JAMES RENNELL CENTRE FOR OCEAN CIRCULATION

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Meteorological observations on OWS *Cumulus* - status and quality of the data set

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1. INTRODUCTION

Since October 1987, the Institute of Oceanographic Sciences has obtained meteorological data from the Ocean Weather Ship Cumulus at ocean weather station Lima (57.5°N, 20°W), using the 'MultiMet' instrument system and data logger (Birch and Pascal, 1987). The aims of this deployment are:

1) To check the accuracy of the Cumulus meteorological observations by comparison of the MultiMet and Meteorological Office data.

2) To obtain a large data set suitable for investigating the effect of waves on wind stress.

For aim 1, a MultiMet system has been used to log data from psychrometers, cup anemometers and wind vanes at one minute intervals; this is referred to as the "Slow Sampling" system. For aim 2, data from a fast response anemometer system must be sampled at a frequency of several Hertz or more (the "Fast sampling system"). Wave data are also required; these are obtained from the Ship Borne Wave Recorder (SBWR) which had already been fitted to the Cumulus to support other IOSDL research.

A typical Cumulus cruise lasts about 5 weeks. The passage from Greenock to Lima takes about 3 days, 4 weeks are spent on station at Lima, and a further 3 days returning to Greenock. The ship spends about 2 days in port before the next cruise begins. While on station at Lima the Cumulus normally drifts with the port side to the wind, only steaming to ensure that the ship stays within a 30 n.mile box about the nominal position. However in bad weather the ship may steam slowly into the wind or leave station as the safety of the ship requires. Thus the data set collected represent a near continuous, but not complete, sample of the weather conditions at an open ocean site.

The IOS measurement program commenced with Cumulus cruise UK19 (October/November 1987) and is still continuing. This report will consider data up to the end of cruise UK65 (May, 1992). The next section summarises the instrumentation for the Cumulus, the sensor positions and any problems with the instrumentation noted during the cruise. The data processing used and the present state of the data set will be summarised in Section 3.

2. INSTRUMENTATION

2.1 Summary of Instrumentation on the ship

The main instrumentation systems deployed by IOSDL were the MultiMet "Slow" and "Fast" sampling systems, and the Ship-borne Wave Recorder. For cruises UK63 onwards a GPS based navigation system has also been mounted on the ship. Table 1 summarises which IOSDL systems have been deployed on each cruise.

2.2 Meteorological Office Instrumentation

Figure 1 shows a side and top plan of OWS Cumulus. Louvered thermometer screens are situated outboard of the rails to either side of the wheelhouse-top. Anemometer and wind vanes are situated on either side of the cross-trees on the aft mast. Observations are obtained manually once per hour. In each case the observers read the data from the windward sensor at the time of observation. The hourly meteorological observations from the Cumulus include: date, time, dry bulb temperature, wet bulb temperature, wind speed, wind direction, dew point, sea surface temperature, pressure, cloud cover, and latitude and longitude. These data are part of the operational data set obtained by the Cumulus and are therefore available from every cruise.

2.3 MultiMet Slow Sampling System

The MultiMet Slow Sampling system has been operated on all cruises from UK19 onwards (Table 1). In general this deployment has been very successful with data obtained from almost all cruises except for UK62 when a lightning strike damaged the MultiMet logger and the following cruise, UK63, while the logger was being repaired. This system records values each minute which are the mean of 50 samples obtained at one Hertz. The variables recorded are summarised in Table 2 and the instruments used to measure these variables are shown in Table 3..

Electrically aspirated psychrometers were situated adjacent to the Meteorological Office screens for cruises up to UK 32. From UK33 onwards the psychrometers were situated directly over the screens. The height of these sensors is approximately 10 meters from the sea surface. On most cruises a cup anemometer has been mounted near each of the psychrometers to determine the air flow in the region of the thermometer screens. The wind direction has also been measured at the port screen, that is the upwind screen when the ship is drifting..

To determine the relative wind a Vector Instruments cup anemometer and wind vane were mounted on the midships goal post mast for cruises UK19 to UK29. From cruise UK30 onwards, an R.M. Young propeller-vane anemometer was used on the midships goal post mast (24 meters from the sea surface). This sensor has been sampled by both the "Slow" and "Fast" systems. After cruise UK62 a sonic anemometer has been fitted in place of the propeller-vane. The available wiring has restricted sampling of this anemometer to the Fast system only.

Up to cruise UK41 the MultiMet sensors were replaced as and when damage or malfunction required (Table 3). From cruise UK42 (January 1990) increased resources in terms of manpower and instruments allowed the sensors to be replaced on a regular schedule. For all deployments the sensors used have been calibrated before the cruise and also on return to the laboratory.

2.4 Fast sampling system

"Fast sampling" data, from which the wind stress can be determined using the dissipation method, were first collected on cruise UK19. Two IOS personnel (K. Birch and R. Pascal) sailed on this cruise in order to install the instrumentation and operate the system. The sensor was a R.M.Young propeller-vane anemometer mounted on the IOS 10m meteorological mast which was

erected on the foredeck. The data were sampled at 8Hz and logged directly to half-inch magnetic tape using a Digidata tape recorder. Since this required manual operation, fast sampled data was only collected on UK19, and on UK22 when R. Pascal was on board and again the 10m mast was used.

To avoid the need for an operator to sail with the ship an automatic Fast Sampling system was devised and deployed on the Cumulus from cruise UK30 onwards. The R.M.Young propeller-vane instrument was mounted on the midships goal-post mast and sampled at 8Hz by a MultiMet system which was connected to a BBC microcomputer. The BBC was equipped with an "ARM" co-processor (a 32bit microprocessor with 4 Mbytes of memory) which calculated spectra using a Fast Fourier Transform. Only the spectral information was stored on disk, obviating the need to store large quantities of 8 Hz data. The data were sampled for just over 10 minutes (5120 samples) and a further 8 minutes taken to calculate the spectra. This system was used during winter 1988/89 (cruises UK30 to UK36), winter to spring 1990 (cruises UK42 to UK46), and from cruise UK50 (October, 1990) to UK62 (December 1991).

In order to ensure that the system continue working through bad weather the R.M.Young propeller-vane anemometer was equipped with the polypropylene propeller. Despite this, the propeller suffered damage or was lost on two cruises (UK32 and UK44). A disadvantage of this propeller is that it is heavier and therefore has a slower response compared to the polystyrene propeller normally used on research cruises. This means that a large response correction has to be made. To avoid these problems a new Fast Sampling system based on the Solent Sonic anemometer was deployed on the ship from cruises UK63 onwards. The sonic anemometer provides samples at 21 Hz which are logged on a NEC 286 portable PC system. The PC calculates and stores the spectra in a similar manner to the previous Fast sampling system.

2.5 Ship-borne Wave Recorder (SBWR)

The original SBWR system used a Hewlett-Packard microcomputer to log data on cassette. These cassettes were translated at the Proudman Oceanographic Laboratory, Bidston, and the data then transferred to IOS. The delay inherent in this process meant that, when one of the sensors on the SBWR failed in January 1989 (cruise UK32) the fault was not detected until several cruises later, and wave data was lost for the winter 88/89 deployment of the fast sampling system. To remedy this problem a new data logging system was implemented on cruise UK42 based on an NEC PC system. This system takes 6 ten minute samples an hour and produces spectra for each 10 minutes in the range of 0 to 0.3 Hertz. To date the new system has operated reliably and no further data has been lost.

