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EVALUATION OF SEAWINDS WIND SPEED MEASUREMENTS IN HURRICANE FLOYD

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1. INTRODUCTION

The measurement of ocean surface wind vector using a Ku-band satellite scatterometer is well established for wind speeds up to 20 m/s. For higher wind speeds, especially those in hurricanes and typhoons, the most notable shortcoming is the apparent under estimation of the speed of the winds.

In general, three effects degrade scatterometer wind retrievals in tropical cyclones (TC's). First, the relationship between the ocean's normalized radar cross section, sigma-0 and the surface wind vector is not well known at high wind speeds > 30 m/s. Second, the relatively poor spatial resolution (antenna footprint) of a satellite scatterometer produces wind smoothing, especially near the high wind gradient regions. Third, there is degradation due to the effects of moderate to heavy rain that is especially important in the spiral rain bands surrounding the eye.

Recently, significant improvements have been reported by Yueh, et al. 2001 for TC wind measurements using the SeaWinds scatterometer on the QuikSCAT satellite. His approach combined sigma-0 and independent rain measurements to retrieve high quality ocean surface wind vectors in hurricane Floyd during 1999.

2. SEAWINDS MEASUREMENTS

This paper also presents significant wind speed improvements for Floyd by combining the simultaneous sigma-0 and brightness temperatures obtained from SeaWinds. The algorithm retrieves only wind speed, and it uses high spatial resolution 12.5 km binned sigma-0 slices. The direction of the wind is modeled as a 20° spiral about the hurricane eye. The wind retrieval is an iterative procedure with an improved rain absorption correction derived from the brightness temperature measurements [Jones et al. 1999]. Details of the algorithm are discussed and results are presented for several passes over hurricane Floyd where near-simultaneous measurements were obtained by the NOAA Hurricane Research Division's P-3 aircraft.

SeaWinds retrieved wind speeds are compared with high temporal and spatial resolution hurricane numerical model results (PSU/NCAR MM5) as shown in Fig. 1 for QuikSCAT rev 1201.

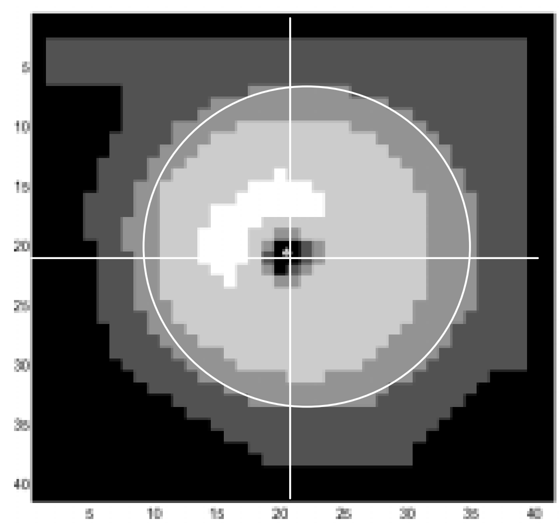

Fig. 1 MM5 model wind speed for Hurricane Floyd for rev-1201. Wind speed contours in m/s are: > 35, 35 - 25, 25 - 15, and < 15. The cross hairs identify the storm center and the circle is the 15 m/s boundary.

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Geophysical validation of our retrieved wind speeds is established using these numerical model calculations as "surface truth". The location of the hurricane eye is established directly from the measured minimum sigma-0; and the modeled wind field was translated to be concentric. For a 5° x 5° region centered on the eye, the assumed spiral direction agrees with the modeled direction within < ± 20°.

The 1st wind retrieval shown in Fig-2 does not include the atmospheric correction derived from the measured brightness temperature. Here the wind speed contours are identical with Fig. 1 with the circle representing the 15 m/s contour from the MM5 model and the cross hairs over the eye. Note that the retrieved winds are between 25 - 35 m/s outside of the model 15 m/s circle.

