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James Rennell Centre
for Ocean Circulation

INTERNAL DOCUMENT No. 12

Meteorological data from RRS *Charles Darwin* Cruise 73

S K Ward, R W Pascal & K G Birch

1993

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Institute of
Oceanographic Sciences
Deacon Laboratory

Natural Environment Research Council

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Contents

1. Introduction

This report summarises the meteorological data from the IOSDL MultiMet system collected during RRS Charles Darwin cruise 73 and supplied to the Woods Hole Oceanographic Institute (WHOI).

2. Instrumentation

The deployment of meteorological instruments on this cruise took place on 27th and 28th September 1992 and is described in the mobilisation report (Appendix A). The instruments were removed on 2nd November 1992, by R.Pascal and K.Birch. Notes made at that time are given in Appendix B. Table 1 summarises the instrumentation fitted to the ship. Figure 1 shows a schematic view of the sensors in position.

3. Data Processing

The general form of the data processing used is described by (Birch et al., 1993). The *PEXEC* programs named are described in the online *PEXEC* manual. The data were received at the James Rennell Centre on magnetic tape in RVS format. The data were converted to pstar format using the program *datapup*, which produced a raw data file containing the voltage values from the MultiMet logger. This was calibrated using the program *mcalms* which requires a file, *coeffs.cd73*, containing the calibration coefficients for the various instruments. The calibration of the instruments is discussed in Section 4. The header for the *phydata.cd73* file produced by program *mcalms* is shown in Figure 2.

Time series plots of the temperature, pressure and radiation data (Figures 3 to 6) showed that the data contained a significant number of spikes. These are evident for example on the port foremast dry bulb on days 274 and 275 (Figure 3) and on several of the sensors from day 287 onwards (Figures 3, 4, 5). These were removed using the PEXEC programs *pedita* and *plxyed*, the latter being an interactive on-screen editing program. A listing of the data cycles replaced with absent data values by *plxyed* is contained in the file *edit_recs*. The number of data cycles removed for each variable in the despiking process is shown in Table 3. The despiked temperature, pressure and radiation data is shown in Figures 8 to 11. The temperature data (Figure 8) for days 290 to 297 appears to contain noise. The cause of this is unknown, and no attempt was made to remove the noise by further editing.

Navigation data for the cruise was included on the RVS tape, and had already been processed to a stage where the ship's speed, direction and heading were available. This data was merged onto the despiked meteorological data to produce the file *phydspi.cd73*. The header for this file is given in Figure 7.

4. Contents of Data Tape

The files contained on the tape supplied to WHOI are as follows:-

coeffs.cd73 - input file for *mcalms*, containing calibration coefficients.

phydata.cd73 - pstar file containing data in geophysical units.

phydspi.cd73 - pstar file containing data as above, but with spikes removed, navigation data and true wind data included in file.

edit_recs - ASCII file containing records of data cycles replaced with absent data by *plxyed*.

The files were copied onto the tape using the UNIX command, 'tar cvfb /dev/rst0 1024 *' and can be extracted using the command, 'tar xvfb <device name> 1024 *'.

5. Sensor Calibrations

5.1 Temperatures

The temperature sensors were calibrated against a Standard Thermometer by submersion in a stirred bath. A comparison between pre- and post-cruise calibrations was made, and the results are shown in Table 4. The difference between temperatures calculated using the original coefficients and those calculated using the post-cruise ones is less than 0.1°C except where the frequency modulated signal was >2300Hz. This was equivalent to temperatures greater than 32°C. Since Figure 3 shows that the temperature on the cruise did not exceed 28°C, it was decided to use the original pre-cruise coefficients.

The temperature sensors were also compared with each other to ensure that no individual instrument was reading high or low. This was done by selecting data from the times when the wind was coming over the bow of the ship, that is wind directions from 160° to 200° (where 180° represents winds on the bow), and calculating the mean temperature from each sensor. This ensured that both sensors were similarly exposed to the air flow. The results are shown in Table 5.

The sensors agreed to within 0.1°C or better, and so no corrections were thought necessary.

5.2 Pressure

The pressure sensor is calibrated against a Precision Aneroid Barometer. A re-calibration of the barometric standard required an additional correction:

$$P_{new} = P_{old} \times 0.9924079469 + 6.741248$$

which has been applied to the data in the despiked file, *phydspi.cd73*.

5.3 Radiation

The only calibration values available for the radiation sensors are those supplied by the manufacturers. The values used are shown in Table 2.

5.4 Winds

Wind speed and direction sensors were calibrated in a wind tunnel. Note that a relative wind of 180° represents the wind on the bow. Once the Navigation data was merged onto the met data, the true winds were calculated using the program *truecalc*.

6. References

Birch, K. G., E. C. Kent, R. W. Pascal and P. K. Taylor, 1993: *MultiMet Scientific Users Manual.* James Rennell Centre Internal Document No. 10.

7. Tables

Variable	Sensor Description	Position	Var. Name	Chan. No.
Longwave Radiation	Eppley Radiometer	Foremast top	lwmt	1
Shortwave Radiation	Kipp and Zonen Solarimeter	Foremast (Stbd)	swms	2
Shortwave Radiation	Kipp and Zonen Solarimeter	Foremast (Port)	swmp	3
Wind Direction	Young Propeller Vane	Foremast	ydfm	5
Wet Bulb Air Temperature	Vector Psychrometer	Foremast (Port)	vwfmp	13
Dry Bulb Air Temperature	Vector Psychrometer	Foremast (Port)	vdfmp	14
Wet Bulb Air Temperature	Vector Psychrometer	Foremast (Stbd)	vwfms	15
Wet Bulb Air Temperature	Vector Psychrometer	Foremast (Stbd)	vdfms	16
Air Pressure	IOSDL Barometer	Laboratory	PRESS	19
Wind Speed	Young Propeller Vane	Foremast	ysfm	22
Ship's Head	Gyro	Laboratory	gyro	30

Table 1: Summary of instruments deployed on Cruise 73. The columns give the variable measured, type of instrument used, the position of the instrument on the ship, the variable name in the data file and the MultiMet channel number to which the instrument was connected.

