P5.56 STATISTICAL CHARACTERISTICS OF QUIKSCAT "REAL-TIME" OCEAN SURFACE WIND VECTOR RETRIEVALS

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1. INTRODUCTION

QuikSCAT was launched in June 1999 with a SeaWinds Ku-band scatterometer on board and ocean surface wind vector retrievals from it became available in "real-time" (within three hours of observation) for operational use during February 2000, at NCEP.

It is a customary practice at NCEP to evaluate the timeliness of availability and the quality of every new data set before using them in operational models. The specification criteria for satellite ocean surface wind retrievals require that the RMS speed errors should be less than 2 m/s for winds up to 20 m/s and no more than 10% for wind speeds above 20 m/s. The RMS errors for direction should be less than 20 degrees, The design of QuikSCAT's antenna system is different from the ones used for previous scatterometers. It uses two antennas at different look angles to scan the ocean surface. The radar design suggests that there are three regions of the swath where the accuracy may deteriorate; two regions are located along the outer 200km edges of the swath where only one scanning antenna can retrieve measurements, and the third region is near nadir where the viewing angles are small, suggesting that wind direction may be less accurate.

It is well known that the backscatter in the Ku-band will be affected by atmospheric attenuation due to rain and cloud liquid water as well as being subjected to distortions at the ocean surface due to rain. In addition, the wind retrievals suffer from the well-known directional ambiguity problem because the inversion process from backscatter measurements to wind vector is not unique and may provide up to 4 vector solutions which are ranked in order of their Most Likelihood Estimate (MLE). But the MLE is not always adequate to select the "best" wind retrieval. The procedure applied to reduce errors in determining the "best" wind vector was to use the 6-hour forecast from NCEP's global forecast model. The closest of the first two MLE solutions to the forecast wind field is selected as the "nudged" solution. The nudged solutions are used to initialize a 7X7 median filter which is applied at each QuikSCAT cell to provide for consistency in the wind vector retrievals over the swath.

This poster presents the statistical results of the evaluations carried out during the Spring of 2001 to determine the quality of QuikSCAT data. Two types of evaluations have been carried out; 1) collocated fixed buoy wind data with "real-time" QuikSCAT wind retrievals from 2001/03/06 to 2001/04/30. Collocation in time is within +/- 3hours and in space within 50km. and 2) ocean model surface wind field analyses (from NCEP's global data assimilation system) matched with QuikSCAT swath data from 2001/03/06 to 2001/04/11. Collocation in time is +/- 1.5 hours.

2. FIXED BUOY COMPARISON STATISTICS

From the scatter diagrams of buoy data vs QuikSCAT data (excluding the edge data), it can be observed that the data do not meet specifications (figure 1). The overall statistics seem to suggest that data are close to the specifications with an RMS speed difference of 2.13 m/s and directional RMS of 25.0 degrees. But, there are many satellite retrieved wind speed outliers that are much higher than the buoy data. In an attempt to improve the quality of the retrievals only those retrieval with a probability of rain flag set to 0, were examined. A probability of rain flag (Huddleston and Stiles, 2000) is included as part of the retrieval data. There was a substantial improvement of the wind speeds for these data, but there did not appear to be much difference in the wind direction. Unfortunately, the process also eliminated many of the high wind cases. To determine the influence of rain contamination on the retrievals, only those retrievals with a probability of rain greater than 10% were compared (excluding the outer edges).

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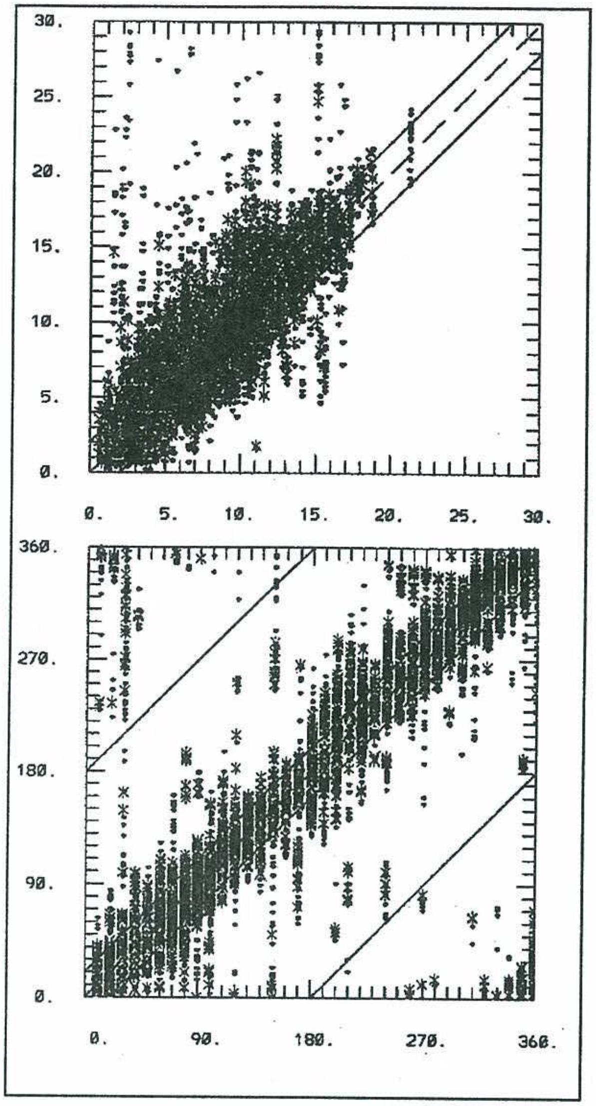