2.6 GPS Navigation system

Because it was not possible to automatically log data from the ship's navigation system, the ship's officers were asked to manually keep a navigation log showing whether the ship was lying to, hove to, or steaming. The ship's positions were also logged manually with the hourly meteorological data. It was recognised that reconstructing the ship's velocity from this information

would be difficult, however it was the best arrangement that could be made. Recently, compact and relatively cheap satellite navigation systems based on the Global Positioning System (GPS) have become available. A portable navigation system has been devised at IOSDL using a Magnavox MX4200 GPS receiver, a KVH Industries Azimuth 314AC fluxgate compass, and a PC system for control and data logging (Birch et al., 1992; Kent et al., 1992). This system has been mounted on the Cumulus for cruises UK63 onwards.

2.7 Summary of instrument status following each cruise

Normally IOS personnel meet the ship after each cruise. The instruments are inspected and compared to the Meteorological Office instruments, and a "Visit Report" is written. This describes the state of the instrumentation and any problems that were reported during the previous cruise; it also documents any MultiMet sensor or instrument changes. Table 4 summarises the information from those visit reports.

There have been certain periods when either there were no personnel available to meet the ship, or finances did not allow a visit to be made. These periods were generally scheduled to be during the summer months when the data were considered to be of less interest due to the lack of a large range of wind speeds. Thus the ship was not met at the end of cruises UK26 to UK29 inclusive (June to November, 1988), nor following cruises UK46 to UK48 inclusive (June to September, 1990). Obviously the data from cruises where the ship was not met are likely to be less reliable than those from other cruises.

Based on the information in the visit reports, the quality of the data from each sensor for each of the cruises is shown in Table 5. The majority of the data is good. The main period of lost data occurs on cruises UK62 and UK63 and was a result of the lightning strike on cruise UK62.

3. CUMULUS DATA PROCESSING

3.1 Introduction

This section describes the present state of the data set for the main IOSDL instrumentation systems on the Cumulus. However first it is necessary to briefly describe the organisation of the data processing for each system.

3.2 Data processing scheme

3.2.1 MultiMet Slow Sampling System

The MultiMet Slow logger records the data either on Seadata cassette tapes or on EPROM solid state memory cards. These are translated onto a DOS disk which is then converted to a UNIX format and copied onto the Sun Network at IOSDL, Wormley (Figure 2). A tape data description file, *tapedd*, showing which instruments are connected to the various logger channels, and a file containing calibration coefficients, *coeffs*, are manually assembled. The files are then copied to exabyte tape using the UNIX 'tar' command and transferred to the James Rennell Centre (JRC) for further processing.

At the JRC the tape is read onto the Sun network, again using the 'tar' command and the raw ascii files are converted to a standard data format ("PSTAR") using the PEXEC program *mpstar* (Figure 3). The file created, *rawdata*, contains raw output from the MultiMet logger and needs to be calibrated using the PEXEC program *mcalms* which takes the calibration coefficients from the *coeffs* file. The output file, *phydata*, now contains calibrated physical data. Unfortunately radio transmissions from the Cumulus frequently resulted in bad data values being recorded. These spikes in the data must be edited using program *plxyed* to produce the final data file, *phydspi*.

3.2.2 MultiMet Fast Sampling System

To date most of the data collected by the Fast Sampling System has come from the BBC based system with an ARM co-processor. The spectra were recorded on BBC format disks and a Archimedes microcomputer was used to reformat these data on to MSDOS format disks for transfer to the JRC SUN system (Figure 4). The Archimedes was also used to check the apparent distance constant for the anemometer for that data set to ensure that a correct sensor response function was used in the processing on the SUN system. The final data set from the Fast Sampling system consists of corrected PSD values. These can be combined with the mean meteorological data from the slow sampling system to calculate the time series of wind stress values.

3.2.3 Ship-borne Wave recorder

Figure 5 shows the processing scheme for the SBWR data. Because of the problems of interference from the radio transmissions from the Cumulus, the spectral data from each 20 minutes sampling period for the SBWR is logged as two files. The "F" series files correspond to the first 10 minute period and the "S" series files to the second. The procedure, *Rdscrp*, checks the data for corruption and then merges the two file series to form a single PSTAR format file. Correction factors for each frequency are merged onto this file to produce a file containing the corrected spectra, *pcorr*. These data are gridded and smoothed before being plotted as a contoured energy spectrum plot. The significant wave height, Hs, is calculated by integrating the spectral values, and a time series plotted.

3.3 Present state of the data set

The analysis phase for the data from OWS Cumulus has now commenced in earnest and the state of the data set will rapidly change. This section describes the processing stage reached at the time of publication of this report[1].

The present state of the data processing for the Slow sampling system is shown in Table 6, where the shading indicates the progress for each cruise. All the existing data is available on the JRC Sun system as *tapedata* files. Most of the data has been processed to physical units (*phydata* files). Most of the later cruises still require despiking before the production of final plots. Also shown in Table 6 is the availability of Meteorological Office data. This is presently available up to the end of cruise UK64, although data after cruise UK43 has still to be plotted.

Table 7 shows the state of processing for the SBWR. Priority has been given to the cruises from UK42 onwards when the implementation of the new IOS logging system ensured a reliable data return. All the data for these cruises has been processed (except for cruises UK47 to UK49) when the Fast Sampling system was not on the ship and the SBWR data is therefore not required.

Also shown in Table 7 is the availability of Fast Sampled data. All the data is available at the JRC but processing to calculate corrected PSD values has been delayed while the response correction for the anemometer was checked. Processing of these data is now commencing.

4. REFERENCES

Birch, K. G. and R. W. Pascal, 1987: A meteorological system for research applications - MultiMet. *Fifth International Conference on Electronics for Ocean Technology*, Heriot-Watt University, Edinburgh, 7 - 12.

Birch, K. G., R. W. Pascal and A. L. Williams, 1992: *GPS and Ship Head Recording System - Installation and Operators Guide.* IOSDL Internal Document No. 308.

Kent, E. C., K. G. Birch, R. W. Pascal and P. K. Taylor, 1992: *Evaluation on Cruise CD 62A of a Magnavox MX 4200 GPS receiver and KVH fluxgate compass to provide ship speed and heading.* James Rennell Centre Internal Document 2, 6 + figs and apps.

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[1] Although a version of this report was completed during summer 1992, advantage has been taken of delays in the final publication to update Tables 6 and 7 to show the processing state as at mid November 1992.

