Ronald H. Brown IMET Data Quality Control Report:

1997 and 1998

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Addendum:

On April 25, 2002, WOCEMET discovered four files WTEC.980517001, WTEC.980518001, WTEC.980711001, and WTEC.980712001 (.nc and .asc) that had a scale factor error in the sea temperature's (TS) missing data value. Previously the missing data value was 99.99, but it has now been changed to -9999. All flags associated with missing values on sea temperature are Z flags. The statistical tables in this report do not reflect this update.

1.0 Introduction

This report summarizes the quality of surface meteorological data collected by the research vessel *Ronald H. Brown* (identifier: WTEC) IMET system during 16 cruises beginning 28 July 1997 and ending 20 November 1998. The data were provided to the Florida State University-Research Vessel Surface Meteorology Data Center (RVSMDC) in electronic format by J. Shannahoff of NOAA Corps and were converted to standard RVSMDC netCDF format. Data for the remainder of 1997 and 1998 were not made available to the Data Center. Original data received were in ten-second intervals. One minute centered averages were constructed by the Data Center. The available data were preprocessed using an automated screening program, which adds quality control flags to the data, highlighting potential problems. Finally, the Data Quality Evaluator (DQE) reviews the data and current flags, whereby flags are added, removed, or modified according to the judgment of the DQE and other RVSMDC personnel. Details of the quality control procedures can be found in Smith et al. (1996). The data quality control report summarizes the flags for the *Ronald H. Brown* IMET surface meteorological data, including those added by both the preprocessor and the DQE.

2.0 Statistical Information

The *Ronald H. Brown* IMET data include observations averaged over every minute. Values for the following variables were provided:

Time	(TIME)
Latitude	(LAT)
Longitude	(LON)
Platform Heading	(PL_HD)
Platform Heading 2	(PL_HD2)
Platform Course	(PL_CRS)
Platform Speed Over Ground	(PL_SPD)

Platform Speed Over Water	(PL_SPD2)
IMET Platform Relative Wind Direction (14.12 m)	(PL_WDIR)
IMET Platform Relative Wind Speed (14.12 m)	(PL_WSPD)
Earth Relative Wind Direction (14.12 m)	(DIR)
Earth Relative Wind Speed (14.12 m)	(SPD)
IMET Platform Relative Wind Direction 2 (14.12 m)	(PL_WDIR2)
IMET Platform Relative Wind Speed 2 (14.12 m)	(PL_WSPD2)
Earth Relative Wind Direction 2 (14.12 m)	(DIR2)
Earth Relative Wind Speed 2 (14.12 m)	(SPD2)
Platform Relative Wind Direction 3 (25.5 m)	(PL_WDIR3)
Platform Relative Wind Speed 3 (25.5 m)	(PL_WSPD3)
Earth Relative Wind Direction 3 (25.5 m)	(DIR3)
Earth Relative Wind Speed 3 (25.5 m)	(SPD3)
Atmospheric Pressure	(P)
Air Temperature	(T)
Sea Temperature	(TS)
Relative Humidity	(RH)
Precipitation	(PRECIP)
Atmospheric Radiation	(RAD)

A number of parameters on multiple cruises were found to be of poor quality and not included in the statistical results. These values will not be publicly released with the data (see details below, Section 3). Note also that flow distortion was found to be a major problem on four of the sixteen *Ronald H. Brown* cruises, resulting in extensive flagging (discussion follows, section 4.2).

Details of the cruises are listed in Table 1 and include cruise dates, number of records, number of values, number of flags, and total percentage of data flagged. A total of 7,803,606 values were evaluated with 866,896 flags added by the preprocessor and the DQE resulting in a total of 11.11 percent of the values being flagged.

