward section of the JR81 cruise track. Some multiple values are observed during CTD stations and during recovery of other equipment.

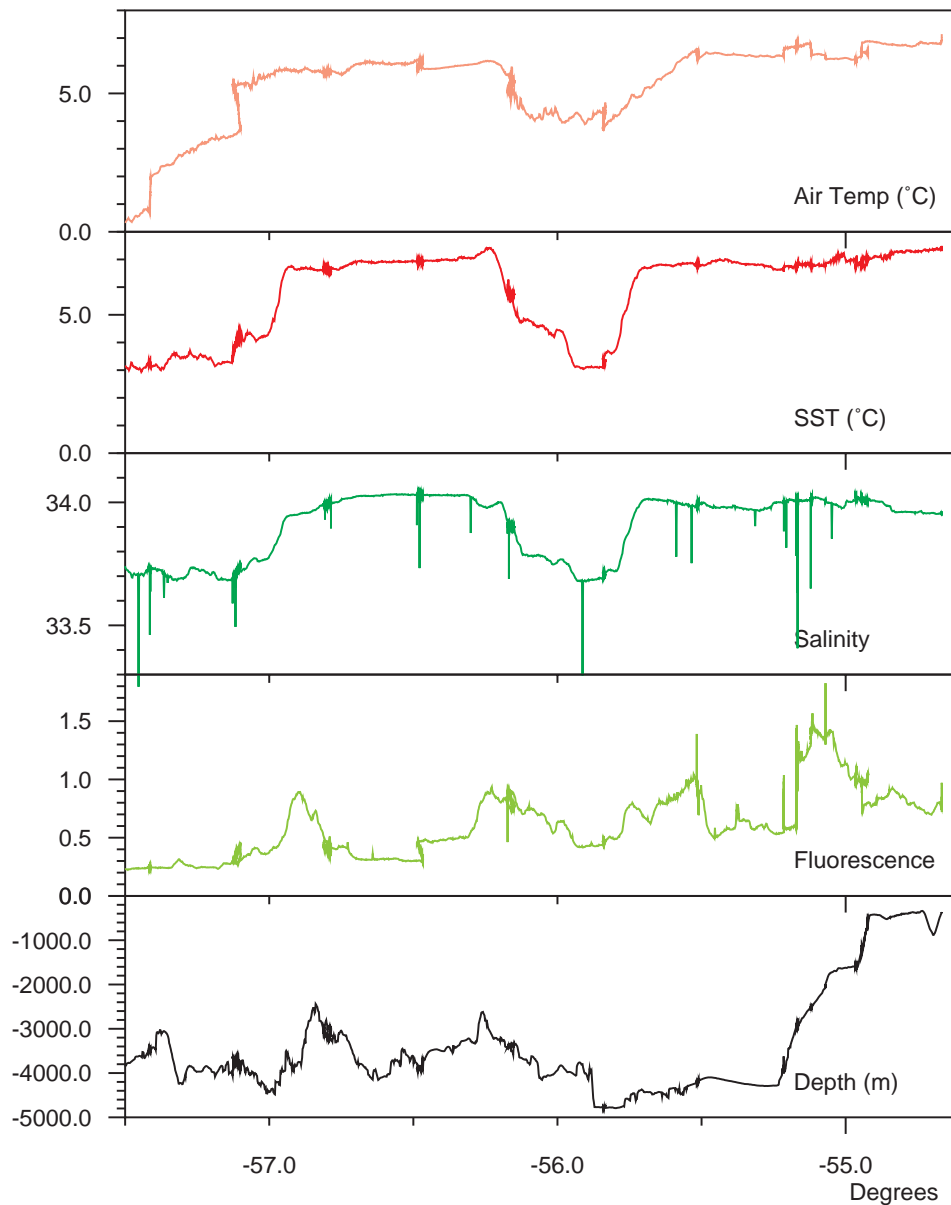


Figure 6.6: Expanded version of underway measurements of air temperature (°C), sea surface temperature (°C), salinity, fluorescence (ug/l) and depth (m), during the later northward section of the JR81 cruise track. Some multiple values are observed during CTD stations and during recovery of other equipment.

