Meteor DVS Data Quality Control Report

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1. Introduction:

This report summarizes the quality of surface meteorological data collected by the Meteor (identifier: DBBH) DVS system during WOCE cruises in 1990 through 1995. The data were provided to the Florida State University Data Assembly Center (DAC) on CD-rom by Khosro Motamedi at the Bundesamt für Seeschiffahrt und Hydrographie, Germany. They were converted to standard DAC netCDF format and then processed using an automated data screening program which adds quality control flags to the data, highlighting potential problems. Finally, the Data Quality Evaluator reviewed all the data and the preprocessor flags. Flags were added, modified, and deleted according to the judgement of the Data Quality Evaluator and other DAC personnel. An in depth description of the WOCE quality control procedures can be found in Smith et al. (1996). The data quality control report summarizes all flags for the Meteor DVS data and provides reasons for the assigned flags.

2. Data Available:

The Meteor DVS data included observations recorded every 50 to 60 seconds on all of the WOCE cruises. The DAC rounded the time stamps to the nearest minute, resulting in duplicate times on rare occasions. Two different sets of navigation data were provided to the DAC, one from the inertial navigation system (INS) and the other from the TRANSIT satellite system (SATNAV). As a result, two independent sets of platform course and platform speed data were available from the navigation data. All meteorological data, except for radiation and pressure measurements, were taken with two independent sensors, one mounted on the port side and the other on the starboard side of the vessel. Below is a list of the variables for which values were collected and the instrument system that made the measurements.

TIME	Time
LAT	Latitude (INS)
LON	Longitude (INS)
LAT2	Latitude (SATNAV)

LON2	Longitude (SATNAV)
PL_CRS2	Platform Course (SATNAV)
PL_HD	Platform Heading (gyrocompass)
PL_CRS	Platform Course (INS)
PL_SPD	Platform Speed (INS)
PL_SPD2	Platform Speed (SATNAV)
PL_SPD3	Platform Speed (EMlog)
PL_WDIR	Platform (ship) Relative Wind Direction (port)
PL_WSPD	Platform (ship) Relative Wind Speed (port)
PL_WDIR2	Platform (ship) Relative Wind Direction (stbd)
PL_WSPD2	Platform (ship) Relative Wind Speed (stbd)
DIR	Earth Relative Wind Direction (port)
SPD	Earth Relative Wind Speed (port)
DIR2	Earth Relative Wind Direction (stbd)
SPD2	Earth Relative Wind Speed (stbd)
TS	Sea Temperature (port)
TS2	Sea Temperature (stbd)
P	Atmospheric Pressure
T	Air Temperature (port)
T2	Air Temperature (stbd)
TD	Dewpoint Temperature (port)
TD2	Dewpoint Temperature (stbd)
RH	Relative Humidity (port)
RH2	Relative Humidity (stbd)
RAD	Short Wave (Solar) Radiation
RAD2	Ultraviolet Radiation

The quality controlled data set does not necessarily include all of these variables in every WOCE cruise. If the values for a variable were missing or highly suspect for an entire cruise, that variable was removed from the final quality controlled data set. The yearly summaries provide information about exactly which variables were not included for each cruise.

3. Overall Quality:

The quality of the Meteor DVS data is excellent for many of the variables. On the other hand, the variables T, T2, TD, TD2, RH, and RH2 have a major problem related to the placement of the instruments resulting in extensive flagging of these variables. Both instrument sets measuring

temperature and moisture variables are located on the superstructure in front of and above the exhaust stack of the ship. Consequently, measurements of temperature, dewpoint temperature, and relative humidity are greatly influenced by the ship's exhaust whenever the ship-relative wind direction was in the vicinity of 180 degrees (blowing from stern to bow). In addition, the radiation data are highly suspect for many of the cruises. The satellite navigation data are also unreliable. The major problems present throughout the six years of data are discussed in detail in section 4. Sections 5 through 9 contain yearly summaries detailing the distribution of flags and minor problems specific to each year of data.

4. Major Problems:

4.1 Exhaust Problem

As stated earlier, the research vessel's exhaust creates a problem with the measurement of air temperature and the quantities used to calculate dewpoint temperature and relative humidity. The instruments that sample these meteorological variables are placed on the tower at a height above the top of the exhaust stack, which is located behind the tower (see Figure 1). Consequently, any ship relative wind blowing from the stern towards the bow (in the vicinity of 180 degrees) carries the rising exhaust to the instruments. Because the exhaust is warm and moist, the measured temperature and dewpoint temperature suddenly rises one to five degrees C when the exhaust hits the instruments. After a change in ship-relative wind direction, the exhaust cleares from the instruments and temperature and dewpoint return to normal. The data are affected for only a few minutes when the ship-relative wind direction is changing rapidly (i.e., caused by the turning of the research vessel). At other times the data are affected for much longer periods, in some cases up to several hours, if a constant light wind from the stern keeps the exhaust around the instruments. Relative humidity measurements are also influenced by this problem, although the response to trends in the temperature and dewpoint temperature are not uniform.