Figure 1. Scatter plots for buoy (horizontal) vs QuikSCAT (vertical) speeds (m/s) (top panel) and directions (degrees) (bottom panel) for all data.

PR	0.0	0.0<0.1	> 0.10	ALL
SPEED BIAS	0.21	0.76	3.98	0.50
SPEED RMS	1.53	2.02	6.71	2.13
DIREC-TION RMS	23.4	25.8	40.1	25.0

Table 1. QuikSCAT vs buoy collocated match-up errors by probability of rain (PR) category. With speed in m/s and direction in degrees. Bias = QuikSCAT - buoy.

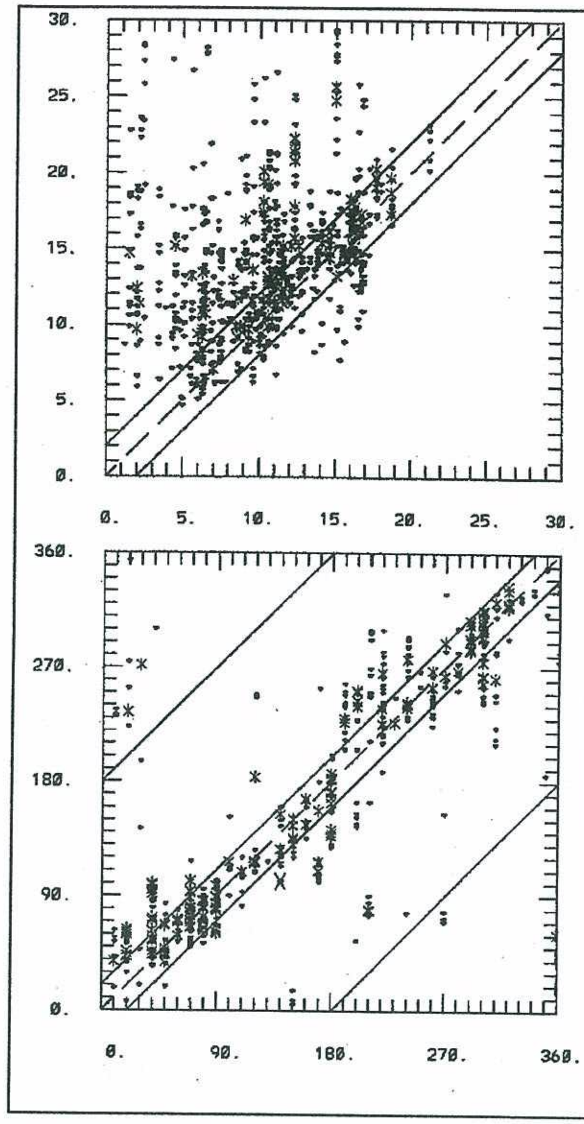

Figure 2. Scatter plots for bouy (horizontal) vs QuikSCAT (vertical) speeds (m/s) (top panel) and directions (degrees) (bottom panel) for data with probability of rain > 10%.

It is clear from figure 2 that the impact of rain on the retrievals is large on both speed and direction (figure 2). The results of rain on the accuracy of wind retrievals are summarized in Table 1.

3. MODEL ANALYSES COMPARISON STATISTICS

This part of the evaluation is designed to determine the sensitivity of errors across the swath due to cell location.

