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James Rennell Centre
for Ocean Circulation

INTERNAL DOCUMENT No. 10

Multimet scientific users guide

K G Birch, E C Kent, R W Pascal
& P K Taylor

1993

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SCOPE OF THIS MANUAL

This Users Manual provides an introduction to the MultiMet system and describes the routine procedures for operating the MultiMet system at sea and for processing the data. It consists of three parts:

Part A. provides a general introduction to the MultiMet system and describes the hardware;

Part B. describes the data processing on NERC ships;

Part C. describes the post-cruise processing (eg. for the OWS Cumulus data).

Fortran code and UNIX scripts that form part of the appendices following all three sections are supplied on disk. All are text files that can be opened into a word processing package, the scripts can be used (following checking and alteration) after they have been transferred back onto the SUN system using ftp.

PART A INTRODUCTION TO THE USE OF MULTIMET ON SHIPS

A1. INTRODUCTION

A1.1. Purpose of this Section

This Section provides a general introduction to the MultiMet system which is used for obtaining one minute samples of the normal meteorological variables (air temperature, humidity, wind, etc.). This system is known as the "MultiMet Slow Sampling System"[1]. The typical hardware installation is described. See Part B of this manual for NERC shipboard operations and Part C for post-cruise processing.

A1.2. Scientific Requirements

A1.2.1 Variables to be Measured

Normally the Slow Sampling MultiMet system is used on cruises in order to determine the air sea fluxes of heat, water vapour, and momentum. This requires measurement of the air temperature and humidity, true wind velocity, sea surface temperature, air pressure, and components of the net radiation budget. The methods of obtaining these data are shown in Table A.1.

A1.2.2 Accuracy sought

Scientifically it is desirable to obtain mean values of the total heat flux to an accuracy of about 10W/m^2. This implies that, when averaged over periods of a day or longer, the variables must be measured to the accuracy shown in Table A.2.

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[1] A separate manual will describe the "MultiMet Fast Sampling System" which samples at 8 Hz and is used to obtain wind spectra for calculation of the wind stress.

Table A.1. Variables to be measured to obtain the air-sea fluxes.

Variable	Sensor(s)	Comments
Air Temperature	Psychrometer	The dry bulb value.
Air Humidity	Psychrometer dry and wet bulbs	Evaporation of water from the wet bulb lowers its temperature by an amount which depends on the air humidity.
True wind velocity	Anemometer and wind vane, compass, Electro-magnetic Log.	The anemometer measures the relative wind, we also need the ships velocity relative to the water[1] and the direction in which the ship is pointed (remember it may be drifting sideways).
Sea-surface temperature	SST Fish, trailing thermistor	Other methods include hull sensor, or thermosalinograph.
Shortwave radiation	Solarimeter	This is the radiation from the sun. We measure the downward component and estimate the upward (reflected) component.
Longwave radiation	Pyrgeometer	This is the heat radiation from the sky, clouds, and sea. We measure the downward component and calculate the upward component (emitted from the sea) from the sea surface temperature value.

Table A.2. Accuracy to be aimed for in meteorological measurements. These values will normally give the desired accuracy in the calculated fluxes under average meteorological conditions.

Variable	Accuracy	Comments
Temperature (dry bulb, wet bulb, and sea surface)	±0.2°C	Individual readings will vary much more than this due to natural fluctuations.
Wind speed	±0.2 m/s or 5%	Which ever is greater
Ship's speed through water	±0.2 m/s	
Wind direction, ship's head	±5°	
Pressure	0.5 mb	(but ±0.1 mb accuracy is required for the ship's meteorological reports)
Radiation components	±5 W/m^2.	After correction for any constant biases

[1] For flux calculation the wind velocity relative to the water is more appropriate than that relative to the solid earth. However it is the latter which is required for ship's weather reports.

A2. HARDWARE

A2.1. MultiMet System

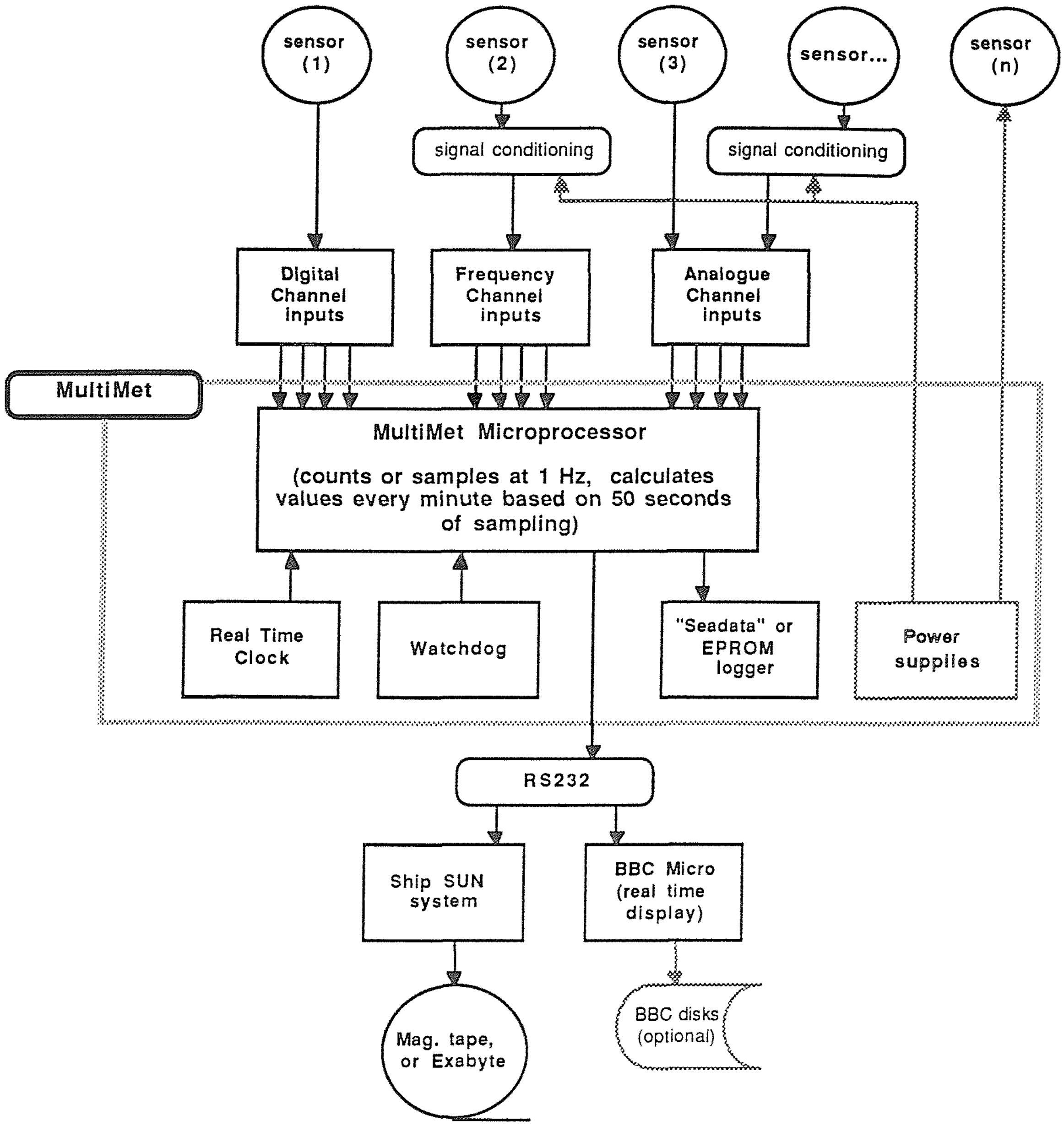

Figure A1. Schematic diagram for the MultiMet system on a NERC ship.

A2.1.1 System Components

Figure A1 shows schematically the MultiMet system layout (Birch and Pascal, 1987[1]). The MultiMet system consists of three main parts: the logger/averaging microprocessor, and the EPROM

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[1] Birch K.G. & Pascal R.W. (1987) A meteorological system for research applications - MultiMet, IERE no. 72, pp.7 - 12.

data storage (both housed together with the power supplies for the sensors and signal conditioning circuits in the MultiMet case) and the BBC Master 128K Computer which is running the MetMan software. All three parts fulfil quite separate functions which are :-

A. Logger/Averaging Microprocessor, this collects the data controlling which channels are selected and performs averaging of the data prior to data output to the EPROM logger, the Master 128K Computer, and on NERC ships, to the ship's SUN computer network.

B. EPROM data storage, the MultiMet data is written via an Output Port to the EPROM logger Microprocessor which stores incoming data in RAM. The data is then written to EPROM from the RAM under control of the EPROM Logger Microprocessor. This microprocessor is separate from that of the MultiMet microprocessor and should have no effect on its operations.

C. Master 128K Computer, this accepts the RS232 serial data output stream from the MultiMet logger and is independent from that of the EPROM logger. The BBC runs a program "MDisplay" which gives a four hour real time display of the sampled data and optionally allows storage of the raw and/or calibrated data on disk.

A2.1.2 MultiMet Logger General Description

The MultiMet hardware (Figure A.2) consists of a microprocessor and associated boards built to the RCA Microboard series 600 Bus Standard, with additional signal processing and multiplexing boards which have a similar design, but do not conform fully to the RCA Standard.

The microprocessor acts as the system controller and data processor. Data is collected over a period, averaged and output to various storage media. Timing of the averaging period and the sampling intervals is derived from a crystal controlled hardware clock, which generates interrupts to initiate software polling of the sensors. During the averaging period the processor runs assembly code routines to control the polling of analogue, digital and frequency channels, enabling each sensor to be sampled; it also performs initial averaging dependent on each sensor type. At the completion of the sampling period the calculations of the mean values are performed using software written in RCA BASIC, and the data is formatted and time stamped prior to storage. There are two types of data output streams from the system, a parallel port to the Eprom Logger, and via an RS232 serial port.

For each of the three data input formats, polling techniques are used to acquire and store the data, the analogue and digital channels are selected through multiplexors in sequence: the frequency sensors are sampled using software counters.

The analogue sensor signals are connected to the anti-aliasing filters by charge transfer circuitry to provide power supply decoupling between individual sensors and the microprocessor. Each filter output is then polled to the input of a A/D converter whose output is stored via DMA control. The software then polls the frequency sensors input before sampling the digital sensors.

The digital sensor data are isolated from the logger with opto-isolators, before being latched under software control. The latch strobe is applied to all digital input latches to ensure simultaneous readings of all data, which can then be polled sequentially by the processor.

Each frequency input channel has an input latch which is set by the rising edge of the sensor signal. Each latch state is tested during the polling sequence and the respective software counter incremented and latch reset on detection of an event occurrence. The time taken to complete the frequency polling routine together with the maximum time for any software module (i.e. poll analogue sensors) determines the maximum allowable input frequency.

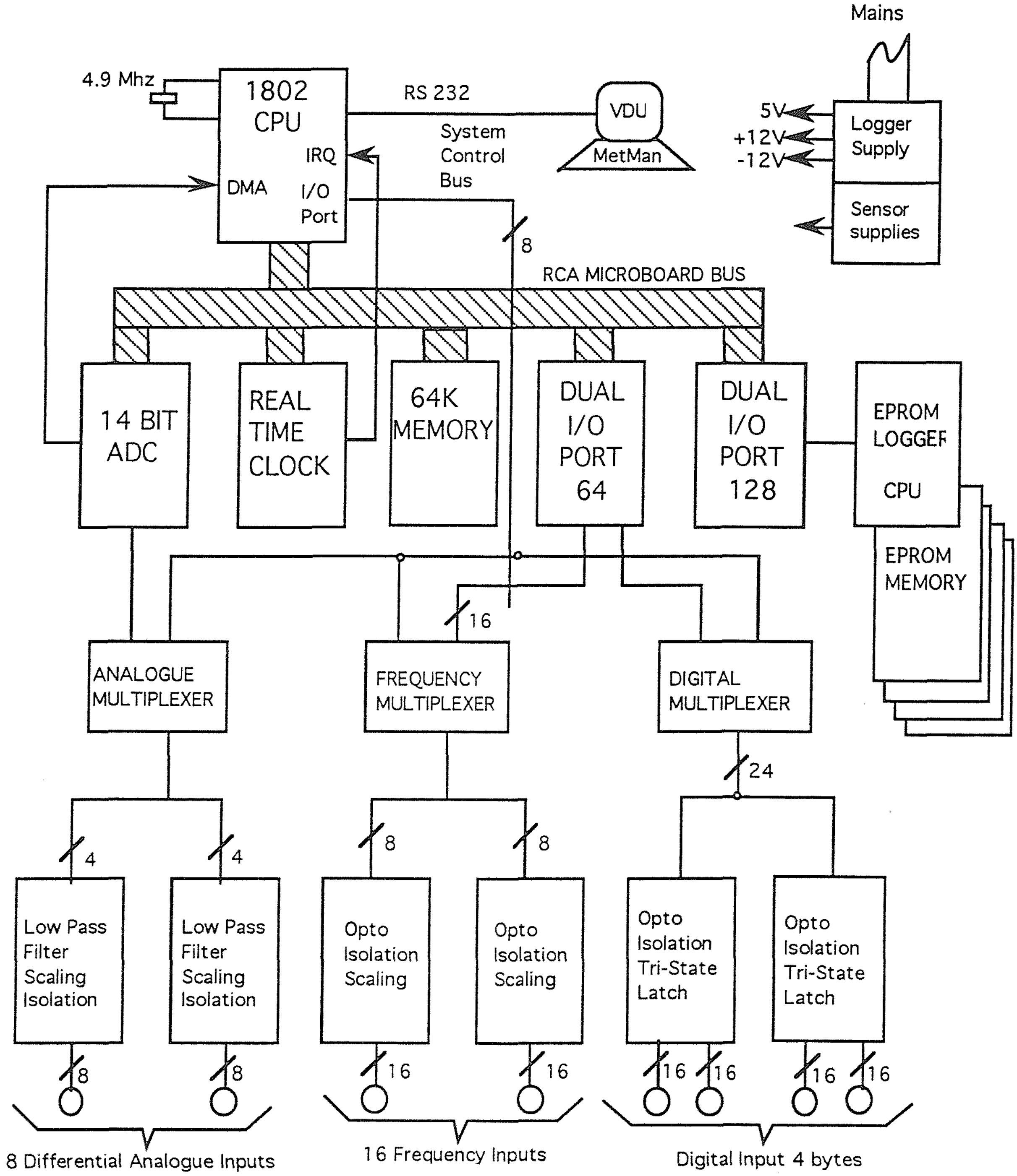

Figure A.2 Block diagram of the MultiMet hardware.