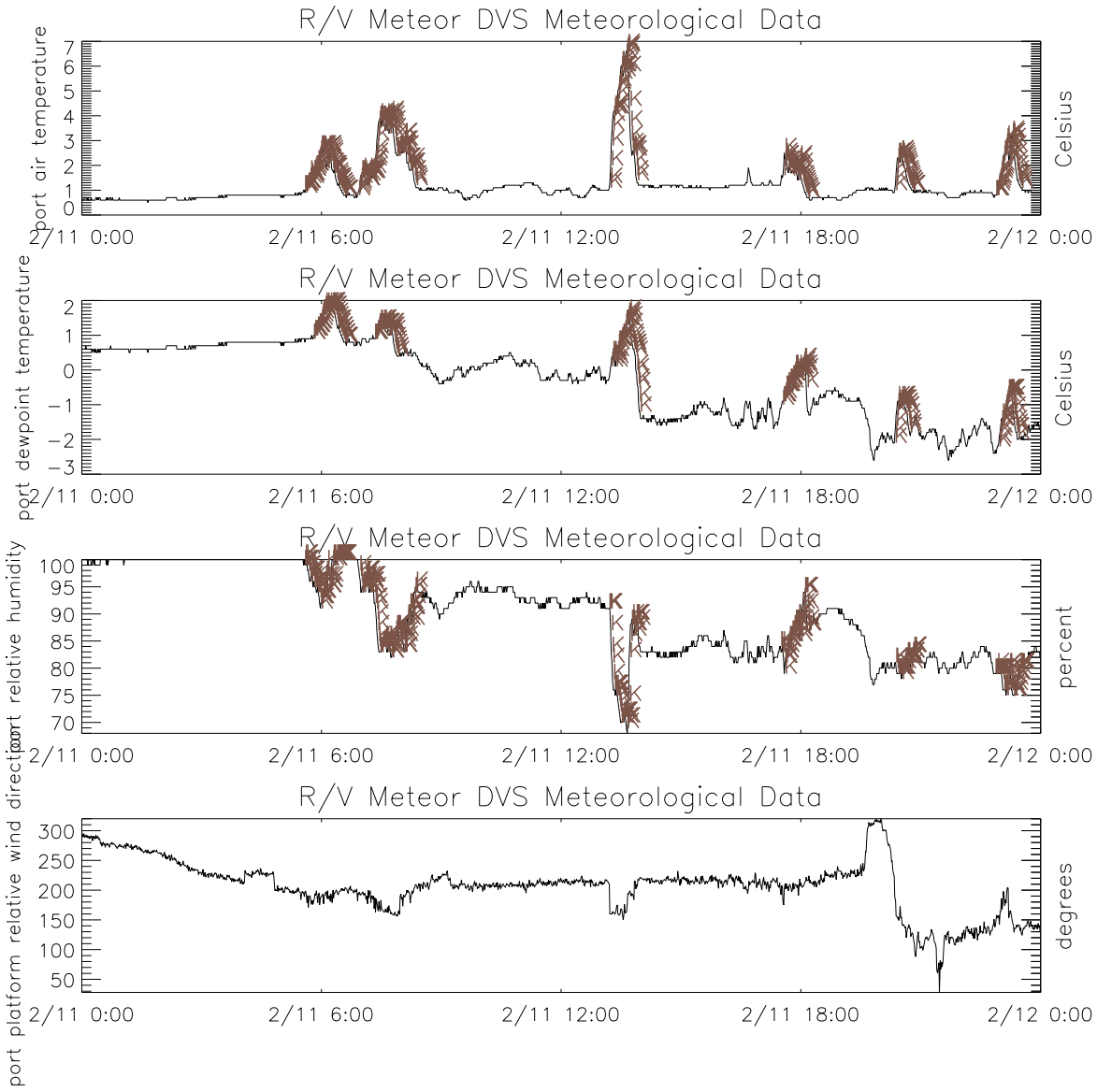
Figure 1: Research Vessel *Meteor*

The analyst attempted to flag all exhaust events with a "K". Differences in response time and exposure of the instruments resulted in varying times and amounts of flagging among the six different variables. In addition, the exhaust problem was not always discernable from normal background noise and some events may not have been flagged completely in all of the variables. The user may wish to apply an automated filter based on ship-relative wind direction, but such a task was beyond the scope of DAC quality control procedures. Figure 2 shows a typical plot of T, TD, RH, and PL_WDIR and the flagging of these variables.

4.2 Temperature

In addition to the exhaust problem, temperature data were also sensitive to radiational heating. Inadequate ventilation of the instrument and direct sunlight sometimes combined to force

Figure 2: Flagging of the Exhaust Problem



unrealistically high temperature readings from the instrument least exposed to the wind. Although this problem could be differentiated from the exhaust problem by checking the platform relative wind direction, it was flagged similarly with the ”K” flag. Relative humidity measurements were also affected by this ventilation problem and were flagged with the “K”.

4.3 Earth Relative Winds

The earth-relative winds were fairly reliable and showed very little influence of the ship's movement in the time series plots. Some flow distortion did occur, specifically when the ship-relative winds were from 100 degrees or 260 degrees. The flow distortion was characterized by sudden changes in earth-relative wind direction of 10 to 20 degrees and drops in earth relative wind speed of 1 to 3 m/s. The most likely cause of the flow distortion was the tower, partially blocking the flow to the port instruments when the ship-relative winds were from 100 degrees. Likewise, a ship relative-wind direction of 260 degrees caused the starboard instruments to be blocked. This problem was not flagged, but should be considered by the user of the data. The impact of flow distortion is dependent on the averaging period used (Smith et al. 1998). The WMO recommends combining the data from the two instrument sets, always using measurements from the one more freely exposed to the wind (WMO 1983).

