

**Ka' Imimoana IMET Data Quality Control Report:
1999, 2000, & 2001**

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1.0 Introduction

This report summarizes the quality of the surface meteorological data collected by the research vessel *Ka' Imimoana* (identifier: WTEU) IMET system during 22 cruises beginning 23 January 1999 and ending 24 November 2001. There were 8 cruises in both 1999 and 2000, and 6 in 2001. The data were provided to the Florida State University-Research Vessel Surface Meteorology Data Center (RVSMDC) in ASCII format by the *Ka' Imimoana* chief survey technician and converted to standard RVSMDC netCDF format. The 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) reviewed the data and current flags, whereby flags were 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 *Ka' Imimoana* IMET surface meteorological data, including those added by both the preprocessor and the DQE.

2.0 Statistical Information

The *Ka' Imimoana* IMET data were sampled every 30 seconds and were averaged by the RVSMDC to one minute values. Observations for the following variables were provided:

Time	(TIME)
Latitude	(LAT)
Longitude	(LON)
Platform Course Over Ground	(PL_CRS)
Platform Speed Over Ground	(PL_SPD)
IMET Platform Relative Wind Direction (27.4 m)	(PL_WDIR)
IMET Platform Relative Wind Speed(27.4 m)	(PL_WSPD)
Earth Relative Wind Direction (27.4 m)	(DIR)
Earth Relative Wind Speed (27.4 m)	(SPD)
Sea Temperature (2 m deep)-TSG External	(TS)
Sea Temperature 2 (2 m deep) TSG	(TS2)
Atmospheric Pressure (11 m)	(P)
Air Temperature (19.8 m)	(T)
Relative Humidity (19.8 m)	(RH)
Atmospheric Radiation (Short-wave)	(RAD)
Atmospheric Radiation 2 (Long-wave)	(RAD2)

The parameter Rain Rate (RRATE), on the cruises was found to not function for the entire data set and will not be included in the statistical results, Tables 1 & 2. These values will not be publicly released with the data (see details below, Section 3). There were several cruises in which the long-wave radiation sensor recorded only negative values and was removed, although it is included in the statistical results. These cruises

include: 00-F, 00-G, 00-H, 01-D, 01-E, and 01-F. Note: all deleted data are available from the RVSMDC upon request.

3.0.0 1999 QC Results

A total of 4,816,083 values were evaluated with 90,660 flags added by the preprocessor and the DQE resulting in a total of 1.882 percent of the values being flagged for 1999's cruises. A breakdown of each 1999 cruise is provided in Table 1.1.

Table 1.1: Statistical 1999 Cruise Information

Cruise Identifier*	Cruise Dates	Number of Records	Number of Values	Number of Flags	Percent Flagged
99-A	1/23 - 2/24	46,570	791,690	12,802	1.62
99-B	4/30 - 5/29	40,004	680,068	16,179	2.38
99-C	5/31 – 6/04	5,459	92,803	1,666	1.80
99-D	7/01 – 7/30	41,800	710,600	12,940	1.82
99-E	8/05 – 8/29	33,928	576,776	11,972	2.08
99-F	9/09 – 10/14	49,997	849,949	14,073	1.66
99-G	10/21 – 11/12	32,906	559,402	14,797	2.65
99-H	11/21 – 12/13	32,635	554,795	6,231	1.12

*Assigned by RVSMDC to ease identification

3.1.0 Quality Control Information

The quality of the 1999 IMET data from the research vessel *Ka' Imimoana* ranged from excellent to good depending on the variable and cruise. It was determined that the rain rate needs to be removed from the data set altogether. The short-wave atmospheric radiation data needs to be used with caution especially during periods of very low readings, as some values recorded are falsely negative, yet remain in the data set and statistical information. Table 1.2 details the distribution of the flags among the variables. Discussions of the flagged and removed variables follow.

