P2.12 SEAWINDS IMPROVED OCEAN VECTOR WIND RETRIEVALS IN HURRICANES

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1. INTRODUCTION

The most pressing issue for the Ku-band scatterometer is associated with the measurement of ocean surface winds in tropical cyclones in the presence of precipitation, which can significantly degrade the wind vector retrieval. Furthermore, at high wind speeds (> 32 m/s), the measurements suffer from radar backscatter saturation effects. Since the spatial resolution of satellite scatterometer and associated ocean vector winds (OVW) retrieval algorithms have been specifically developed for global synoptic-scale wind measurements, scatterometers have failed to estimate the peak winds in tropical cyclones.

Previously, the Central Florida Remote Sensing Laboratory (CFRSL) developed a special hurricane retrieval algorithm that uses a novel active/passive scatterometer retrieval algorithm designed specifically for extreme wind events, known as QuikSCAT hurricane wind vector retrieval (Q-Winds). To assess the performance of the algorithm, the retrieval results were compared to an independent "surface truth". The National Oceanic and Atmospheric Administration (NOAA) Hurricane Research Division (HRD) H*Wind surface wind analyses (Powell, 1998), derived from near-simultaneous *in-situ* and remote sensor measurements of the hurricane surface winds from NOAA and U.S. Air Force Weather Squadron aircraft, were used to validate the Q-Winds retrieval.

Recently, under the Joint Hurricane Testbed (JHT) project, the Q-Winds product has been extended to near real-time (NRT) application. In this new approach, existing software utilities are implemented to transform the Q-Winds vector wind output to existing NRT QuikSCAT data products in the Binary Universal Form for the Representation of meteorological data (BUFR) format, Merged Geophysical Data Record (MGDR), which is presently used at the Tropical Prediction Center/National Hurricane Center (TPC/NHC) and Joint Typhoon Warning Center (JTWC).

The performance of Q-Winds and the SeaWinds Project's standard L2B 12.5km ocean vector wind product (hereafter referred to as L2B-12.5km) are assessed with H*Wind for composite data of ten hurricane revolutions and results are presented. Also, the Q-Winds results for NRT retrieval of Super Typhoon Melor are shown and compared to the MGDR ocean surface wind product.

2. HURRICANE RETRIEVAL ALGORITHM

Unlike SeaWinds L2B and L2B-12.5km, which only flags rain affected cells, Q-Winds uses the simultaneous QuikSCAT radiometer (QRad) brightness temperature T_b measurements (Ahmad, 2005) to estimate the atmospheric integrated rain transmissivity. By correcting light to moderate rain contaminated ocean surface backscatter measurements, Q-Winds is able to retrieve wind speeds up to ~50 m/s. However, this approach involved significant manual analyst intervention in locating a given storm and its center of rotation; which restricted the algorithm use in NRT processing.

Recently, we have improved this algorithm by incorporating autonomous storm detection and center locating and wind direction initialization routines that enable the existing algorithm to run in near real-time. In addition, the previous geophysical model function (GMF) was modified to simultaneously correct for rain attenuation and volume backscatter using the QRad T_b as an additional dimension (Laupattarakasem, 2010).

3. QUIKSCAT HURRICANE RESULTS

First, the overall wind speed retrieval performance of Q-Winds and L2B-12.5 km is assessed using the composite data of ten hurricane revolutions and results are shown in Fig. 1. The upper panel is the binned-average wind speed comparison before applying rain flags, and

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the lower panel is after rain flags are applied. These composite results are consistent with the individual revolutions, and the comparisons with H*Wind surface wind speeds demonstrate that Q-Winds retrievals (solid blue lines) are superior to L2B-12.5 km retrievals (dashed red lines) for both cases (with and without rain flags applied). This is especially evident in the lower panel, where after the quality rain flags have been applied, Q-Winds are in good agreement in the mean > 40 m/s; whereas L2B-12.5 km underestimates wind speed by greater than 5 m/s at 33 m/s.