Software algorithms have been developed to cope with each sensor type, for example the calculation of mean direction is specially averaged using a statistical technique to account for the step function in the data set. Care must be taken as these algorithms are only applied to particular channels and sensors, different sensors may not be averaged in the correct way.

Figure A.3 shows the physical layout of the circuit boards in the MultiMet system and Table A.3 contains a description of each of the boards.

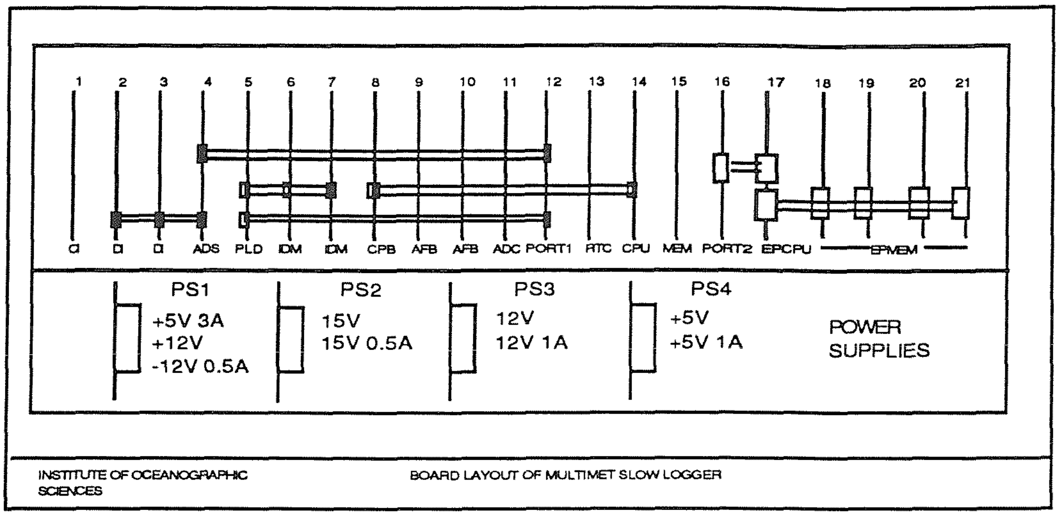

Figure A.3 Physical layout of circuit boards in the MultiMet system

Board label	Description
CI	Compass Interface. The compass data is double buffered to ensure static data during acquisition. A BUSY flag inhibites the sampling of the digital input borad during the update period.
DI	Digital Interface. The board accepts two data bytes of eight bits, which are opto-isolated as two separate channels. Data is strobed into the digital latches simultaneously under software control allowing subsequent sequential polling of the digital channels.
ADS	Analogue/Digital Select. The control codes for the selection of both the analogue and digital sensors is decoded from four bit binary code to sixteen bit select lines.
PLD	Pulse Latch Decoder. Individual latches are set by the incoming frequency signals, and each latch is sequentially read by the CPU by using a polling technique.
IDM	Isolator/Divider Board. This is an eight channel frequency isolator/divider board. The frequency inputs are opto-isolated and then divided by eight before being output to the pulse latch decoder board.
CPB	Control Port Board. This board allows connections from the control port on the CPU to gain access to the logger mother board.
AFB	Analogue Filter Board. The four channel board consists of charge transfer isolation and anti aliasing filters with 1/2 Hz cutoff frequency A four channel switch is used to multiplex each output to the analogue bus.

Table A.3(a) Description of MultiMet circuit boards (continued overleaf)
(* Indicates boards conforming to RCA Microboard Standard.)

Board label	Description
RTC*	Real Time Hardware Clock with battery backup. Used to provide systems interrupts to start the sampling of sensor suite. The data output stream is time stamped using the clock.
CPU*	1802 Processor Unit operating at 4.9 Mhz. RS232 interface at 2400 baud. Output port used to control systems operation.
MEM*	64K Memory See memory Map.
PORT2*	Dual I/O Port Group 128. Parallel data communication to Eprom Logger.

Table A.3(a) (continued) Description of MultiMet circuit boards (* Indicates boards conforming to RCA Microboard Standard.)

Board Label	Description
EPCPU	Eprom Logger Controller board. 1802 processor running FORTH software with a clock speed of 4.9152 Mhz
EPMEM	Eprom Logger memory board. Each board contains 4 Mbytes of eprom storage space and there can be a total of 4 boards within MultiMet giving a maximum capacity of 16 Mbytes.

Table A.3(b) Description of Eprom Logger Boards

PS1	MultiMet Power Supply	Fuses 20mm
	+5V @ 3 Amps	3.1 Amp 250 V
	+12V @ 0.5 Amps	500 mA 250 V
	-12V @ 0.5 Amps	500 mA 250 V
PS2	Analogue Sensor Power Supply	Fuses 20mm
	+15V @ 0.5 Amp	1 Amp 250 V
	+15V @ 0.5 Amp	1 Amp 250 V
PS3	Psychrometer Power Supply	Fuses 20mm
	+12V @ 1 Amp	1 Amp 250 V
	+12V @ 1 Amp	1 Amp 250 V
	Combined to give a 24V supply	
PS4	Wind Speed and Direction Power Supply	Fuses 20mm
	Psychrometer Fan Power Supply	
	+5V @ 1 Amp	1 Amp 250 V
	+5V @ 1 Amp	1 Amp 250 V

Table A.3(c) Description of Power Supply Boards

A2.1.3 Data Recording

The data are recorded in various ways depending on the ship installation (Table A.3).

Table A.3. Means of recording MultiMet data

Data file type	NERC ships	Other ships
Main data file	SUN system file	MultiMet EPROM logger
Backup data file	EPROM logger	BBC system floppy disk
Other	BBC floppy disk (optional)	

A2.2. Meteorological Sensors

A2.2.1 MultiMet Sensors

A typical sensor installation on a research ship is shown in Figure A4. The details of the instrumentation are given in Table A.5. To enable fault diagnosis it is necessary to understand the signal output type of each sensor following any signal conditioning that has been applied[1]. Normally the system is configured for 16 frequency channels (channel numbers 9 to 24), 8 analogue channels (channel numbers 1 to 8), and 8 digital channels (channel numbers 25 to 32). Certain of the digital channels are specifically designed for wind vane data and are specially averaged to give the correct wind direction during 360° to 0° direction fluctuations.

Typical sensors used by MultiMet classified by type of interface are:-

Frequency	Psychrometers i.e. Wet and Dry Bulb Temperatures, Sea Surface Temperature, Wind Speed
Analog	Eppley Long Wave Radiometer, Kipp Short Wave Radiometer,
Digital	Wind Direction, Ship Head Gyro.

[1] Some sensors (e.g. the psychrometers and solarimeters) are connected via signal conditioning circuitry to allow long cable runs.

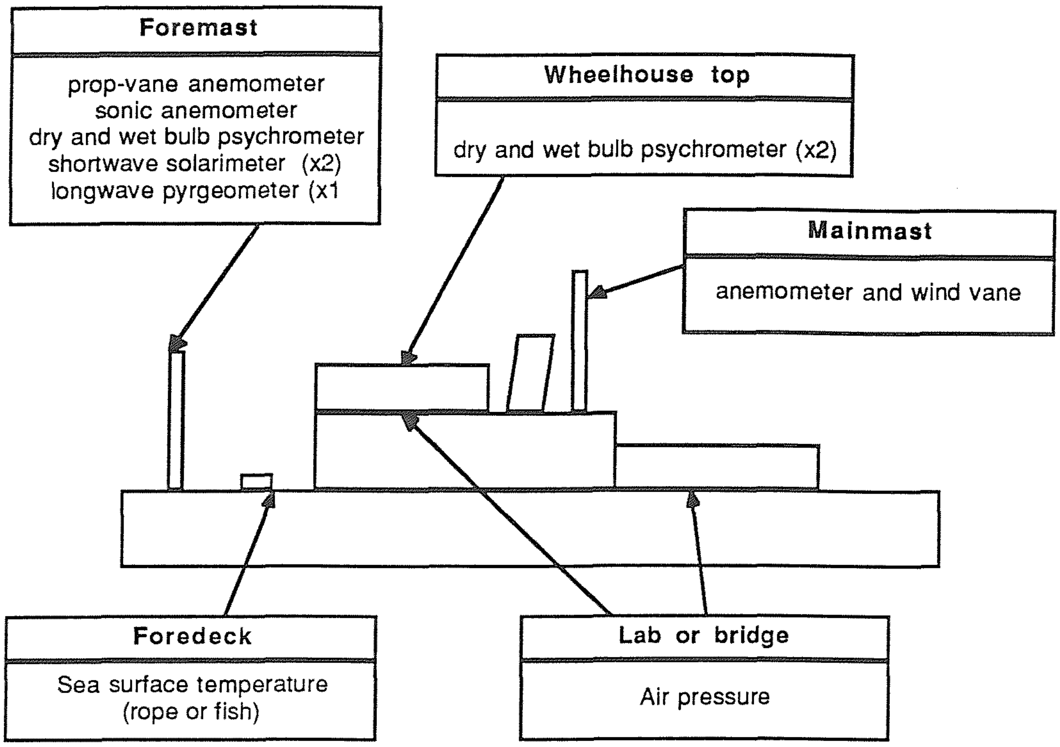

Figure A4. Diagram showing typical MultiMet installation on a Research Ship.(the ship's bow is to the left).

A2.2.2 Frequency Output Sensors.

The Psychrometers and the Sea Surface Temperature senors are identical electrically, using the same circuit which requires a positive 24 Volt supply and give a sinusoidal frequency output signal. The output frequency is dependant on the sensor temperature and lies in the range approximately 1.4 - 2.2 KHz. The wind speed sensors could be from two manufacturers and are electrically different although they run from the same power supply (+5V). The Vector has a relay contact closure which allows current to flow through the opto isolator input. The Young sensor has an additional circuit in the sensor junction box to produce a frequency output of constant amplitude as at low speeds the signal level decreases. The interface for these sensors is on the Isolator Divider Board which has an opto isolator for each channel followed by a CD40103 divider set to divide by eight. The wind speed sensors have low frequency outputs (tens of Hertz), and for these sensors the dividers are removed and replaced by wire links. The opto isolators are directly driven from the sensors and require a current of about 0.5 milliamps, there is a series resistor to set the current limit and this may be different on each channel to accommodate signal variations.

A2.2.3 Analog Output Sensors.

The radiometers have low signal outputs, micro volts per Watt/m^2, (short wave max 1200 Watts/m^2 at equator on sunny day, long wave approx 400 Watt/m^2) and are amplified on the mast using instrumentation amplifiers which are internally powered from lithium battery packs.