Table 1.2: Number of Flags and Percentage Flagged for Each Variable

Variable	B	G	H	J	K	M	S	T	Total Number of Flags	Percentage of Variables Flagged
TIME								14	14	0.00*
LAT			2	485			27		514	0.18
LON			2	482			31		515	0.18
PL_CRIS					47		29		76	0.03
PL_SPD				462	14		33		509	0.18
PL_WDIR			2		218		50		270	0.10
PL_WSPD			2		28		22		52	0.02
DIR			16		6,977		20		7,013	2.48
SPD		157	6		9,967		41		10,171	3.59
TS	156		4	373	1,576		90		2,199	0.78
TS2	737	6		305	1,611		17		2,676	0.94
P			4		14				18	0.01
T	46	67	4	4	77		1,588		1,786	0.63
RH		1	4		2,275	64	692		3,036	1.07
RAD (SW)	61,335		4		220		8		61,567	21.73
RAD2 (LW)					224		9		233	0.08
Total Number of Flags	62,274	231	50	2,111	23,248	64	2,657	14	90,649	
Percentage of All Values Flagged	1.29	0.00*	0.00*	0.04	0.48	0.00*	0.06	0.00*		

* Percentages < 0.01

3.1.1 Deleted Data

The DQE determined that the only data in need of deletion was the rain rate data mentioned above. The device never recorded any amount of rain the entire year. As this seemed an unlikely result, this variable was removed from the set.

3.1.2 Missing Data

Most of the cruises of 1999 experienced periods in which data was missing. During the 99-B cruise, all data went missing between 22:06 Z 5 February to 4:31 Z on 6 February, and again from 18:45 Z to 20:45 Z 22 February. Data was also missing from the 99-B cruise around 17:40 Z 14 May until 23:21 Z 15 May for all variables. The 99-C cruise is missing random points in the PL_WDIR on 31 May. The instrument would record values for a few minutes and quit, only to start again a few minutes later. This cycle repeated itself for a short time, roughly 3 hours, and resulted in K-flags for the true wind direction for the period. All data again went missing in the 99-E data between 1:15 Z 7 August and 3:30 Z 8 August. Finally the last period of missing data for the 1999 cruises was experienced from 14:15 Z – 17:47 Z on 30 September.

3.2.0 Variable Flagging

3.2.1 Stair Stepping

Stair stepping of the meteorological variables was a minor problem found in this data set. Stair stepping is a response in the data to the research vessel's change in platform speed or direction, which do often stair step. Meteorological data readings, in the absence of flow distortion (section 3.2.2) should not reflect ship-motion and therefore such values received the cautionary K-flag. The true winds of this set occasionally stair-step with the motion of the vessel but not drastically. Some of the steps were not flagged because the *Ka' Imimoana* did not provide heading data, which are essential to diagnose true wind errors. Examples of stair stepping in the *Ka' Imimoana* are distinguishable on 7 July in both the true wind speed and direction. Steps may also be found in the temperature and relative humidity traces correlated with the platform relative wind speed. This is likely due to deck heating and discussed in Section 3.2.4.

3.2.2 Flow Distortion

No severe flow distortion was evident in the *Ka' Imimoana* data. Some flow distortion is inevitable, although it is very difficult to detect with only one anemometer and wind vane. Flow distortion is caused by the wind flow around and over cargo on the deck and the superstructure of the ship relative to the position of the wind vanes. Since the cargo varies from cruise to cruise, it is even more difficult to identify with only one set of wind instruments. No flags were added due to flow distortion on the 1999 cruises.

3.2.3 Winds

The wind data for this set are of good quality. At times the data become very noisy and a smoother should be used. This is especially true when the ship is changing course very

rapidly and averaging propagates some error into the earth-relative winds. There are times when the true winds look similar to the platform-relative winds, especially when the course or platform speed over ground is relatively constant, but the lack of heading data makes it difficult to determine whether these data are suspect.

3.2.4 Ventilation

An insufficiently ventilated thermometer can experience steep temperature rises in a relatively short amount of time when the platform-relative wind speed is low, or when the flow over the instrument is blocked. A ventilation problem was apparent for both the temperature and relative humidity on one of the cruises of 1999, the 99-A cruise. This occurred twice, once on 2 February and again on 13 of February. Both of these instances have temperature maximums at platform-relative wind speed minimums indicating the ventilation problem. These ventilation problems are more notable when the short-wave radiation is near the daily maximum.