Cruise : DARWIN 73 (WHOI cruise)				
CH.	Variable	Serial No.	Formula	Position
1	Rad Long Wave	27225F3	((8190-HEX Value)/819)*4.17E-3	Mast Top
2	Rad Short Wave	871958	((8190-HEX Value)/819)*4.52E-3	FwdMast Stbd
3	Rad Short Wave	902837	((8190-HEX Value)/819)*4.51E-3	FwdMast Port
4	N/C			
5	Young DIR	YG6992	((8190-HEX Value)/819)*72	Fwd Mast
6-12	N/C			
13	Psychrometer Vector WET Electronics	VI1065 43W	HEX Value/6.25 CO -21.26299 C1 3.054931 E-3 C2 7.284154 E-6 C3 7.988612 E-10	FwdMast Port
14	Psychrometer Vector DRY Electronics	VI1065 44D	HEX Value/6.25 CO -21.40524 C1 2.329264 E-3 C2 7.192338 E-6 C3 6.513675 E-10	FwdMast Port
15	Psychrometer Vector WET Electronics	VI1066 25W	HEX Value/6.25 CO -20.90085 C1 2.47122 E-3 C2 7.532635 E-6 C3 7..279925E-10	FwdMast Stbd
16	Psychrometer Vector DRY Electronics	VI1066 26D	HEX Value/6.25 CO -20.61619 C1 7.03344 E-4 C2 8.09891 E-6 C3 5.186331 E-10	FwdMast Stbd
17-18	N/C			
19	Air Pressure	IO0001	HEX Value/6.25 CO -2.3721320E3 C1 1.6222621	Lab
20-21	N/C			
22	Young AQ Speed	YG6992	(HEX Value/50)/9.86428E-2	Fwd Mast
23-29	N/C			
30	Ships GYRO		(HEX Value)*1.4117	

Table 2: Calibration equations and coefficients for the sensors deployed on CD73.

Variable	Name	No. spikes	Variable	Name	No. spikes
Port wet bulb temp	vwfmp	21	Pressure	PRESS	71
Port dry bulb temp	vdfmp	364	Longwave radiation	lwmt	93
Stbd wet bulb temp	vwfms	16	Port shortwave rad	swmp	1
Stbd dry bulb temp	vdfms	35	Stbd shortwave rad	swms	0

Table 3: Number of spikes removed for each variable.

Freq/Hz	Approx temp/°C	VI1065 Dry Bulb	VI1065 Wet Bulb	VI1066 Dry Bulb	VI1066 Wet Bulb
1400	-2.2	-0.02	-0.05	0.03	-0.01
1500	0.5	-0.03	-0.05	-0.01	-0.05
1600	3.5	-0.04	-0.05	-0.04	-0.07
1700	6.5	-0.04	-0.04	-0.05	-0.08
1800	9.9	-0.04	-0.04	-0.05	-0.08
1900	13.5	-0.04	-0.04	-0.05	-0.08
2000	17.2	-0.03	-0.04	-0.05	-0.08
2100	21.2	-0.04	-0.04	-0.05	-0.09
2200	25.5	-0.04	-0.05	-0.06	-0.10
2300	29.9	-0.06	-0.06	-0.09	-0.13
2400	34.6	-0.09	-0.09	-0.12	-0.18
2500	39.5	-0.13	-0.11	-0.18	-0.25

Table 4: Comparison between pre- and post-cruise calibrations for temperature sensors. For each sensor the temperature readings were calculated for the standard frequencies shown using the calibration coefficients obtained in pre-cruise and post cruise calibrations. The Table shows the difference (pre cruise - post cruise) in °C.

	Foremast, Port °C	Foremast, Starboard °C	Difference(P-S) °C
Wet Bulb	20.53 ± 0.07	20.47 ± 0.02	0.05 ± 0.08
Dry Bulb	23.17 ± 0.02	23.28 ± 0.02	0.10 ± 0.03

Table 5: Comparison of mean temperatures from each sensor for winds over the bow only.