Table A.5. Details of standard MultiMet instrumentation. Signal types are A = Analogue, F = Frequency, D = Digital

Variable	Instrument	Signal conditioning	Signal type	Comments
Air temperature and humidity	Vector Instruments (VI) Psychrometer (dry and wet bulb PRT's)	Resistance is transmitted as a frequency signal	F	Needs 18-24V power to signal conditioning tube.
Sea temperature	IOS "Soap on a rope"	As for air temperature	F	As for air temperature. This is a trailing thermistor device.
	IOS SST fish	Special deck unit	F	
Wind velocity	R.M.Young Prop/vane anemometer	None but needs 5V power for direction	A (x2)	Being replaced with Wind Monitor AQ
	R.M.Young Wind Monitor AQ	None	F A	Needs 5V power for both speed and direction
	Solent Sonic Anemo	Derived from D/A within instrument	A (x3)	Digital output is also available from this instrument.
Wind Speed	VI cup anemometer	None	F	
Wind Direction	VI wind vane	None	D	Connected to special channels for correct averaging.
Ship's Head	Digicourse compass	None	8 bit grey D	Great care needed in siting and calibration for magnetic field disturbances.
	Ship's Gyro	Level "A" system	8 bit binary D	A level "A" system exists for interfacing to the ship's gyro. On NERC ships this is via the SUN system.
Ship's velocity	GPS receiver			(not connected to MultiMet)
Pressure	IOS barometer		F	Prototype instrument. Needs 18-24V power.
Shortwave radiation	Kipp and Zonen solarimeter	Amplifier	A	Amplifier requires ±12V.
Longwave radiation	Eppler pyrgeometer	Amplifier	A	Amplifier requires ±12V.

The Young direction sensor output is an analog voltage in the range 0-5V with a dead band 350-360 degrees with respect to the sensor housing. The sensor is orientated with north at the aft end of the ship to minimise errors due to averaging over this discontinuity. When the wind is from aft, the data will in any case be contaminated by the effect of the ships structure and be of debatable quality. The analog inputs are interfaced to the common 12 Bit A/D convertor via DC isolators, active filters, and multiplexor onto the analog bus.

A2.2.4 Digital Sensors.

The digital interface is for parallel data, with all inputs opto isolated from the processor. Series resistors are used to limit the current drive to each opto isolator and are all configured for +5V signals. Each interface word (that is 8 bits) has its own address which is patched via a hardware link. These are different for each board, therefore the boards are not directly interchangeable.

A2.2.5 Use of data from other Ship Systems

Note that on some cruises no MultiMet sea surface temperature sensor is deployed; this is normally because SST is available continuously from another source (e.g. a Thermosalinograph or pumped CTD system). In these cases the maintenance of the SST sensor and the corresponding data set is as important as that for the other MultiMet sensors. The SST data should be quality controlled and saved so that it can be used with the MultiMet data in later analysis.

On NERC ships, the navigational information for calculation of the true wind is available in the navigation files. Variables needed are the ship's head (° True) and the fore and aft, and port and starboard, motions through the water (from the two component EM-log). On these cruises no MultiMet compass or GPS system is normally installed.

The IOSDL pressure sensor is a prototype system and is not fitted on all cruises. Pressure normally varies relatively slowly and the values logged in the ship's meteorological reports will be adequate in these cases.

A2.2.6 Channel naming conventions

The normal convention for naming channels attempts to indicate the make, type, and position of each sensor. This is not strictly followed particularly where only one make of sensor is in use. Table A.6 gives examples of sensor names which are used in the examples shown in Part B.

Table A.6 Examples of Sensor Names

Name	Expansion	Sensor
lwmt	LongWave Mast Top	Eppley pyrgeometer at the top of the foremast
swms	ShortWave Mast Starboard	Kipp and Zonen solarimeter on starboard side of foremast platform
swmp	ShortWave Mast Port	as above but port side of foremast platform
ydfm	Young Direction ForeMast	R.M.Young propeller vane wind direction
ysfm	Young Speed ForeMast	as above but wind speed
vwbtp	Vector Wet Bulb Top Port	Vector Instruments psychrometer on port side of wheel house top
vdbtp	Vector Dry Bulb Top Port	as above but dry bulb.
vwbts	Vector Wet Bulb Top Starboard	Vector Instruments psychrometer on starboard side of wheel house top
vdbts	Vector Dry Bulb Top Starboard	as above but dry bulb.
vwfmp	Vector Wet Bulb ForeMast Port	Port of two Vector Instruments psychrometers on foremast
vdfmp	Vector Dry Bulb ForeMast Port	as above but dry bulb.
vwfms	Vector Wet Bulb ForeMast Starboard	Starboard of two Vector Instruments psychrometers on foremast
vdfms	Vector Dry Bulb ForeMast Starboard	as above but dry bulb.
press	Pressure	IOSDL made air pressure sensor
soap	Soap on the Rope	IOSDL made SST sensor (trailing thermistor)
vsmm	Vector Speed MainMast	Vector Instruments anemometer wind speed
vsts	Vector Speed Top Starboard	Vector Instruments anemometer wind speed on starboard side of wheelhouse top.
vstp	Vector Speed Top Port	Vector Instruments anemometer wind speed on port side of wheelhouse top.
vdmm	Vector Direction MainMast	Vector Instruments anemometer wind direction

A3. PRECRUISE OPERATIONS

A3.1. Instrument Calibration

Before a cruise all the instruments to be deployed (including spares) are calibrated as shown in Table A.7. Detailed instructions for performing this calibration are contained in the User's guide to the MultiMet Sensor and Calibration Facility (Pascal, Williams and Ahmed, 1991[1])

Table A.7. Calibration procedures for the MultiMet sensors

Variable	Calibration procedure	Comments
Temperature sensors (dry bulb, wet bulb, and sea surface)	Computer controlled constant temperature bath	Part of the MultiMet calibration facility.
Wind Speed	Wind tunnel	At present the Met. Office wind tunnel is used.
Wind Direction	None	
Pressure	The sensor is checked against a Precision Aneroid Barometer	The PAB is referred to a mercury Fortin Barometer.
Shortwave radiation	None	The instruments have been calibrated at the Meteorological Office.
Longwave radiation	None	(see shortwave radiation)

A3.2. Preparation of Sensor Calibration Sheets

The information contained on the calibration certificates is needed for the "met.cal" file, the input to the calibration program "mcalms", see Appendices B2.1 and B2.2 (both on disk). An example of a psychrometer calibration certificate is included as Appendix A5.1.1. For each cruise the calibrations from the certificates for all sensors (deployed and spare) are included on a cruise calibration summary sheet, an example sheet is included as Appendix A5.1.2.

[1] Pascal, R.W., Williams, A.L. and Ahmed, R. (1991) A user's guide to the MultiMet Sensor and Calibration Facility, IOSDL Internal Document No. 298, 114pp.

A4. SHIPBOARD OPERATIONS

A4.1. System operation

A4.1.1 Power Up Conditions

Before power is applied to the MultiMet unit, check that all mains power cables are connected to the MultiMet logger, the RS232 interface box, and the MetMan BBC Master computer system. There should be communication cables between the MultiMet logger and the RS232 interface box and from the interface box to the MetMan system. Note that there are two RS232 ports at the back of the MultiMet Logger and the cable should be connected to the one labelled MultiMet. The RVS cable is connected to the interface box into one of the 25 way 'D' type connectors. Figure A5 shows the interconnections required.

When power is applied check that all the power supply LED's are illuminated, the BUSY LED should be off. If any LED's are off, disconnect mains lead from the logger and check the fuses on the power supply boards.

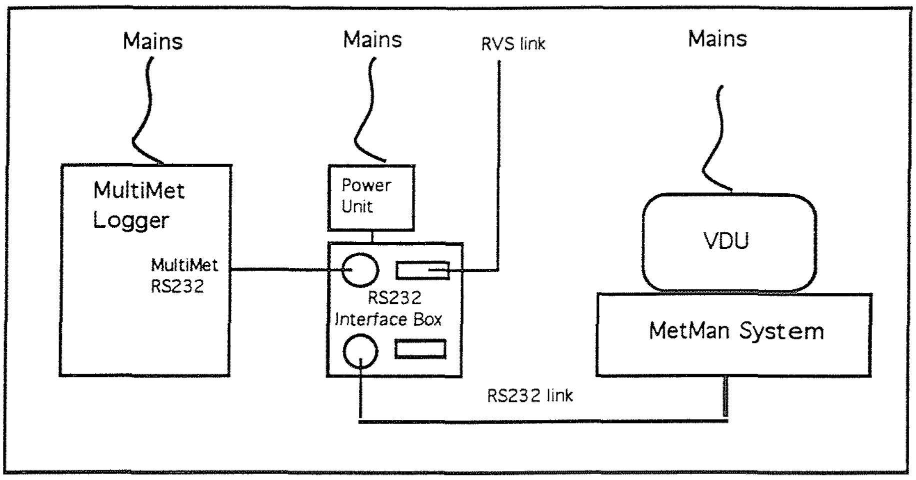

Figure A5 MultiMet System interconnection diagram

When power is applied to the MultiMet unit, the Logger and EPROM device both become active. They both have battery back-up for all systems configuration parameters, however notes are included in Appendix A5.2 on how to re-configure these manually with the use of a terminal.

The main logger has a Watch Dog circuit which will re-boot the system approximately every 15 seconds in event of a systems crash. However a manual reset can be made by pushing the reset button on the processor board which can be accessed by releasing the front panel.

Logging commences as soon as power is applied, it does not wait to start on the exact minute as determined by its own hardware clock. The time stamp on the data stream uses the time at the start of the '1' minute period and can result in the time as shown by the data displayed on the

Master 128K being up to TWO minutes behind that of real time. It can never be better than ONE minute behind realtime.

A4.1.2 Procedure for checking the time for MultiMet real time clock

Equipment required:-

1) Dumb terminal or Computer with terminal emulator
   -Terminal configuration 2400 Baud and no parity
   Refer to notes on Terminal Emulation using the BBC Master in Appendix A5.2.3
2) Serial cable

Connect Multimet to the Terminal via the serial cable. To check the MultiMet time open the front panel of the MultiMet Logger and press the RESET button on the CPU board at a known time, preferably on an exact minute. This will reset the logger to the selected time and generate the message :-

********* SLOW LOGGER IN RUNTIME BASIC **************

The message will be imediatly displayed on the screen of the BBC Master, followed by the data string after about 55 second. Within the data string is a time word and this will have the time and date at which the button was pressed, plus 1 second.

The TIME and DATE, which form the time word is at the start of the data string, can be retrieved and compared with the known time of the RESET. The start of the data string is constructed as follows:-

Data string	S00920827113901001FFF1FFF........ ETC
Time word	S00yymmddhhmmss00

The time in this case is 11:39:01 27/08/92. If the MultiMet time is incorrect then follow the procedure for resetting the hardware clock in A4.1.2

A4.1.3 Resetting of MultiMet Hardware Clock

This should not be required as the clock is battery backed, but could be corrupted in event of some mains borne interference. It is possible to reset the clock using the Master 128K computer at 'power on' or when a manual reset is activated. The method is:

1) Remove the screws securing the front panel and lower on hinge carefully.
2) Remove the screws securing the back panel and lower it, the wiring can be damaged at this stage as the back panel will have no mechanical support - so be careful!!!!!
3) In the top unit, in between the 'D' Type connectors, is a small hole which allows access to a push button on the Watch Dog circuit board, this must be depressed when 'power on' or a manual reset is applied. The Master screen will ask you to update the clock and display the

correct entry format. Beware that you will have to be quick or else the Watch Dog will activate and you must start again.

4) Format of data required is:

<seconds>,<minutes>,<hours>,<date>,<month> <RETURN>

NB - each reply must be two digits, i.e. 2 o'clock must be entered as "02"

A4.2. Sensor maintenance

The recommended schedule for maintaining the MultiMet sensors is shown in Table A.7. **It is important to note that this schedule can only be kept if the weather conditions and instrument siting allows safe access to the sensors.** A log book must be kept detailing the procedures followed. Obviously it is important to record the date and time that any changes are made to an instrument, e.g. cleaning, servicing, or replacement. In a number of cases visual inspection using binoculars is suggested. Usually these inspections find nothing, however they must be performed regularly so that, if something has gone wrong it can be rapidly dealt with.

A4.3. Procedures for replacing a sensor

A4.3.1 Changes to Make

If sensors are replaced or swapped the following changes must be made:

1. First note that if it becomes necessary to change sensor positions which require disconnection at one position and reconnection to a different cable then appropriate action must be taken with respect to back panel connections. If this is not done then the wrong calibrations will be applied to the data.
2. Note time the day number, exact times and sensor serial numbers in the MultiMet logbook when one sensor is removed and another sensor mounted, so that subsequent data processing can allow for the change.
3. Edit the "met.cal" coefficients file so that the coefficients for the first sensor apply only up to the correct time, and the coefficients for the second sensor apply after that time (see next section).
4. Change the coefficients in the BBC "MDisplay" program to the values for the new sensor. It is probably worth doing a screen dump before halting the program or the current time series plot will be lost.

A4.3.2 Failure of SST sensor

The most likely failure is due to water leakage into the "soap-on-a-rope" SST sensor cable. If the SST values on the screen display vary rapidly over a wide range or gradually drift away from calibration the sensor should be replaced. The depressor weights should be swapped onto new cable. For this, as for the other sensors, the changes listed above must be made.A4.4.

Using the MultiMet Real-time Display.