4.4 Latitude and Longitude

Two separate sets of latitude and longitude data were collected using SATNAV (LAT2 and LON2) and INS (LAT and LON) navigation systems. The SATNAV data were collected using the older and less reliable TRANSIT satellites. When no signals were available, the system changed over to using dead reckoning. The INS is a fully integrated system that makes use of GPS data from the Trimble 4000 AX. The INS is a state of the art navigation system and quality control has proven the data very reliable. Both sets of navigation data were visually quality controlled, but were not preprocessed to check for unrealistic ship movement or positions over land. The visual quality control process identified erroneous data, which may have resulted in an "L" flag from the preprocessor for position over land, and flagged them instead with a "J" for bad data or a "K" for caution. Again, the INS data were found to be of very high quality and should be preferred by the user for most position information. The SATNAV data should only be used when the INS data is flagged or missing.

Other quality controlled data sets released by the DAC consist of only data which are identified with a valid TIME, LAT, and LON stamp. The *Meteor* quality controlled data contains some records with missing LAT or LON data; however, LAT2 and LON2 will be available for records to identify the ship's position. The inverse, missing LAT2 and LON2 with available LAT and LON may also occur Data are only excluded if no position information is available from either the INS or the SATNAV systems. The quality controlled data contains no records which are missing data from both the INS and SATNAV systems.

Periods occurred where the SATNAV values for latitude and longitude would differ significantly from the INS values. These periods lasted from less than one day to over one month. During these times the values for latitude and longitude would either continue to drift further apart or remain different by a constant amount. The SATNAV data were determined to be in error by comparison to independent platform heading data and because the SATNAV data often yielded positions over land. LAT2 and LON2 were assigned the "J" flag during these periods. During some of these episodes PL_CRS2 and PL_SPD2, calculated from the SATNAV data, also proved to be erroneous when compared to independent variables (PL_HD, PL_CRS, PL_SPD, and PL_SPD3) and were flagged. At other times PL_CRS2 and PL_SPD2 seemed to agree well with the independent variables even though the satellite navigation was in error. No flags were assigned to PL_CRS and PL_SPD in this case until the DAC can learn more about the exact nature of satellite navigation problem. LAT and LON should be used exclusively when the SATNAV data is flagged with a "J", while PL_CRS and PL_SPD should also be preferred during these periods, even if PL_CRS2 and PL_SPD2 are not flagged.

4.5 Moisture discontinuities

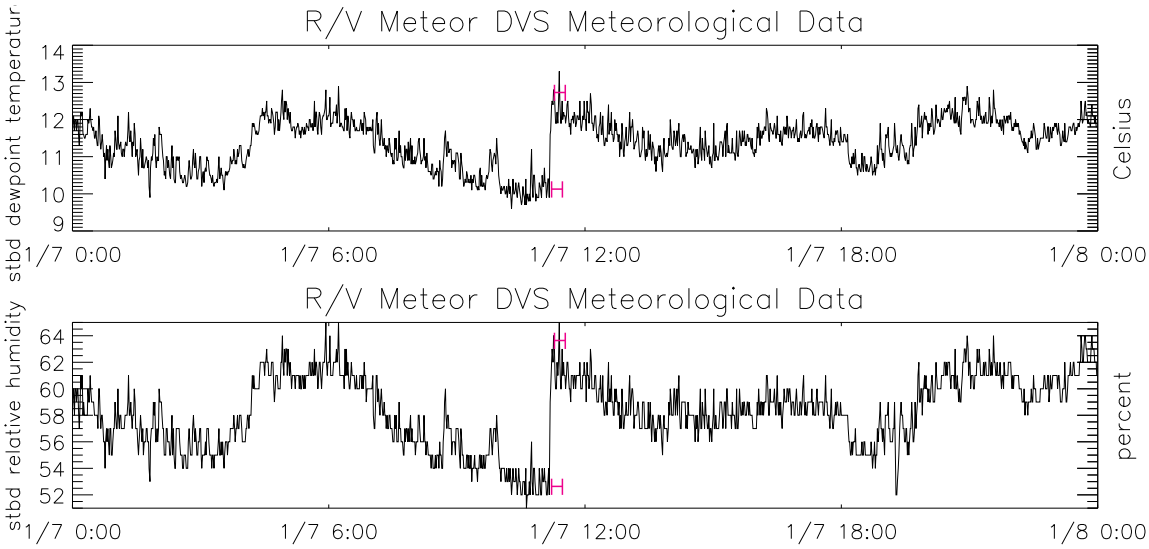
Discontinuities occurred in the plots of dewpoint and relative humidity where the local average

would suddenly change dramatically, as seen in figure 3. An adjustment of the instruments may have caused the some of the discontinuities, as the port and starboard measurements would differ by a constant amount before the change and agree more closely afterwards. The "H" flag was placed at the points of discontinuity, but it is left for the user to determine which set of data is more accurate.

4.6 Climatology

The prescreener compared the values of pressure, sea temperature, air temperature, relative humidity, and wind speed to a climatology (da Silva et al., 1994) and assigned the "G" flag for values outside of four standard deviations from the mean. These "G" flags often occurred where there were other problems in the data, in which case they were overwritten with more appropriate

Figure 3: Moisture discontinuity



flag by the analyst. Other times the values flagged with the "G" represented realistic values. These flags were left unaltered, calling attention to relatively extreme events.

4.7 PL_SPD3

The PL_SPD3 variable exhibited an increased number of negative spikes beginning in 1992. These spikes occurred when the ship was underway with a speed greater than 2 m/s. Most spikes were flagged individually with the "S" flag. Some blocks of data had too many spikes to flag individually. The entire blocks were assigned the "K" flag and should be used with caution. As an alternative, the user may want to filter these data.