Cruise No. UK -	Start Date		End Date		Multimet		SBWR	GPS
	Date yy/mm/dd	Jday	Date yy/mm/dd	Jday	Slow	Fast		
19	17/10/87	290	15/11/87	319	✔	✔	✔	-
20	23/11/87	327	18/12/87	352	✔	-	✔	-
21	25/12/87	359	23/1/88	23	✔	-	✔	-
22	31/1/88	31	27/2/88	58	✔	✔	✔	-
23	6/3/88	66	2/4/88	93	✔	-	✔	-
24	10/4/88	101	7/5/88	128	✔	-	✔	-
25	15/5/88	136	11/6/88	163	✔	-	✔	-
26	19/6/88	171	16/7/88	198	✔	-	✔	-
27	31/7/88	213	27/8/88	240	✔	-	✔	-
28	4/9/88	248	1/10/88	275	✔	-	✔	-
29	9/10/88	284	5/11/88	310	✔	-	✔	-
30	13/11/88	318	10/12/88	345	✔	✔	✔	-
31	18/12/88	353	14/1/89	14	✔	✔	✔	-
32	22/1/89	22	18/2/89	49	✔	✔	×	-
33	26/2/89	57	25/3/89	84	✔	✔	×	-
34	2/4/89	92	29/4/89	119	✔	✔	×	-
35	7/5/89	127	3/6/89	154	✔	✔	×	-
36	11/6/89	162	8/7/89	189	✔	✔	×	-
37	23/7/89	204	19/8/89	231	✔	-	×	-
38	27/8/89	239	23/9/89	266	✔	-	×	-
39	1/10/89	274	28/10/89	301	✔	-	×	-
40	5/11/89	309	2/12/89	336	✔	-	×	-
41	9/12/89	343	7/1/90	7	✔	-	×	-
42	13/1/90	13	11/2/90	42	✔	✔	✔	-
43	19/2/90	50	18/3/90	77	✔	✔	✔	-
44	25/3/90	84	22/4/90	112	✔	✔	✔	-
45	29/4/90	119	26/5/90	146	✔	✔	✔	-
46	3/6/90	154	30/6/90	181	✔	✔	✔	-
47	15/7/90	196	11/8/90	223	✔	-	✔	-
48	19/8/90	231	15/9/90	258	✔	-	✔	-
49	23/9/90	266	20/10/90	293	✔	-	✔	-
50	28/10/90	301	24/11/90	328	✔	✔	✔	-
51	2/12/90	336	28/12/90	362	✔	✔	✔	-
52	6/1/91	6	2/2/91	22	✔	✔	✔	-
53	10/2/91	41	9/3/91	68	✔	✔	✔	-
54	17/3/91	76	13/4/91	103	✔	✔	✔	-
55	21/4/91	111	18/5/91	138	✔	✔	✔	-
56	23/5/91	143	25/6/91	176	✔	✔	✔	-
57	4/7/91	185	6/8/91	218	✔	✔	✔	-
58	8/8/91	220	10/9/91	253	✔	✔	✔	-
59	12/9/91	255	15/10/91	288	✔	×	✔	-
60	17/10/91	290	19/11/91	323	✔	✔	✔	-
61	21/11/91	325	24/12/91	358	✔	✔	✔	-
62	26/12/91	360	21/1/92	21	×	✔	✔	-
63	23/1/92	23	25/2/92	56	×	✔	✔	✔
64	27/2/92	58	31/3/92	91	✔	✔	✔	✔
65	2/4/92	93	5/5/92	126	✔	✔	✔	✔

Table 1 : Dates of each cruise and the instrumentation deployed.
✔ = deployed successfully, × = deployed but failed, - = not deployed.

Variable	Sensor	Position
Date and time	MultiMet real time clock	
Wet bulb temperature	Vector Instruments aspirated psychrometer	Port wheelhouse top
Dry bulb temperature	(as above)	(as above)
Wet bulb temperature	Vector Instruments aspirated psychrometer	Starboard wheelhouse top
Dry bulb temperature	(as above)	(as above)
Wind speed at screen	Vector Instruments cup anemometer	Port wheelhouse top
Wind direction at screen	Vector Instruments wind vane	Port wheelhouse top
Wind speed at screen	Vector Instruments cup anemometer	Starboard wheelhouse top
Air pressure	IOS barometer	Oceanographic Lab.
Wind Speed (UK19 - UK29)	Vector Instruments cup anemometer	Goal post mast
Wind Speed (UK30 on)	R.M.Young Propeller-vane anemo.	Goal post mast
Wind direction (UK19 - UK29)	Vector Instruments wind vane	Goal post mast
Wind direction (UK30 on)	R.M.Young Propeller-vane anemo.	Goal post mast

Table 2. Summary of the variables logged by the MultiMet Slow Sampling system. Note that not all of these variables were logged on each cruise (see Table 3).

Cruise UK	Port Psychro	Stbd Psychro	Port anemo	Port vane	Stbd anemo	Wind Vel.	GP wind Speed	GP wind dir	Air Press
19	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895	YG 001	VI 1894	VI 2118	
20	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	
21	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	
22	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895	YG 001	VI 1894	VI 2118	IOS 01
23	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	IOS 01
24	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	IOS 01
25	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	IOS 01
26	VI 1048	VI 1029	VI 1892	VI 2102	VI 1895		VI 1894	VI 2118	IOS 01
27	VI 1048	VI 1055	VI 2238	VI 2135	VI 2237		VI 1894	VI 2118	IOS 01
28	VI 1048	VI 1055	VI 2238	VI 2135	VI 2237		VI 1894	VI 2118	IOS 01
29	VI 1048	VI 1055	VI 2238	VI 2135	VI 2237		VI 1894	VI 2118	IOS 01
30	VI 1048 VI 1055	VI 1055 VI 1048	VI 2238	VI 2135	VI 2237	YG 001			IOS 01
31	VI 1055	VI 1054	VI 2238	VI 2135	VI 2237	YG 001			IOS 01
32	VI 1055	VI 1054	VI 2238	VI 2135	VI 2237	YG 001			IOS 01
33	VI 1060	VI 1054	VI 2238	VI 2135	VI 2237	YG 002			IOS 02
34	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237	YG 002			IOS 02
35	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237	YG 002			IOS 02
36	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237	YG 002			IOS 02
37	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237				IOS 02
38	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237				IOS 02
39	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237				IOS 02
40	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237				IOS 02
41	VI 1060	VI 1061	VI 1992	VI 2179	VI 2237				IOS 02
42	VI 1048	VI 1061	VI 1991	VI 2117	VI 2238	YG 003			IOS 02
43	VI 1048	VI 1006	VI 1991	VI 2117	VI 2238	YG 003			IOS 02
44	VI 1048	VI 1006	VI 1991	VI 2179	VI 2238	YG 003			IOS 02
45	VI 1055	VI 1006	VI 2237	VI 2179	VI 2238	YG 003			IOS 02
46	VI 1055	VI 1054	VI 2237	VI 2179	VI 1893	YG 003			IOS 02
47	VI 1073	VI 1122	VI 2383	VI 2204	VI 2556				IOS 02
48	VI 1073	VI 1122	VI 2383	VI 2204	VI 2556				IOS 02
49	VI 1073	VI 1122	VI 2383	VI 2204	VI 2556				IOS 02
50	VI 1058	VI 1059	VI 1893	VI 2153	VI 1991	YG 004			IOS 02
51	VI 1058	VI 1059	VI 1893	VI 2153	VI 1991	YG 004			IOS 02
52	VI 1070	VI 1059	VI 2621	VI 2153	VI 1991	YG 004			IOS 02
53	VI 1070	VI 1058	VI 2621	VI 2208	VI 1992	YG 004			IOS 02
54	VI 1070	VI 1058	VI 2621	VI 2208	VI 1992	YG 005			IOS 02
55	VI 1066	VI 1058	VI1895	VI 2208	VI 1992	YG 005			IOS 02
56	VI 1066	VI 1055	VI1895	VI 2205	VI 2779	YG 005			IOS 02
57	VI 1061	VI 1055	VI 2777	VI 2205	VI 2779	YG 005			IOS 02
58	VI 1061	VI 1055	VI 2777	VI 2205	VI 2779	YG 005			IOS 02
59	VI 1061	VI 1059	VI 2777	VI 2205	VI 2556	YG 005			IOS 02
60	VI 1070	VI 1059	VI 2237	VI 2204	VI 2556	YG 002			IOS 02
61	VI 1070	VI 1059	VI 2237	VI 2204	VI 2556	YG 002			IOS 02
62	VI 1070	VI 1060	VI 2237	VI 2204	VI 1893	YG 002			IOS 02
63	VI 1058	VI 1060				SS 0037			IOS 02
64	VI 1061	VI 1060				SS 0037			IOS 02
65	VI 1061	VI 1060				SS 0037			IOS 02

Table 3. Make and serial number of the instruments deployed on each cruise. VI = Vector Instruments, YG = R.M.Young, SS = Solent Sonic, IOS = IOSDL design. GP mast is the midships goal post mast.