3.2.5 Navigation Data

This ship, as mentioned before, did not provide the data from the heading instrument. This allows for a higher degree of uncertainty in the true winds since the heading is one of the major components used in visually identifying error in the winds.

Spikes in the latitude and longitude were fairly common for the vessel. These spikes are reflected in the platform-relative speed over ground. False position readings place the ship hundreds to thousands of miles from their true location and when using finite differencing to calculate the speed of the vessel, large, unrealistic speeds are the result. These spikes were S-flagged in the latitude and/or longitude and usually the platform-relative speed data.

3.2.6 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 over the open ocean. When the data values taken in port are relatively out of trend of the data experienced at sea (i.e. sea temperature recording several degrees Celsius above the open waters) the values may be representative of real conditions in the port and thus are not K-flagged. Use of a port flag will be implemented by RVSMDC to mark data recorded while the ship is in port.

3.2.7 B Flag

The B-flag is assigned to values falling out of a realistic, acceptable range by the preprocessor. At times, these bounds flags highlight extreme, natural events. For the 1999 cruises, 61,335 bounds flags were added to all of the cruises for short-wave radiation. This instrument recorded values of radiation during the evening and night that were less than 0 Watts per square meter. These physically unrealistic values indicate that this is a sensor problem. Most likely the sensor is not tuned to read very low values of short-wave atmospheric radiation. One should avoid using these values.

There were also other variables that received the bounds flag. Both sea temperature thermosalinographs (TSG) were flagged during the 99-A, B, and C cruises. This was due to the fact that the temperatures were out of the latitude-dependent ranges. This occurs most often when the ship is either in port or still in the channel leaving or returning to the port where the temperatures are much different than those over the open ocean. Another scenario of this event is when the ship is cruising through a thermal current where the temperatures may be very different than the surrounding temperatures. Finally, the air temperatures were B-flagged during the 99-B cruise. These values were just out of the acceptable range determined at the RVSMDC, highlighting an extreme in the air temperature for the period.

3.2.8 G Flag

There were G-flags assigned by the preprocessor to values greater than 4 standard deviations from the climatological mean (da Silva et al., 1994). The flagged values were mostly only slightly greater than the 4 standard deviations limit and may represent realistic, extreme values. There were G-flags added to the following cruises in 1999: A, D, E, F, and H. The variables G-flagged in the 99-A cruise were the true wind speed and the sea temperature from the second TSG. The true wind speed values were slightly greater than the four standard deviation limit and represent an extreme high wind event. The earth-relative wind speed was also G-flagged during the D, E, and H cruises. The sea temperature was also flagged. Its value was just a bit lower than the limit. At this time, the vessel was operating in the equatorial cold tongue in the Pacific, a feature not well represented in the climatology.

The air temperature was flagged during the 99-D, E, F, and H cruises. These values were very close to the limit of four standard deviations. At times, the difference was as small as a tenth of a degree. At the same time as the G-flagging of the air temperature during the 99-F cruise, the relative humidity was also G-flagged. These values were somewhat further than the limit yielding the flagging of the relative humidity, although they are examples of extremes in the temperature and relative humidity for the region.

3.2.9 H Flags

The H-flag is used to identify discontinuities, large and sudden shifts in the data time series, in the data readings. Four of the cruises from 1999 experienced discontinuities in

