Knorr IMET Data Quality Control Report

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INTRODUCTION:

This report summarizes the quality of surface meteorological data collected by the research vessel *Knorr* (identifier: KCEJ) during ten cruises completed in 1993 and 1994. The data were provided to the Florida State University Data Assembly Center (DAC) in electronic format by B. Walden (WHOI) and were converted to standard DAC netCDF format. The data were then processed using an automated screening program, which added 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 DAC personnel. Details of the quality control procedures can be found in Smith et al. (1994). The data quality control report summarizes the flags for the *Knorr* meteorological data, including those added by both the preprocessor and the DQE.

DATA VARIABLES:

The *Knorr* data are expected to include observations averaged once every minute on these cruises. Values for the following variables were collected:

Time	(TIME)
Latitude	(LAT)
Longitude	(LON)
Platform Course	(PL_CRS)
Platform Speed Over Ground	(PL_SPD)
Atmospheric Pressure	(P)
Air Temperature	(T)
Humidity Temperature	(T2)
Sea Temperature	(TS)
Relative Humidity	(RH)
Precipitation	(PRECIP)
Atmospheric Radiation	(RAD)

REMOVED DATA:

The winds for the 1993 and 1994 *Knorr* data, wind vane direction (W_VANE), compass direction (W_COMP), platform relative wind direction (PL_WDIR), platform relative wind speed (PL_WSPD), earth relative wind direction (DIR), and earth relative wind speed (SPD) were not included in the public release of the data. The quality of these winds were extremely poor.

1993 FLAG SUMMARY

Statistical Information:

Details of each 1993 cruise are listed in Table 1 and include the cruise dates, number of records, number of values, number of flags, and total percentage of data flagged. A total of 1,924,332 values were evaluated with 147,356 flags added by both the preprocessor and the DQE resulting in a total of 7.66% 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
93- A	01/28/93 – 02/01/93	6,788	81,456	1,890	2.32
93-B	02/03/93 – 02/18/93	21,697	260,364	15,719	6.04
93-C	03/18/93 – 03/28/93	15,138	181,656	5,017	2.76
93-D	07/25/93 – 08/18/93	35,290	423,480	23,292	5.50
93-E	09/27/93 – 10/21/93	35,525	426,300	57,084	13.39
93-F	11/01/93 – 11/19/93	27,097	352,164	18,240	5.18
93-G	12/08/93 – 12/21/93	18,826	225,912	26,114	11.56

Summary:

The 1993 IMET data from the *Knorr* proves to be of fair quality with 7.66% of the reported values flagged for potential problems. The distribution of flags for the remaining variables are detailed in Table 2.

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 Variable Flagged
TIME		1						1	0.00*
LAT			160		3,101		71	3,332	2.08
LON			159		3,623		73	3,855	2.40
PL_CRS	3				5,624		154	5,781	3.6
PL_SPD	47				5,982		253	6,282	3.92
P	1				8,457		93	8,551	5.33
T	1			76	25,097	1,040	111	26,325	16.42
T2	1			35	6,338	1,103	21	7,498	4.68
TS				1	3,997	519	446	4,963	3.09
RH	59			1	3,746	6,742	21	10,569	6.59
PRECIP					8,885	545	203	9,633	6.01
RAD	54,267				6,223	69	7	60,566	37.77
Total Number Of Flags	54,379	1	319	113	81,073	10,018	1,453	147,356	
Percent Of All Values Flagged	2.83	0.00*	1.66	5.87	4.21	5.21	7.55	7.66	

*Percentages < 0.01

C-Flags:

During the 93-E cruise, one data value was assessed a C-flag by the preprocessor on 1993 October 2. C-flags are given to data times that are non sequential. All flags which were assessed on 1993 Jan 1 2:16, include “CFFZZBBBGGZZ”. All data in the C-flagged record should not be used. The DQE felt these data values should remain in the Statistical Information for 1993 *Knorr* data, as the rest of the day’s data are useful.

B-Flags:

Three unrealistic negative data values, –0.01, were recorded on platform course (PL_CRS).

Platform speed over ground (PL_SPD) was given 47 bounds flags to negative data values during the 93-A, 93-B, and 93-C cruises. Negative ship speed is possible when the vessel is moving at slow speeds. Currents, waves, and wind can cause realistic negative values. Negative values will also occur when the ship is in reverse.