CRUISE	PROBLEMS / COMMENTS
19	**"Manned"**cruise. Wind speed logger for Vector anemometer on **goalpost** mast ceased logging on 17, 19 and 31 Oct and 14 Nov. **Fast sampling** from Young anemometer on 10m mast in bows (**North** ref to starboard). **Fast sampling** o/p amp. gain reduced from 1 to .5 from run 57 onwards. Possible **position** inaccuracies from Loran C replacement receiver. **Headings** from compass unreliable. Drifted **starboard to wind** from 30 Oct. onwards.
20	NO VISIT REPORT (therefore must assume faults reported in next visit report may also apply to this cruise) Drifted on port and starboard tacks.
21	Incorrect **jday** (time correct). **Both psychrometers** had dry wicks. No wind speed from **port wheelhouse.** Drifted on port and starboard tacks.
22	Incorrect **jday** (time correct). Fans on **both psychrometers** not working before day 31. **Fast sampling** from Young anemometer on 10m mast in bows (**North** ref to aft). Drifted **starboard to wind** from days 39-42 (storm).
23	**Jday** one day behind (time correct). No information as to which tack when drifting.
24	**Jday** one day "out" (time correct). **Port psychrometer** fan stopped by end of cruise. No information about tack.
25	**Jday** one day behind (time correct). No information about tack.
26	NO VISIT REPORT
27	NO VISIT REPORT
28	NO VISIT REPORT
29	**Jday** wrong - read 1/2/87 instead of 9/11/88. **Port psychrometer** had wick on wrong bulb for unspecified period, and fan connector eroded but still working (NOT REPLACED) No information about tack.
30	**"Manned"** cruise. **Jday** wrong **Port and starboard psychrometers** swapped on 23/11/88 since port psychrometer suspect (fan failed later). No information about tack.
31	**Both wheelhouse anemometers** repositioned over screens. Seems to coincide with a significant change in the data. **Both wind vanes** missing (from port wheelhouse and goalpost). **Drifted on port tack from this cruise onwards unless stated otherwise.**
32	**Both psychrometers** died during the cruise. **Port wheelhouse vane** repositioned (North to Port) on 28/1/89. **Young propeller** blown away 27/1/89.
33	"**Clock** correct" (not mentioned since cruise 30). **Both psychrometers** suspected of calibration errors. **Port psychrometer** failed during cruise. **Fast logger** crashed four times. **SBWR** "appears to work ok intermittently".

Table 4 : Summary of instrument service log and fault reports extracted from the visit reports. Note that in most cases the faults can be corrected during data processing, also that data from instruments not mentioned can be assumed to be good.

CRUISE	PROBLEMS / COMMENTS
34	**Clock** correct **Port psychrometer** fan stopped. **Starboard psychrometer** wick dry. **Port wheelhouse vane** now North to bow. **Fast logger** needed resetting repeatedly. MultiMet **data tape** finishes 5 days before Cumulus leaves station.
35	**Clock** correct **Fast sampling** playing up still.
36	NO PROBLEMS REPORTED
37	**Both psychrometer** fans showed problems. (No **fast sampling** system on cruises 37-41 inclusive)
38	NO PROBLEMS REPORTED
39	**Port psychrometer** dirty (wicks replaced in both psychrometers).
40	**Both psychrometer** fans showed problems - port was noisy, st'bd stopped. **Port temps** ~1 deg. lower than both st'bd and Met Office.
41	**Jday** read 21/1/89 for 10/1/90 - couldn't correct year. **MultiMet logger** affected by light on/off - no details. (**SBWR** checked and now found ok by J. Driver.)
42	New **EPROM** installed for correct year. **Port psychrometer** fan stopped - both replaced. **Vane** from **port wheelhouse** lost - makeshift installed. **Young wind vane** damaged, left disconnected. **Fast sampler** crashed after 2 days. Hove-to a lot.
43	**Jday** 9 days slow by end. **MID CRUISE PORT CALL.** **Starboard psychrometer** possibly off-calibration. No **wind direction** from **Young.** **Port wheelhouse anemometer** "stiff", makeshift **vane** still in place. Hove-to a lot.
44	**Port psychrometer** replaced at end of cruise 43 without altering cals. **Starboard psychrometer** using a lot of water for no reason. **Young propeller** lost. No reliable **fast sampling** data after day 100. **SBWR** printout (Hs only?) slow by 2 hours. Fast sampling clock 46s fast
45	**Both psychrometers** had dry(ish) wicks and wrong calibs still. (Rectified for next cruise). **Starboard anemometer** corroded - replaced.
46	NO VISIT REPORT
47	NO VISIT REPORT
48	NO VISIT REPORT
49	**Starboard anemometer** detached from mounting - replaced 30/8/90.
50	**Starboard psychrometer** fan failed - replaced, along with corroded power connector. **Young wind direction** now with North to stern. **SBWR** 10 min slow but repeatedly reset during cruise, so ok? Slow logger 6s fast - reset. Fast sampling 10s slow - reset. Hove-to a lot.

Table 4 (continued): Summary of instrument service log and fault reports extracted from the visit reports. Note that in most cases the faults can be corrected during data processing, also that data from instruments not mentioned can be assumed to be good.

CRUISE	PROBLEMS / COMMENTS
51	**Both psychrometer** fans stopped. **Port wheelhouse vane** may be suspect for bow winds. **Young vane** broken but seemed to work ok. Slow logger 16s fast - reset. Fast sampling 10s slow - reset. SBWR ~3min slow - reset. Hove-to a lot.
52	NO PROBLEMS Slow logger 7s fast - not reset. Fast sampling 8 sec slow - not reset. "SBWR time corrected" (?) Hove-to a lot.
53	**Starboard psychrometer** "physical units out of range" **Young propeller** missing - replacement "may be prone to vibration"-next cruise. Slow logger out by 10s - reset. Fast sampling out by 14s - reset.
54	**Fast sampling** needed re-booting early in cruise - possibly due to interference from winch. **Young propeller** missing - replacement "may be prone to vibration" - previous visit report. SBWR clock 3mins slow. Hove-to and drifted on starboard as well as port tacks.
55	**Port dry bulb** - possible intermittent fault causing very low readings. **Starboard psychrometer** motor stopped. **Fast sampling** errors possible halfway through voyage - caused by flickering fluorescent tube.
56	**Port dry bulb** read negative and was very unstable. **Port psychrometer** "had incorrect values in ZC56.BAS". All instrument **cabling** replaced. Fast sampling 1min 8s slow - reset. SBWR 2min 42s slow - reset.
57	First week of **tape data** may be dubious. Slow logger 23s slow - not reset. SBWR 1min 26s slow - reset. Drifted on starboard and port tacks.
58	**Young propeller** was not turning. SBWR 32s fast - reset.
59	**Starboard psychrometer** motor stopped and wick dry. No **wind speed** or **fast sampling** data from **Young** anemometer - replaced. SBWR 2min slow - reset.
60	"The **fast sampling** system had not been running through its usual graph sequence for some time."
61	**Port psychrometer** motor noisy. **Starboard psychrometer** motor stopped. SBWR 2min slow - reset.
62	LIGHTENING STRIKE 2 DAYS OUT FROM PORT BLEW FUSES IN THE LOGGER. SHIP'S MAGNETIC FIELD WILL CAUSE PROBLEMS WHEN OUR COMPASS IS INSTALLED? **Logger**, **Young** and **port psychrometer** removed.