the data: A, B, F, and H. These occur for several reasons, such as electronic interference, although a return of the values to their original trend values may not take place. The 99-A cruise experienced discontinuities in all of the variables at the same time with the exception of the time, platform-relative winds and the long-wave radiation. An example of the discontinuity took place 12:00 Z 22 February. On this day, the true wind speed jumped 1.2 meters per second in one minute. This is not extreme, but it was discontinuous with the rest of the data. The sea temperature jumped 0.6° C in one minute, pressure changed by 3 mb in one minute, air temperature changed one degree Celsius, relative humidity changed 4.5 %, and finally, the shortwave radiation rose 500 Watts per square meter in one minute. 99-B cruise had discontinuities in the TSG on 26 May when the temperature of the ocean changed 0.8° C in one minute at 14:55 Z. Many of the variables in the 99-F cruise also experienced discontinuities 14:00 Z 30 September. These variables include: the platform-relative winds, 250° in one minute; true wind direction, 20° in one minute; pressure, 2.5 mb in one minute; temperature, 1.5° C in a minute; relative humidity, 4.5 % in one minute; and the long-wave radiation which changed 800 W/m² in a minute. The last cruise of 1999 to experience a discontinuity was the G cruise. The only variable to have this occur was the true wind direction and it changed 150° in one minute.

3.2.10 Data Spikes

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

Latitude and longitude had frequent spikes throughout the data and they were translated into the platform speed over ground since the latitude and longitude positions are used in calculating the platform's speed. False positions yield false speeds. Latitude and longitude had spikes in the 99-A, B, C, D, E, and F cruises.

The temperature sensor also experienced spikes in the data for each cruise. At times there would be spikes at regular intervals hinting at a systematic problem with the sensor. This occurred in the 99-C cruise. Spikes in the temperature time series may also represent natural phenomena such as passing showers and clouds and last up to 5 minutes. Some temperature spikes had matching spikes in the relative humidity time series.

At times, groups of spikes in the temperature data were prolonged for several minutes to several hours. These drops are, again, likely due to the passing clouds and showers and were not flagged by the DQE. These periods of lower temperatures were also associated with RH increases, slight wind shifts and higher speeds.

Acceleration spikes are often found in the data due to the movement of the ship and therefore the instrument. They are often found as the ship is changing speed and/or direction (Smith et al., 1999). They are visible as spikes where the time series levels off,

yielding continued accelerating motion, i.e. turning, speeding up or slowing down. The main variables with acceleration spikes are the platform speed, platform heading, platform course, and the platform-relative winds. All of the 1999 cruises have some degree of acceleration spikes.

3.2.11 Sea Temperature Problems

At the beginning of half of the cruises of 1999, A, B, F, and H, the two different thermosalinographs (TSG) report very different values for the sea temperature. In fact, they even have different slopes, one temperature is rising and the other is falling until they reach the same value. The data after this seems to be of good quality. These early periods were J-flagged as the DQE felt that neither of the TSG sensors had reported true values representative of the local sea temperatures. These problems may be due to the initial startup of the TSG at the beginning of a cruise.

3.3.0 Final Comments

3.3.1 Winds and Overall Quality

The majority of the flagging of the 1999 cruises was due to the minor stair stepping of the data. Even though all of the meteorological data experienced stair stepping, over all, they proved to be of excellent quality as only 1.88 % of the entire data set was flagged for 1999. In fact, less than 4 % of all of the true wind data were flagged. Some of the RH data was problematic for these cruises, as the sensor seemed to stop working for several hours, only to return to normal operation a short time later.

3.3.2 Insufficient Data

In parts of each of the cruises, the DQE would like to note that some data may have been left unflagged because of insufficient meteorological backing due to the lack of other variables such as heading and even a second anemometer. In some cases, there was not enough evidence to say whether certain questionable data should have been flagged. It is very possible that some data left unflagged on these cruises are questionable and should be used with caution.

4.0.0 2000 QC Results

A total of 4,682,246 values were evaluated with 210,452 of them being flagged. This results in flags on 4.494 % of the values.