Table 1: Statistical Cruise Information

Cruise Identifier*	Cruise Dates	Number of Records	Number of Values	Number of Flags	Percent Flagged
	07/28/97 - 09/06/97 09/12/97 - 09/16/97 09/19/97 - 10/05/97				

97-A	10/11/97 - 10/25/97 10/29/97 - 11/14/97 11/16/97 - 11/19/97 05/07/98 - 05/19/98 05/25/98 - 06/25/98 06/28/98 - 07/07/98 07/11/98 - 07/29/98 07/30/98 - 08/15/98 08/19/98 - 08/24/98 08/26/98 - 09/20/98 09/24/98 - 10/03/98 10/14/98 - 11/14/98 11/17/98 - 11/20/98	48,784	1,219,600	56,877	4.66
97-B		5,794	133,262	20,386	15.30
97-C		23,355	537,165	155,566	28.96
97-D		20,071	461,633	135,165	29.28
97-E		22,376	514,648	31,662	6.15
97-F		4,066	101,650	2,472	2.43
98-A		16,902	388,746	24,915	6.41
98-B		44,074	1,013,702	285,754	28.19
98-C		13,398	308,154	5,242	1.70
98-D		26,180	602,140	11,329	1.88
98-E		22,748	523,204	101,300	19.36
98-F		7,705	177,215	3,945	2.23
98-G		36,505	912,625	19,627	2.15
98-H		12,958	323,950	8,013	2.47
98-I		43,796	525,552	4,624	0.88
98-J		5,030	60,360	19	0.03

*assigned by RVSMDC to ease identification

3.0 Quality Control Information

The quality of the IMET data from the research vessel *Ronald H. Brown* ranged from good to very poor, depending on the cruise and variable. It was determined that precipitation (PRECIP) should be removed all together from this data set not be included in the public release (see section 3.1). Table 2 details the distribution of flags among the remaining variables. Discussions of the flagged and removed variables follow.

Table 2: Number of Flags and Percentage Flagged for Each Variable

Variable	B	C	F	G	J	K	S	Total Number of Flags	Percentage of Variables Flagged
TIME		1						1	0.00*
LAT			4				1	5	0.00*
LON			4				1	5	0.00*
PL_HD							11	11	0.00*
PL_HD2						1,511	4	1,515	0.54
PL_CRS						303	3	306	0.09
PL_SPD							8	8	0.00*
PL_SPD2	4,005					3,182	211	7,398	2.62
PL_WDIR					3,143		8	3,151	1.03
PL_WSPD						3,143		3,143	1.03
DIR					3,286	110,117	34	113,437	37.17
SPD				1	76	112,908	64	113,049	37.08
PL_WDIR2					2		9	11	0.00*
PL_WSPD2					2		5	7	0.00*
DIR2					106	111,961	19	112,086	36.76
SPD2					106	112,054	62	112,222	36.80
PL_WDIR3					7,536	3,425	56	11,017	3.11

PL_WSPD3						11,069	10	11,079	3.13
DIR3					15,686	93,142	55	108,883	30.78
SPD3					8,446	100,261	111	108,818	30.76
P				463		17,438	28	17,929	5.07
T						5,284	15	5,299	2.38
TS					36	2,518	179	2,733	0.77
RH						1,013	13	1,026	0.46
RAD	133,701					56		133,757	37.81
Total Number of Flags	137,706	1	8	464	38,986	689,385	907	866,896	
Percentage of All Values Flagged	1.76	0.00*	0.00*	0.01	0.49	8.83	0.01	11.11	

*Percentages < 0.01

3.1 Deleted Data

The DQE determined that a large amount of the 1997 and 1998 *Ronald H. Brown* IMET data were unusable due to extensive missing, highly suspect, or erroneous data. As a result, these data were removed from the final quality controlled data set.

The quality of the Precipitation (PRECIP) data was extremely poor. There were extensive problems associated with the PRECIP data recorded by the self-siphoning rain gauge. The self-siphoning rain gauge is designed to fill to 50 mm, and then rapidly drain to zero. During all of the cruises, the precipitation gauge experienced extensive leakage and/or sensor malfunction problems. The problems with the PRECIP data varied, from slow steady leaks to rapid drops in the data. At other times, the PRECIP data trend was erratic with rapid fluctuations. Precipitation amounts and accumulation rates from these cruises could not be determined with any accuracy. As a result, the PRECIP data were removed from the final data set.