The MDisplay software is used to give a real time display on the BBC Master computer. The contents of the program disc and detailed instructions for using the program are given in Appendix A5.3. The real-time display consists of time plots of most of the variables logged by MultiMet. Each one minute sample is added to the plot until, after 4 hours, the plot is (optionally) recorded on the printer, the screen is cleared, and the trace starts again. There is also a compass plot of the wind direction values (with the latest wind direction highlighted) and a bar-plot of the maximum and latest wind speeds recorded during the present 4 hour interval. An example of the display is shown in Figure A6.

The numerical values of chosen channels are displayed in a window and can also (optionally) be printed out. Some of these are dummy channels (channel numbers >50) containing, for example relative humidity, calculated from the observed data. If more than eight channels are selected, the channel values are displayed in two sets with a pause between. Further options are whether or not the raw data and or calibrated data are to be logged to disk. If required each raw data record will be logged to disk in a format which can be read by the PSTAR program mdpsta.F (Appendix A5.4, on disk). Calibrated data will be logged to disk in a format suitable for plotting using either the Cricket Graph package on the Apple Macintosh or the DaDisp program on an MS-Dos PC (depending on which version of the program is being run).

Most of the options are selected on program start-up, however a menu allows some of the options to be changed while the program is running. This includes which channels have the values displayed and whether the values should be printed out. The size of the disk files used for logging data can be checked and the logging to disk can be cancelled (but not turned on). In selecting these options note that while sampling is taking place the screen may not display the characters which you type. It will catch up once the sampling has finished. The use of Mdisplay to check the data quality is described in Table A.9.

Table A.8. Maintenance schedules for the deployed sensors

Variable	Maintenance		Comments
	Frequency	Procedure	
MultiMet system	Each watch	BUSY LED flashes once per minute, all other LED's are illuminated.	Close attention is needed to see Busy LED flash. If any other LED is out, check fuses
Dry and wet bulb psychrometers	Each watch	Check MultiMet Real-time display	See section B2.3
	Daily	Check reservoir, check dry bulb for salt and wipe clean, check wick and replace if soiled or salty. Check fan motor is going, if not, replace psychrometer.	Typically wick may need replacing once or twice per cruise. If in doubt compare reading with hand held psychrometer. Water bottles need refilling about every 5 days.
	Once or twice per cruise	Consider swapping positions of a pair of psychrometers, do not replace wicks or make any other changes at the same time.	Valuable if you suspect one psychrometer to be in error. Allows effect of different ship sites to be removed.
"Soap on a rope"	Each watch	Check rope is trailing correctly; check real-time display.	See section B2.3
Wind Speed and direction	Each watch	Check MultiMet Real-time display	See section B2.3
	At least daily	Visually inspect sensors using binoculars	Look for obvious damage - e.g. a missing wind vane
Wind Direction	Each watch	Check MultiMet Real-time display	See section B2.3
Pressure	Each watch	Check MultiMet Real-time display	See section B2.3
Shortwave radiation	At least daily	Visually inspect sensors using binoculars	Is the gimbal keeping the sensor horizontal, check that the weight is still attached to the gimbal.
	Every few days if possible[1]	Wipe clean the solarimeter dome.	
Longwave radiation	At least daily	Visually inspect sensors using binoculars	See shortwave

[1] if the sensor is on the foremast it is normally only possible to do this regularly in calm weather. Safety must be the controlling factor in determining the servicing rate for these instruments. Radiometer domes should be wiped clean during port calls.

Table A.9. Suggested MultiMet data checks using the Real-time display

Variable	Checking Procedure
Dry and wet bulb psychrometers	All dry bulbs should agree to within about 0.3°C, similarly all wet bulbs. Wet bulb should be colder than dry bulb (unless it is foggy outside!). Relative Humidity is normally between 50% and 100%. If dry and wet bulb temperatures are similar and it is not foggy or raining hard then the wet bulb wick is dry and needs servicing..
"Soap on a rope"	Should agree to about 0.3°C with other SST devices. Sea temperature is normally warmer than the air by less than 1°C, however it can range from several degrees warmer to one or two degrees colder. In the latter case you would expect high humidity and possibly fog.
Wind Speed	All wind speed values should agree to about 1m/s although for some wind directions one anemometer may read low or high due to flow obstruction. The mainmast anemometer should read higher than the lower anemometers, but not by much more than about 1 m/s or so.
Wind Direction	All values should agree to within about 5°. Try to detect any constant biases due to a particular wind vane being misaligned with respect to the bow.
Pressure	Pressure values should vary fairly smoothly and spot readings should agree to within 0.5 mb with the PAB on the bridge (any height difference in the barometers will cause the lower instrument to read high by about 1mb for every 8m height).
Shortwave radiation	The two shortwave radiometers should agree to within 5W/m^2 except when one is in shadow. At night both should read zero. Try to detect any constant offsets and biases.
Longwave radiation	This should give a fairly constant value day and night, but with step changes as clouds or cloud clearances pass overhead. Typically the longwave values is somewhere between 250 W/m^2 to 400 W/m^2 varying by about 50 W/m^2 due to the passage of clouds.

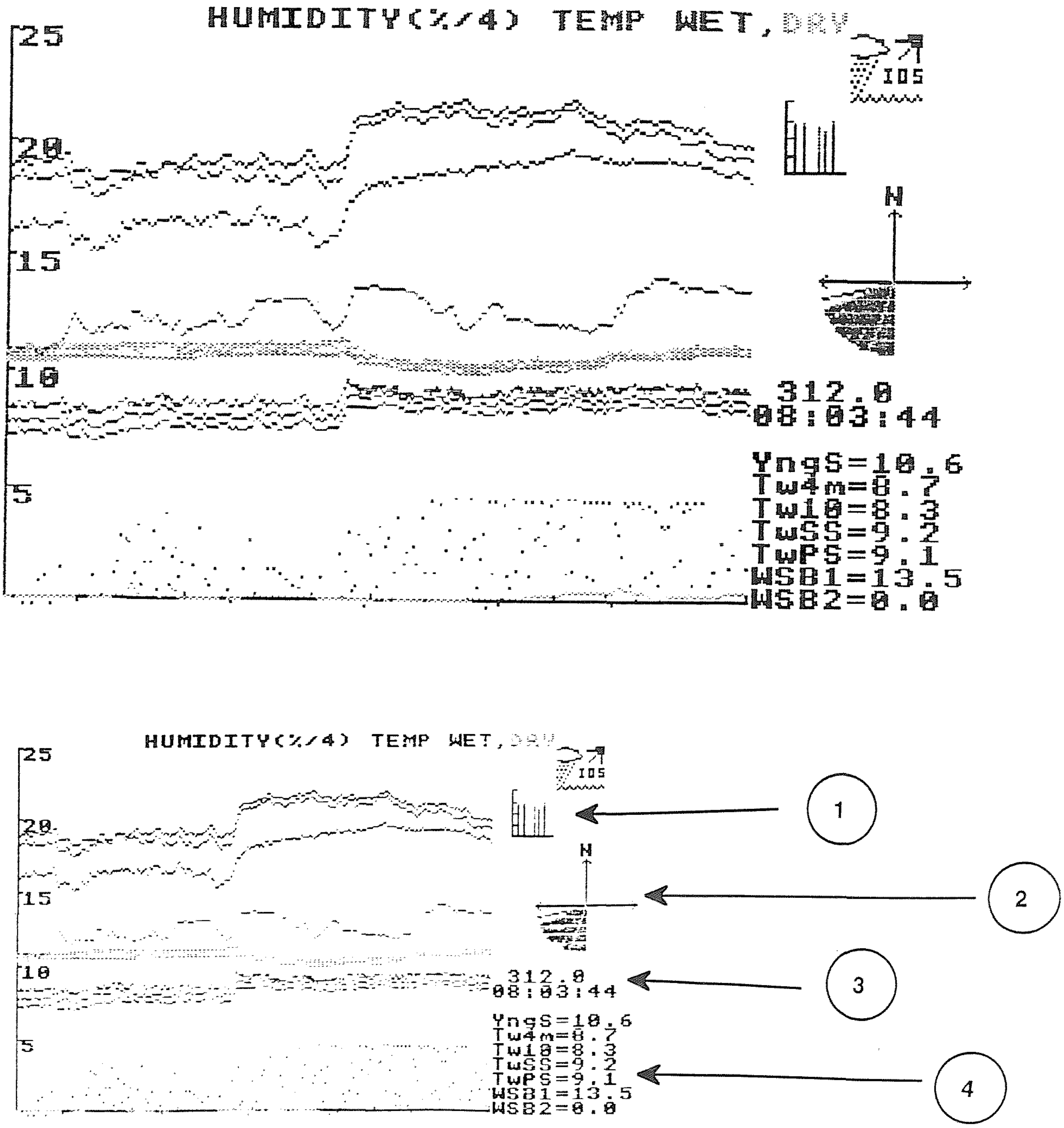

Figure A6. Example of the MultiMet real-time display. The horizontal axis shows four hours of data. The traces will vary depending on the installation but will typically show relative humidity, wet and dry bulb temperature and long and short wave radiation.

1 Last wind speed value and the maximum wind speed value since the start of the graph is shown for each anemometer.

2 Last wind direction value and all wind direction values since the start of the graph: N represents the ships bow.

3 Day of year and time of last point plotted.

4 Values of channel readings as selected by the user.

A5. APPENDICES

A5.1. Calibration Information

A5.1.1 Sample Calibration Certificate

```
CALIBRATION CERTIFICATE
Psychrometer VI1071

Date Produced : 01-18-1991

Cal   td10190B
  C          0     -20.93618
  C          1     8.259702E-04
  C          2     8.380603E-06
  C          3     4.365153E-10

Cal   td17190A
  C          0     -23.67878
  C          1     5.227892E-03
  C          2     6.058437E-06
  C          3     8.404015E-10

Freq  Temp A     Temp B      Diff
1400  -2.1560    -2.1791     0.0231
1500   0.6324     0.6309     0.0015
1600   3.6277     3.6377     -0.0101
1700   6.8325     6.8464     -0.0139
1800  10.2495    10.2620     -0.0125
1900  13.8812    13.8895     -0.0083
2000  17.7303    17.7340     -0.0037
2100  21.7994    21.8005     -0.0011
2200  26.0911    26.0940     -0.0029
2300  30.6080    30.6197     -0.0117

Mean = -3.95751E-03
```

Notes

Diff is the quality check between two calibrations. If the value is less than 0.05 then the calibration is considered to be GOOD.

The calibration figures used from the certificate are the C0, C1, C2, C3 values of the most recent calibration i.e. Cal td17190a

where td = dry bulb, 171= day no., 90= year no., a = sequence letter.

A5.1.2 Sample Calibration Summary Sheet (Multimet Calibrations for BOFS Darwin Cr53)

Chan.	Variable	Ser No	Formula	Position
Ch1	Rad Long	27960F3	((8190-Hex Value)/819)/3.65E-3	Top F Mast
Ch2	Rad Short	902837	((8190-Hex Value)/819)/4.51E-3	Port F Mast
Ch3	n/c			
Ch4	n/c			
Ch5	n/c			
Ch6	n/c			
Ch7	n/c			
Ch8	n/c			
Ch9	n/c			
Ch10	n/c			
Ch11	Psychrometer Vector Wet Electronics	1070 29W	Hex Value/6.25 0 -21.789883 1 2.334592 E-3 2 8.268262 E-6 3 5.930658 E-10	Stbd Bridge screen
Ch12	Psychrometer Vector Dry Electronics	1070 30D	Hex Value/6.25 0 -21.544162 1 6.082651 E-4 2 8.640511 E-6 3 3.461783 E-10	Stbd Bridge screen
Ch13	Psychrometer Vector Wet Electronics	1071 31W	Hex Value/6.25 0 -21.641942 1 2.411321 E-3 2 8.228403 E-6 3 5.669007 E-10	Port Bridge screen
Ch14	Psychrometer Vector Dry Electronics	1071 32D	Hex Value/6.25 0 -20.481232 1 -1.431887 E-4 2 9.028328 E-6 3 2.977208 E-10	Port Bridge screen
Ch15	Psychrometer Vector Wet Electronics	1066 25W	Hex Value/6.25 0 -21.09002 1 1.608094 E-3 2 8.551765 E-6 3 5.045984 E-10	Forward Mast
Ch16	Psychrometer Vector Dry Electronics	1066 25D	Hex Value/6.25 0 -21.469295 1 9.746697 E-4 2 8.495635 E-6 3 4.029051 E-10	Forward Mast
Ch17	n/c			
Ch18	n/c			
Ch19	n/c			

Chan.	Variable	Ser No	Formula	Position
Ch20	n/c			
Ch21	Vect Speed	2237	(Hex Value/50)/1.1398	Main mast
Ch22	n/c			
Ch23	Vect Speed	1895	(Hex Value/50)1.1444	Fwd mast
Ch24	n/c			
Ch25	Vect Dir	2103	Hex value = Degrees	Main Mast
Ch26	Vect Dir	2102	Hex Value = Degrees	Fwd Mast
Ch27	n/c			
Ch28	n/c			
Ch29	n/c			
Ch30	Ships Head		(Hex Value)*1.4117=Degrees	

A5.2. Procedure for Manual Configuration of EPROM Logger

A5.2.1 Getting started with the EPROM Data Logger

Equipment required :-

1) Dumb terminal or Computer with terminal emulator

- Terminal configuration 2400 Baud and no parity

2) Serial cable, with switch to enable interactive mode communications

Connect the EPROM Data Logger(EDL) to the Terminal via the serial cable. Set the switch on the serial cable and push the reset switch on the EPROM Logger Processor Board. The software will then enter interactive mode.