8. Figures

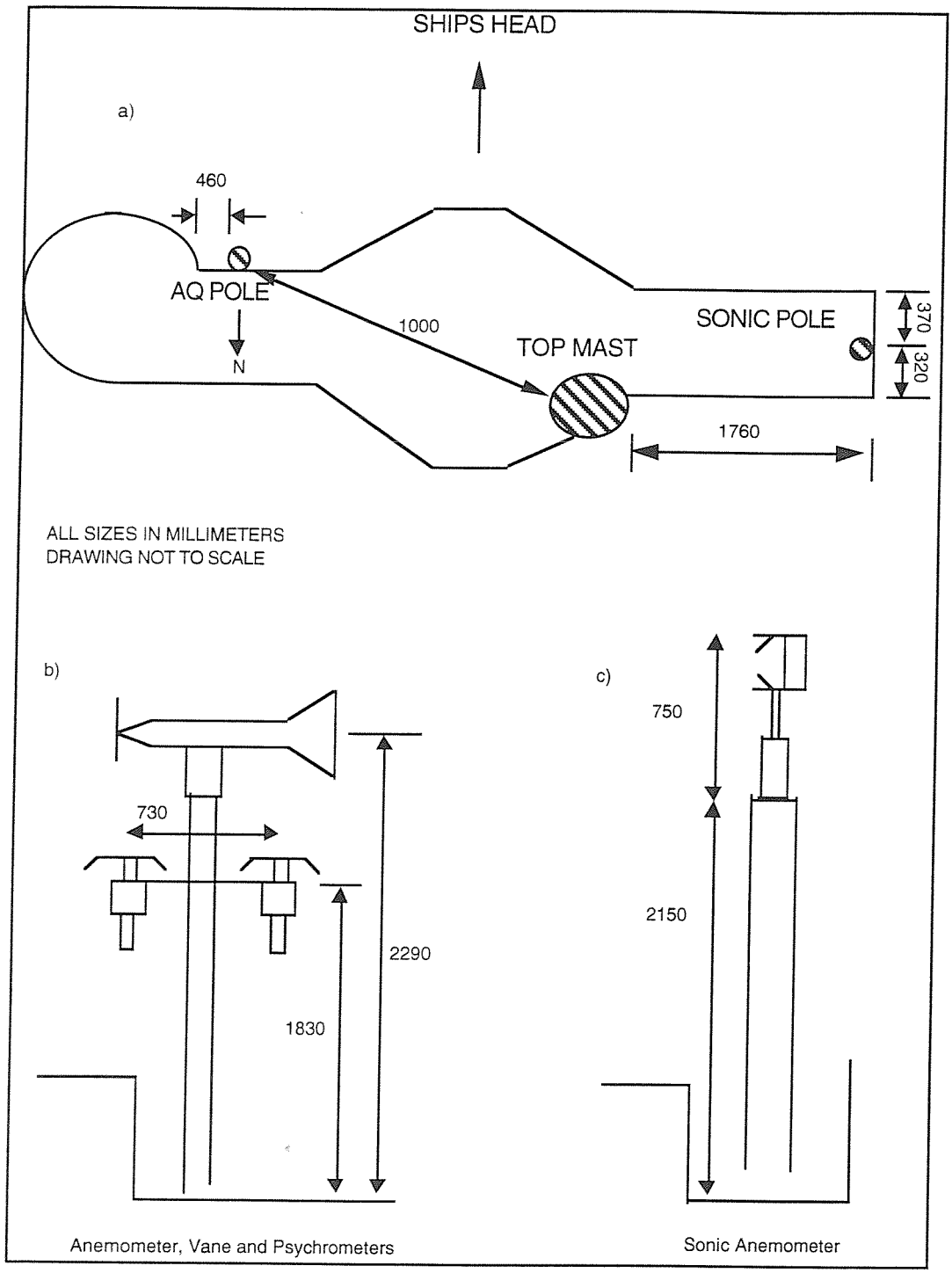

Figure 1: Foremast Sensor Positions. a) Plan view of mast. b) Wind vane pole. c) Sonic anemometer pole

```
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                              Data Name: *multimet  ruKN*          Postfl:
                                         ****************

Even samp:60       Seconds
Archive flag: N                          Platform                Depth of  Depth of
Raw data flag: P              **Type** ****Name**** *Number*  instrument  water
Instrument:                                                        0.00M     0.00M

Fields (Vars):  13    Data cycles:  36688    (2/3D: NROWS:   0   NPLANE:   0)
Start time:19/920101/000000  Position:  0.0000   0.0000( 0  0.00N   0  0.00E)
*********************************************************************************
*   Field    * Units  *   Lower Limit   *   Upper Limit   * Absent data val *
*********************************************************************************
*  1.time    *seconds *    23672027.750 *    25924722.500 *        -999.000 *
*  2.jday    *days    *         273.982 *         300.055 *        -999.000 *
*  3.lwmt    *w/m2    *         167.479 *         438.023 *        -999.000 *
*  4.swms    *w/m2    *       -2178.239 *         600.940 *        -999.000 *
*  5.swmp    *w/m2    *       -5506.495 *         599.592 *        -999.000 *
*  6.ydfm    *degrees *       -1921.580 *         339.077 *        -999.000 *
*  7.vwfmp   *degc    *          15.527 *        1600.274 *        -999.000 *
*  8.vdfmp   *degc    *         -19.470 *        1428.670 *        -999.000 *
*  9.vwfms   *degc    *          -1.158 *         244.683 *        -999.000 *
* 10.vdfms   *degc    *          17.411 *        1261.640 *        -999.000 *
* 11.PRESS   *Mbar    *       -2372.130 *        1225.918 *        -999.000 *
* 12.ysfm    *m/s     *           0.000 *          57.678 *        -999.000 *
* 13.gyro    *degrees *           1.412 *       20747.727 *           0.000 *
*********************************************************************************

Comment:
```

Figure 2: Standard Pstar file description for original data file.

Figures 3 to 6. (page 8):

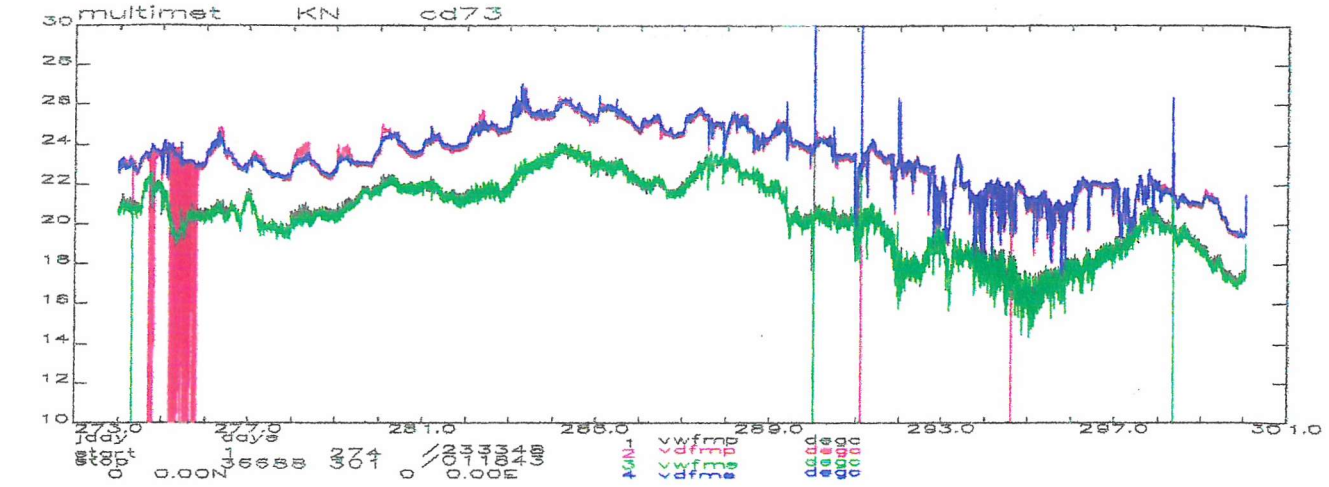
These are, from the top:-

Figure 3: Temperature data from foremast port wet and dry bulbs (variables vwfmp and vdfmp respectively), and foremast starboard wet and dry bulbs (vwfms and vdfms) from the data file *phydata.cd73*.

Figure 4: Pressure data from the data file *phydata.cd73,* variable name PRESS.

Figure 5: Longwave Radiation data from the Eppley Radiometer on the foremast top, variable name lwmt from the data file *phydata.cd73.*