During the 93-B cruise, relative humidity (RH) received 59 B-flags on values that were between 100% and 100.2%. This is likely due to the sensor not tuned to high relative humidity values.

Radiation (RAD) received 54,267 B-flags during the 1993 cruises. The values were between zero and negative one Wm^{-2}. These physically unrealistic negative radiation values are likely the result of the instrument not tuned to low radiation values.

F-flags:

Latitude (LAT) and longitude (LON) were assessed a total of 319 F-flags by the preprocessor during all of the 1993 *Knorr* cruises. These F-flags show that the platform speed computed by the preprocessor exceeds the realistic speed (15 ms^{-1}). This may have been caused by uncertainties or truncation error in the navigation data.

G-flags:

Note: During the 93-A cruise, the ship traversed south of 40 degrees South Latitude. In this region of the globe, little information is known about the climatology, as the data is sparse. Consequently, the G-flagged data values may be realistic, though extreme observations.

Temperature (T) was assessed seven G-flags by the preprocessor during the 93-A cruise. The DQE felt these flagged values were realistic, as they were approximately four to five degrees Celsius lower than the climatological data value and were left in place to highlight extreme temperatures. During the 93-C cruise, temperature had 69 G-flags that were approximately five to six degrees higher than the climatological value; therefore, the DQE felt these were realistic, though extreme temperatures.

Humidity temperature (i.e., temperature in the relative humidity sensor) (T2) received 8 G-flags during the 93-A cruise and 27 G-flags during the 93-C cruise. The flagged values on the 93-A cruise were approximately four to five degrees Celsius lower than the climatological value. During the 93-C cruise, the G-flagged values were approximately five to six degrees Celsius higher than the climatological data value and were left in place to highlight extreme humidity temperatures.

All G-flags were left in place to highlight values that are greater than four standard deviations from the climatological mean (da Silva et al. 1994).

<u>*J-flags*</u>:

All of the J-flags assessed to the 1993 *Knorr* cruises were associated with measurements holding at a constant value (often zero) for an unrealistic period of time. On numerous occasions, all variables would flat-line at the same time.

<u>*K-flags*</u>:

The K-flag represents suspect data and should be used with caution. K-flags were used to highlight many different suspect situations. For example, on the last day of the 93-A cruise, temperature (T) had a three degree Celsius increase in one minute and five minutes later returned back to its previous data trend. A signature to support such an increase was not found in humidity temperature (T2) or relative humidity (RH). Consequently, the increase was flagged as suspect and should be used with caution.

Temperature (T), humidity temperature (T2), and relative humidity (RH) received K-flags on the 93-E, F, and G cruises. These K-flags emphasize periods when the three variables did not adhere to expected meteorological relationships (e.g., RH generally increases when T decreases). The exact cause of the variables' discontinuities is unknown as the DQE did not have enough meteorological (e.g., winds) or ship (e.g., heading) data to thoroughly assess the situations.

Sea temperature (TS) and precipitation (PRECIP) were given K-flags to draw attention to some type of interference that would occur on both variables at the same time. **(See *Fig. 1*)**.

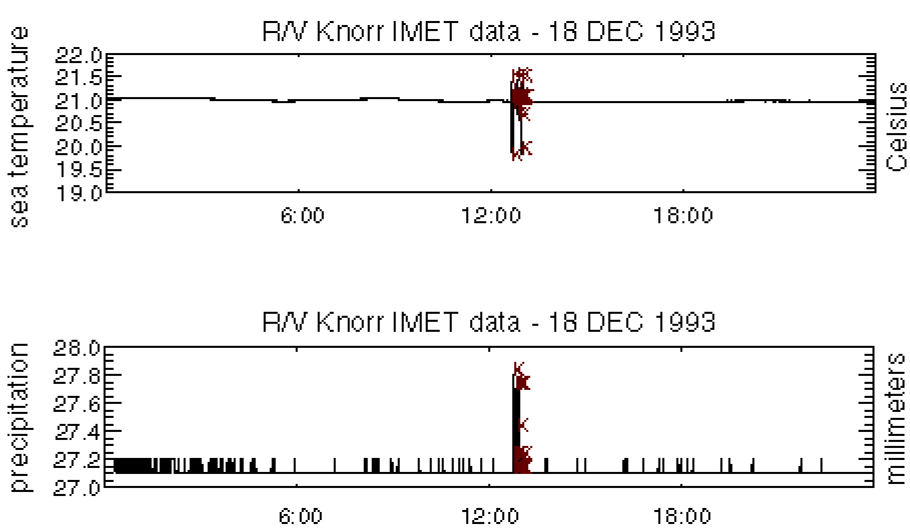

Fig. 1. Illustration of interference on the sea temperature and precipitation data from the 93-G *Knorr cruise*.

