Discovery Multimet Data Quality Control Report

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December 9, 1999

Report WOCEMET 99-15

Version 1.0

Introduction:

This report summarizes the quality of surface meteorological data collected by the research vessel *Discovery* (identifier: GLNE) Multilmet automated data collection system during seven WOCE cruises beginning 6 February 1993 and ending 18 November 1996. The pre-quality controlled data were provided to the Florida State University Data Assembly Center (DAC) in electronic format by D. Martin Gould of the British Oceanographic Data Center (BODC) and were converted to standard DAC netCDF format. The data are then processed 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 judgement of the DQE and other DAC personnel. Details of the WOCE quality control procedures can be found in Smith et al. (1996). The data quality control report summarizes the flags for the *Discovery* Multilmet data, including those added by the BODC, the preprocessor, and the DQE.

Statistical Information:

The *Discovery* Multilmet data are expected to include observations taken every minute for the following variables on all WOCE cruises:

Time	(TIME)
Latitude	(LAT)
Longitude	(LON)
Earth Relative Wind Direction	(DIR)
Earth Relative Wind Speed	(SPD)
Sea Temperature	(TS)
Atmospheric Pressure	(P)
Air Temperature	(T)
Wet Bulb Temperature	(TW)
Downwelling Longwave Radiation	(RAD)
Downwelling Shortwave Radiation	(RAD2)
Photosynthetically Available Radiation	(RAD3)

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 4,172,772 values are evaluated with 134,509 flags added by the BODC, the preprocessor, and the DQE resulting in a total of 3.22% of the values being flagged.

Table 1: Statistical Cruise Information

CTC	Dates	Number of Records	Number of Values	Number of Flags	Number Flagged
I__08A/00; ISS01_/03; S__04I/03	02/06/93 - 03/18/93	57,183	686,196	8,630	1.26
ISS01_/04	03/23/93 - 05/02/93	56,189	681,816	5,124	0.75
ISS01_/07	02/19/94 - 03/30/94	56,160	673,920	39,389	5.84
UNKNOWN	08/01/94 - 08/22/94	25,140	301,680	1,597	0.53
ISS01_/08	01/07/95 - 02/21/95	64,050	768,600	28,140	3.66
UNKNOWN	02/25/95 - 03/08/95	15,420	185,040	6,908	3.73
AR_12_/07	09/28/96 - 11/18/96	72,960	875,520	44,721	5.11

Summary:

The Multimet data from the *Discovery* proves to be of excellent quality. No major problems were found in the data. The distribution of flags for each variable is detailed in Table 2. The BODC Q-flag was assessed by the BODC to any data that was thought to be questionable by the BODC.

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

Variable	B	D	G	H	J	K	L	Q	R	S	Total Number of Flags	Percentage of Variable Flagged
TIME											0	0.00
LAT							61		543		604	0.17
LON							61		543		604	0.17
DIR						163		5,186		89	5,438	1.56
SPD	4,632		720			191		512		60	6,115	1.76
TS	719		1,671			231		225		4	2,850	0.82
P				28		597		127		2	754	0.22
T		7,320	812	2		2,190		10		37	10,371	2.98
TW		7,320				1,841				2	9,163	2.64
RAD					24			101		37	162	0.05
RAD2	1,555										1,555	0.45
RAD3	95,296							1,597			96,893	27.86
Total Number of Flags	102,202	14,640	3,203	30	24	5,213	122	7,758	1,086	231	134,509	
Percentage of All Variables Flagged	2.45	0.35	0.08	0.00*	0.00*	0.12	0.00*	0.19	0.03	0.01	3.22	

* Percentage<0.01

The Q Flag:
The *Discovery* Multimet data came to the DAC already quality controlled by the BODC. The BODC suspect data flag was converted to a Q-flag (questionable) under our flagging system. The Q-flag was assessed to data the BODC found to be suspect.

The R Flag:
The R-flag represents values that were interpolated by the BODC and are considered to be of good quality by the DAC.

D-Flags:
A total of 14,640 D-flags were assessed to T and TW for failing the T≥TW test. The wet bulb and air temperatures for these periods were recording very close to the same temperatures, which would indicate that the reservoir for the psychrometer had run dry.