A Welcome! message should appear on the Terminal screen followed by the current SETUP information.

The SETUP conditions will indicate the : -

BPR - bits per record (for MultiMet operations this is 68 Bytes per record)

BOARDS - number of completely filled memory boards installed

CHIPS - number of chips on a partially filled board installed

To modify the SETUP parameters, if required, use the MODIFY command (all commands must be entered in UPPERCASE characters) as follows :-

for 2 full boards

2 BOARDS MODIFY

If there there is a partially populated board (only one partially populated is permissible and must be the highest board number installed) the the number on that board must be declared as follows :-

for 8 Memory chips

8 CHIPS MODIFY <cr>

The system will check for any obvious errors in the input of BOARDS or CHIPS ie. outside technical limitations of EDL.

A5.2.2 EPROM Data Logger Initialisation

Before data is collected the EDL Directory File structure must be initialised. The Directory commands are as follows :-

INIT-AFT <cr>	this will remove directory of any previous EPROM Memory cards
SEARCH<cr>	this will locate the Next Free EPROM address
OPEN <cr>	starts command to 'Open a file'
	prompts the user for keyboard entry for a file name <cr>

The switch on the Serial Cable should returned to the non-interactive position. Visual observation of the 'Busy' LED on the front panel, which should flash for less than one second each minute, will confirm that the logger is functioning correctly.

A5.2.3 Terminal Emulation using the BBC Master

To exit from MetMan to that of the terminal emulator mode :-

Press <control> + <break> together

Type *TE. <cr>

the screen will then display TERMINAL

Press <cr> once again

the BBC Master will then be correctly configured to act as a terminal to the EPROM Data Logger.

To exit from the Terminal Mode :-

Type *B. <cr>

Press <shift> + <break> together, MetMan will then be re-booted and the display will be re-started.

A5.2.4 Procedure For Changing an Eprom Logger Memory Board

This operation will terminate all Serial data output to both the BBC Master computer, and to the Shipboard Logging on the SUN's. Hence please read notes carefully and check on where all the different components for this operation are located.

1) Perform any screen dumps that may be required as the current plot on the MetMan system will be lost during this operation.

2) Change the MetMan system to the Terminal Emulation mode see Appendix A5.2.3

3) Locate the RS232 cable at the back of the MultiMet unit, which is at present connected between MultiMet logger output via the Interface box to the display BBC Master computer.

4) Wait until the BUSY LED has just flashed and the terminal is displaying MultiMet data.

5) Change the RS232 cable connector from MultiMet to Eprom.

6) Change status (ie closes contacts) of the single pole change over switch on the RS232 cable.

7) Open the front panel of the MultiMet Unit. This is achieved by unscrewing the captive screws located at the top corners of the frame. The front panel then hinges down to give access to the PCB's and PSU's inside.

8) Reset the EPROM logger by manually operating the slider reset switch located on the EPROM controller board. The controller board (see MultiMet board layout diagram) is located in the fifth board slot from the right handside of the chassis, when viewed from the front of the unit. The reset switch is on the lower edge of the PCB, close to the end of the card guide.

9) The EPROM logger will then display its setup message giving its current status :-

BPR	bits per record
BOARDS	Number of completly filled memory boards
CHIPS	number of chips on a partly filled memory board

10) Remove the power from the MultiMet logger by disconnecting the mains lead at the back of the unit.

11) Remove the current memory cards from the first four card slots from the right handside, and replace with a new set of cards.

12) Power up MultiMet logger by returning the mains lead into the back of the unit.

13) Resst the EPROM logger by manually operating the slider reset switch located on the EPROM controller board.

14) The EPROM logger will then display its setup message giving its current status :-

BPR	bits per record
BOARDS	Number of completly filled memory boards
CHIPS	number of chips on a partly filled memory board

15) Type INIT-AFT <cr>
This will remove the directory information of the replaced eprom memory boards.

16) Type SEARCH <cr>
This will locate the next free EPROM address, which should be HEX 00.

17) Open a file
Type OPEN <cr>
A prompt will then ask for a filename ie CR46 <cr>

18) Return switch on the RS232 cable to its original state (contacts open).

19) Return RS232 cable from the EPROM to MultiMet connector on the back panel.

20) Wait for the next MultiMet data output to be displayed and check that the TIME word is correct. If there is an error refere to A4.1.2

21) Recommence data display on the BBC Master Computer
Type *B. <cr>
Press <shift> + <break> together
MetMan will then be re-booted and the display re-started.

A5.3. The Mdisplay program for the BBC system

A5.3.1 Starting the program

The program Mdisplay provides a real time display for MultiMet data. It must be run under HiBasic in the Turbo co-processor. The program is run by placing the program disk in drive 0 and a disk for logging data (if required) in drive 1[1]. If starting from power-on initialise the system as follows...

Action	Comment
Press BREAK while holding down SHIFT.	(This will exec the !boot file which loads the HiBasic, Basic Editor, and Dumpout ROMS)
when instructed... Press BREAK while holding down CTRL	(This will initialise the ROMS and enter the second processor under HiBasic)

Now continue as follows ([cr] = carriage return)...

Prompt	Type	Comment
>	*start [cr]	to start the display program.
Enter channels to display or print Channel Nos. (max = 16)?	*e.g.* 1,3,6,7/[cr]	These are the channels for which values are displayed in the window and (optionally) printed out. Enter nos. in free format, end with "/"
Print out values? (Y/N)	n	This would generate lots of paper; usually it is turned on and off from the menu for selected periods only.
Do you want auto-screen dump? (Y/N)	y	Gives screen dump to printer at end of each 4 hour period.

[1] if the system has a hard disk drives 0 and 1 become drives 4 and 5 respectively.

Prompt	Type	Comment
Save raw data to disk? (Y/N)	y *or* n	y will save raw data in format that can be read using program mpstar.F and result in next question...
File for data ("Mjjjhhhh") (or *cat/*dir)?	*e.g.* M2311435	File name for the raw data where *jjj* is the day number and *hhhh* the hour.
Save geophysical data to disk ? (Y/N)	y *or* n	y will save calibrated data in format that can be read using either DaDisp or Cricket graph (depending on program version) and result in next question...
File for data ("Pjjjhhhh") (or *cat/*dir)?	*e.g.* P2311435	File name for the calibrated data where *jjj* is the day number and *hhhh* the hour.
Enter channel nos. to save to disk Channel Nos. (max = 16)?	*e.g.* 3,4,5/[cr]	These are the channels for which calibrated values are logged to disk Enter nos. in free format, end with "/"

The screen will now clear and the axes for the 4 hour plot will be drawn. A menu at the bottom of the screen allows the choices shown in the next section.

A5.3.2 Running the program - Menu choices

The table on the next page gives the choices available while the MDisplay program is running. Note the the menu choices indicate whether certain options are on or off and that the convention for this has been changed compared to previous versions of the program. For example if Dmp[ON] is displayed it indicates that the auto-dumping of the screen is at present turned ON and selecting this option will turn it off.

A5.3.3 Contents of the program disk

!boot	- boot file to load roms and initialise Turbo processor
Aform	- *aform to format discs
Backup	- *backup to backup discs
Master	- exec file to exit Turbo and use Master
Mdisplay	- Basic program to provide MultiMet real time display
Mdisplayp	- Packed Basic program, will run without second processor
MLAlogo	- logo for plot screens
Readme	- (text) this file
ROMS	- directory containing ROM images
start	- exec file to CHAIN Mdisplay program
testdata	- text file of test data for testing Mdisplay
Testdisp	- Basic program, to display all 30 channels on the screen

Menu Choices offered by the MDisplay program

Menu choice	Comment
ScrPrnt	dumps the screen to the printer
Dmp[ON]	indicates that auto-dumping of the screen to the printer is ON. Select this option to switch it off.
Dmp[OF]	indicates that auto-dumping of the screen to the printer is OFF. Select this option to switch it on.
Prt[OF]	indicates that the printout of selected channels is OFF. Select this option to switch printing on. The channels printed are the same as those displayed in the screen window and independent of those logged to disk.
Prt[ON]	indicates that the printout of selected channels is ON. Select this option to switch printing off.
Chans	change channels to be displayed/printed. This does not change the channels logged to disk. You will be prompted for the new channel numbers.
File	Displays the file names if logging to disk is switched on and also shows the space remaining on the disk.
Geo[OF]	Indicates that the logging of Geophysical values in DaDisp or Cricket graph format is OFF. This option cannot be used to switch the logging on - you have to restart the program.
Geo[ON]	Indicates that the logging of Geophysical values in DaDisp or Cricket graph format is ON. Selecting this option will, after asking for confirmation, turn the logging off
Raw[OF]	Indicates that the logging of raw data in SeaData format is OFF. This option cannot be used to switch the logging on - you have to restart the program.
Raw[ON]	Indicates that the logging of raw data is ON. Selecting this option will, after asking for confirmation, turn the logging off
@=exit	Use this option to exit the program. If logging to disk is ON you MUST use this to avoid possible loss of data.

A5.4. Program Listing "mdpsta.F" on disk

Text file containing fortran source code of PSTAR program to read MultiMet data logged by real time display on BBC Master computer.

PART B DATA PROCESSING ON NERC SHIP SYSTEM

B1. DATA PROCESSING

B1.1. Sensor Equations and Coefficients

The program mcalms.F (Appendix B2.1, on disk) contains the equations needed to calculate the physical value, v (in °C , m/s, etc.), from the logged value s (in volts, Hertz, etc.). The equations are shown in Table B.1. These equations are selected, and the coefficients used in them defined, by the "met.cal" file (Appendix B2.2, on disk).

Table B.1. Program mcalms.F - equation numbers, equation definitions and usage. Presently valid equations are shown in bold. The other equations are for use with past cruise data and should not be used for new cruises.

No.	Equation	Comments
1	$v = ((32768-s)/3200)*C_1+C_2$	analogue channels - old MultiMet systems
2	$\mathbf{s = s/6.25}$ $\mathbf{v = C_1 + s * (C_2+s*(C3+s*C_4))}$	**frequency channels - temperatures**
3	$\mathbf{v = s * 0.02 * C_1 + C_2}$	**frequency channels - wind speeds**
4	$\mathbf{v = s * C_1 + C_2}$	**digital channels - directions**
5	$v = 2.*(((8190.-s)/819)/.2824)$	analogue channels - used for Young propvane wind speed on one cruise - do not use.
6	$v = ((8190.-s)/819.)*C_1$	alternative form of equation 8
7	$v = 2.*((8190.-s)/819.)*C_1$	More general form of equation 5
8	$\mathbf{v=((8190-s)/819)*C_1+C_2}$	**analogue channels - new MultiMet systems**
5a	$v=((8190-s)/819)*C_1+C_2$	Used on CD51 as equation 5

B1.2. Data Calibration and Archiving

The processing scheme for MultiMet data logged on the ship SUN systems is shown in Figures B1.1 to B1.3 The scheme is implemented as scripts "mmexec0" to "mmexec6" and plotted with "mmexecp" which should be run on a daily basis. Appendix B2.3, on disk, gives listings of these scripts and the files used are described in Table B.2. The processing is as follows:

mmexec0 Create raw data file.

The data is copied from the RVS SUN system file using *datapup* and the resulting PSTAR format file of raw met data is tidied up by copying it onto itself using *pcopya*. The PSTAR header is them assembled to identify the data using *pheadr*. The user enters an identification number for the daily file <nnn>. Sample data files are included on disk as Appendix B2.4.

mmexec1 Create geophysical data file.

The day of year (JDAY) is calculated from the time in seconds using *ptimes*, and the data calibrated to geophysical units using *mcalms*. Note that *mcalms* uses a file of coefficients "met.cal" (Appendix B2.2, on disk) in the current directory which must include the correct calibration coefficients for each of the channels. Thus if an instrument is replaced "met.cal" must be edited. The dataname is then changed using *pheadr* to indicate that the data is now in geophysical form.

mmexec2 Merge navigational information.

Navigation data from the ships GPS system and output from "besnav" is now merged onto the data file. Navigation data is usually in a file nav/abnav<ccc>1 (a symbolic link called nav may be made to the navigation directory to enable this default to be used, otherwise the full pathname of the navigation data can be input. <ccc> is the cruise number and should have been already set up as an environment variable CRUISE) The navigation and physical data start and stop times are checked and the user is notified if the navigation data does not cover the whole of the MultiMet data period and is asked whether to continue. If the times are ok the two files are merged using *pmerg2* . The dataname is then changed using *pheadr*.

mmexec3 Create EM log data file.