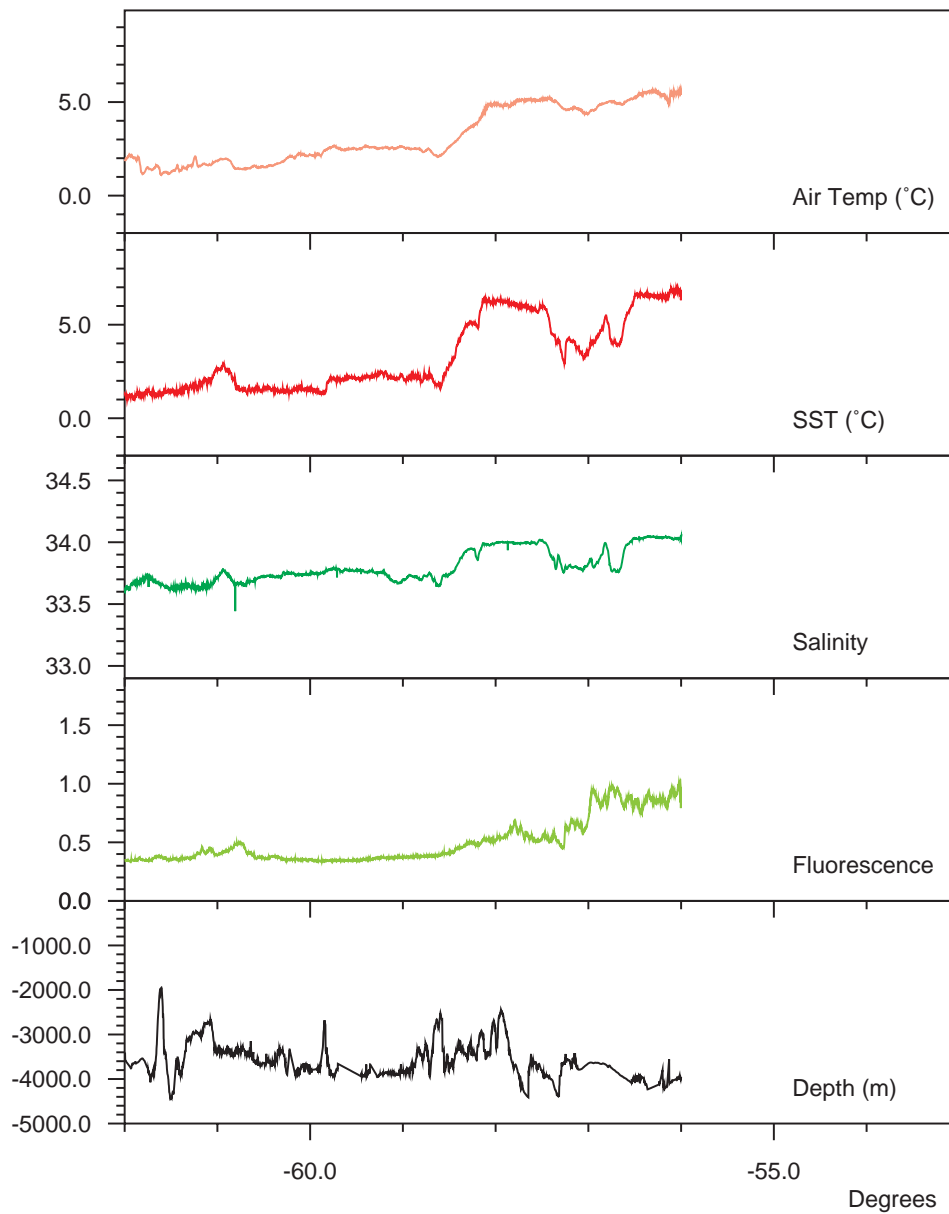


Figure 6.7: Underway measurements of air temperature ($^{\circ}\text{C}$), sea surface temperature ($^{\circ}\text{C}$), salinity, fluorescence ($\mu\text{g/l}$) and depth (m), during the earlier southward section of the JR81 cruise track.