Table 4 (continued): Summary of instrument service log and fault reports extracted from the visit reports. Note that in most cases the faults can be corrected during data processing, also that data from instruments not mentioned can be assumed to be good.

CRUISE	PROBLEMS / COMMENTS
63	**Logger** not installed. **Port psychrometer** reservoir missing - replaced. **Starboard psychrometer** motor stopped - replaced. **SOLENT SONIC** fast sampling ok. **GPS** worked ok - no ship's GPS for comparisons. **Compass** had wrong damping (2 instead of 4). Compass swung. SBWR slow < 2min - reset. Hove-to a lot.
64	**Logger** ok **Both psychrometer** motors noisy. **Sonic analogue** (i.e. mean wind data channels) and MultiMet 0volts joined (?). Sonic analogue cable loose. **Sonic fast sampling** needed rebooting 5 times, otherwise ok. **GPS** failed 9/3/92 and 28/3/92, otherwise ok. Comparison of **compass** and ship's head from gyro. SBWR slow ~2min - reset.
65	**Jday** wrong - 1/5/92 instead of 5/5/92 **Port psychrometer** motor noisy. **Starboard psychrometer** motor stopped. **Sonic analogue** channels 1-3 gave very large values, while reference channel 4 gave 0 rather than 2.5volts. GPS failed to track satellites after first week or so - removed. **Met Office** installed new, smaller **screens** - 1m further forward, 1m further inboard and 0.5m higher (now same height as our psychrometers).

Table 4 (continued): Summary of instrument service log and fault reports extracted from the visit reports. Note that in most cases the faults can be corrected during data processing, also that data from instruments not mentioned can be assumed to be good.

Instrument	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
visit report	G	-	OK	G	P	P	P	-	-	-	P	G	OK	OK	G	OK	G	G	OK	OK	OK	OK	G	G
logger clock	Y	?	?	?	?	Y	?	?	?	?	?	?	Y	?	?	?	Y	Y	?	Y	?	?	?	?
wet bulb w.h. port	Y	?	?	?	Y	?	Y	?	?	?	?	?	Y	?	?	?	Y	Y	?	Y	?	?	?	?
dry bulb w.h port	Y	Y	Y	?	Y	?	Y	?	?	?	?	?	Y	?	?	?	Y	Y	?	Y	Y	?	Y	?
wet bulb w.h.stbd	Y	?	?	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	?	?	Y	Y	?	Y	Y	?	Y	Y
dry bulb w.h.stbd	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	?	Y	Y	Y	?	Y	Y	?	Y	Y
anemometer w.h. port	Y	?	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
vane w.h. port	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	?	Y	?	Y	Y	Y	Y	Y	Y	Y	?
anemometer w.h. stbd	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
anemo. spd goalpost	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	?	Y	Y	Y	Y	/	/	/	/	/	Y
anemo. dirn goalpost	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	?	Y	Y	Y	Y	/	/	/	/	/	?
fast sampl. (goalpost)	/	/	/	/	/	/	/	/	/	/	/	Y	Y	?	?	?	?	Y	/	/	/	/	/	?
SBWR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	?	Y	Y
GPS	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Instrument	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
visit report	G	G	G	-	-	-	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
logger clock	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y	?
wet bulb w.h. port	Y	?	?	Y	Y	Y	Y	Y	?	Y	Y	Y	?	?	Y	Y	Y	Y	?	-	-	?	?
dry bulb w.h port	Y	?	?	Y	Y	Y	Y	Y	?	Y	Y	Y	?	?	Y	Y	Y	Y	?	-	-	?	?
wet bulb w.h.stbd	?	?	?	Y	Y	Y	Y	?	?	Y	?	Y	?	Y	Y	Y	?	Y	?	-	-	?	?
dry bulb w.h.stbd	?	?	?	Y	Y	Y	Y	?	?	Y	?	Y	?	Y	Y	Y	?	Y	?	-	-	?	?
anemometer w.h. port	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	/	/
vane w.h. port	?	Y	Y	Y	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	/	/
anemometer w.h. stbd	Y	Y	?	?	?	?	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	/	/
anemo. spd goalpost	Y	?	Y	Y	/	/	/	Y	Y	Y	?	-	Y	Y	Y	?	-	Y	Y	-	-	?	?
anemo. dirn goalpost	-	?	Y	Y	/	/	/	?	?	Y	?	Y	Y	Y	Y	Y	-	Y	Y	-	-	?	?
fast sampl. (goalpost)	?	?	-	Y	/	/	/	Y	Y	Y	Y	?	?	?	Y	?	-	?	Y	-	Y	?	?
SBWR	Y	?	Y	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GPS	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	?	?	?	?

Table 5: Quality of data from each sensor:

Y Data good. ? Problem noted with data - Data bad or lost / Sensor not mounted.

The quality of information contained in the visit report is rated as Good, Poor, or OK.

CUM no.	calib files	tape data	coeff	tapedd	phy-data	plot	phy-dspi	plot		met obs log	met files	met plot
19	h	?	s	?	s		s			h	s	h
20	h	-	-	-	-	-	-	-		h	s	h
21	h	-	-	-	-	-	-	-		h	s	h
22	h	s	s	s	s	h	s	h		h	s	h
23	h	s	s	s	s	h	s	h		h	s	h
24	h	s	?	?	s	h	s	h		h	s	h
25	h	s	?	?	s	h	s	h		h	s	h
26	h	s	s	?	s	h	s	h		h	s	h
27	h	s	s	s	s	h	s	h		h	s	h
28	h	s	s	s	s	h	s	h		h	s	h
29	h	s	s	s	s	h	s	h		h	s	h
30	h	s	s	s	s	h	s	h		h	s	h
31	h	s	s	s	s	h	s			h	s	h
32	h	s	s	s	s	h	s	h		h t	s	h
33	h	s	s	s	s	h	s	h		h	s	h
34	h	s	s	s	s	h	s	h		h	s	h
35	h	s	s	s	s	h	s	h		h	s	h
36	h	s	s	s	s	h	s	h		h t	s	h
37	h	s	s	s	s	h	s			h	s	h
38	h	s	s	s	s	h	s			h	s	h
39	h	s	s	s						h t	s	h
40	h	s	s	s	s	h				h t	s	h
41	h	s	s	s	s					h	s	h
42	h	s	s	s						h	s	h
43	h	s	s	s						h	s	
44	h	s	s	s						h	s	
45	h	s	s	s	s	h	s			h	s	
46	h	s	s	s	s	h	s	s		h	s	
47	h	s	s	s	s	h				h	s	
48	h	s	s	s	s	h				h	s	
49	h	s	s	s	s	h				h	s	
50	h	s	s	s	s	h				h	s	
51	h	s	s	s	s	h				h	s	
52	h	s	s	s	s	h				h	s	
53	h	s	s	s						h	s	
54	h	s	s	s	?	h				h	s	
55	h	s	s	s	?	h				h	s	
56	h	s	s	s						h	s	
57	h	s	s	s						h	s	
58	h	s	s	s						h	s	
59	h	s	s	s						h	s	
60	h	s	s	s						h	s	
61	h	s	s							h	s	
62	h	-	-	-	-	-	-	-		h t	s	
63	h	-	s	s	-	-	-	-		h	s	
64	h	s	s	s	s					h t	s	
65	h	s	s	s						h t		