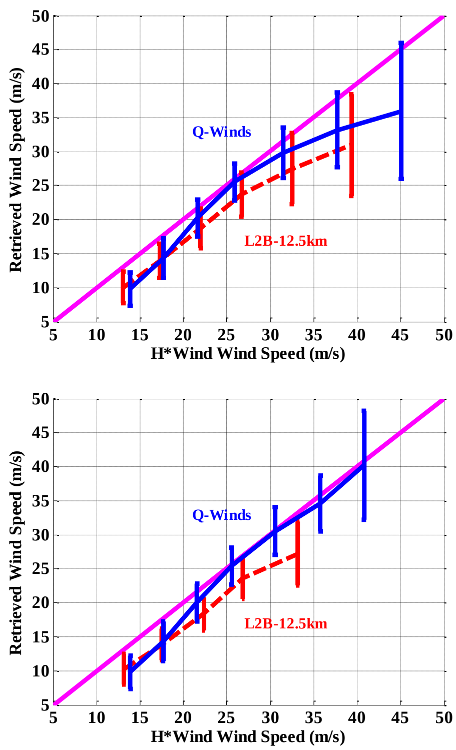

Figure 1: Wind speed comparisons for composite of ten QuikSCAT hurricane revs. Upper panel is QuikSCAT retrievals without rain flags and the lower panel is after rain flags applied.

In order to apply Q-Winds for NRT application, an autonomous storm center module is incorporated. Because the accuracy of the storm center is crucial to the initial guess wind direction and the overall retrieval performance, we evaluate our estimated storm center by comparing to the NHC hurricane "best-track" as shown in Fig. 2, and usually reasonable storm centers are found, especially when the storm structure is well defined. Next, the initial wind direction field is computed from differential backscatter (contrast) pattern and then used in the wind vector retrieval procedure. An example of the initial wind direction field compared with the retrieved wind direction is shown in Fig. 3.

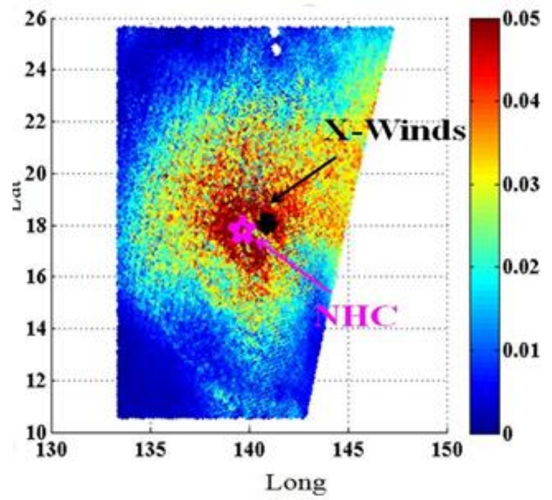

Figure 2: Automated storm center comparison with NHC "best-track".

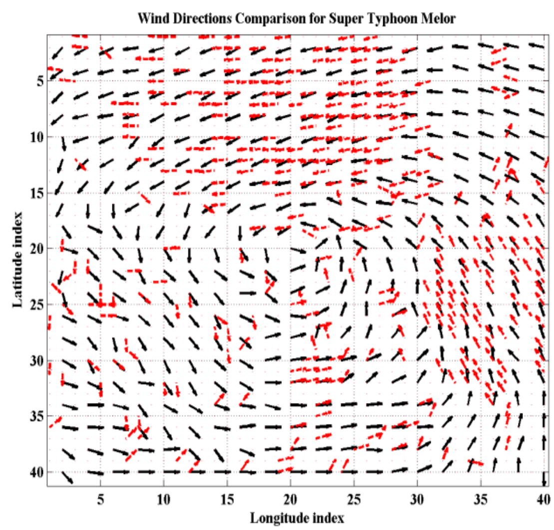

Figure 3: Wind directions comparison. Black solid lines are retrieved wind directions from retrieval and red dashed lines are the initial wind directions computed from the backscatter contrast.

Although only about 30% of the wind directions are estimated in the initial wind direction procedure, they are very useful in wind direction ambiguity removal. False wind directions can be eliminated by comparing their locations to the initial wind direction field and a counter-clockwise rotation field about the estimated storm center.