This exec runs *datapup* to read RVS EM log data into PSTAR format. A file called emlogdata is created in the current directory containing all the data currently on the system. Any file of that name in the current directory is overwritten. *Pcopya* and *pheadr* are then run to sort out the PSTAR header.

mmexec4 Merge EM log data.

Merges the EM log data produced in mmexec3 onto the combined physical and navigation data file. The times of the MultiMet data and the EM log data are checked as in mmexec2 and the data files are then merged together using *pmerg2*. The dataname is again changed using *pheadr*.

mmexec5 Calculates true wind speed and direction.

This exec calculates the true wind speeds. It must be checked to ensure that the correct variable numbers are being used as in mmexec1. The ships heading is added to the relative wind direction using *parith*. *Prange* is then used to bring the new wind direction between 0 and 360° and the new wind direction and the relative wind speed are converted into east and north components using *pcmcal*. *Pcalib* is then used to convert the components of the ships speed from the navigation data from cm/s to m/s. The sum of the ships velocity and the wind velocity are then calculated for the east and north components using *parith* and the true wind speed and direction then found using *pcmcal*. The new variables created are then renamed using *pheadr* and the dataname changed. 180° is then added to the true wind direction (as the anemometers are aligned with 0° as the ships stern) using *pcalib* and *prange*, and the unwanted variables created removed using *pcopya*.

mmexec6 Append daily files to master files.

The execs 0 to 5 are run on daily files and these need to be appended to the 'master' files. For each of the daily files (.raw, .phy, .nav, .em and .true as below) the user is prompted whether to append the data. If the answer is "y" then the times of the master file are compared with the daily file to ensure there is no overlap and if this is ok then the files are appended using *papend*. If no master file exists the daily file is copied and made into the master file.

mmexecp Plot the data

Plots the data from the daily file as default but can be used to plot any data with the correct variable names. 'Pdf' files are used from a directory pdf/ to plot temperatures, radiation, relative winds, true winds and a met summary. Examples of the 'pdf' files are included on disk in Appendix B2.5. If variables are not present the 'pdf' files must be edited. The exec uses the program *plotty* (or *plotxy* which has similar input requirements) to plot the data, the user is asked which of the plots to process and to enter start and stop times in JDAY. The device to be used is prompted for, and the plots are then produced.

Table B.2. Files used in the ship-board processing.

File name	Description
multimet	Default name of the RVS system file
mm<ccc><nnn>.raw	MultiMet raw data file for single day. (<ccc> is the cruise number, <nnn> is file identification number)
mm<ccc>.raw	Appended raw data file for cruise. This file is needed so that the data can be reprocessed after the cruise when the post-cruise sensor calibrations are known.
met.cal	MultiMet sensor calibration coefficients. (See Appendix B3.2, on disk)
mm<ccc><nnn>.phy	MultiMet calibrated data for a single day.
mm<ccc>.phy	Appended geophysical data for cruise.
mm<ccc><nnn>.nav	MultiMet and navigation data for a single day.
mm<ccc>.nav	Appended MultiMet and navigation data for cruise.
mm<ccc><nnn>.em	MultiMet, navigation and EM log data for a single day.
mm<ccc>.em	Appended MultiMet, navigation and EM log data for cruise.
mm<ccc><nnn>.true	Final daily data file including true wind speed and direction .
mm<ccc>.true	Final unedited MultiMet calibrated data for cruise.

B1.3. Data Plotting and Quality Checks

Figure B2 summarises the data plotting and quality checks.

Step 1. Having created a calibrated MultiMet data file a set of plots should be produced on a daily basis using *plotty* (example plot description files (pdf's) are on disk as Appendix B3.6).

Step 2. The hour of day is added using program *phrofd*, and the specific humidity added by *metqrh*. The resulting file "mmflx" can be used for calculating the heat fluxes and should therefore be saved.

Step 3. The instruments can be compared by calculating differences between pairs of sensors using *parith*. For example take the difference between the dry bulb temperatures as measured by one of the wheelhouse top screens and as measured on the foremast (program *parith*). Using *datpik*, choose the night time data when the wind was within ±30° of the bow (for these cases the mean temperatures should agree to about ±0.1°C). Do the same for the wet bulb temperatures and the specific humidity values (the latter should agree to about 0.05 g/kg).

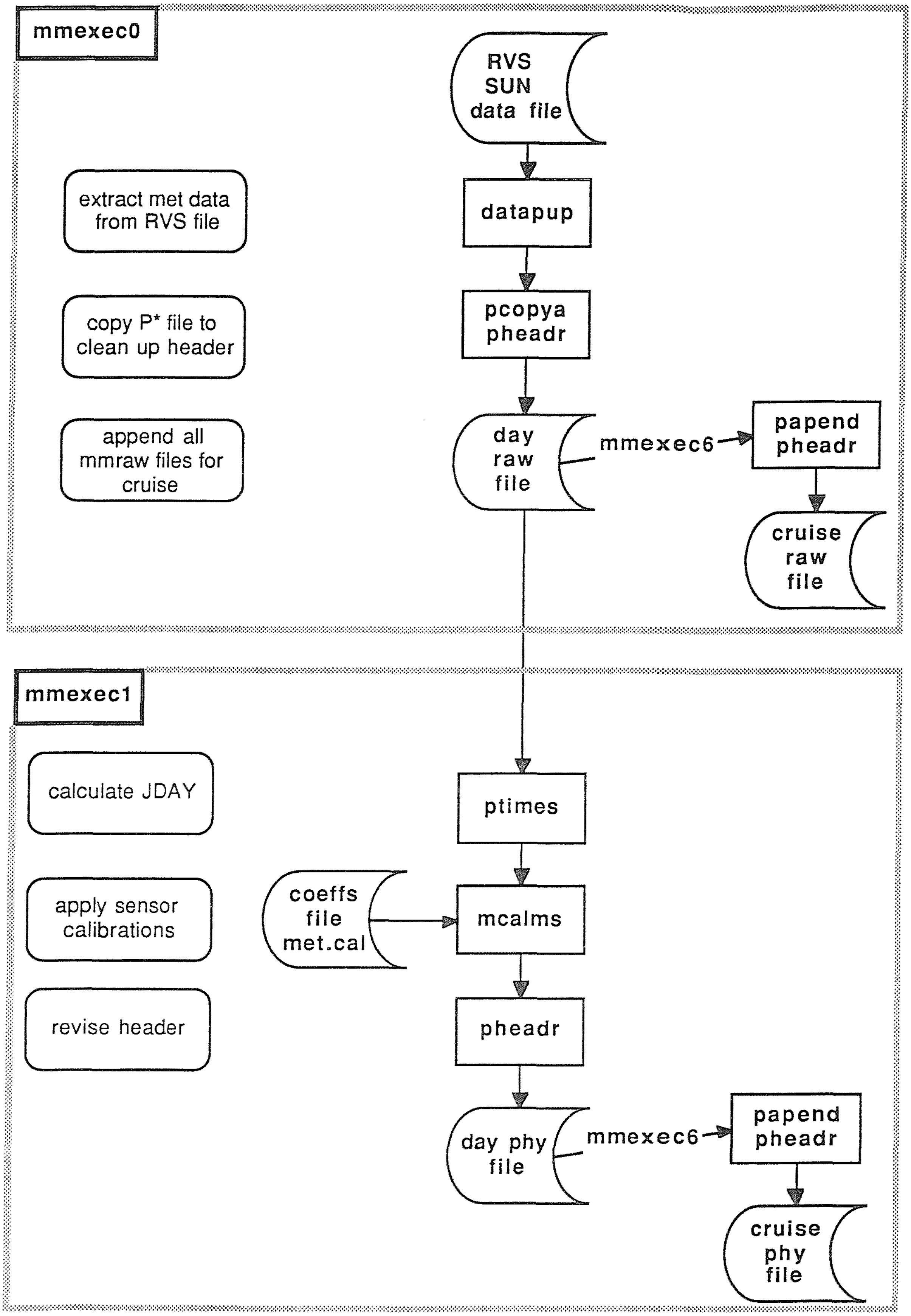

Figure B1.1 Processing scheme for MultiMet data on NERC ships.

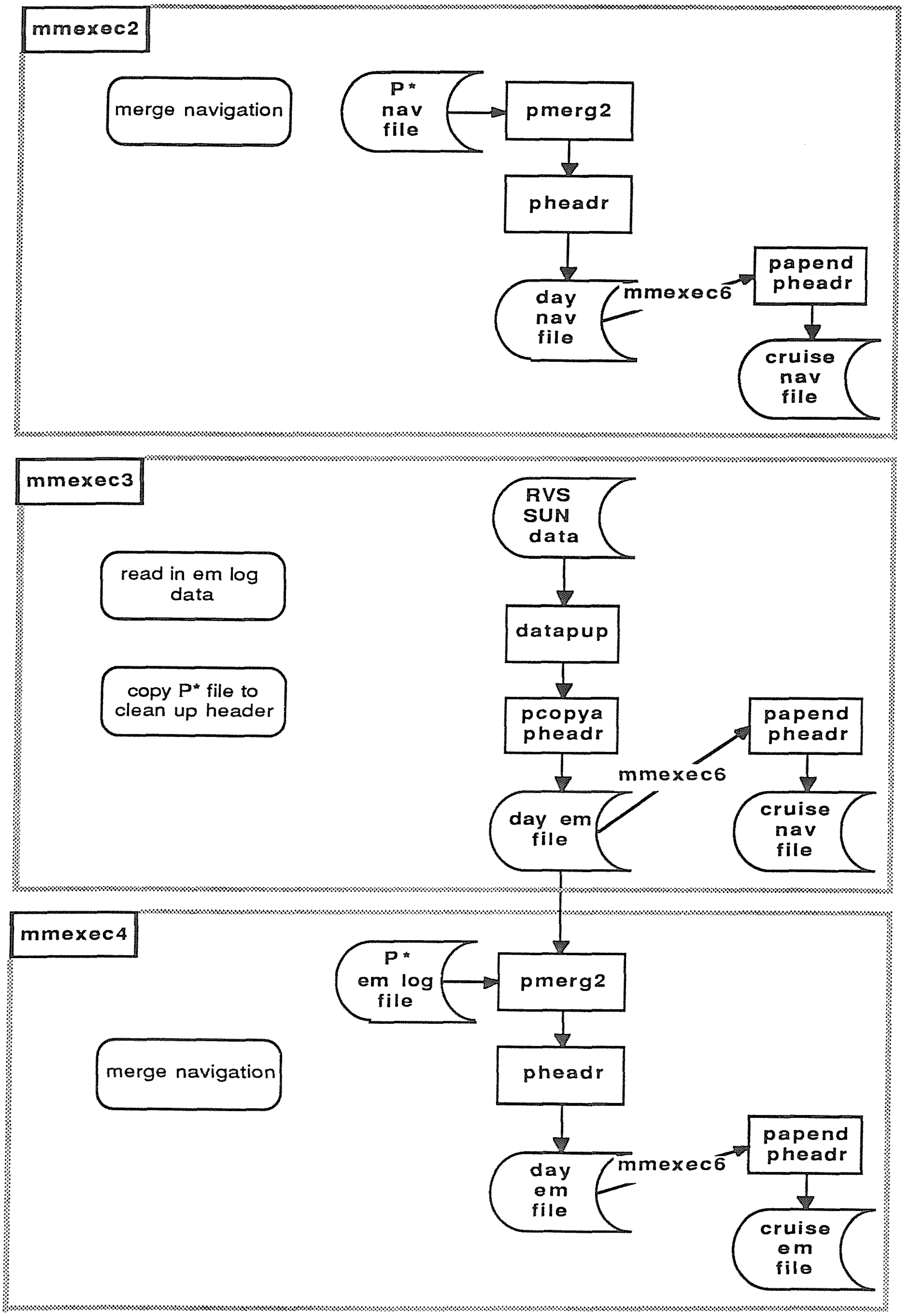

Figure B1.2 Processing scheme for MultiMet data on NERC ships (continued).