Precipitation received K-flags for values recorded above 50 mm and for data which increased rapidly and then dropped back down to the previous data trend. **(See *Fig. 2*)**.

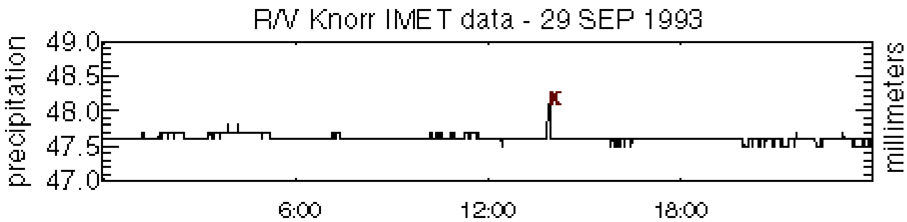

Fig. 2. Shows precipitation data that increases rapidly and then drops back to the previous data trend.

Radiation (RAD) received 69 B-flags on highly unrealistic data values of –600 to –400 Wm^{-2}. These erroneous data values were changed to K-flags by the DQE.

<u>*Spikes*</u>:

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.

<u>*1994 FLAG SUMMARY*</u>

Statistical Information:

Details of each 1994 cruise are listed in Table 3 and include cruise dates, number of records, number of values, number of flags, and total percentage of data flagged. A total of 541,220 values were evaluated with 24,341 flags added by the preprocessor and the DQE resulting in 4.50% of the values being flagged.

Table 3: Statistical Cruise Information

Cruise Identifier	Cruise Dates	Number of Records	Number of Values	Number of Flags	Percent Flagged
94-A	02/19/94 – 02/28/94	14,221	142,210	10,784	7.58
94-B	03/01/94 – 03/19/94	27,057	270,570	10,037	3.71
94-C	03/20/94 – 03/28/94	12,844	128,440	3,520	2.74

Summary:

The 1994 IMET data from the *Knorr* proves to be of good quality with 4.50% of the reported values flagged for potential problems. The distribution of flags for the remaining variables are detailed in Table 4.

Table 4: Number of Flags and Percentage Flagged for Each Variable

Variable	B	F	J	S	Total Number of Flags	Percentage of Variable Flagged
TIME					0	0.00
LAT		44	3,097	7	3,148	5.82
LON		44	3,096	7	3,147	5.81
PL_CRS			160	40	200	0.37
PL_SPD			163	53	216	0.40
T				2	2	0.00*
T2					0	0.00
RH	469				469	0.87
PRECIP				7	7	0.01
RAD	17,152				17,152	31.69
Total Number Of Flags	17,621	88	6,516	116	24,341	
Percent Of All Values Flagged	1.81	0.01	1.20	0.01	4.50	

*Percentages < 0.01

<u>*B-flags*</u>:

During the 94-A cruise, relative humidity (RH) received 469 B-flags on values that were between 100% and 101.4%. This is likely due to the sensor not tuned to high relative humidity values.

Radiation (RAD) received a total 17,152 B-flags on the 1994 cruises. These values were between zero and negative one Wm^{-2}. These physically unrealistic negative radiation values are likely the result of the instrument not tuned to low radiation values.

<u>*F-flags*</u>:

Over the course of the 1994 cruises, latitude (LAT) and longitude (LON) received 88 F-flags. These flags reveal that the platform speed computed by the preprocessor exceeds the realistic speed (15 ms^{-1}). This may have been caused by uncertainties or truncation error in the navigation data.

<u>*J-flags*</u>:

J-flags, erroneous flags, were assigned to data for various reasons. First, J-flags were given to data that were associated with measurements holding at a constant value (often zero) for an unrealistic period of time. For example, the platform course (PL_CRS) and platform speed over ground (PL_SPD) fell out of character with the surrounding data and were consequently J-flagged.

Second, J-flags were used to highlight stair-steps in the data that were erroneous. For example, LAT, LON, PL_CRS, and PL_SPD were J-flagged when a large stair-step in the data was recorded. **(See *Fig. 3*)**.