Figure 6: Shortwave Radiation data from the foremast port and starboard Solarimeters (variables swmp and swms respectively) from the data file *phydata.cd73*.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stop
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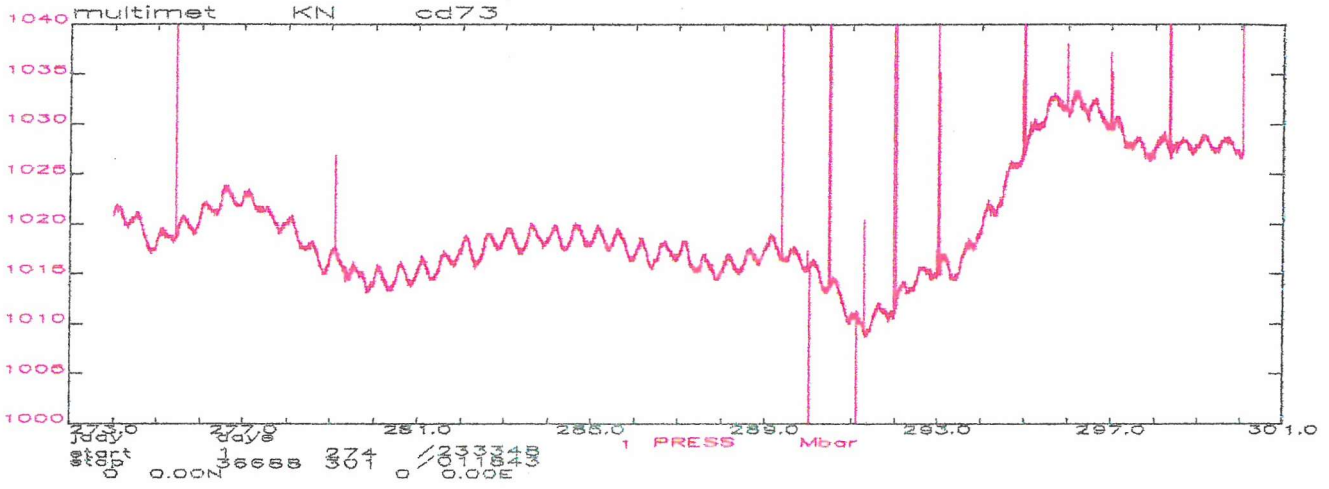
degc degc degc degc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days
start
stop
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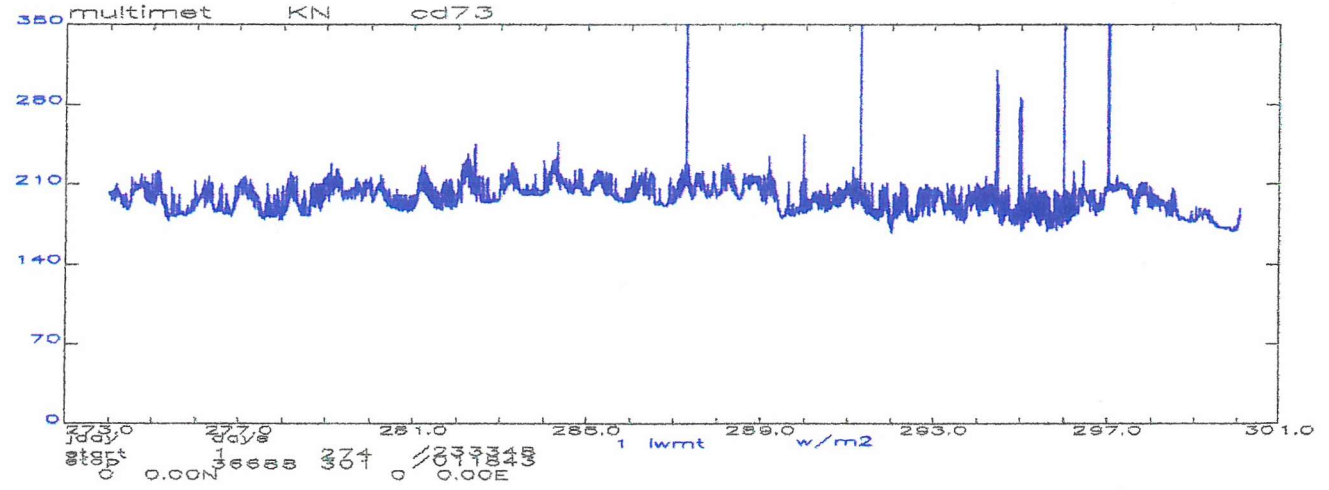
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start
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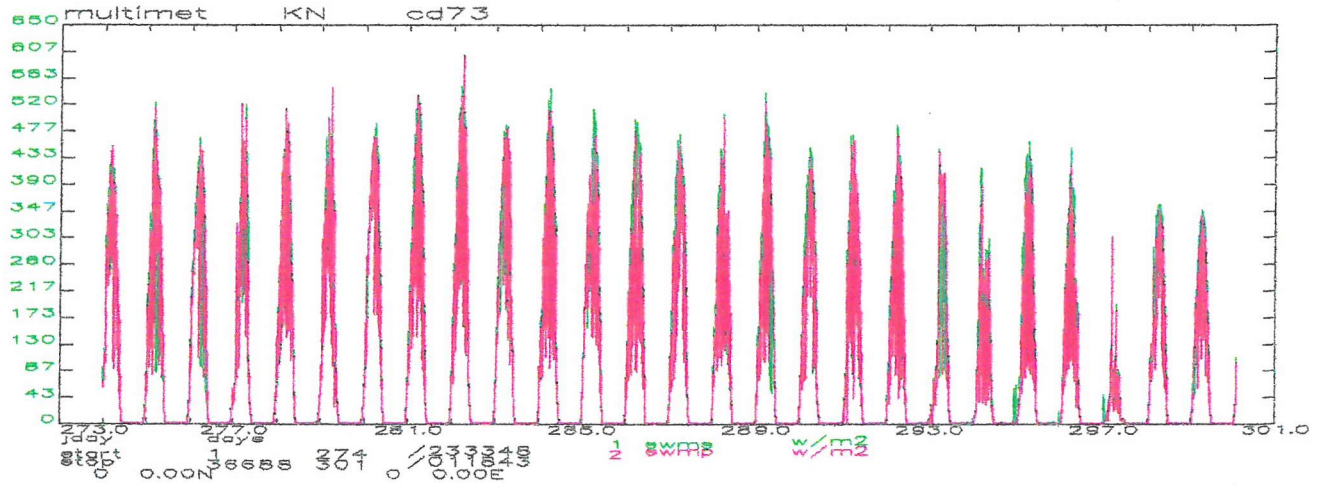
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days
start
stop
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2 swmp w/m2

```
DATA DESCRIPTION
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                                Data Name: *multimet  ruLL*          Postfl:
                                           ****************

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Archive flag: N                            Platform                Depth of  Depth of
Raw data flag: P              **Type** ****Name**** *Number*  instrument  water
Instrument:                                                        0.00M     0.00M

Fields (Vars):  19     Data cycles:  36681     (2/3D: NROWS:   0   NPLANE:   0)
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*   Field     * Units  *   Lower Limit   *   Upper Limit   * Absent data val *
*********************************************************************************
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*  2.lwmt     *w/m2    *         167.479 *         242.435 *         -999.000 *
*  3.swms     *w/m2    *          -0.540 *         600.940 *         -999.000 *
*  4.swmp     *w/m2    *           0.271 *         599.592 *         -999.000 *
*  5.ydfm     *degrees *          21.099 *         339.077 *         -999.000 *
*  6.vwfmp    *degc    *          15.527 *          24.075 *         -999.000 *
*  7.vdfmp    *degc    *          17.308 *          27.059 *         -999.000 *
*  8.vwfms    *degc    *          14.282 *          24.040 *         -999.000 *
*  9.vdfms    *degc    *          17.411 *          27.032 *         -999.000 *
* 10.PRESS    *Mbar    *        1007.748 *        1032.219 *         -999.000 *
* 11.ysfm     *m/s     *           0.000 *          22.191 *         -999.000 *
* 12.gyro     *degrees *           1.412 *         359.983 *         -999.000 *
* 13.lat      *degrees *          17.925 *          37.733 *         -999.000 *
* 14.lon      *degrees *         -35.001 *         -16.905 *         -999.000 *
* 15.cmg      *degrees *           0.052 *         359.848 *         -999.000 *