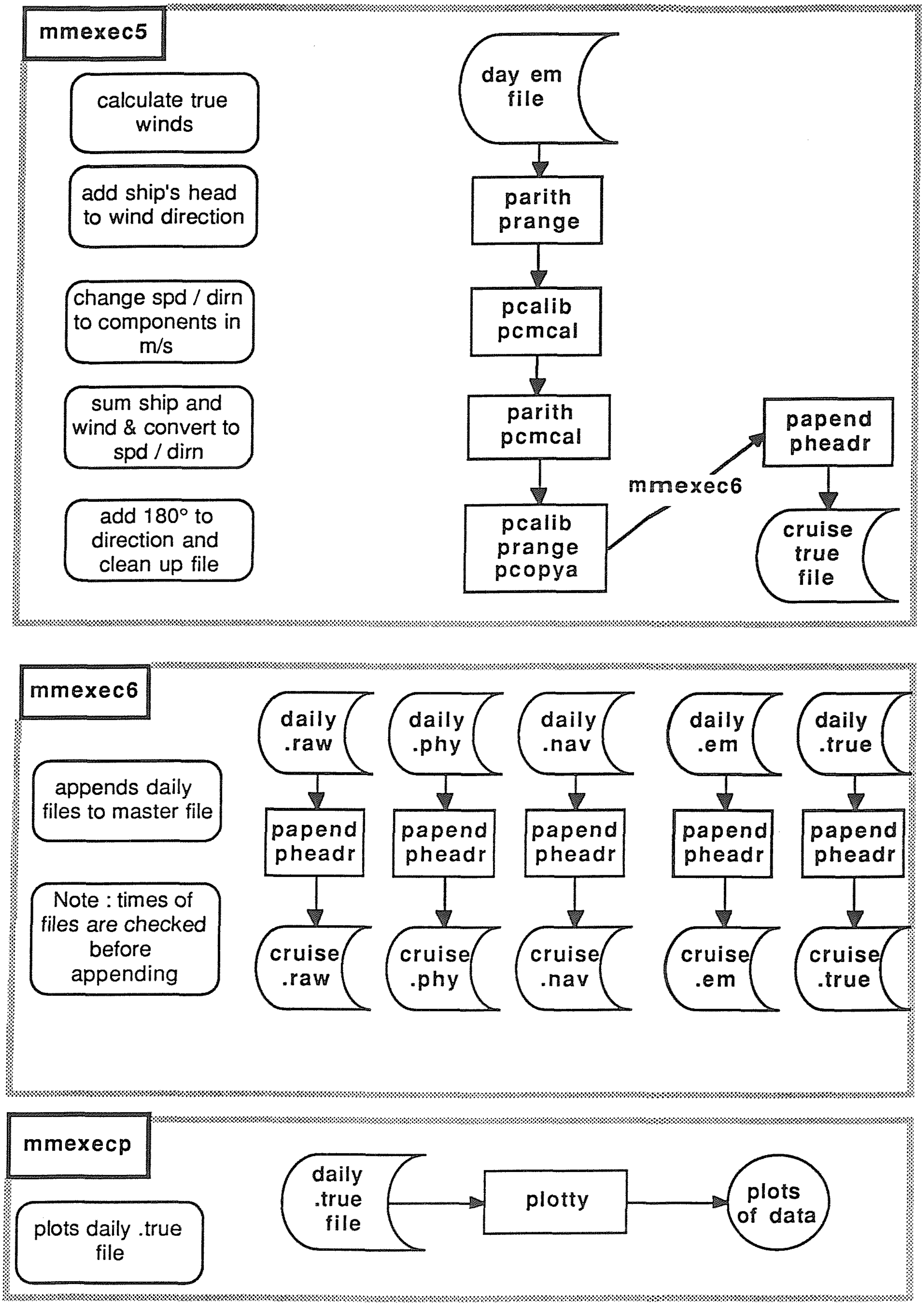

Figure B1.3 Processing scheme for MultiMet data on NERC ships (continued)

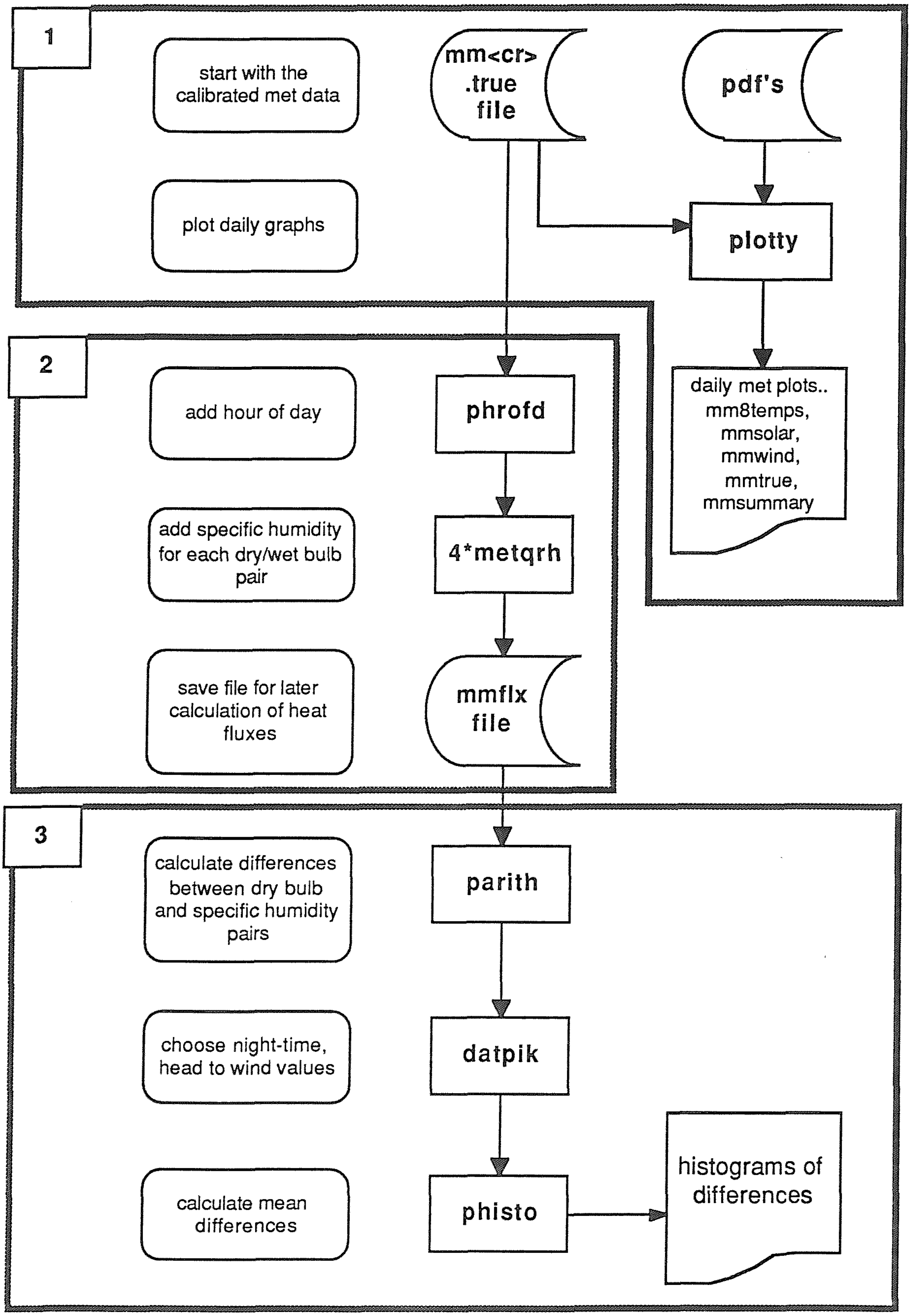

Figure B2 Processing for plotting and data quality checks

B2 APPENDICES

B2.1. Listing of Program "mcalms.F" on disk

Text file containing fortran source code of PSTAR program to calibrate MultiMet data logged on the SUN system.

B2.2. Listing of a Typical "met.cal" File on disk

Text file example of calibration coefficient file required as input to program mcalms.F (Appendix B2.1)

B2.3. Listing of Ships System Scripts on disk

Text files containing example UNIX scripts used on CD62a to process MultiMet data, merge in navigation data and calculate true wind speed and direction. Changes will need to be made to use these files with different sensor configurations as variable numbers appear explicitly in them.

B2.4. Examples of Typical Data Files on disk

Text file examples of PSTAR headers for the main output data files from on-ship processing.

B2.5. Examples of Plot Description Files on disk

Text file examples of plot description files used on CD62a.

PART C POST CRUISE OPERATIONS

C1. INSTRUMENT CALIBRATION

Following the cruise all instruments used must be recalibrated to check for calibration drifts due to sensor deterioration etc.

C2. POST CRUISE PROCESSING

C2.1. Processing on IBM Mainframe

The post cruise processing using the IBM mainframe at Wormley has been described by Pascal (1991)[1]

C2.2. Processing on Sun Network

C2.2.1 Reading Seadata tapes

Seadata tapes are read onto a DOS disk which is then converted to a UNIX format and copied onto the Wormley Sun Network. Tape description (tapedd.*cruisenn*) and calibration coefficient (coeffs.*cruisenn*) files have to be constructed. Tapedd files contain information about the sensors that were connected and the channel numbers, an example is included on disk as Appendix C4.1. "met.cal" (Appendix C4.2, on disk) is an example of a coefficients file containing the calibration equations and the calibration coefficients. Files are then copied to exabyte tape using the UNIX 'tar' command for transfer to the James Rennell Centre (JRC). The file reading and transfer procedures are shown in Figure C.1 and described in detail in Appendix C4.3.

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[1] Pascal, R.W. (1991) Seadata Translation and Initial Processing (Manuscript report).

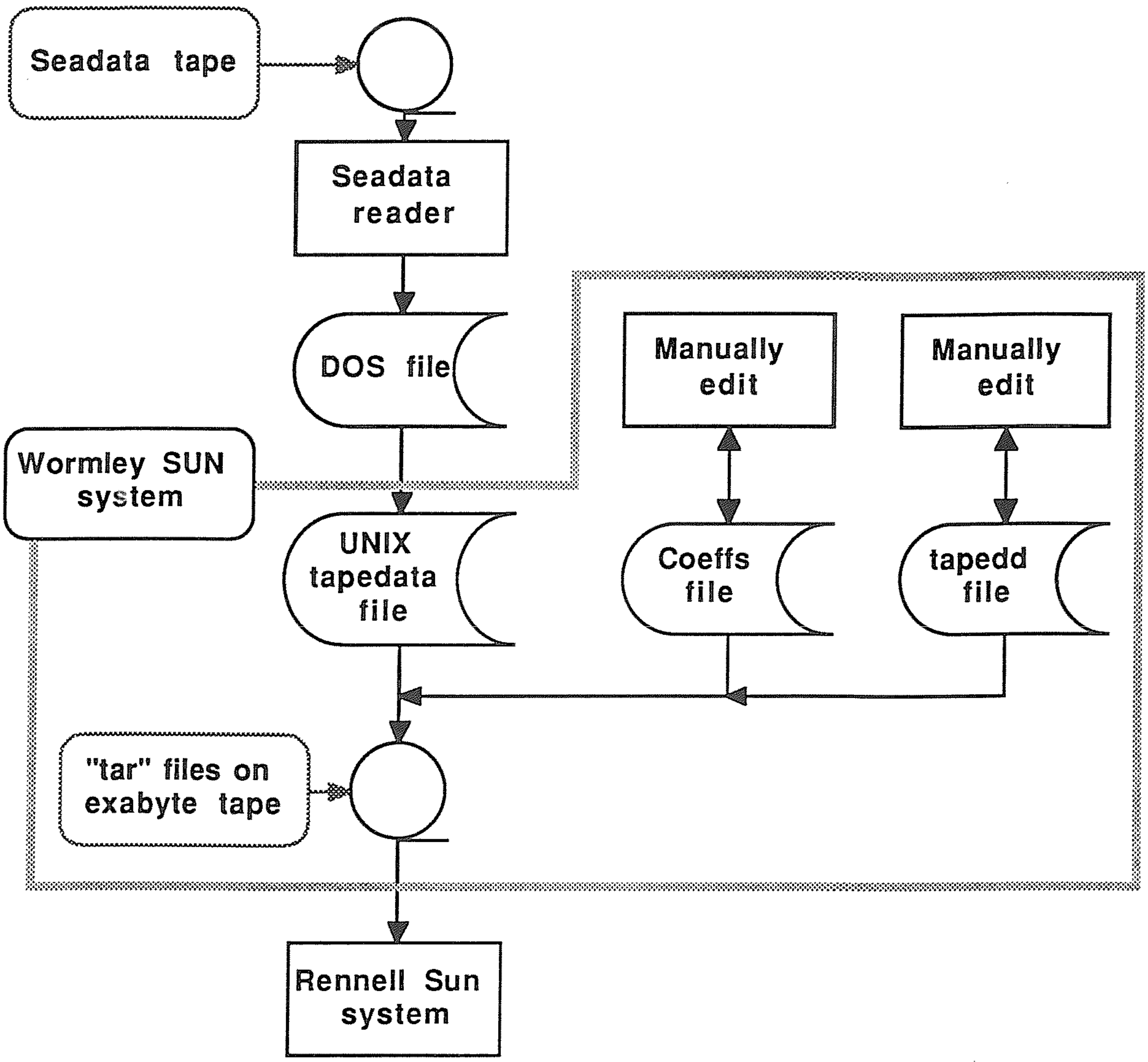

Figure C.1 Flow chart showing transfer of data to the JRC SUN system.