B-Flags:
The vessel traversed into the extremely cold waters of the Antarctic Circle. Due to the high salinity of the ocean in that region due to brine rejection, it is possible for the sea temperature to actually fall a few degrees below freezing without solidifying. These negative sea temperature values, though realistic at only a degree or so below freezing received the B-flag.

Earth relative wind speed was assessed a total of 4,632 B-flags. These flagged data values were recorded wind speeds in excess of 200 m/s, even up to 1000 m/s.

There were numerous B-flags assessed to RAD2 and RAD3 by the preprocessor throughout five of the seven cruises, representing radiation values less than 0 W/m^2. These physically unrealistic negative radiation values are likely the result of the instrument not being tuned to low radiation values.

G-Flags:
The G-Flags assessed to the data by the preprocessor highlight values that are greater than four standard deviations from the climatological mean (da Silva et al. 1994). The G-flag is only found on earth relative wind speed, sea temperature, and air temperature in this data set. However, the majority of the G-flagging for these variables occurred on the second cruise (ISS01_/04). On this cruise, the vessel traversed the south pacific seas, south of the 40º south latitude line. In this region of the globe, little is known of the climatology, as the data is sparse. Consequently, the G-flagged values may be realistic, though extreme observations.

H-Flags:
The H-flag is used at times of abnormally large changes in values in a relatively short amount of time, causing a discontinuity in the data. For example, on 24 March 1993, air temperature dropped ~4ºC in one minute. Pressure, on 29 October 1996 has a normal variability of ~0.1 mb/minute. However it demonstrated an abrupt change of ~0.5 mb in one minute. An H-flag was placed at the beginning and end of these discontinuities.

J-Flags:
There were 24 J-flags assessed by the DQE to RAD on 1 March 1995. The J-flags were assessed to values of downwelling longwave radiation in excess of 500 W/m^2, up to 2000 W/m^2.

K-Flag:
Earth relative wind speed and direction both demonstrated stair stepping - a feature sometimes found in calculated earth relative winds that echo ship movement, often due to

errors in true wind calculation and/or flow distortion. Since platform speed, course, and heading were not provided with the data, determination of these problems are inconclusive. However, the data thought to have problems were flagged as suspect with the K-flag.

The sea temperature while the ship was still in port at the beginning of the ISS01_/08 cruise was flagged with the K-flag as it was about 4-5ºC higher than the sea temperature once it left port.

There was a suspected ventilation problem associated with the air temperature and wet bulb temperature. Again, there was not enough supporting meteorological data to confirm this assumption and therefore the suspect data was flagged with the K-flag. A filter may also be needed for air temperature on a number of cruises.

There were 108 K flags and 2 S flags assessed to the temperature by the DQE. The temperature data that were flagged demonstrated characteristics resembling those associated with a ventilation problem. There was not enough supporting meteorological data to identify this as a definite problem. Therefore, the user should note that other temperature data demonstrating these characteristics that were left unflagged could be experiencing a ventilation problem. Verification from the BODC of a potential problem will be investigated.

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 (i.e. electrical interference). These individual points were assigned the S-flag.

Other Flags and Missing Data:
Not only was there a lack of meteorological variables, but several of them were plagued with sporadic gaps in the data. This made flagging difficult for the DQE, as there were not enough meteorological supporting data to flag potential problems. Flagging by the DQE was sparse, also because the data had already been quality controlled by those that provided it and have the most knowledge of the data's limitations.

On the fourth cruise, the majority of the data was missing. Also, the last day of each cruise (except the first and fourth one) all the data were missing except for the position data. In the case where all data were missing other than the position data, the file was removed and will not be released publicly (2 May 1993, 30 March 1994, 1 August 1994, 2 August 1994, 3 August 1994, 4 August 1994, 21 February 1995, 8 March 1995, 18 November 1996).

Final Comments:
The DQE cautions that some wind data and temperature data may be in need of a smoother, as they become noisy at some parts in the data set.

References:

Smith, S.R., C. Harvey, and D.M. Legler, 1996: *Handbook of Quality Control Procedures and Methods for Surface Meteorology Data*. WOCE Report No. 141/96, Report WOCEMET 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.