* 16.smg      *knots   *           0.009 *          16.454 *         -999.000 *
* 17.heading  *degrees *          -1.000 *         359.879 *         -999.000 *
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*********************************************************************************

       Comment:
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Figure 3: Standard Pstar file description for despiked data file.

Figures 8 to 11 (page 10):

Figure 8: **Despiked temperature data for foremast port wet and dry bulbs (variables vwfmp and vdfmp) and foremast starboard wet and dry bulbs (vwfms and vdfms) from the file *phydspi.cd73*.**

Figure 9: **Despiked pressure data, variable name PRESS from the file *phydspi.cd73*.**

Figure 10: **Despiked longwave radiation data, variable name lwmt, from the file *phydspi.cd73*.**

Figure 11: **Despiked port and starboard shortwave radiation data, variables swmp and swms respectively, from the file *phydspi.cd73*.**

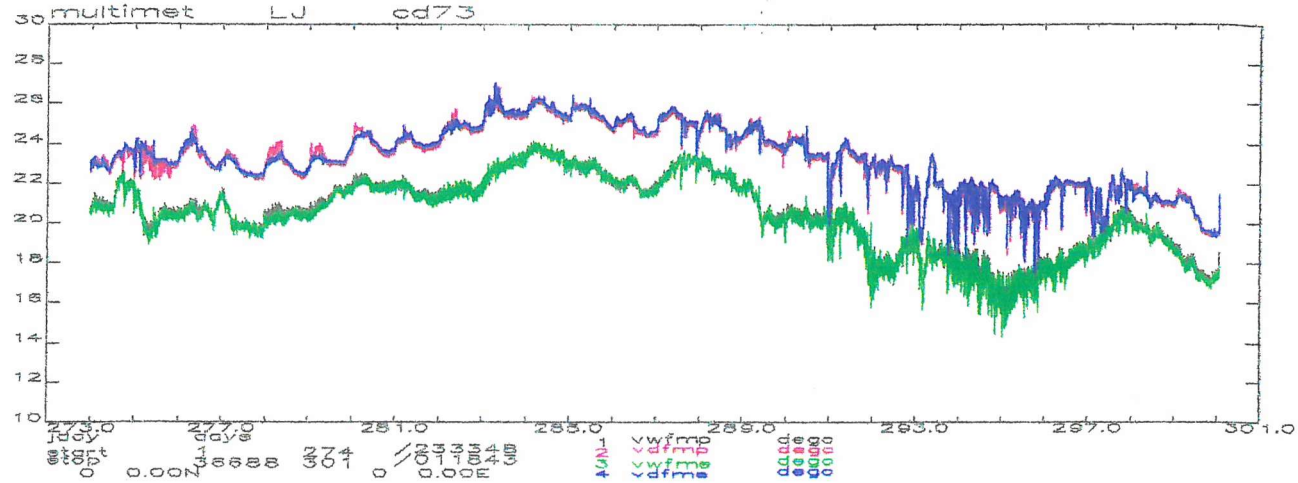
Figures 12 to 15 (page 11):

Figure 12: **Wind speed and direction relative to the ship, variables ysfm and ydfm respectively, from the file *phydspi.cd73*.**

Figure 13: **Ship's direction over ground (variable name cog), ship's head (variable name gyro) and ship's speed relative to the ground (variable name smg) from the file *phydspi.cd73*.**

Figure 14: **True wind speed from the file *phydspi.cd73*.**

Figure 15: **True wind direction from the file *phydspi.cd73*.**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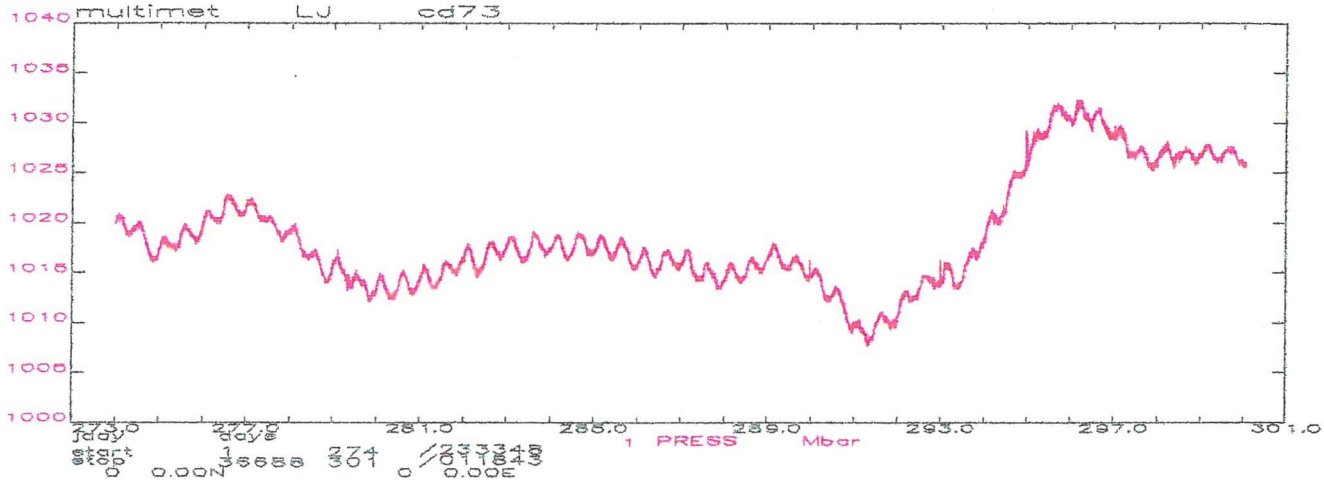
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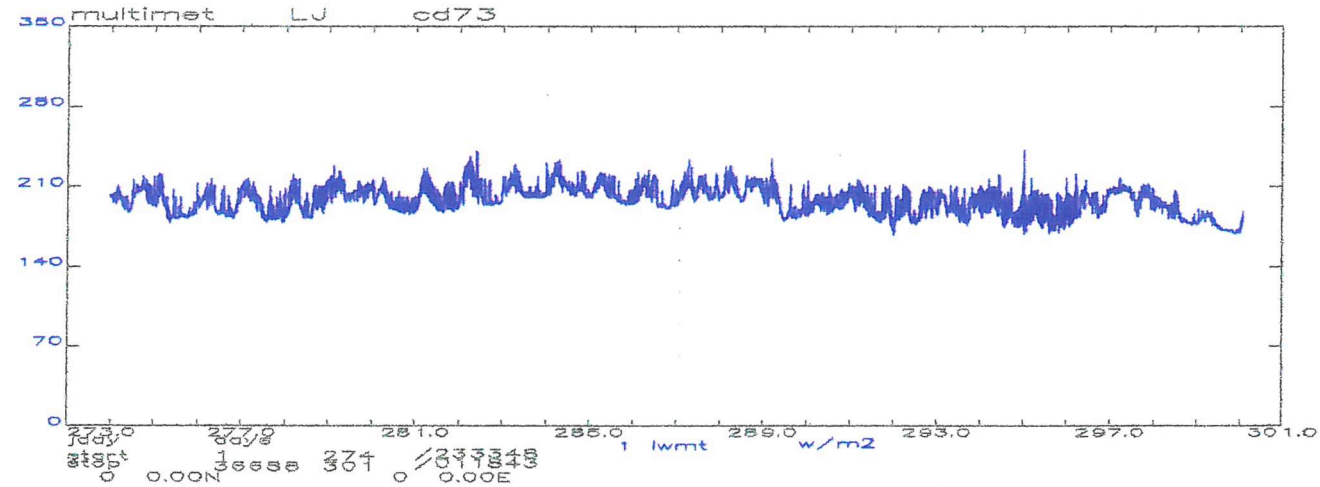
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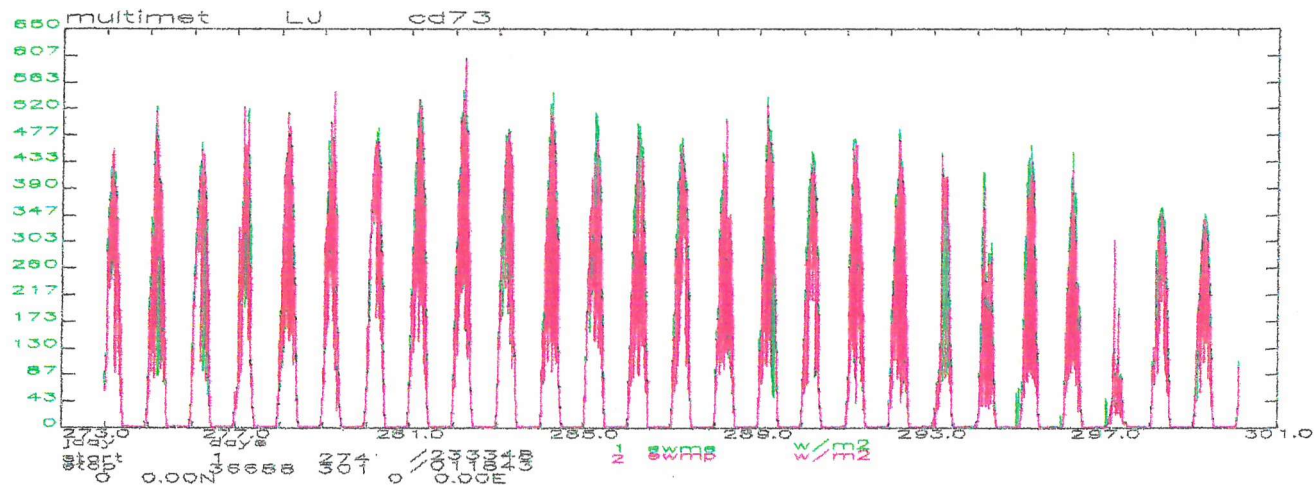
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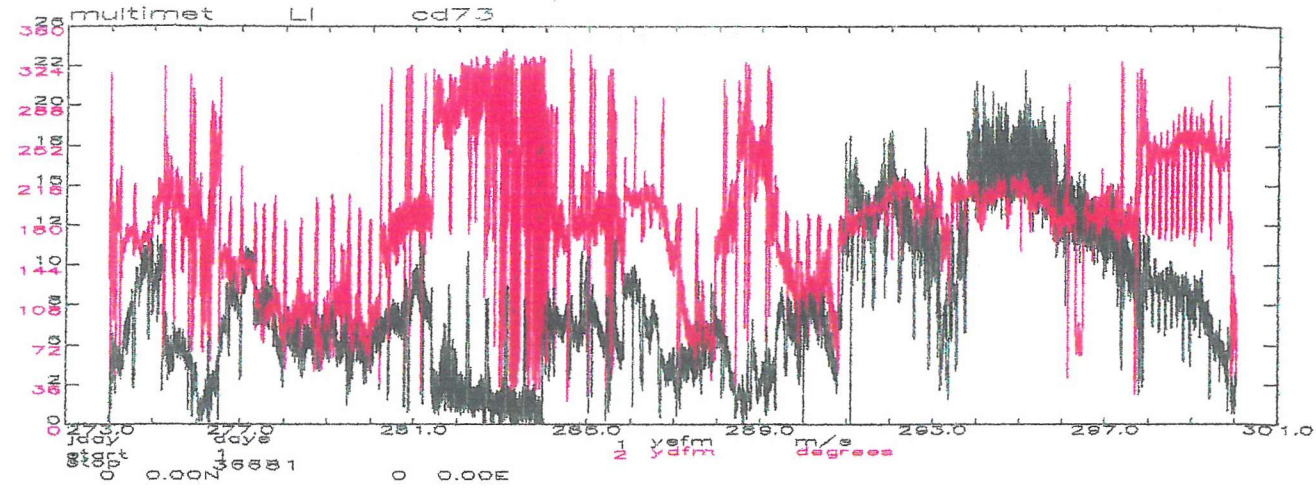
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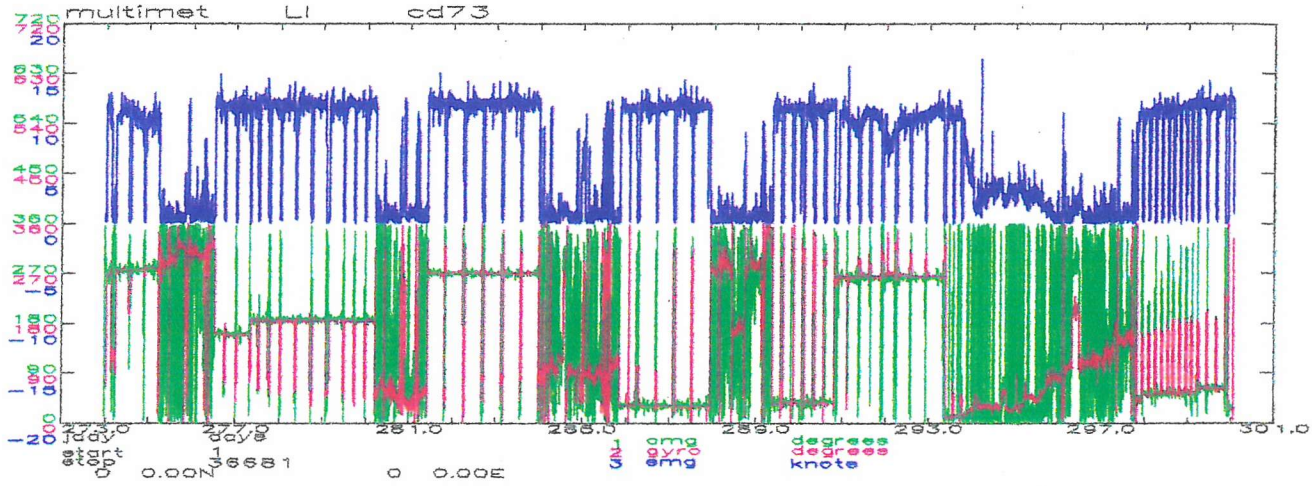
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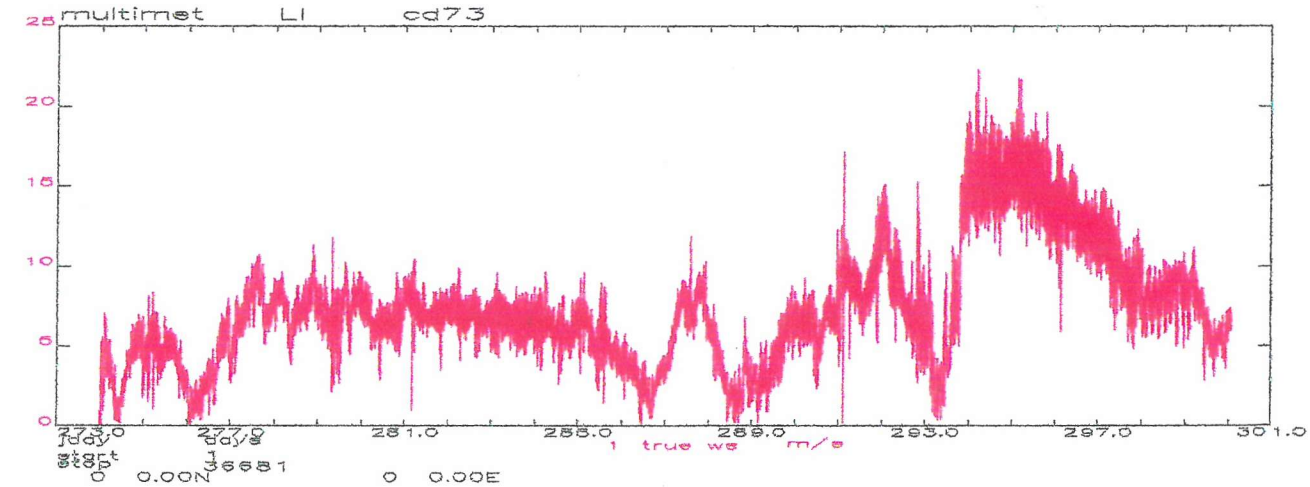
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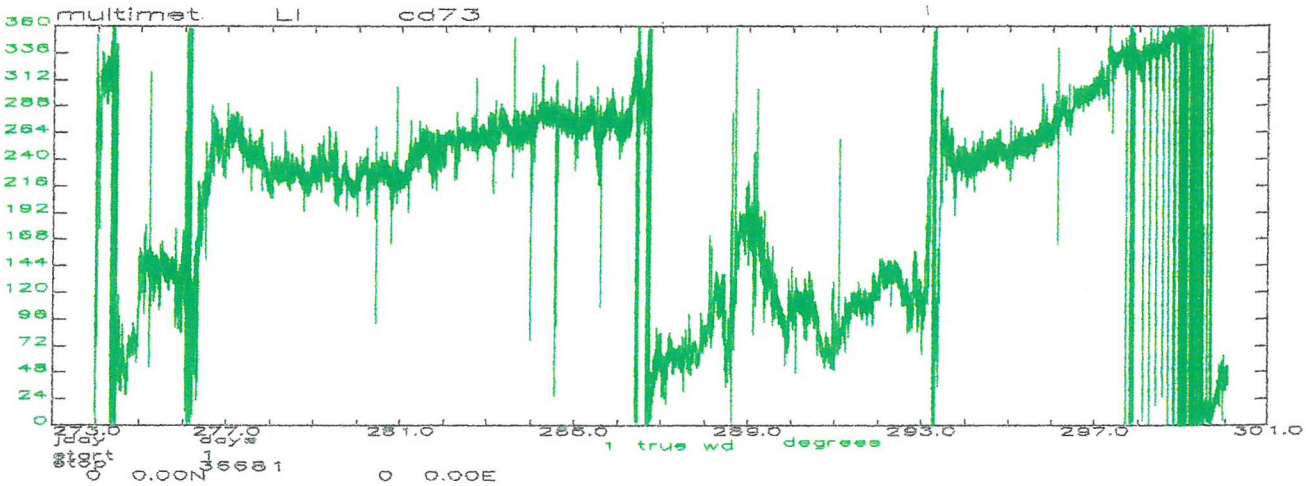
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Appendix A: DARWIN CRUISE 73 (WHOI) MOBILISATION

This Appendix reproduces the notes made by Robin Pascal during the deployment of instrumentation on the Charles Darwin prior to Cruise 73.

I arrived at my Hotel in Funchal on Sunday morning at 0200 hrs, experiencing little problem during the flights to Madeira and had no trouble with customs etc with my tool box and bits. It is worth noting however, that the airport security will not allow floppy disc's to be passed around the screening machine for hand luggage, they say to do so is now illegal.