4.8 Time Duplication

The Meteor data were typically gathered with a frequency between 50 to 60 seconds. The DAC only stores data every minute, requiring the time to be rounded to the nearest minute. In a few cases the rounding produced two different data records with the same time stamp. The TIME variable for these records were each assigned the "T" flag by the preprocessor for time duplication. Other records that received the "T" flags had the same time stamp and exactly equal values for all variables. These exact duplicates were removed from the quality controlled data set.

4.9 Spikes

Isolated positive and negative spikes occurred in most of the variables throughout the data. Spikes are relatively common occurrence in automated data, caused by such factors as electrical interference and ship accelerations. These individual points were assigned the "S" flag.

5. 1990 Flag Summary

The 1990 *Meteor* data contains values from two cruises covering seven WOCE hydrographic lines. Details of each cruise including start and end dates, number of records, number of values, number of flags, percentage flagged, and variables not included with the quality controlled data are listed in Table 5.1. A total of 2,243,108 values were evaluated with 63,074 flags added by the preprocessor and Data Quality Evaluator for a total of 2.81 percent of the values being flagged. Table 5.2 details the distribution of flags among the different variables.

Table 5.1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Percent-age Flagged	Variables not included
A__21_/00 SR_02_/02 S__01_/00 S__04A/01	01/23/90 - 03/07/90	43,835	1,227,380	40,714	3.32	PL_CRS2, PL_SPD2
AR_04E/01 AR_04W/01 AR_15_/01	10/01/90 - 10/27/90	36,276	1,015,728	22,360	2.2	PL_CRS2, PL_SPD2

Description of Problems:

5.1 Truncation of PL_CRS, PL_SPD

All PL_CRS2 and PL_SPD2 data are excluded from the quality controlled data because of a likely truncation error. DAC personnel have confirmed the data were truncated on the CD-rom's that were provided by the Bundesamt für Seechiffahrt und Hydrographie. Values were missing for any PL_CRS over 99.9 degrees and any PL_SPD over 5.1 m/s (9.9 kts). Future recovery of the data is unlikely.

Table 5.2: Number of Flags and Percentage Flagged for Each Variable

Variable	B	D	G	J	K	S	T	Total Number of flags	Percentage of Variable Flagged
TIME							4	4	0.00*
LAT				654		1		655	0.82
LON				22				22	0.03
LAT2	1			1170				1171	1.46
LON2				1170				1170	1.46
PL_HD						1		1	0.00*
PL_CRS						1		1	0.00*
PL_SPD	3					2		5	0.01
PL_SPD3				34		1		35	0.04
PL_WDIR				125		1		126	0.16
PL_WSPD				154		2		156	0.19
PL_WDIR2				123		1		124	0.16
PL_WSPD2				140		2		142	0.18
DIR				556		9		565	0.71
SPD			146	540		14		700	0.87
DIR2				550		10		560	0.70
SPD2			56	526		15		597	0.75
TS			2002	144		2		2148	2.68
TS2			2008	143		4		2155	2.68
P				143				143	0.18
T		16		153	9181	15		9365	11.69
T2			276	1397	8224	13		9910	12.38
TD		16		153	2901	7		3077	3.84
TD2				805	8694	10		9509	11.87
RH				153	8424	1		8578	10.71
RH2				1396	10459	12		11867	14.81
RAD	2			122				124	0.15
RAD2				164				164	0.20
Total Number of Flags	6	32	4488	10537	47883	124	4	63074	
Percentage of All Values Flagged	0.00*	0.00*	0.20	0.47	2.14	0.01	0.00*	2.81	

* less than 0.01 percent flagged

5.2 Suspicious Data

Isolated short periods of suspiciously low values appeared in the variables T, T2, TD, TD2, RH, and RH2. These periods were one to 15 minutes in duration and the values were up to two degrees (10% for relative humidity) lower than surrounding values in an otherwise smooth time series. No corresponding changes in wind or radiation measurements were found to verify these sudden drops as realistic. All values during these periods were assigned the "K" flag.

5.3 Erroneous Data

Problems occurred on 1/26/90 and 2/18/90 where all wind and meteorological data were a constant, unrealistic value for hundreds of records in a row (i.e., TS, T, TD of 40.0 C). All of these values were assigned the "J" flag. On 3/03/90 through 3/05/90 the plots for T2, TD2, and RH2 had periods where the data were very erratic, with many erroneous values (i.e., T2 of -30 C). These periods were also flagged with a "J".

5.4 LAT and LON

During the first one third of 1/23/90 LAT was recorded as exactly zero while LON was missing. These LAT values were flagged with a "J". The ship was docked in port at this time and later values of LAT and LON should yield the correct position. Both LAT and LON were exactly zero for 22 minutes on 01/03/90. These values were also flagged with a "J".

5.5 LAT2 and LON2

For several hours on 1/23/90 LAT2 and LON2 were extremely erratic with large discontinuities. All values during this period received the "J" flag and should be not be used.

5.6 Miscellaneous Flags

T and TD each received 16 “D” flags from the prescreener for failing the T > TD test. Isolated “B” flags were assigned to LAT3, PL_SPD2, and RAD by the prescreener.

6. 1991 Flag Summary

The 1991 *Meteor* data contain values from five cruises covering seven WOCE hydrographic lines. Details of each cruise including start and end dates, number of records, number of values, number of flags, percentage flagged, and variables not included in the quality controlled data are listed in Table 6.1. A total of 3,095,189 values were evaluated with 62,794 flags added by the preprocessor and Data Quality Evaluator for a total of 2.03 percent of the values being flagged. Table 6.2 details the distribution of flags among the different variables.