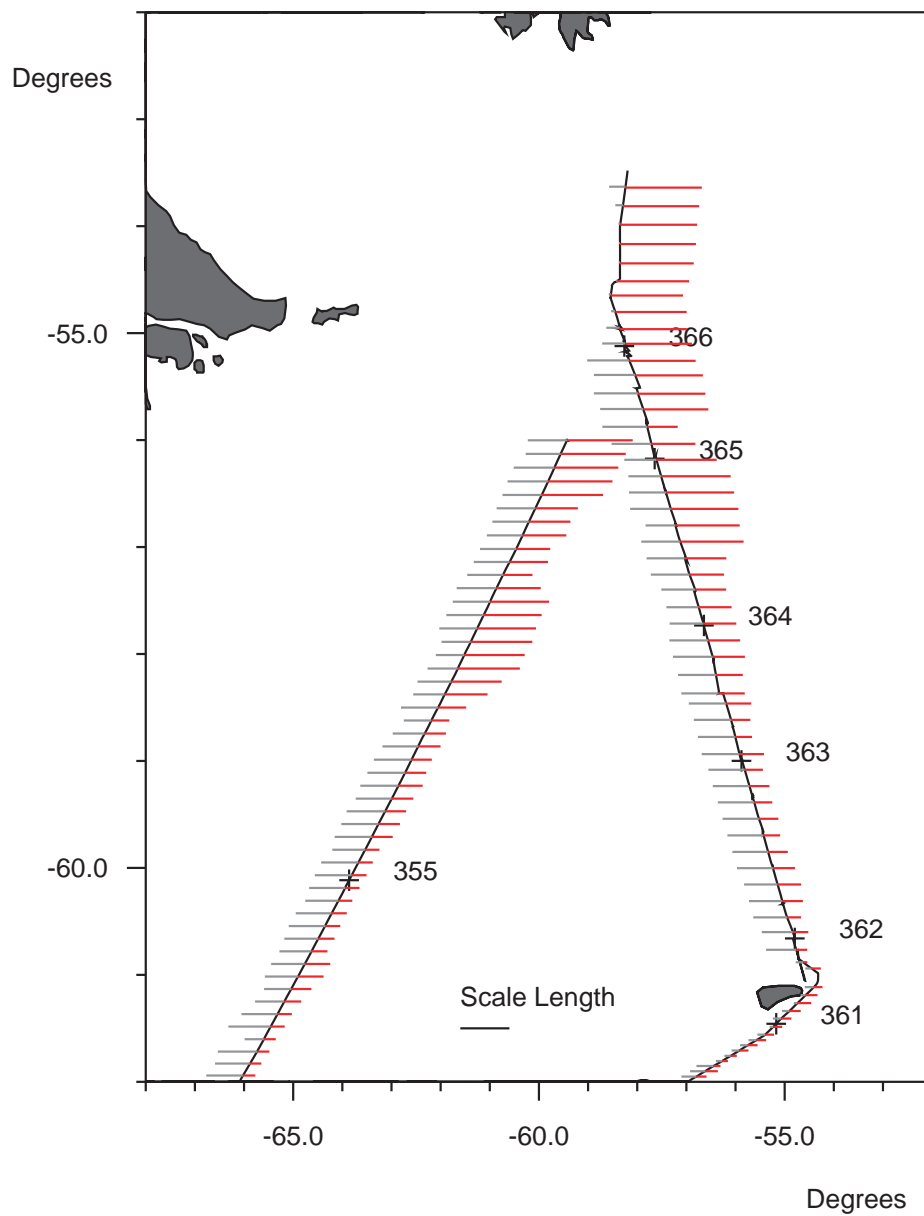


Figure 6.8: Comparison of depth (grey bars) and sea surface temperature measurements (red bars) made during JR81. The numbers indicate the position of the ship at midnight before the indicated Julian Day of 2002. Position 366 corresponds to New Year. The scale length corresponds to a depth of 5000 m or a temperature of 5°C.