Darwin docked at Funchal on the evening of Sat 26th Sept and loading was well under way by 10:00 am the following morning, when I arrived at the docks.

The two systems that had been installed for the previous cruise72 (Lampitt) and MultiMet were all powered down . The first task was to power up the SBWR and SONIC systems and check what state they were in. Initial inspection showed that the clock of the SBWR PC was 9 minutes fast where as the SONIC PC showed the correct time, the SBWR was reset to GMT as given by the ships clocks.

MultiMet

The installation of the MultiMet system began with the deployment of all the sensors on the forward mast , see calibration form. The initial deployment of the sensors i.e. sensors attached, but cables and interface boxes not yet fixed in place, was completed late on Sunday. The MultiMet logger and MetMan system were set-up, in the plot, while Darwin was in Barry. Therefore the system was powered up and the correct date and time were programmed into MultiMet.. MetMan program as used on SOFIA was modified with the correct calibrations and set running over night.

On Monday morning the sensors were compared to check their performance. The Psychrometers agreed within 0.1 deg on all four temperatures (WET bulbs were still dry). Air Pressure sensor located in the plot gave a 0.5 mbar higher reading than that read from the bridge barometer. The long and short-wave Radiation sensors showed a mix-up in the channel allocations but both short-wave sensors appeared to be working OK, whereas the long wave was giving very low readings. The amplifier boxes were swapped over, which corrected the channel mix-up, but the Long wave sensors internal battery had become flat. This is a special 1.35 Volt battery and not readily replaceable, fortunately the Americans had a battery of the same voltage but of larger size. This was fitted (just) into the Epply which was then re deployed on top of the forward mast giving no further problems.

Young AQ wind monitor showed sensible wind speed and direction readings, but on closer study of the MetMan program it was realised that the wrong calibration was being applied to the wind direction i.e. a value of 144 as used on the Young Gill instead of a value of 72 which should be used with the Young AQ. This then showed that the sensor was miss aligned and needed rotating by 180 degrees. Further modifications were required to the MetMan program so that the Young AQ speed was displayed on the small bar graph and that the direction was used in the compass rose display.