4. QUIKSCAT NRT RESULTS

The result of NRT QuikSCAT processing for Super Typhoon Melor in October, 2009 is presented in Fig. 4 and 5. The wind vector images in Fig. 4 are the L2B 12.5-km (upper) and NRT Q-Winds (lower), respectively. The color indicates wind speed in m/s and the arrows are 2× decimated (plot once every two pixels) wind direction. The L2B 12.5-km wind product is well known for underestimating high wind speeds region, especially in the presence of rain (Draper, 2004). The scatter plot (in Fig. 5) demonstrates that NRT Q-Winds can retrieve higher wind speeds than of the standard L2B 12.5-km. Unfortunately, for this typhoon independent surface truth is not available, therefore a quantitative assessment is not possible.

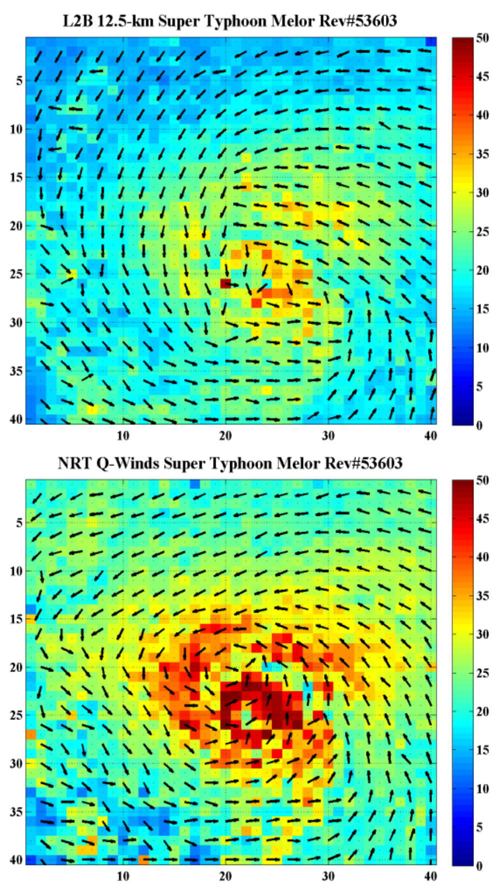

Figure 4: Super Typhoon Melor wind field: Upper panel is L2B 12.5-km, lower panel is NRTQ-Winds. Colors denote wind speed (m/s) and arrows are wind direction flow.

5. CONCLUSIONS

This paper presents comparisons of hurricane ocean vector wind (OVW) retrievals for Q-Winds and the JPL SeaWinds Project's L2B-12.5km OVW products with independent NOAA HRD H*Wind surface analysis for ten hurricane overpasses. Results show that Q-Winds is superior to the JPL L2B-12.5km wind vector product when compared to H*Wind under hurricane conditions. After removing rain-flagged cells, the L2B-12.5km rarely produce wind speeds > 30 m/s, while Q-Winds compares well with H*Wind for wind speed up to ~ 45 m/s. This new combined active/passive hurricane NRT retrieval algorithm was developed for QuikSCAT and it could be used to reprocess of the entire mission record.

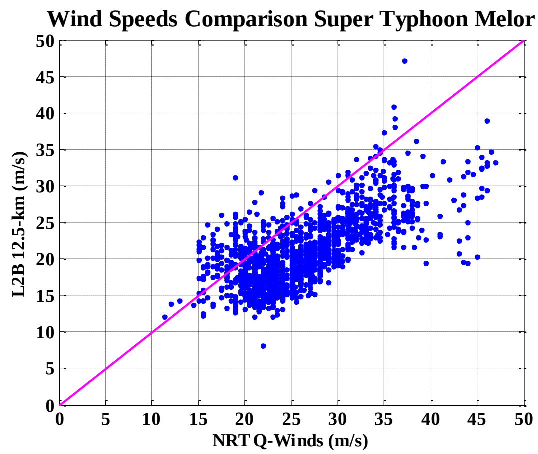

Figure 5: L2B 12.5-km and NRT Q-Winds retrieved wind speed comparison for Super Typhoon Melor rev#53603.

6. REFERENCES

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