Table 2.1: Statistical 2000 Cruise Information

Cruise Identifier*	Cruise Dates	Number of Records	Number of Values	Number of Flags	Percent Flagged
00-A	2/01 – 3/01	41,723	709,291	12,408	1.75
00-B	4/13 – 5/18	49,279	837,743	23,114	2.76
00-C	6/15 – 7/04	26,396	448,732	8,801	1.96
00-D	7/06 – 7/12	7,807	132,719	1,616	1.22
00-E	7/18 – 8/12	38,266	650,522	12,174	1.87
00-F	8/30 – 9/24	37,009	629,153	50,969	8.10
00-G	10/15 – 11/10	38,152	648,584	53,896	8.31
00-H	11/16 – 12/11	36,806	625,702	47,474	7.59

*Assigned by RVSMDC to ease identification

4.1.0 Quality Control Information

The quality of the 2000 IMET data ranged from excellent to fair depending on the cruise and variable. The rain rate data, as mentioned before, needs to be left out of the set. The short-wave atmospheric radiation needs to be used cautiously in times of low short-wave radiation as some values are recorded as negative, and that is physically impossible. These data are left in the data set and statistical information. Also, the long-wave atmospheric radiation should not be used for cruises 00-F, G, and H, as the entire cruise's readings are negative, again physically impossible. This is likely a sensor malfunction. These data also remain in the statistics but will be removed from the public data set. Table 2.2 details the distribution of the flags among the variables and the discussion of the flagged and removed variables follows.

Table 2.2: Number of Flags and Percentage Flagged for Each Variable

Variable	B	G	H	J	K	N	S	Total Number of Flags	Percentage of Variables Flagged
TIME								0	0.00*
LAT			2	185	7		48	242	0.09
LON			2	186	7		50	245	0.09
PL_CRSS			2		165	68	33	268	0.10
PL_SPD	7		2	185			23	217	0.08
PL_WDIR			2				26	28	0.01
PL_WSPD			2					2	0.00*
DIR			4		12,786		14	12,804	4.67
SPD		52	2		14,500			14,554	5.31
TS	224		2	3,242	115		100	3,683	1.34
TS2	297		2	3,203	413		3,964	7,879	2.88
P			2		6			8	0.00*
T		119	2		654		1,189	1,964	0.72
RH		30	2		9,267		702	10,001	3.65
RAD (SW)	46,574		2					46,576	17.00
RAD2 (LW)	111,922		2				1	111,925	40.85
Total Number of Flags	159,024	201	32	7,001	37,920	68	6,150	210,396	
Percentage of All Values Flagged	3.41	0.00*	0.00*	0.15	0.81	0.00*	0.13		

* Percentages < 0.01

4.2.1 Deleted Data

The data in need of deletion is the rain rate data from all cruises and the long-wave radiation data from the 00-F, G, and H cruises.

4.2.2 Missing Data

Most of the 2000 cruises had periods of time in which some of the variables went missing. The 00-B cruise had all variables go missing from 19:48 Z 18 April until 15:25 Z 19 April. The 00-C cruise had several periods in which all data went missing, including: 5 minutes of data on 16 June beginning at 18:23 Z; 16:22 – 18:31 Z on 22 June; 4:17 – 5:29 Z on 24 June; and finally 9:18 Z on 2 July until 0:46 Z on 3 July. The 00-E cruise also had two periods of missing data. The first began 21:00 Z on 1 August

and ended 1:34 Z on 2 August. The last was also on 2 August from 23:44 Z until 00 Z on 3 August. The last of the 2000 cruises to have missing data was the 00-G cruise. The time the data was missing on this cruise was 21 October from 13:38 Z up until 20:01 Z. This is a relatively small amount of time overall that the data were missing.

4.3.0 Variable Flagging

4.3.1 Stair Stepping

Stair stepping of the meteorological variables was not a significant problem for the 2000 cruises of the *Ka' Imimoana*. Stair stepping did occur, but the magnitude of the steps was relatively minor. Some of the steps were K-flagged when they were truly noticeable, for example, the true winds on 31 July.

4.3.2 Winds

The wind data for the 2000 cruises is again of good quality. Some vessel motion influence is noticeable for the data in each of the cruises although nothing severe enough to be flagged.