When the data appeared to be correct and all wiring was secured in place the Eprom Logger was installed into the MultiMet frame. This required MultiMet to be Powered down while the three Eprom memory cards were inserted into the frame. The system was the powered up an the Eprom Logger set-up was checked:

SET-UP:-

BOARDS	3
CHIPS	0
BYTES PER RECORD	68
Next Eprom free address	0 HEX
Number of files opened	0

The MultiMet time and date were reprogrammed and the Watch Dog timer was set on. A file was opened on the Eprom Logger - WHOI. A few records were recorded by the logger and checked by typing DUMP-DATA producing good recorded data.

The MultiMet system was shown to the prime WHOI met person (Richard Payne) , how to operate the MetMan system, change the calibrations if needed, check the MultiMet LED's etc. I showed him the New MultiMet Manual and went through the major processes in the manual like changing the MultiMet time. They were interested in trying to use PSTAR on the ships computing, I showed them the Met disc and instructions in the manual and how to edit the Coeffs file. I didn't have to much time to spend with them on it , it will be up to them to sort it out at sea.

SONIC

The Sonic was installed in Barry for cruise 72. The system was re-started by applying power which showed it to be functioning correctly. The PC clock was giving the correct time and the PSD values produced over the two days while I was on the ship, seemed to be reasonable. I talked to Bernie Woodly (RVS) who was sailing on the cruise and he said he would put a Floppy disc in the system and change it every two days. There were 20 x 1.4 Mbyte formatted floppy discs on board, which would cover the cruise if changed every other day.

SBWR

Before meeting the ship in Madeira it was discovered that the data from the previous cruise (CR. 72) was incorrect, each file contained that same data repeated. Therefore although the system appeared to be working, it needed close scrutiny to try and find the fault. By halting the control program after each LabTech notebook set-up had been loaded it became apparent that the setup loading was not working correctly. Further examination of the program showed that the code for loading two of the setups were wrong i.e.

SHELL"C:\NB\COPY SETUP\COMP5"

should have been

SHELL"COPY C:\NB\SETUP\COMP5"

This accounted for the final file produced by LabTech notebook never being updated and so the same data was loaded into the final data file.

With the two lines of code corrected the program ran OK but seemed to hang at the end. This was due to the LPRINT statement for printing HS out to a printer, but there was no printer attached to the PC. It is possible that the error handling would cope with the error flag produced, but I decided to be safe and change the LPRINT to a normal PRINT and so avoiding any errors. The program was left to run for a few hours and it produced a number of files all with different data that looked to be good. There was 21 Mbytes of free space on the hard disc, more than enough to last the cruise.