C2.2.2 Conversion to PSTAR Format and Calibration

At the JRC the tape is read onto the Sun network, again using the 'tar' command and the raw ascii files are converted to PSTAR format using the information in the tapedata file by the PSTAR program *mpstar*. The file created, rawdata.*cruisenn*, contains raw output from the MultiMet logger and needs to be calibrated. Calibration is performed using the PSTAR program *mcalms* which takes the calibration coefficients from the named coefficients file. The output file, phydata.*cruisenn*, now contains calibrated physical data. This processing scheme is shown in figure C.2.

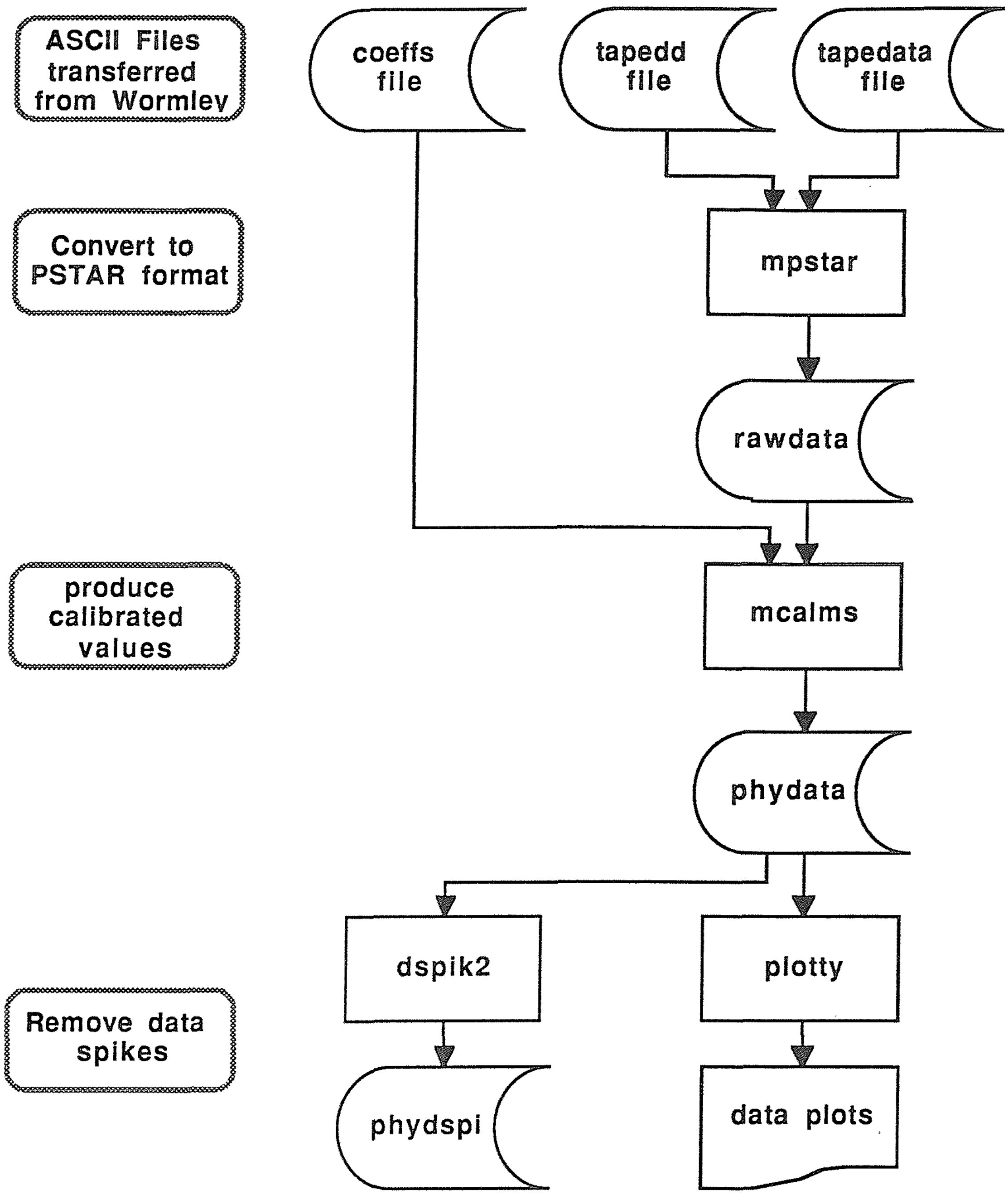

Figure C.2 MultiMet processing on the JRC SUN system.

C2.2.3 Plotting and Archiving

Plots are produced on an HP Paintjet plotter using the PSTAR plotting program 'plotty'. The plotting can be partially automated using UNIX scripts and PSTAR plot description files similar to those in Appendix C4.4, on disk.

After examination of the plots the data should be transferred to the correct directories on the JRC epoch file server. The appropriate directory for the ascii data and all the files created is "/data/*cruise*/raw/mmslow" for cruise data and "/data/cumulus/raw/mmslow" for OWS Cumulus data. Write access is restricted for these directories the data managers for the Rennell site. Instructions must therefore be given to the Meteorological Team data manager to store the data. Once the phydata files have been edited to remove erroneous data the edited phydspi.*cruisenn* files are stored in the archive partition of the relevant cruise directory. The filing system structure is summarised in Figure C.3

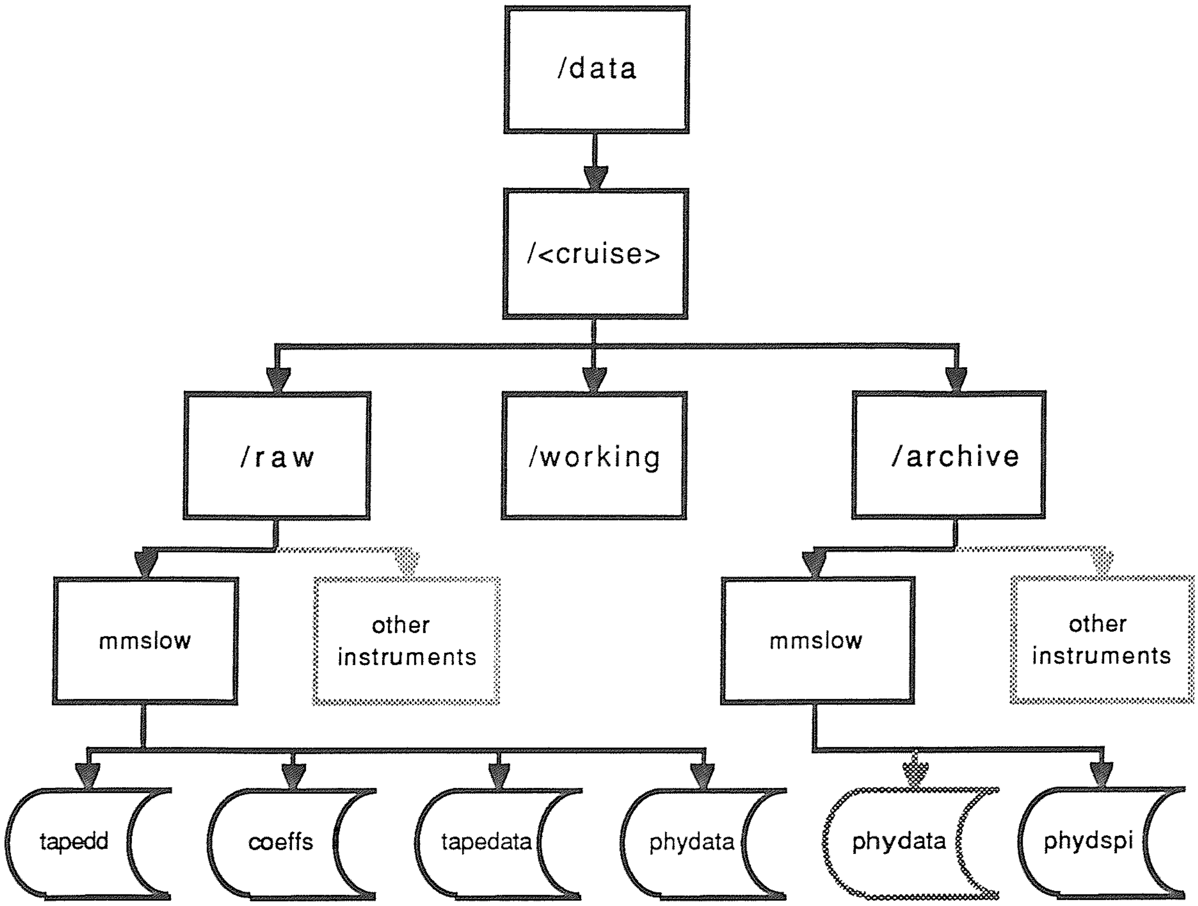

Figure C3 Filing system structure on the James Rennell Centre Sun network. Note that the phydata file is replaced as the final archive quality data by a phydspi file only if the latter exists.

C3. REPORT PRODUCTION

The meteorological data standard report format contains the visit or cruise report, pre and post calibration certificates for each of the sensors used on the cruise, a calibration summary sheet containing all the calibration coefficients for the cruise, the tapedata and coefficients files used in the processing to create PSTAR data and plots of the physical data before editing to remove erroneous values.

C4. APPENDICES

C4.1. Example of Tape Description File on disk

Text file containing a sample tape description file required as input to PSTAR program *mpstar* which reads data logged on Seadata tapes into PSTAR according to the format specified in the tape description file.

C4.2. Example of Calibration Coefficients File on disk

Text file containing a sample input file for *mcalms* with sensor calibration coefficients.

C4.3. Seadata Transfers with PCNFS

C4.3.1 Introduction

The TANDON PC data translation system has now been fitted with PCNFS, which enables it to be networked with the SUNs. PCNFS allows the PC to be setup so that a directory on the SUN is seen by the PC as another hard disk drive. Therefore by writing PC files to that drive, they are written to the directory on the SUN in DOS format. If they are to be read later by the SUN they should be converted from DOS to UNIX format. This document describes the procedures for replaying SeaData tapes on this system and then transfering them to the SUN in a UNIX format, an explanation on how to operate the cartridge drive is also given.

C4.3.2 Power up Tandon PC

You will be prompted for your SUN ID and PASSWORD and it is best if these are entered. You should then be informed that the SUN directory /local/pc/pcdata/jrp has been mounted as drive E for the PC.

C4.3.3 Translation Software

Now continue as described previously in the SeaData translation notes for the IBM mainframe. When the transfer is complete the data will be located in the C:\datatrans directory on the PC. Data file must be converted into a UNIX format and transferred into the E:\datatran\cumulus directory before it can be processed on the SUN.

C4.3.4 DOS to UNIX Conversion

To convert the file type the following at the DOS prompt.

DOS2UNIX pc-filename unix-filename <cr>

This will take about 10 Mins for a 3Mbyte file.

Use the DOS2UNIX command to transfer the file from the C:\datatrans directory to the E:\datatran\cumulus directory by giving the full path name in the filename.

C4.3.4 Conversion by FTP

If multiple file's or very large files need to be converted, then FTP can be used, this is a slightly more complex procedure but is much faster, about 1.5 Mins for 3 Mbytes.

At the DOS prompt type

ftp -i wocomms <cr>

-i = turns off prompt for each file sent, use on multiple files

Your ID should already be known by the server and will be displayed on the line:-

NAME (wocomms:rwp)

Press <cr> or enter your ID

Enter your PASSWORD

This should produce an FTP prompt.

Change to the transfer directory on the SUN.

cd /local/pc/pcdata/jrp/datatran <cr>

For individual files

Type **put pc-filename** <cr>

For multiple files

type **mput a:\ * <cr>**

This will send all files on the disk in the A: drive root directory to the SUN directory

Once transfer is complete

type **quit <cr>**

C4.3.6 Copy CUMULUS Directory to an EXABYTE CARTRIDGE

You need to be logged on to the SUN and in the CUMULUS directory.

cd /local/pc/pcdata/jrp/datatran/cumulus <cr>

Reserve the tape drive

Type mtr <cr>, to check if drive is free drive 0 = 1/4" 150 Mb Cartridge

drive 1 = Exabyte 2 Gb Cartridge

drive 2 = 9 track 6250/1600 bpi

Type mtr -1 <cr>, To reserve Exabyte drive

If the tape drive is in use, you will be informed and will have to wait until it is free.

Once the drive has been reserved a tape must be mounted into the drive. PHONE Margaret (Ext 263) and ask for the RWP Exabyte tape (no.82) to be mounted.

To copy the entire directory and any sub-directories type

tar cvfb /dev/rst1 126 *

r= rewind tape after write.

nrst1 = no rewind

To check tape

tar tvfb /dev/rst1 126

To quit type exit <cr> or CTRL D

C4.4. Example of Plotting Script **on disk**

Text file example of UNIX script to plot met data.

C4.5. Examples of Plot Description Files **on disk**

Text file examples of plot description files that have been used with the UNIX plotting script in Appendix C4.4.

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