Table 6.1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Percent-age Flagged	Variables not Included
AR_15_/02	12/30/90 - 01/16/91	24,956	698,768	11,993	1.72	PL_CRS2, PL_SPD2
AR_15_/03	1/18/91 - 2/07/91	28,167	788,676	7,306	0.93	PL_CRS2, PL_SPD2
A__09_/00	2/10/91 - 3/23/91	37,244	1,042,832	19,270	1.85	PL_CRS2, PL_SPD2
AR_04E/02 AR_04W/02 AR_15_/04	5/23/91 - 6/02/91	12,677	316,925	9,964	3.14	PL_CRS2, PL_SPD2, T, TD, RH
A__01E/00	9/18/91 - 9/25/91	9,385	247,988	14,261	5.75	LAT2, LON2, PL_CRS2, PL_SPD2

Description of Problems:

6.1 Truncation of PL_CRS2, PL_SPD2

All PL_CRS2 and PL_SPD2 data are excluded from the quality controlled data because of a likely truncation error. DAC personnel have confirmed the data were truncated on the CD-rom's that were provided by the Bundesamt für Seeschiffahrt und Hydrographie. Values were missing for any PL_CRS over 99.9 degrees and any PL_SPD over 5.1 m/s (9.9 kts). Future recovery of the

Table 6.2: Number of Flags and Percentage flagged for Each Variable

Variable	B	G	H	I	J	K	S	T	Total Number of flags	Percentage of Variable Flagged
TIME								8	8	0.00*
LAT					134	203			337	0.30
LON					60	196			256	0.23
LAT2					4771		9		4780	4.64
LON2					4420				4420	4.29
PL_HD										0.00*
PL_CRS					34	196			230	0.20
PL_SPD					34	196	3		233	0.21
PL_SPD3										0.00*
PL_WDIR					281				281	0.25
PL_WSPD					924				924	0.82
PL_WDIR2										0.00*
PL_WSPD2										0.00*
DIR					1026		1		1027	0.91
SPD		182			1028		1		1211	1.08
DIR2					36		1		37	0.03
SPD2		104			36		1		141	0.13
TS		154		1					155	0.14
TS2		140		1					141	0.13
P										0.00*
T					1324	11679	13		13016	13.05
T2						7705	4		7709	6.86
TD			8		861	4566	4		5439	5.45
TD2			10			1401	7		1418	1.26
RH			8		2182	11998	14		14202	14.24
RH2			10			6808	8		6826	6.07
RAD	3								3	0.00*
RAD2										0.00*
Total Number of Flags	3	580	36	2	17151	44948	66	8	62794	
Percentage of All Values Flagged	0.00*	0.02	0.00*	0.00*	0.55	1.45	0.00*	0.00*	2.03	

* less than 0.01 percent flagged

data is unlikely.

6.2 Missing Variables

The satellite navigation data are missing on cruise A__01E/02. PL_CRS and PL_SPD, which are calculated from the satellite navigation data, are also missing.

6.3 Erroneous Values

On cruise AR_04E/02 the port variables T, TD, and RH each reported a constant, unrealistic value for the entire cruise (T = 40 C, TD = 273.15 C, RH = 0). These variables contain no useful information on this cruise and were not included in the quality controlled data set.

6.4 Latitude and Longitude

For several hours on 3/13/91 LAT and LON were erratic with large discontinuities. All values in this period received the "K" flag and should be used with caution. PL_CRS and PL_SPD were also assigned the "K" flag at this time, since they are calculated using LAT and LON. The same problem occurred on 9/21/91, but the platform course and speed data calculated from these variables were unrealistic (PL_SPD greater than 40 m/s), suggesting the INS navigation data were erroneous. All INS data and the derivative variables, including earth relative winds, were flagged with the "J" flag during this period. Other isolated periods occurred where one or both of the INS navigation variables had zero values for many records in a row. The zero values were flagged with a "J".

On 5/23/91 the satellite navigation data began to differ over two tenths of a degree from the INS data. The problem was corrected on 5/27/91 and the two navigation data sets agreed well for the remainder of the cruise. This discrepancy was likely caused by an unconfirmed malfunction of the satellite navigation system (section 4.4) and LAT2 and LON2 were flagged with the "J" flag.

LAT and LON should be used during this period.

6.5 Suspicious Data

Isolated short periods of suspiciously low values appeared in the variables T, T2, TD, TD2, RH, and RH2. These periods were 1 to 15 minutes in duration and the values were up to two degrees (10% for relative humidity) lower than surrounding values in an otherwise smooth time series. No corresponding changes in wind or radiation measurements were found to verify these sudden drops as realistic. All values during these periods were assigned the "K" flag.

6.6 Moisture Variables

On 9/18/91 and 9/19/91 port dewpoint temperatures were 7 degrees C greater than the starboard readings before an adjustment of the port instrument brought them within one degree of each other. The discontinuities were flagged with an "H" and all preceding port values were flagged with the "J" flag. Port relative humidity followed the same trend and was flagged similarly.

6.7 Interesting Feature

On 1/31/91 the sea temperature measurements from both instruments began to rise and fluctuate rapidly 1 to 2 degrees C. This trend began at the same time the research vessel moved over the relatively shallow water of the Rio Grande Plateau and continued through the end of the cruise. No similar behavior was observed in any of the other variables that might suggest an electronic or mechanical problem. The beginning of the trend was flagged with an "I" for both TS and TS2 and possible physical causes should be investigated before using the data between the "I" flag and the end of the cruise.