Appendix B: Demobilisation of Charles Darwin on 2nd November 1992

This appendix reproduces the notes made by Keith Birch and Robin Pascal during the demobilisation of met instrumentation from the Charles Darwin following Cruise 73.

MultiMet

Set of data readings from MetMan compared to Bridge values

Sensor	MultiMet Values	Bridge
Young Speed	9.8m/s	
Young Direction	40.7°	
Gyro	94.6 °	
Port Wet	8.9 °	8.8°
Port Dry	12.2°	12.7°
Stbd Wet	8.8 °	9.5°
Stbd Dry	12.3 °	12.0°
Eppley	297 W/m2	
Stbd Kipp	358 W/m2	
Port Kipp	339 W/m2	
Pressure	1001 mb	1000.2 mb
SST		10.7

Readings taken at	307 13:14:01
Logger Reset	307 13:18:00
Eprom Logger terminated	307 13:19:00
MultiMet Clock	8 seconds slow compared to Ships Clock
EPROM Logger Next Free Address	388D11 Hex

Met Conditions Windy with strong gusts blowing the length of the ship from the stern

Data for MultiMet processing from RVS SUN system on DC6150 Tape Cartridge. This is in RVS Format CPIO and can be translated by programs available on JRC SUN system.

Sonic Fast Sampling

Software Clock 56 Seconds slow compared to ships clock. Data is time stamped by software clock. Hardware clock 7min and 26 seconds slow compared to ships clock. Date correct.

Hard Disk data files were copied to floppies, plus data already on backup floppies. Copies of Hard Disc Files are labelled:-

Day 278-281	Day 282-284
Day 285-287	Day 288-290
Day 291-293	Day 294-296
Day 297-299	Day 300-302
Day 303-305	Day 306

Backup Disks Labelled :-

278/20:16 to 281/04:26	281/04:26 to 284/05:54
284/0:58	disc full, last file written F2872015.MWS
289/13:20 to 291/13:20	288/11:00 to 289/12:17
291/13:20 to 294/10:04	294/10:04 to 297/16:20
297/16:21 to 300/10:53	
300/10:53 to 307/11:11	disc full. last file written F3032015.MWS

SBWR

Software Clock 1min 4 seconds slow compared to ships clock. Data is time stamped by software clock. Hardware Clock 14 seconds slow compared to ships clock. Date correct.

Data files copied to disc. Copies of Hard Disc Files are labelled:-

F271-F279	S271-S279
F280-F289	S280-S289
F290-F299	S290-S299
F300-F306	S300-S306

Transport

KGB and RWP Guildford to Barry in Hire Peugeot 505 Estate - 07:15 - 22:00

Hire Car Delivered to RWP's house 31/10/92. Returned to IOS morning 3/11/92.

Hardware still to be removed

The gimbal mount on top of the Forward Mast was not removed due to the High Winds.

KGB,RWP, November 3, 1992


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