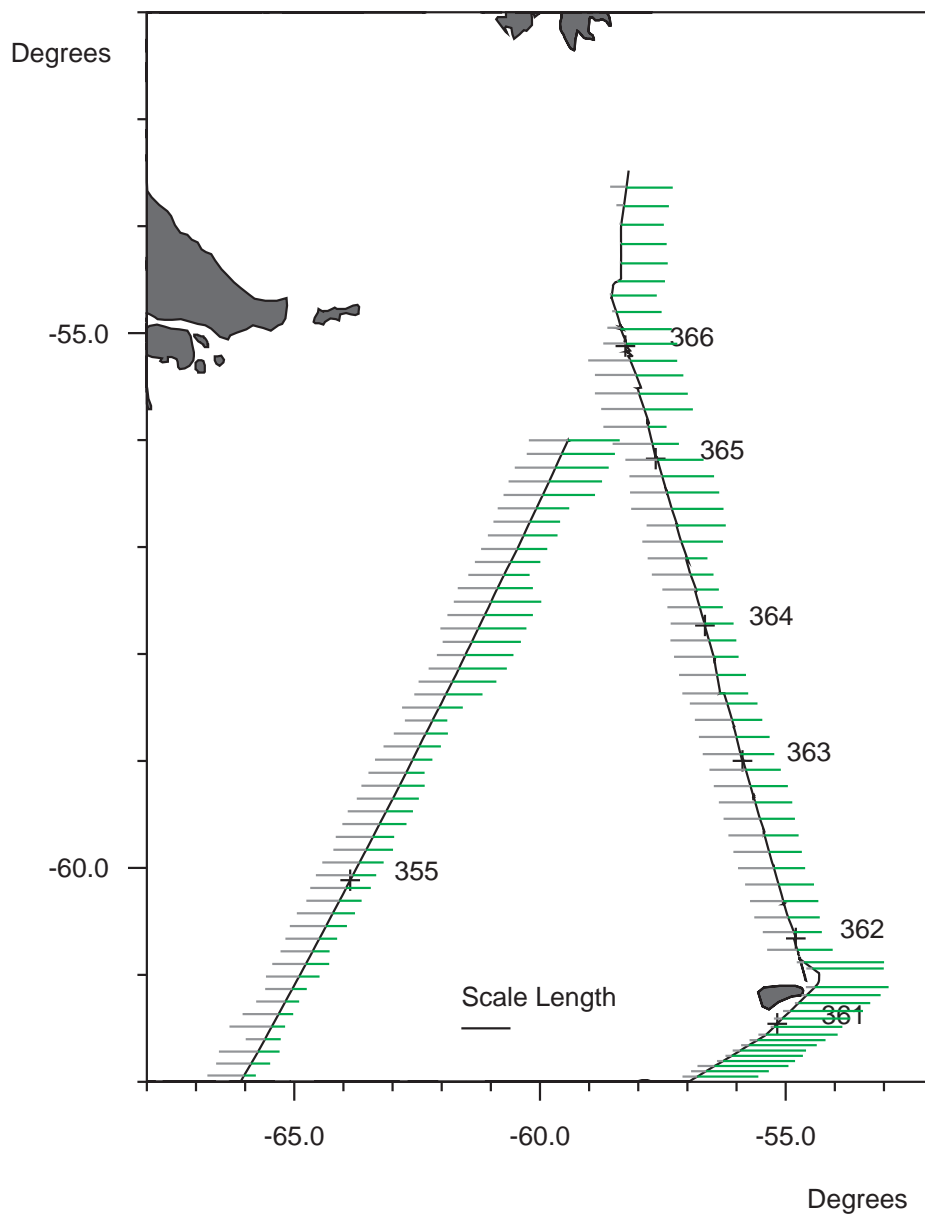


Figure 6.9: Comparison of depth (grey bars) and salinity measurements (green bars) made during JR81. The numbers indicate the position of the ship at midnight before the indicated Julian Day of 2002. Position 366 corresponds to New Year. The scale length corresponds to a depth of 5000 m or a salinity of 0.5 above the zero length value of 33.5.