7. 1992-1993 Flag Summary

The 1992-1993 *Meteor* data contains values from four cruises covering four WOCE hydrographic lines. Details of each cruise including start and end dates, number of records, number of values, number of flags, percentage flagged, and variables not included in the quality controlled data are listed in Table 7.1. A total of 3,229,410 values were evaluated with 255,711 flags added by the preprocessor and Data Quality Evaluator for a total of 7.92 percent of the values being flagged. Table 7.2 details the distribution of flags among the different variables.

Table 7.1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Percent-age Flagged	Variables not Included
AR_04E/04	10/23/92 - 11/15/92	34,367	893,542	38,929	4.36	LAT2, LON2, PL_CRS2, PL_SPD2
AR_15_/07	11/18/92 - 11/30/92	18,687	560,610	28,861	5.15	None
AR_15_/08	12/02/92 - 12/22/92	14,687	440,610	59,699	13.55	None
A__10_/00	12/27/92 - 1/31/93	47,666	1,334,648	128,222	9.61	RAD, RAD2

Description of Problems:

7.1 Radiation Data

Beginning 12/16/92 all RAD and RAD2 data were erroneous. RAD values were constant at -200 W/m^2 while RAD2 values were -20 W/m^2. For this reason RAD and RAD2 were not included in the quality controlled data set on cruise A__10_/00. The erroneous values were flagged with a "J" on cruise AR_15_/08. On the other cruises RAD and RAD2 received "B" flags from the prescreener for slightly negative values. These negative values were recorded during nightime

Table 7.2: Number of Flags and Percentage flagged for Each Variable

Variable	B	D	G	H	J	K	S	T	Total Number of flags	Percent-age of Variable Flagged
TIME								6	6	0.01
LAT					1791		6		1797	1.56
LON					101		5		106	0.09
LAT2					4894		2		4896	6.04
LON2					4895				4895	6.04
PL_CRS2					3446				3446	4.25
PL_HD					128				128	0.11
PL_CRS					60		5		65	0.06
PL_SPD					60		7		67	0.06
PL_SPD2							4		4	0.00*
PL_SPD3						684	258		942	0.82
PL_WDIR									0	0.00
PL_WSPD									0	0.00
PL_WDIR2									0	0.00
PL_WSPD2									0	0.00
DIR					2135	57325	8		59468	51.53
SPD					2050	56687	29		58766	50.92
DIR2					784		10		794	0.69
SPD2			310		611		19		940	0.81
TS			124		611		1		736	0.64
TS2			130		611		1		742	0.64
P					5987		48		6035	5.23
T		270				15658	1		15929	13.80
T2		265				11602			11867	10.28
TD		266		2		2888			3156	2.73
TD2		78		6		2441			2525	2.19
RH				2		14888			14882	12.90
RH2				4	16	12102			12122	10.50
RAD	29218				9060				38280	56.51
RAD2	4088				9031				13119	19.37
Total Number of Flags	33306	879	564	14	46271	174267	404	6	255711	
Percentage of All Values Flagged	1.03	0.03	0.02	0.00*	1.43	5.40	0.01	0.00*	7.92	

* less than 0.01 percent flagged

hours, when short wave and ultrviolet radiation should be near zero, but never negative. The daytime values were realistic and the "B" flags on some nightime values should not present a problem for the user.

7.2 Missing SATNAV Data

The SATNAV variables LAT2 and LON2 along with PL_CRS2 and PL_SPD2 were missing on cruise AR_04E/04 and were not included in the quality controlled data for that cruise.

7.3 Port Earth Relative Winds

The port earth-relative winds on cruises AR_15_/08 and A__10_/00 were calculated incorrectly. Earth-relative winds should be calculated using the platform-relative winds, platform heading, platform speed over the ground, and platform course. Unrealistically erratic values of DIR at low ship speeds are evidence that the port earth-relative winds on these two cruises were computed without the use of platform heading. All values of DIR and SPD were flagged with a "K" during these cruises. The user is advised to use the starboard winds and avoid the port wind data. However, the differences between the incorrect port-earth relative wind data and the true earth-relative winds should be small at ship speeds over 2.5 m/s. More details on the problems associated with earth-relative winds from automated systems can be found in Smith et al. (1998).

7.4 LAT and LON

LAT and LON received "J" flags for erroneous zero values. The zero values were more prevalent in LAT than in LON.

7.5 LAT2 and LON2

On three occasions the SATNAV data differed from the INS data as described in section 4.4 and were flagged with the "J" flag. Much of the PL_CRS2 data was also incorrect during these

periods and were also flagged with a “J”.

7.6 Dewpoint Greater than Air Temperature

The preprocessor performs a check to ensure that dewpoint is not greater than the air temperature. When the dewpoint exceeds the air temperature both variables are flagged with a “D” flag. An increased number of “D” flags were assigned beginning in 1992, primarily because of the problems with the moisture variables discussed in section 4.5. The “D” flag should discourage the use of the dewpoint values, but the air temperature values are still accurate. The analyst would have applied a “J” or “K” flag if a problem had been apparent in the air temperature data.

7.7 Pressure

Values of atmospheric pressure had a tendency to “flatline”, or stay at exactly the same value for many records in a row, during cruise AR_04E/04. All values during these episodes were flagged with a “J”.

8. 1994 Flag Summary

The 1994 *Meteor* data contains values from four cruises covering five WOCE hydrographic lines. Details of each cruise including start and end dates, number of records, number of values, number of flags, percentage flagged, and variables not included in the quality controlled data are listed in Table 8.1. A total of 4,936,075 values were evaluated with 339,255 flags added by the preprocessor and Data Quality Evaluator for a total of 6.87 percent of the values being flagged. Table 8.2 details the distribution of flags among the different variables.