4.3.3 Ventilation

Ventilation was an issue for five of the cruises of 2000. There would be a temperature maximum when there was a platform-relative wind speed minimum. This occurred on the 00-B cruise on 20 April. Cruise 00-D had this problem twice, once 6 July and again the next day. The 00-E cruise had one identifiable ventilation problem on 29 July. November 7 was an example of this on the 00-G cruise. And finally, the 00-H cruise had three of these occasions: 20, 23, and 28 November.

4.3.4 Navigation Data

The 2000 cruises also experienced the same problems with the latitude, longitude, and platform speed with the spikes as the 1999 cruises. They were handled in the same manner with the spike flag.

4.3.5 B Flag

The platform-relative speed over ground received 7 B-flags from the preprocessor during the 00-E cruise for negative values. Speed over ground cannot be negative and therefore was B-flagged.

The short-wave radiation sensor again had the problem with low values of radiation where it recorded negative radiation values. This is likely due to the instrument not being tuned to low values of atmospheric short-wave radiation. This occurred during all of the 2000 cruises.

The long-wave atmospheric radiation sensor had major problems for the last three cruises of 2000: F, G, and H. For these cruises the sensor recorded only negative values of long-wave radiation, physically impossible. These data were removed prior to public release.

Both of the TSG reported values just out of the bounds for the sea temperature during the 00-B cruise and were also B-flagged.

4.3.6 G Flags

There were only three variables, totaling 201 flags, to receive the G-flag for the 2000 set of cruises: true-wind speed, air temperature, and relative humidity. The true-wind speed was G-flagged during the 00-C, E, F, G, and H cruises, as the recorded values were greater than four standard deviations from the climatological mean.

The air temperature was flagged for only the 00-E and G cruises. These values were barely greater than four standard deviations from the mean.

Finally, the relative humidity was flagged for the 00-A cruise on 26 May only. This was due to extremely low, yet realistic values of recorded relative humidity.

4.3.7 H Flags

The only 2000 cruise to experience a discontinuity in the time series was the 00-F cruise. This discontinuity occurred in all of the variables on 19 September.

4.3.8 Data Spikes

There were the normal, occasional data spikes in each cruise of 2000, especially in the latitude, longitude, platform-relative speed, both sea temperatures, air temperature, and relative humidity data.

There were also acceleration spikes distinguishable in all but two of these cruises, (00-D and 00-G). Not all acceleration spikes were noticeable and able to be flagged by the DQE.

4.3.9 Sea Temperature Problems

This set of cruises also has the problems with both of the TSG instruments that the 1999 cruises had (see section 3.2.11). The readings from the thermosalinographs report different temperatures and even have different slopes during the beginning parts of the cruises. These errors were found in all of the cruises except for the 00-B and D cruises. These periods were J-flagged and should not be used. Also, at the end of the 00-E cruise, the water temperatures readings reflect the same malfunctioning manner as the beginning, both have opposite slopes, one temp is rising and the other is falling as they record the same location's water temperature. These problems may be due to the startup of the TSG at the beginning of a cruise and the shutdown of the TSG at the end of a cruise.

4.4.0 Final Comments

4.4.1 Winds and Overall Quality

The quality of the data for the 2000 cruises was again of good quality. Statistically, a slightly larger percentage of flags were added (4.52 %) as compared to 1999. This was mainly due to the entire cruises in which the long-wave radiation is erroneous. There was still the stair stepping taking place as expected, but it was minor. There was more error, i.e. stair-stepping, in the true winds, yet they too are of good quality. The relative humidity sensor continued to be problematic, although most of the time it functioned appropriately.

4.4.2 Insufficient Data

See section 3.3.2.

5.0.0 2001 QC Results

A total of 5,355,986 values were evaluated with 236,855 values receiving flags by the preprocessor and the DQE. This results in 4.422 % of the 2001 values being flagged.