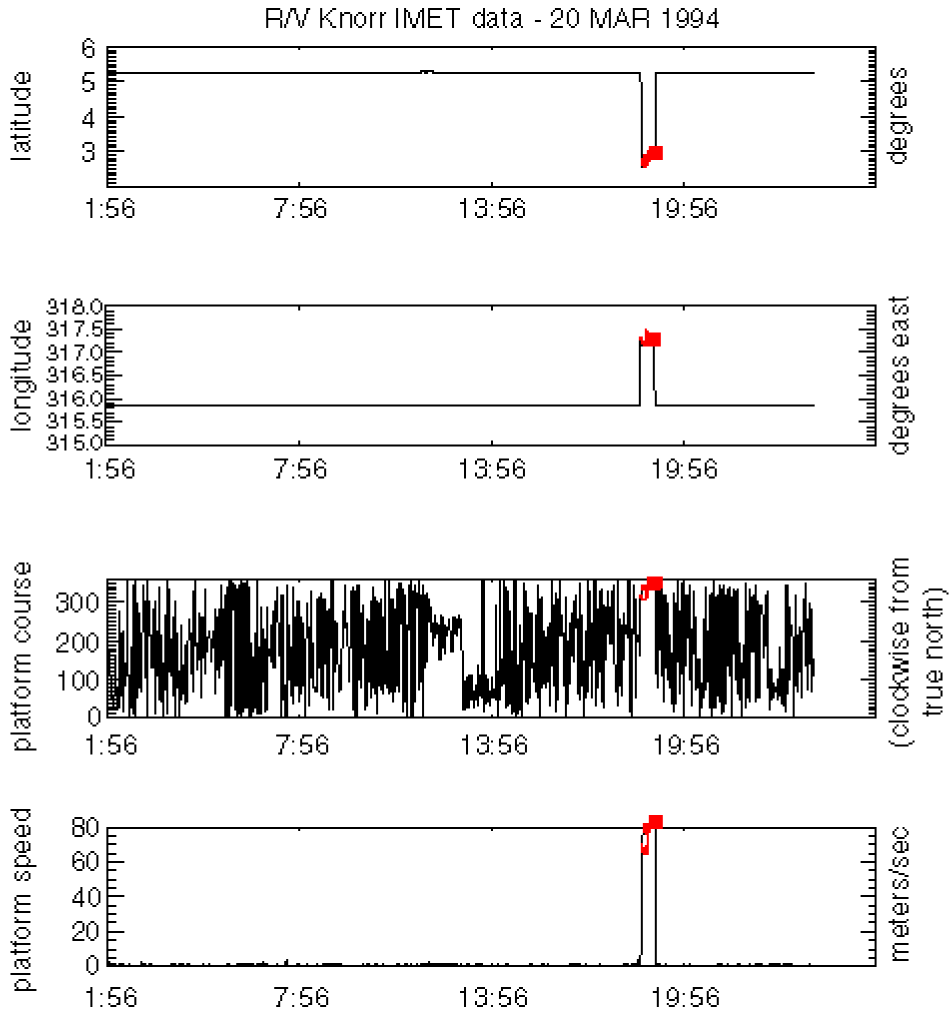

Fig. 3. Erroneous latitude, longitude, platform course, and platform speed data for the 94-C *Knorr cruise.*

<u>*Spikes*</u>:

Isolated spikes occurred in all of the variables in 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.

<u>*Removed Data*</u>:

Pressure (P) and Sea Temperature (TS) were not included in the public release of the 1994 *Knorr* data, because the data values were flat-lined on zero for each cruise.

Final Discussions:

Precipitation (PRECIP) data were flat-lined on zero for almost all of the 1994 *Knorr* cruises, except for a few spikes periodically. On the last two days of the 94-C cruise, PRECIP recorded useful data. The flat-lined data was not removed from the data set, as it was unknown to the DQE if it truly did not rain or if a possible instrument malfunction occurred and was then fixed before the end of the last cruise.

References:

Smith, S.R., C. Harvey, and D.M. Legler, 1994: *Handbook of Quality Control Procedures and Methods for Surface Meteorology Data*. Report No. 141/96, Report MET 96-1, Center for Ocean-Atmospheric Prediction Studies Florida State University, Tallahassee FL 32306-2840

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.