Table 6 State of processing for the Slow Sampling and Meteorological Office data. h = hardcopy, s = on JRC SUN system, d = on disk at JRC, t = navigation data on SUN, ? = data which should be available but is not on system, - = system not installed on ship

CUM no.	sbwr rolls	sbwr data	pcorr file	sbwr plot	Hs Plot		mm fast	psd
19	ios	o	-	-	-		*	*
20	ios	o	-	-	-		-	-
21	ios	o	-	-	-		-	-
22	ios	o	-	-	-		*	*
23	ios	o	-	-	-		-	-
24	ios	o	-	-	-		-	-
25	ios	o	-	-	-		-	-
26	ios	o	-	-	-		-	-
27	ios	o	-	-	-		-	-
28	ios	o	-	-	-		-	-
29	ios	o	-	-	-		-	-
30	ios	o	-	-	-		d	
31	ios	o	-	-	-		d	
32	-	-	-	-	-		d	
33	-	-	-	-	-		d	
34	-	-	-	-	-		d	
35	-	-	-	-	-		d	
36	-	-	-	-	-		d	
37	-	-	-	-	-		-	-
38	-	-	-	-	-		-	-
39	-	-	-	-	-		-	-
40	-	-	-	-	-		-	-
41	-	-	-	-	-		-	-
42	-	s	s	h	h		d	
43	h	s	s	h	h		d	
44	-	s	s	h	h		d	
45	h	s	s	h	h		d	
46	h	s	s	h	h		d	
47	h	o					-	-
48	h	o					-	-
49	h	o					-	-
50	h	s	s	h	h		d	
51	h	s	s	h	h		d	
52	h	s	s	h	h		d	
53	h	s	s	h	h		d	
54	h	s	s	h	h		d	
55	h	s	s	h	h		d	
56	h	s	s	h	h		d	
57	h	s	s	h	h		d	
58	h	s	s	h	h		d	
59	h	s	s	h	h		-	-
60	h	s	s	h	h		s	
61	h	s	s	h	h		d	
62	h	s	s	h	h		d	
63	h	s	s	h	h		s	
64	ios	s	s	h	h		s	
65	ios	s	s	h	h		s	

Table 7 State of processing for the SBWR and Fast Sampling system. h = hardcopy, s = on JRC SUN system, d = on disk at JRC, ios = data at I.O.S., o = old format SBWR data on JRC Sun, * = data available from manned cruises, - = system not installed on ship.

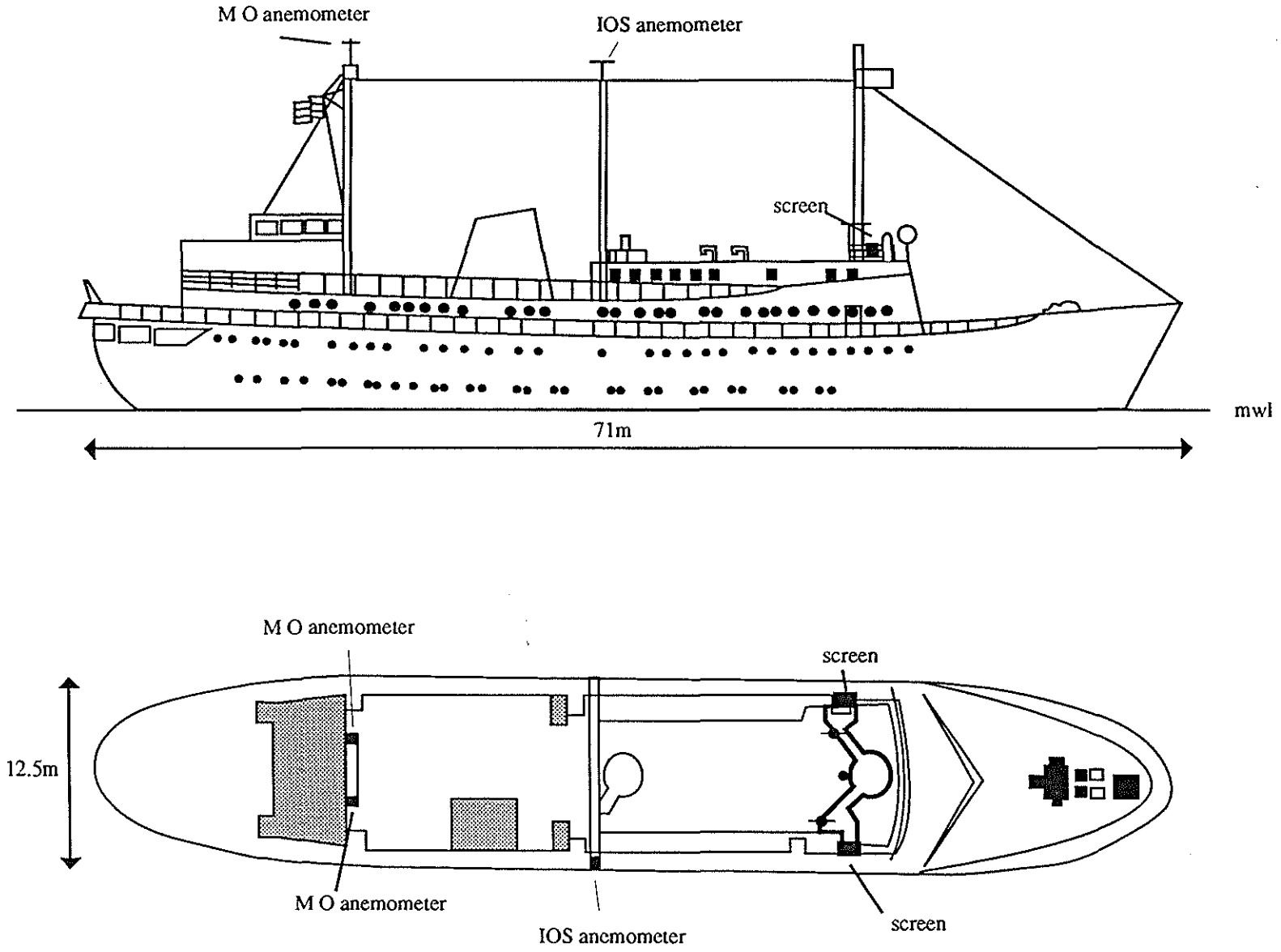

Figure 1. Position of the instrumentation on the OWS Cumulus.