The Relative Humidity (RH) and Temperature (T) data from the 98-A, 98-B, 98-C, 98-D, 98-E, and 98-F cruises were missing for most of these cruises. The little data that were recorded were highly erratic, uncharacteristic to normal temperature and relative humidity trends trends. The values from the 98-A, 98-B, 98-C, 98-D, 98-E, and 98-F cruises were determined to be unreliable and were deleted from the final data set.

On the 98-I and 98-J cruises, the platform relative wind data (PL_WDIR, PL_WSPD, PL_WDIR2, PL_WSPD2) received by the Data Center were exactly identical to the Temperature (T) data received. The raw data were received with this problem and is likely due to a data logging/recording error. The temperature data were determined to be of good quality and processed. The winds, however, will not be released publicly for the 98-I and 98-J cruises. Note that a third set of wind data was not made available to the Data Center.

3.2 Missing Data

During the 97-A cruise, all data went missing for a period of about seven hours. Upon the data?s return the first set of platform relative winds (PL_WDIR, PL_WSPD) were missing. However, DIR and SPD both continued to record values during this time. The values recorded obviously mimicked the movement of the ship, stair-stepping (section 4.1) right along with platform speed and heading. All values recorded for DIR and SPD were flagged as unusable with the J-flag.

Values for Platform Heading 2 (PL_HD2) and Platform Speed Over the Water (PL_SPD2) were missing all together from the following cruises: 97-B, 97-C, 97-D, and 97-E. The two variables begin to go missing on the 97-A cruise, having large gaps in the data. But they sporadically record only a few minutes of data values during these gaps. These data values were highly suspect and received the K-flag. This problem is also experienced in the 98-B cruise by the two variables.

4.0 Variable Flagging

4.1 Stair stepping

Stair stepping of the meteorological variables was an inherent problem found in this data set. The problem was not isolated to specific variables, but was experienced by all of the meteorological variables. Stair stepping is a response in the data to the research vessel?s change in platform speed or direction. Meteorological data readings, in the absence of flow distortion (section 4.2), should not reflect ship-motion and therefore such values received the cautionary K-flag.

4.2 Flow Distortion

Flow distortion was a serious problem experienced by the *Ronald H. Brown* by all three wind vanes. Flow distortion is caused by the wind flow around the superstructure of the ship and the relative position of the wind vanes. Being that the ship?s deck cargo likely changed from cruise to cruise, depending on the instruments carried aboard and type of research being done, the severity of the flow distortion also varied from cruise to cruise. On the majority of the cruises, suspect data caused by flow distortion could be identified and flagged as cautionary (K) by the DQE. However, on cruises where distortion was severe, identification of correct data was not possible; therefore all winds (Platform relative wind direction and speed, as well as earth relative direction and speed) for all three wind vanes from that cruise were flagged with the K-flag. Such incidences occurred on the following cruises: 97-C, 97-D, 98-B, and 98-E*.

*Note: On the 98-E cruise, only the first two wind sets were K-flagged completely. The third set of winds were only partially K-flagged - only areas identified as suspect due to flow distortion were flagged with the K-flag.

4.3 Winds

As noted above, the winds were questionable throughout the data set. Some of the wind data was quite noisy. The DQE recommends a smoother be used for wind data that experience an anomalously high degree of variability. Earth Relative Wind Direction (DIR) and Earth Relative Wind Speed (SPD) experience such occurrences in the following cruises: 97-A, 97-B, 98-A, and 98-D. Earth Relative Wind Direction 2 (DIR2), Earth Relative Wind Speed 2 (SPD2), Earth Relative Wind Direction 3 (DIR3), and Earth Relative Wind Speed 3 (SPD3) also get quite noisy on the 98-D cruise.