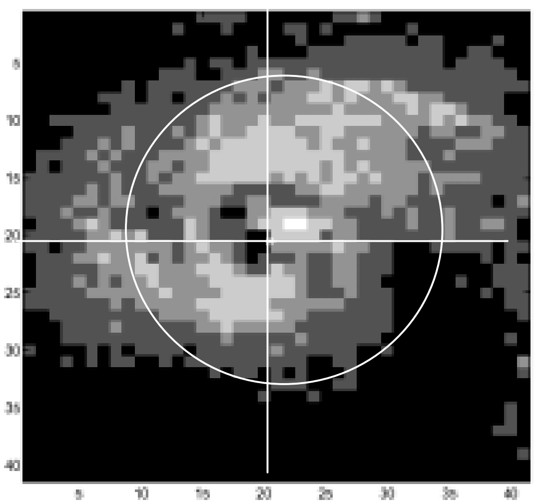

Fig. 2 Retrieved wind speeds for rev 1201 without atmospheric correction. Peak wind speeds are between 35 - 25 m/s.

Next the wind speed was retrieved using the measured brightness to increase the sigma-0 to correct for the atmospheric (rain) attenuation. Because the derived value of attenuation depends upon the assumed surface wind speed, this was iteratively estimated. Convergence was reached after four iterations, and the resulting wind speed and corresponding transmission coefficient are shown in Fig.'s 3 and 4 respectively. Wind retrievals were eliminated when the transmission was less than 75% and these regions are shown in black in Fig. 3. When compared to the surface truth, these retrievals are considerably improved over the first results that were not compensated. Note that the previous anomalous retrieved winds between outside of the modeled 15 m/s circle have been mostly eliminated. These bogus winds were the result of the true ocean sigma-0 being increased by rain backscatter.

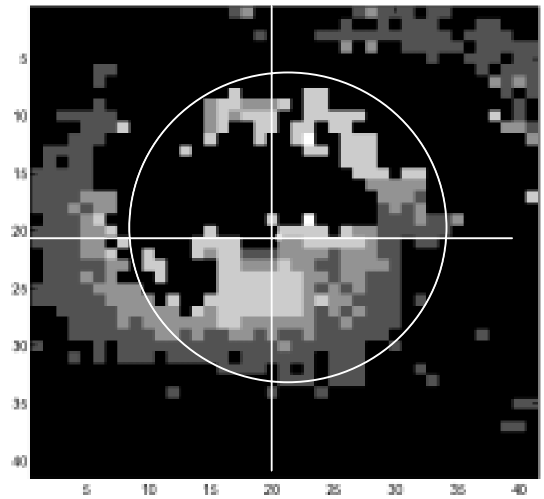

Fig. 3 Retrieved wind speeds for rev 1201 with atmospheric correction applied.

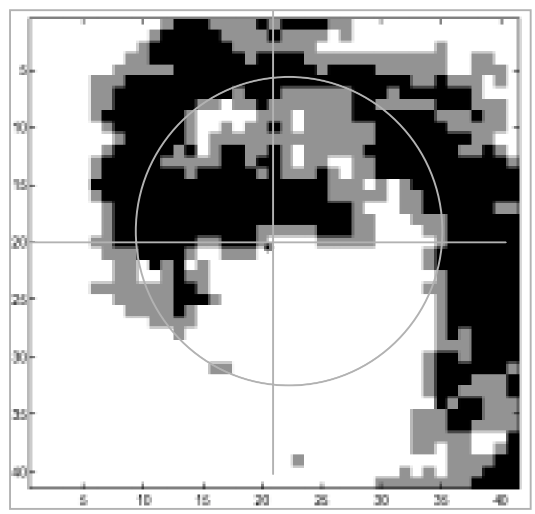

Fig. 4 Atmospheric transmission coefficient corresponding to Fig. 3. White is 90% - 100% and black is < 75%.

3. REFERENCES

Yueh, S. L. et al, 2001: QuikSCAT geophysical model function for tropical cyclones and application to hurricane Floyd, Trans. GeoSci. & Rem. Sens., vol. 39, no. 12, 2601-2612.