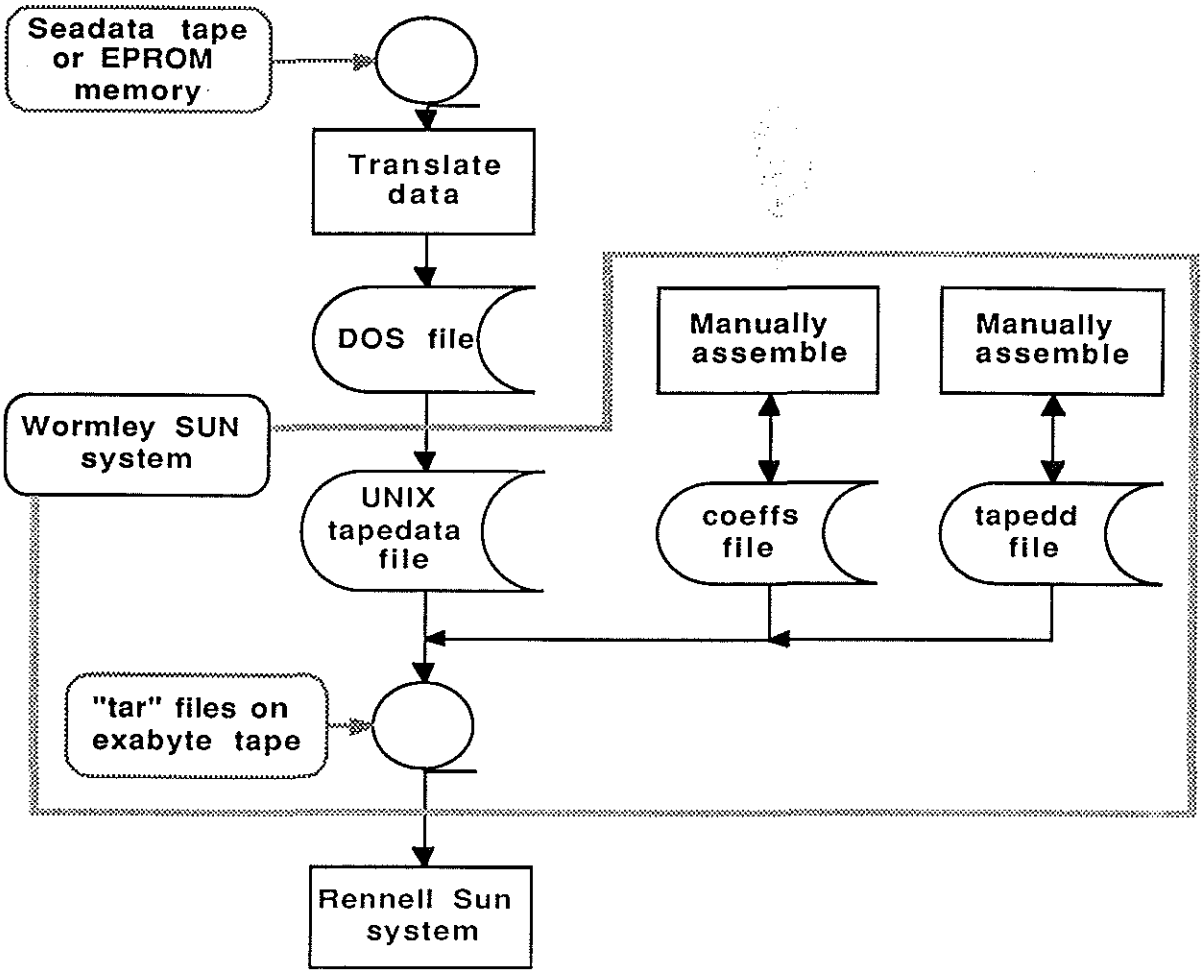

Figure 2 Flow chart showing transfer of data to the JRC SUN system.