Table 8.1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Percent-age Flagged	Variables not Included
AR_04E/06	2/19/94 - 3/12/94	29,980	899,400	56,885	6.32	None
A__08_/00 AR_15_/14	3/26/94 - 6/01/94	84,565	2,536,950	146,805	5.79	None
A__02_/02	10/21/94 - 11/12/94	31,334	783,350	51,904	6.63	LAT2, LON2, PL_CRS2, PL_SPD2, RAD2
AR_07E/05	11/16/94 - 12/22/94	28,655	716,375	83,661	11.68	LAT2, LON2, PL_CRS2, PL_SPD2, RAD2

Description of Problems:

8.1 Radiation Data

The RAD values on cruises A__02_/02 and AR_07E/05 appeared to be an order of magnitude too low. The time series plots had the correct shape and response to cloud cover, but only achieved

Table 8.2: Number of Flags and Percentage flagged for Each Variable

Variable	B	D	G	H	J	K	S	T	Total Number of flags	Percent-age of Variable Flagged
TIME								8	8	0.00*
LAT					39				39	0.02
LAT2					28351		1		28352	24.75
LON2					27667				27667	24.15
PL_CRS2					18100				18100	15.80
PL_HD									0	0.00
PL_CRS									0	0.00
PL_SPD	1						7		8	0.00*
PL_SPD2							1		1	0.00*
PL_SPD3						3169	843		4012	2.30
PL_WDIR					3900		185		4085	2.34
PL_WSPD	1					117	131		249	0.14
PL_WDIR2					1132		84		1216	0.70
PL_WSPD2	10						156		166	0.10
DIR					3897		89		3986	2.28
SPD	1		228		3899		148		4276	2.45
DIR2					1131		8		1139	0.65
SPD2	5		241		1143		8		1397	0.80
TS			136						136	0.08
TS2			121				2		123	0.07
P							154		154	0.09
T		4919				6858	3		11780	6.75
T2		960				9103	1		10064	5.77
TD		531		6	19723	1179	4		21443	12.29
TD2		277		12	5908	4055	23		10275	5.89
RH				4	20228	5116	4		25352	14.53
RH2				8	12167	8693	22		20890	11.97
RAD	107275				75	15431	2		122783	70.35
RAD2	21521						33		21554	18.82
Total Number of Flags	128814	6687	726	30	147360	53721	1909	8	339255	
Percentage of All Values Flagged	2.61	0.14	0.01	0.00*	2.99	1.09	0.04	0.00*	6.87	

* less than 0.01 percent flagged

maximum values of near 100 W/m^2. Climatology showed the correct maximum should be near 1,000 W/m^2. Because of this problem RAD was flagged with a "K" if no other problems occurred. The user may wish to rescale these values by a factor of 10. On all cruises RAD received "B" flags from the prescreener for negative values. These negative values were recorded during nightime hours, when short wave radiation should be near zero, but never negative. The "B" flags should not present a problem for the user, since they do not occur during daytime hours. Also, the variable RAD2 did not contain any useful values for the AR_07E/05 and A__02_/02 cruises and was not included in the quality controlled data.

8.2 Missing SATNAV Data

The SATNAV variables LAT2 and LON2 along with PL_CRS2 and PL_SPD2 were missing on cruise AR_07E/05 and were not included in the quality controlled data for that cruise.

8.3 Erroneous SATNAV Data

The SATNAV LAT2 and LON2 were in error from 3/06/94 through 3/12/94 and again from 3/29/94 through 4/10/94. All values of LAT2 and LON2 were flagged with a "J" during these periods, consistent with the discussion of SATNAV problems presented in section 4.4. The problem with the SATNAV data was also evident in PL_CRS2 from 3/29/94 through 4/10/94, as it differed from PL_HD by a constant 60 degrees. For this reason PL_CRS2 was also flagged with a "J" during this period.

8.4 Moisture Problems

The moisture discontinuities discussed in section 4.5 were a prominent problem in 1994. Discontinuities occurred seven different times on either the port or starboard moisture variables,

and the corresponding dewpoint and relative humidity was often unrealistically high in the vicinity of the jump. If the relative humidities were consistently over 100 percent, both dewpoint and relative humidity were flagged with a "J". Where the moisture variables were deemed suspect by comparison to the values from the other side of the ship, but the relative humidity was not consistently over 100 percent, the dewpoint and relative humidity were flagged with a "K". After a jump which occurred on 11/18/94 the port variables TD and RH reported excessively high values, with RH often over 100 percent. These variables were flagged with a "J" for the remainder of the cruise.

8.5 Dewpoint Greater than Air Temperature

The preprocessor performs a check to ensure that dewpoint is not greater than the air temperature. When the dewpoint exceeds the air temperature, both variables are flagged with a "D" flag. An increased number of "D" flags were assigned in 1994, primarily because of the problems with the moisture variables. Many of the "D" flags in the dewpoints were changed to a "K" or "J" as described above. However, the "D" flags remain in the temperature variables if no other problem is apparent. The "D" flag should discourage the use of the dewpoint values, but not temperature values.

8.6 Wind Variables

Two different problems were present in the wind data in 1994. The first was present in PL_WDIR from 10/28/94 through 10/31/94. A majority of PL_WDIR values were recorded as exactly 1 degree, and the other values were suspect. The analyst determined that it would be too difficult to extract any reliable data, so all values of PL_WDIR were flagged with a "J" during this period. DIR and SPD are calculated using PL_WDIR and were likewise flagged with a "J". The second problem involved the occurrence of periodic spikes in one or more of the wind variables. These spikes repeated every 10 to 15 minutes and were present for an entire day at a time. The periodic

nature of these spikes suggest that electrical interference may be the cause. The analyst was able to flag the spikes individually with the “S” flag.