Table 3.1: Statistical 2001 Cruise Information

Cruise Identifier*	Cruise Dates	Number of Records	Number of Values	Number of Flags	Percent Flagged
01-A	1/14 – 2/15	45,896	780,232	13,024	1.67
01-B	3/26 – 5/04	53,833	915,161	20,784	2.27
01-C	5/29 – 7/29	86,624	1,472,914	35,913	2.44
01-D	8/13 – 9/19	53,201	904,417	68,753	7.60
01-E	9/28 – 10/25	39,827	677,059	51,229	7.57
01-F	10/31 – 11/24	35,659	606,203	47,152	7.78

* Assigned by RVSMDC to ease identification

5.1.0 Quality Control Information

The quality of the 2001 IMET data from the *Ka' Imimoana* ranged from excellent to fair depending on the cruise and variable. The rain rate sensor is still out for the year and was removed from the set altogether, including statistical information. The radiation sensors experienced periods in which the data should be used very cautiously or not at all. Short-wave radiation continues to record negative values when the incoming radiation is low. Long-wave radiation recorded only negative values again on the 01-D, E, and F cruises and should not be used. It is, however, left in the statistical information although it will not be released to the public. Both TSG sensors for the sea temperature experience some sort of problem at the beginning of the 01-A, B, C, and E cruises and these early data should not be used as they are J-flagged. Table 3.2 details the distribution of the flags among the variables and a discussion of the flagged and removed variables follows.

Table 3.2: Number of Flags and Percentage Flagged for Each Variable

Variable	B	G	J	K	S	Total Number of Flags	Percentage of Variables Flagged
TIME							0.00
LAT			116		27	143	0.05
LON			116		25	141	0.04
PL_CRG				1,169	402	1,571	0.50
PL_SPD			102		24	126	0.04
PL_WDIR					48	48	0.02
PL_WSPD				2	52	54	0.02
DIR				11,414	45	11,459	3.64
SPD		90		12,688	5	12,783	4.06
TS	1,858	2,560	8,236	8	49	12,711	4.03
TS2	184		8,242	6	19	8,451	2.68
P			1,197			1,197	0.38
T		105		8,774	413	9,292	2.95
RH		6		9,320	64	9,390	2.98
RAD (SW)	40,806			3	1	40,810	12.95
RAD2 (LW)	128,687				1	128,688	40.85
Total Number of Flags	171,535	2,761	18,009	43,384	1,175	236,864	
Percentage of all Values Flagged	3.20	0.05	0.34	0.81	0.02		

* Percentages < 0.01

5.2.1 Deleted Data

Rain rate on all cruises and the long-wave radiation from the 01-D, E and F cruises are deleted from public files.

5.2.2 Missing Data

The set of cruises for *Ka' Imimoana* in 2001 had very little missing data. In fact, there were only 2 cruises to experience loss of data, the 01-B and the 01-C cruises. All variables were missing during the 01-B cruise from 16:08-20:23 Z on 2 April, and the other period was from 3 April 22 Z until 20:49 Z on 4 April. The pressure data was missing, actually reporting the platform speed over ground, from the beginning of the 01-B cruise on 26 March until 17:23 Z on 27 March when it returns to normal with a spike. For the 01-C cruise, data went missing in all variables twice also, from 5 June 00 Z until 3 Z, and again 3 July 11:12 Z through 00 Z 4 July.

5.3.0 Variable Flagging

5.3.1 Stair Stepping

Meteorological variables stair stepping with the motion of the ship was a minor problem with the vessel. There was some mimicking of vessel motion in the true winds. There were also the temperature readings that imitated the speed of the vessel over ground and the platform-relative wind speed. This is a ventilation issue and is discussed in Section 4.3.3. Overall, the stepping done by the variables was a minor problem for the ship.

5.3.2 Winds

There were times when the meteorological variables fluctuated with the motion of the vessel as mentioned. These identifiable periods were K-flagged and should be used with caution. Also on 29 June the true wind direction and speed were constant for a half of an hour. This is very rare naturally, unless there are clam winds. This time range was K-flagged as well. Otherwise, the winds were of good quality for this year's cruises.