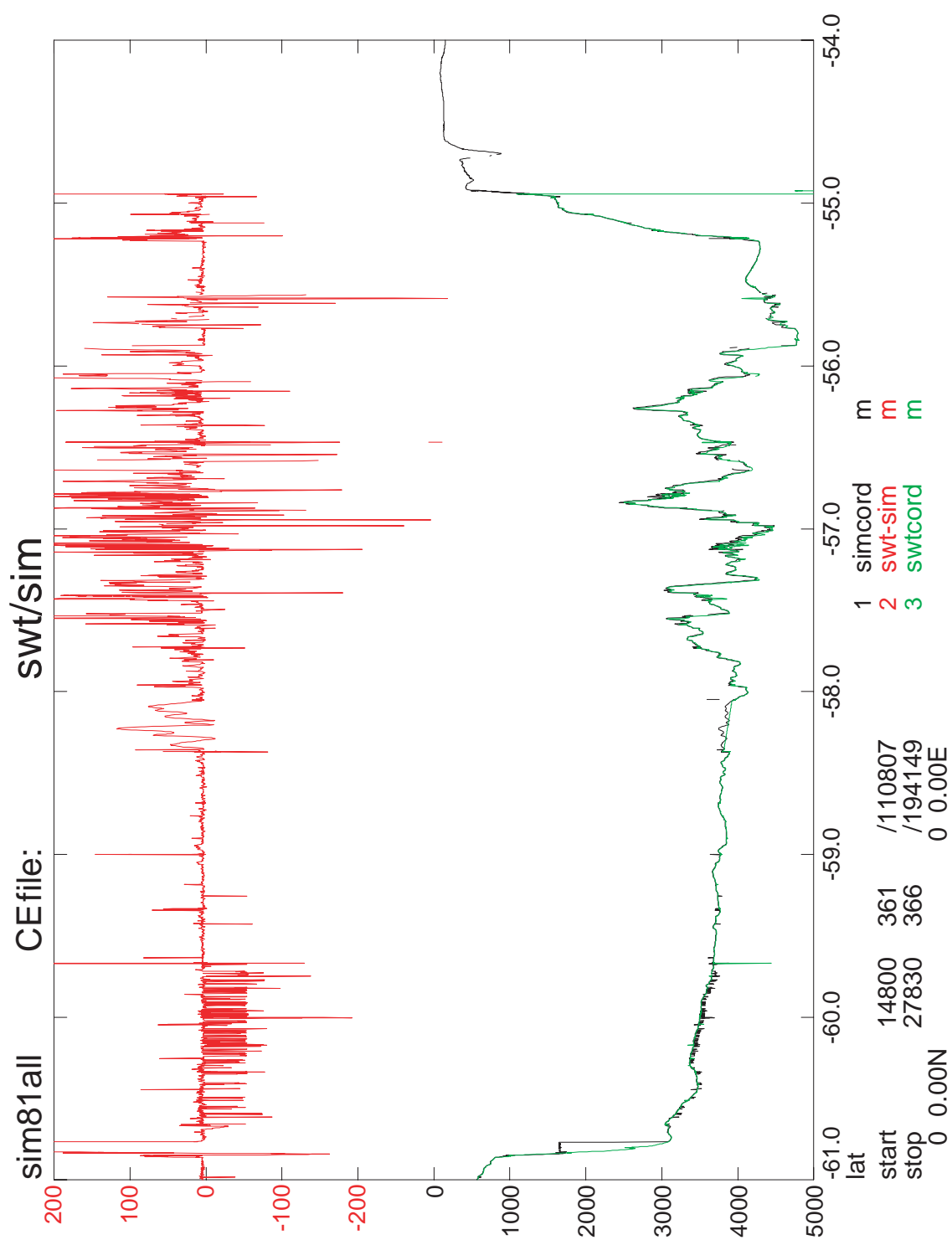


Figure 7.1: Comparison of Simrad EA500 echosounder bathymetry (black) and EM120 swath bathymetry from centre beam (green); the difference (EM120 minus EA500) is shown in red.