In both the 97-A and 97-B cruises the third wind vane experiences some sort of malfunction. Platform Relative Wind Direction 3 (PL_WDIR3) drops to ~0 degrees. It does not flat-line at zero, but rather demonstrates extremely little variability, recording values only within a few degrees of zero. During these episodes, all values of PL_WDIR3 are J-flagged as unusable, and, subsequently so is DIR3. Even though wind speeds were still recorded by the instrument, it was not certain that they could be reliable. Therefore Platform Relative Wind Speed 3 (PL_WSPD3) and SPD3 received the K-flag. During such events as just described, the wind vane would appear to be operating normally for short periods of time - however, the third set of wind data was nowhere near equal to that of the other two recorded sets of winds. The DQE could only determine that such data was suspect and subsequently received the K-flag as well.

On 8 November through 10 November, on the 97-E cruise the two IMET wind vanes experienced serious problems. Both wind vanes were recording earth relative winds of ~14 m/s. The first wind vane became stuck in one direction. For this time, all PL_WDIR3 and DIR3 were J-flagged. Even though a wind speed continued to be recorded, it was uncertain whether the values were reliable and thusly received the K-flag. The second wind vane?s data went missing all together. Any true winds recorded during this time received the J-flag.

4.4 Ventilation

An insufficiently ventilated thermometer can experience steep temperature increases in a relatively short amount of time when the platform relative wind speeds are low, or when wind flow over the instrument is blocked. A ventilation problem was apparent for both temperature and relative humidity on several of the cruises (97-C, 97-D, 97-E, 98-A, 98-B, 98-C, 98-G, 98-H) and was appropriately flagged with the

K-flag. The relative humidity was not always flagged when the temperature was flagged for this problem, as it was not always apparent in the relative humidity.

4.5 Position Data

A smoother is recommended on Platform Heading (PL_HD), Platform Heading 2 (PL_HD2), and Platform Course (PL_CRS) for the parts of the 97-A cruise where the data gets anomalously noisy. A smoother is also recommended for the Platform Heading (PL_HD), Platform Course (PL_CRS), and Platform Speed (PL_SPD) for the 97-E cruise for the last half of 30 October and the first part of 31 October.

4.6 Port Data

It is possible, while the ship is in port, for some of the meteorological variables to experience data values quite different than would be experienced in the open ocean. If the data values taken in port were relatively out of the trend of the data experienced at sea (i.e. sea temperature recording 3 degrees Celsius above the open waters) the values were K-flagged. Use of a port flag is under consideration by RVSMDC to mark data recorded while the ship is in port.

4.7 B Flag

Platform speed over water (PL_SPD2) received 4,005 B-flags from the preprocessor for recorded negative values. At very low platform speeds, it is possible to have negative ship speeds, relative to the water, caused by winds, waves, and currents. Negative values also occur when the vessel is in reverse. Values of PL_SPD2, flagged B due to negative recorded values, could conceivably be good data. The user may want to disregard the boundary flags in this case.

There were also 133,757 B-flags assessed to atmospheric radiation by the preprocessor representing radiation values less than 0 Watts per meter squared. These physically unrealistic negative radiation values are likely the result of the instrument not being tuned to low radiation values.

4.8 G Flag

There were *G*-flags assigned by the preprocessor to Pressure (P) values that were greater than four standard deviations from the climatological mean (da Silva et al. 1994). The flagged values are only a few tenths of a hPa lower than 4 standard deviations and represent a realistic extreme low pressure for the region.

4.9 Data Spikes

Isolated spikes occurred in most of the variables throughout the data. Spikes are a relatively common occurrence with automated data, caused by various factors (e.g. electrical interference, ship movement, etc.). These individual points were assigned the S-flag.

5.0 Final Comments:

5.1 Winds and Overall Quality

The vast majority of the flagging was due to the flow distortion experienced in the winds. Even though all of the meteorological experienced some stair stepping, over all, they proved to be of excellent quality. Note also that the flow distortion problem does not necessarily mean the winds were calculated incorrectly, or that the sensor was malfunctioning. The DQE suspects it is a realistic response to deck cargo by the winds.

5.2 Insufficient Data

In the last two cruises of 1998, 98-I and 98-J, the DQE would like to note that some data may have been left unflagged because of insufficient meteorological backing due to the lack of the true winds. In these cases, there was not enough evidence to say whether the certain questionable data should be flagged. It is possible that some data left unflagged on these cruises are questionable and should be used with caution.

References:

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