5.3.3 Ventilation

All of the 2001 cruises experienced ventilation issues. Each individual cruise also had multiple days in which the problem occurred. The 01-A cruise encountered the problem on February 1, 3, 8, and 14. The problems for the 01-B cruise were on April 22 – 24, and again on 30 April. 00-C had the problem June 1, 2, 15, 17, 19, and 21 as well as 24 July. 01-D had many examples also: August 28 – 30, September 8 –9, 17, and 19. For the 01-E cruise we see this on October 6, 11 – 14, and the 16 – 18. Finally the last cruise, 01-F, experienced ventilation issues on October 31, November 2, 10, 12 – 15, and 19 – 21. For example, the temperature rose from 28.5 °C to 30 °C in just 20 minutes on 15 June as the radiation was at a relative minimum and so was the platform-relative wind speed. This is odd, indicating a deck-heating problem. One would expect the temperature to decrease with the radiation values decreasing. This is the DQE's reasoning for the addition of the K-flags.

5.3.4 Navigation Data

This year of cruises' navigation data had the common problem of spikes in the variables, namely the latitude and longitude, and platform speed over ground. The platform course had minor acceleration spikes.

5.3.5 B Flag

There were 4 variables that received the B-flag for the 2001 cruises: both sea temperature TSG instruments; and both atmospheric radiation instruments, the long-wave and the short-wave radiometers. Both of the TSG reported readings just outside of the limits of the latitude-dependent ranges designated at the RVSMDC highlighting extreme values for the region. These extremes were measured on the 01-B cruise.

The short-wave radiometer had problems measuring low values of radiation for all of the cruises in 2001. The instrument may not have been tuned in order to detect these quantities. These values should not be used and the surrounding values should be used with caution.

Finally the long-wave radiation values were all reportedly negative for the last three cruises of 2001: D, E, and F. These values have been deleted from the public files.

5.3.6 G Flags

Four of the variables of the 2002 cruises were G-flagged. They are the true wind speed, the first TSG for sea temperature, the air temperature, and the relative humidity. The speed was flagged during the 01-A, C, D, and E cruises. These values represent extremes in the wind speed experienced for the regions at the time the ship was present.

The sea temperature only had G-flags on one of the cruises, the 01-B cruise. These values were again just greater than four standard deviations from the climatological mean. This is apparent because the other TSG value was not flagged and the difference between the two of them is minimal. Therefore the flagged values are just over the limit, again highlighting slightly extreme temperatures.

The temperature was in extremes on the 01-C and 01-E cruises. Again these values are good and identify the somewhat rare nature of the occurrence of these temperatures.

The relative humidity was flagged during the 01-A and 01-D cruises. These were extremely low values of RH, however, they do look to be realistic.

5.3.7 Data Spikes

Spikes are normal in automated data. Data spikes occurred on all of the cruises of 2001. They were mostly experienced in the navigation data, and all of the air and sea temperature readings.

There were also the acceleration spikes that are common when data is taken on moving vessels (See Smith, 1999). Acceleration spikes occurred on the cruises of 01-A, C, E, and F. These spikes occur mostly in the platform relative winds and course data. The acceleration spikes were flagged when distinguishable by the DQE.

5.3.8 Sea Temperature Problems

The 2001 set of data has four cruises with the same problems as the previous 2 years with the sea temperatures at the beginning of the cruises (See section 3.2.11). These cruises are the 01-A, B, C, and E. The early data for each of these cruises should not be used.

5.4.0 Final Comments

5.4.1 Winds and Overall Quality

All of the data with the exception of the long-wave radiation for particular cruises was of good to excellent quality. There were about 4.5 % of all variables flagged for the entire year. Only 4 % of the wind data was flagged. Slight stair stepping was experienced in the meteorological variables, although that was expected.

5.4.2 Insufficient Data

See section 3.3.2.

References:

da Silva, A.M., C.C. Young and S. Levitus, 1994: *Atlas of Surface Marine Data 1994, Volume 1: Algorithms and Procedures*. NOAA Atlas Series.

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Smith, S.R., M.A. Bourassa, and R.J. Sharp, 1999: Establishing More Truth in True Winds. *J. Atmos. Oceanic Technol.*, **16**, 939-952.