9. 1995 Flag Summary

The 1995 *Meteor* data contains data from three cruises covering seven WOCE hydrographic lines. Details of each cruise including start and end dates, number of records, number of values, number of flags, percentage flagged, and variables not included in the quality controlled data are listed in Table 9.1. A total of 2,890,366 values were evaluated with 261,427 flags added by the preprocessor and Data Quality Evaluator for a total of 9.04 percent of the values being flagged. Table 9.2 details the distribution of flags among the different variables.

Table 9.1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Percent-age Flagged	Variables not Included
IR_01W/02 ISS02_/04	4/14/95 - 4/26/95	17,360	503,440	20,412	4.05	RAD2
IR_01W/04 ISS02_/07	6/13/95 - 7/11/95	38,754	1,123,860	92,738	8.25	RAD2
IR_01W/05 ISS02_/09	8/17/95 - 9/19/95	43,554	1,263,066	148,277	11.74	RAD2

Description of Problems:

9.1 Radiation Data

The RAD values on cruises and IR_01W/02 appeared to be an order of magnitude too low. The time series plots had the correct shape and response to cloud cover, but only achieved maximum values of near 100 W/m^2. Climatology showed the correct maximum should be near 1,000 W/m^2. Because of this problem RAD was flagged with a "K" if no other problems occurred. The user may wish to rescale these values by a factor of 10. On all cruises RAD received "B" flags from the prescreener for slightly negative values. These negative values were recorded during nightime hours, when short wave radiation should be near zero, but never negative. The "B" flags should

Table 9.2: Number of Flags and Percentage flagged for Each Variable

Variable	B	D	G	J	K	S	T	Total Number of flags	Percent-age of Variable Flagged
TIME							2	2	0.00*
LAT				126				126	0.13
LON				941				941	0.94
LAT2				53276				53276	53.44
LON2				53267				53267	53.44
PL_CRS2				12311				12311	12.35
PL_HD								0	0.00
PL_CRS				99				99	0.10
PL_SPD				133		17		150	0.15
PL_SPD2				12311	16	42		12369	12.41
PL_SPD3					7622	497		8119	8.15
PL_WDIR								0	0.00
PL_WSPD								0	0.00
PL_WDIR2								0	0.00
PL_WSPD2				717				717	0.72
DIR				90	23	18		131	0.13
SPD				45		6		51	0.05
DIR2				806	108	14		928	0.93
SPD2				768		5		773	0.78
TS			469		22	4		495	0.50
TS2			406		108	4		518	0.52
P						159		159	0.16
T		258	414		9201	15		9888	9.92
T2		19	476		12404			12899	12.94
TD					3913			3913	3.93
TD2		8			8582			8590	8.62
RH				249	7972			8221	8.25
RH2					14808			14808	14.86
RAD	49923				8753			58676	58.87
Total Number of Flags	49923	285	1765	135139	73532	781	2	261427	
Percentage of All Values Flagged	1.73	0.01	0.06	4.68	2.54	0.03	0.00*	9.04	

* less than 0.01 percent flagged

not present a problem for the user, since they did not occur during daytime hours. Also, the variable RAD2 did not contain any useful values for any of the 1995 cruises and was not included with the quality controlled data.

9.2 LAT and LON

LAT and LON had short periods when their values were incorrectly recorded as exactly zero. These values were flagged with the "J" flag. On 6/22/95 LAT and LON departed from the true position by up to 20 degrees for over one hour. LAT, LON, along with PL_CRS and PL_SPD were all assigned the "J" flag during this period.

9.3 Problems Affecting Earth Relative Winds

On 6/13/95 PL_SPD registered unrealistic values over 20 m/s for nearly an hour. Both sets of earth relative wind speed and earth relative wind direction were also erroneous, as they were calculated using PL_SPD. All of these variable were flagged with a "J" during this period. On 7/09/95 PL_WSPD2 had values of exactly zero while PL_WSPD showed wind speeds of 8 -10 m/s. PL_WSPD2, DIR2, and SPD2 were all flagged with a "J".

9.4 PL_SPD3

The spike problem affecting PL_SPD3 mentioned in section 4.7 was especially prevalent in 1995, resulting in 7,622 "K" flags and 497 "S" flags.

9.5 Special Note

The problem with the satellite navigation data is especially prevalent in the 1995 cruises. These data were in error from 6/22/95 through 7/09/95 and from 8/31/95 through 9/19/95, resulting in over 40 percent of the variables LAT2 and LON2 being flagged. The analyst recommends using the INS navigation data for the most accurate position information.

10. Final Comments:

Much of the Meteor DVS data is of excellent quality and should be very reliable for the user, with only a few exceptions. Quality control has proven the SATNAV navigation data unreliable with over 20 percent of the data flagged. Use of the more accurate INS navigation data is highly recommended. T, T2, TD, TD2, RH, and RH2 were all adversely affected by the exhaust problem and approximately ten percent of these values were flagged. Short wave and ultraviolet radiation measurements were reliable when available and scaled correctly. Wind data were of very high quality except for port values on cruises AR_15_/08 and A__10_/00. Very accurate wind measurements can be obtained by using data from the most exposed side of the ship. Atmospheric pressure and sea temperature data are also of outstanding quality and should present no problems for the user.

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