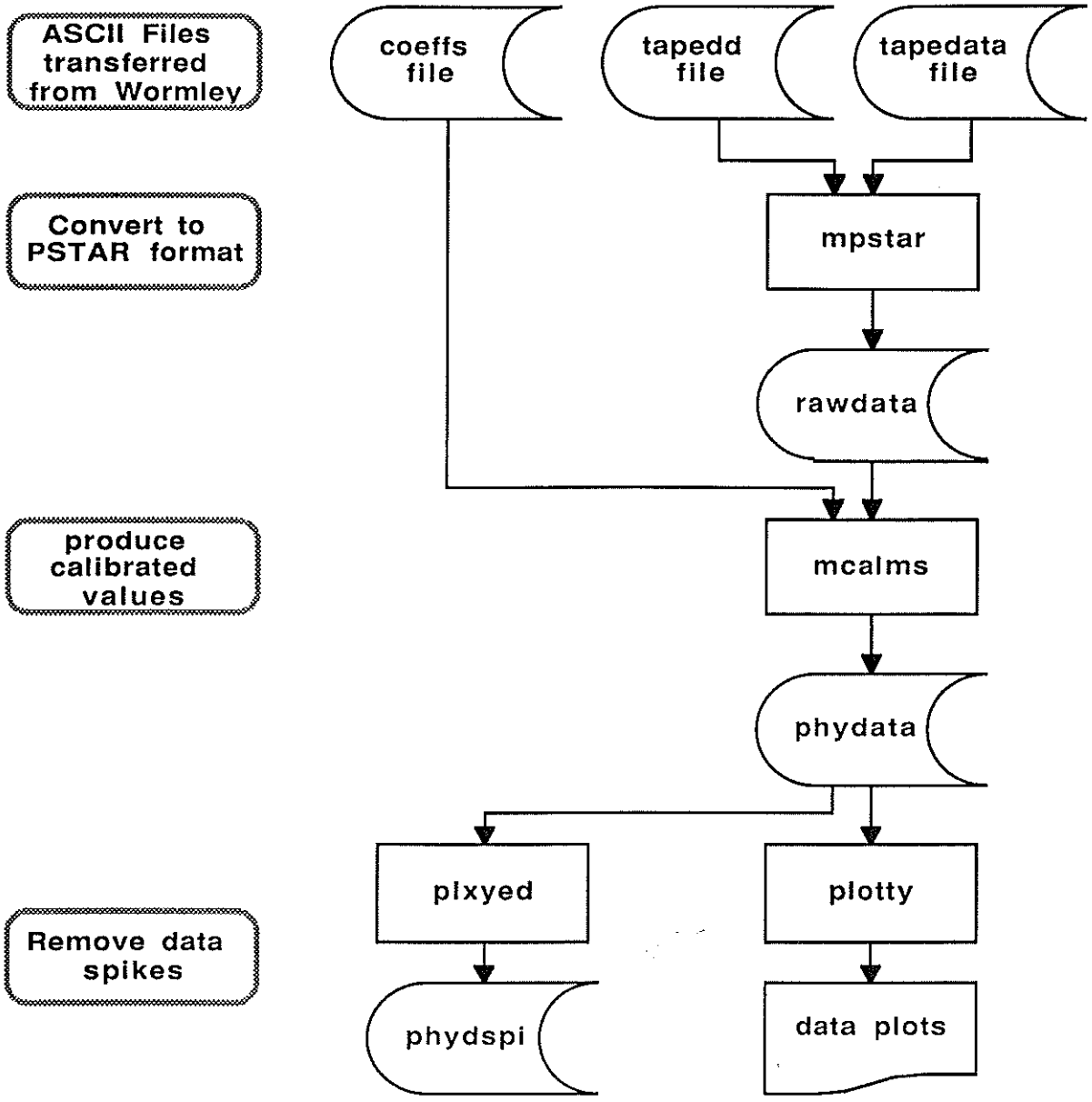

Figure 3 MultiMet processing on the JRC SUN system

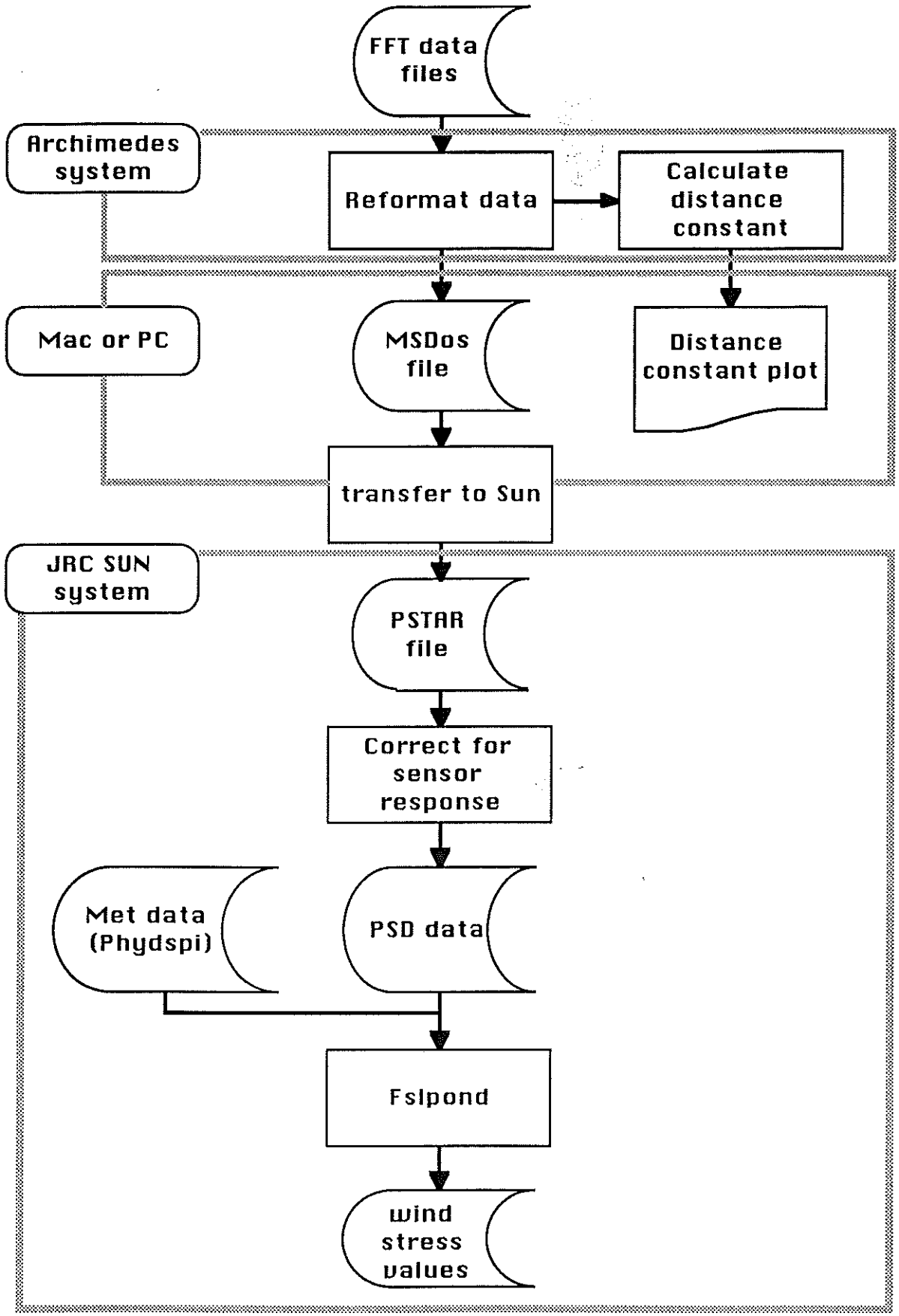

Figure 4 Processing for the Fast Sampling MultiMet system.

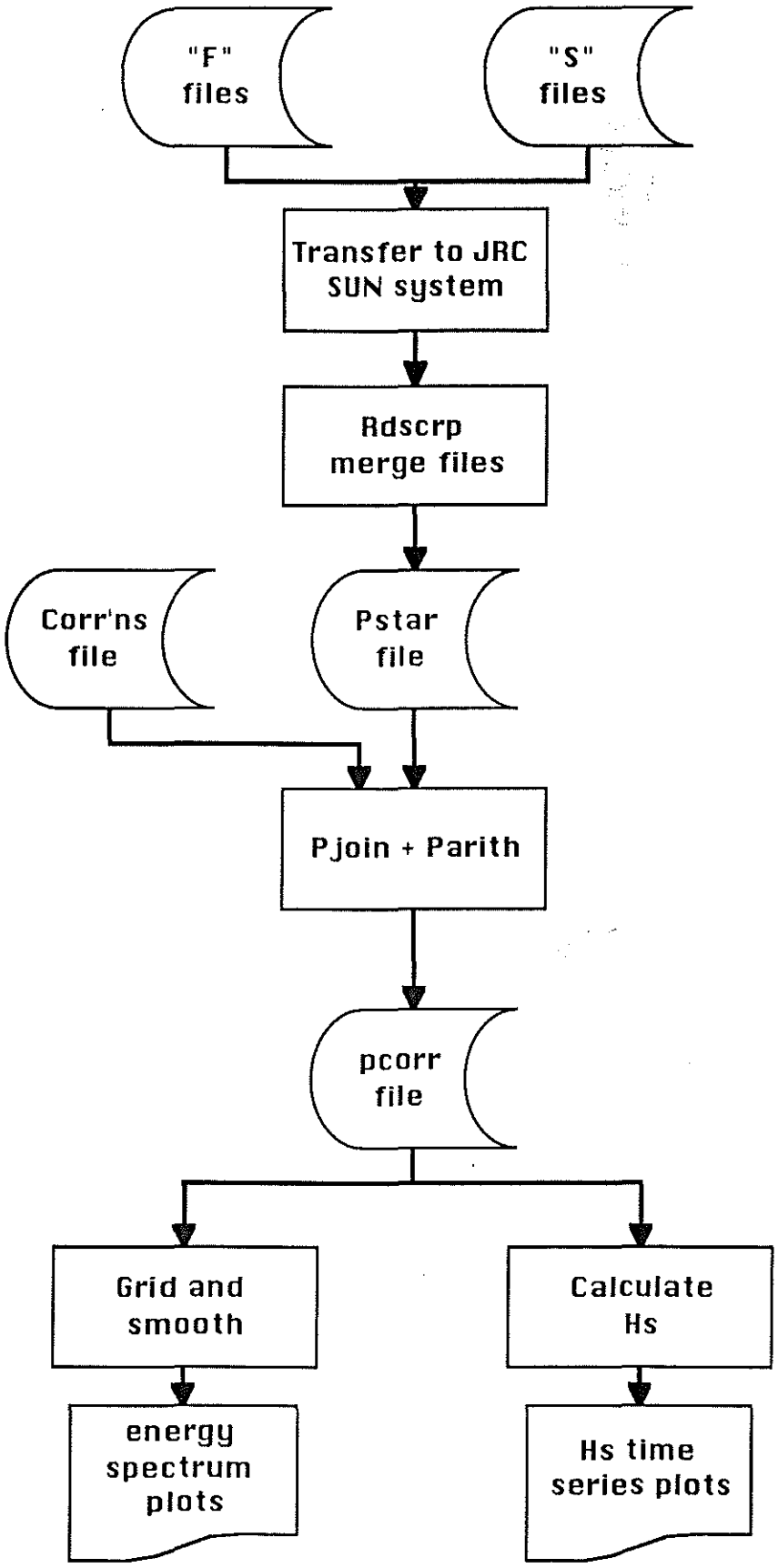

Figure 5 Processing for the SBWR