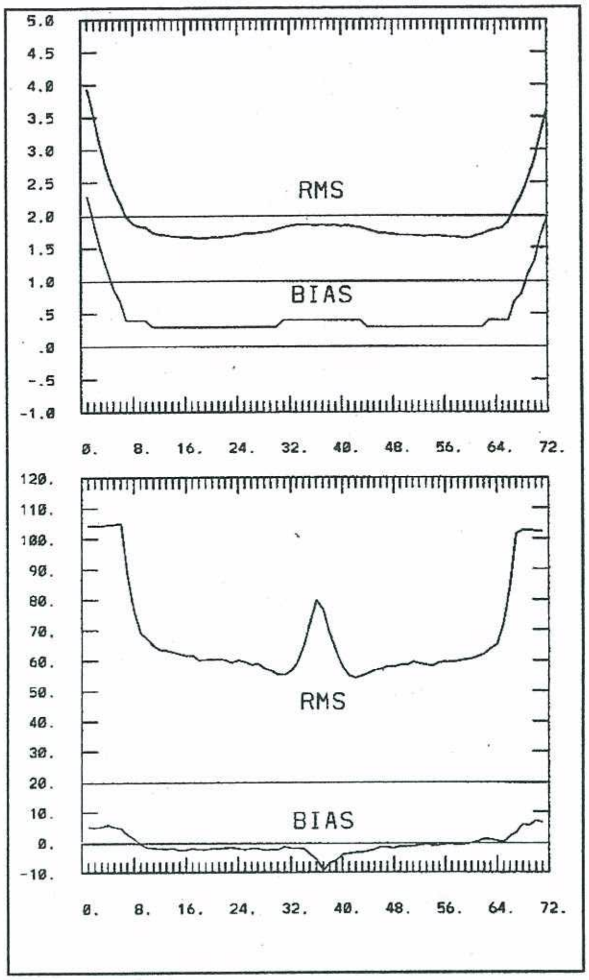

Figure 3. Graph of differences between QuikSCAT swath vs interpolated global model analysis (vertical) and cell number (across) for speed (m/s) (top panel) and direction (degrees) (bottom panel) for all data based the MLE selection.

A comparison of the MLE wind vector selections across the entire swath with the surface wind vectors from the NCEP's Global Model shows that the speed accuracy deteriorates on the outer edges where only one antenna scans, and near nadir, although the values are still close to the 2 m/s specification. But the MLE is incapable of selecting "good" directions anywhere across the swath (figure 3).

The comparison of the "nudged and filtered selected wind vector s shows there is a dramatic improvement in the wind speeds along the edge although the interior part of the swath is nearly

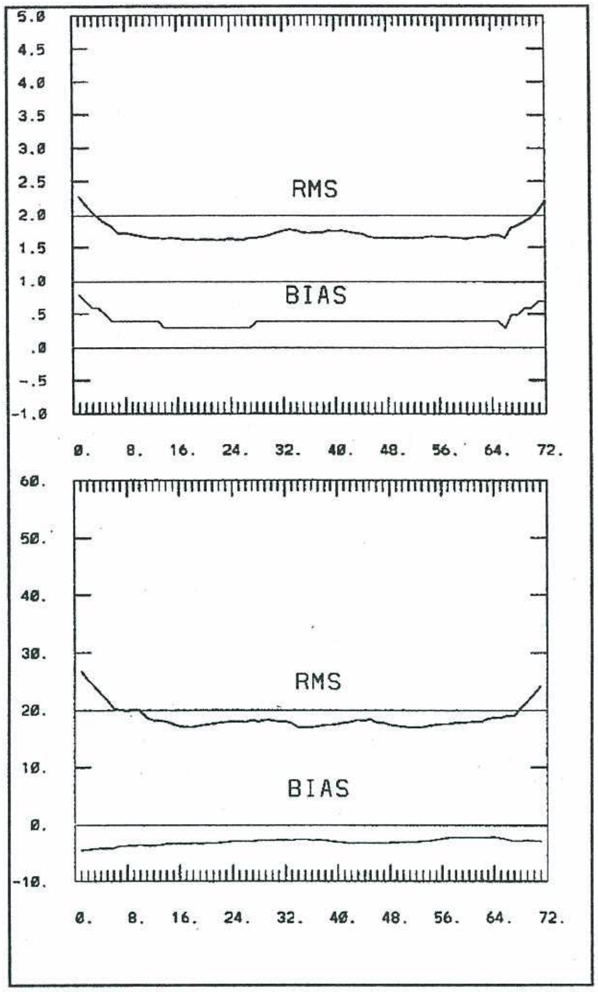

Figure 4. Graph of differences between QuikSCAT swaths vs interpolated global model analysis (vertical) and cell number (across) for speed (m/s) (top panel) and direction (degrees) (bottom panel) for data based the nudged and filtered selection.

the same (figure 4). The speeds now meet the specification across most of the swath. But, the "nudged" direction solution shows the most significant improvement across the entire swath. The directions meet specifications across the swath except for the deterioration along the edges.

Comparisons were made to determine whether or not there was an impact of rain on the vector retrievals

When the probability of rain assigned to the wind retrieval is zero, the wind speed differences are remarkably constant (rms 1.4 m/s) across the swath. The directional differences were not quite as good (RMS 20 degrees), and poorest near the edges.

Since rain contamination causes problems with the retrievals, a comparison was made with those winds whose retrievals were assigned a probability of rain greater than 10% (figure 5) These retrievals definitely show that there are serious problems with rain contamination. The speed RMS differences across the swath were 3.8 m/s, and the satellite wind speeds were bias by 2.4 m/s. The directional RMS across the swath was near 20 degrees.

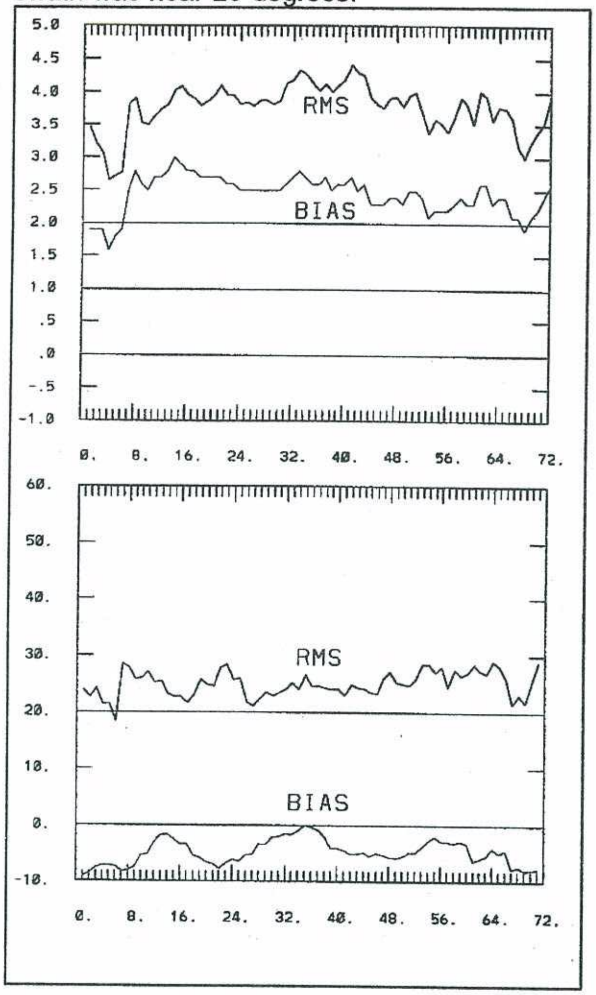

Figure 5. Graph of differences between QuikSCAT swath vs interpolated global model analysis (vertical) and cell number (across) for speed (m/s) (top panel) and direction (degrees) (bottom panel) for data, excluding edges, based on the nudged and filtered selections with a probability of rain greater than 10%.

Wind retrievals were compared with rain probabilities between 0.0 and 0.1, to complete the examination. There is a deterioration of wind speeds but the wind directions are slightly better than the probability of rain of 0.0 cases.

PR	0.0	0 < 0.1	> 0.1	ALL	MLE
SPEED BIAS	-.02	0.85	2.44	0.41	0.50
SPEED RMS	1.42	1.94	3,.78	1.75	2.01
DIREC-TION RMS	19.7	17.3	25.1	18.9	71.1

Table 2. QuikSCAT vs model analyses collocated match-up errors by probability of rain (PR) category, including MLE estimates. With speed in m/s and direction in degrees. Bias = QuikSCAT - analysis.

4. CONCLUSIONS

The above evaluations suggest that the comparison of QuikSCAT data to model analyses (without QuikSCAT data) was better than to buoys. But there are several differences in the data used as "ground" truth, and the space and time windows employed.

Based on these evaluations, the following conclusions can be made: QuikSCAT ocean surface wind vector data meet the accuracy specifications only if retrievals are eliminated for cells along the outer 200km edges of the swath and for cells with a rain probability of greater than 10%.

But, unfortunately, nudging and filtering may remove too much independent information and force the retrieved winds to be too similar to the model wind. Rain contamination often occurs in wind retrievals in weather active regions (storms and fronts), so that reliable retrievals are often not available where they are needed most.

REFERENCES:

Huddleston, J.M., and B.W. Stiles, 2000: Multidimensional Histogram (MUHD) Overlay, Products Description. Ver. 1, Jet Prop. Lab., Cal Inst. Tech, 4p.