P1.8 TROPICAL CYCLONE ANALYSIS TECHNIQUES FROM QUIKSCAT NRCS, WIND AND AMBIGUITY DATA AND MICROWAVE IMAGERY

Roger T. Edson, Anteon Corporation, U. of Guam (WERI), Mangilao, Guam

1. INTRODUCTION

This presentation demonstrates several new tropical cyclone (TC) analysis techniques using a combination of QuikSCAT data and microwave imagery (MI). Although procedures have been discussed in previous talks and papers for each data type (e.g. Edson and Lander, 2002; Edson, et al., 2002; and Edson and Chang, 2003), the concepts presented here emphasize the need to combine and integrate the data rather than maintain its independence. This idea was briefly discussed in Edson and Lander (2003) but is expanded here to give examples for specific TC analysis cases. The added value of combining and cross-referencing the different microwave types of remote sensing data allows the analyst to obtain the highest confidence possible for real time operations, as well as for post-analysis work. Several examples are shown in this preprint while more will be included at the conference presentation.

2. DATA TYPES AND CONCERNS

Satellite-based microwave data offer the TC analyst the unique ability to interpret the entire convective and wind structure of a TC on a regular basis. Limitations exist, however, due to the non-continuous nature of polar-orbiting data, different degrees of sensitivities to rain and ice particles, and poorer horizontal resolutions as compared to the more conventional visual (VIS) and infrared (IR) imagery. In the MI, an analyst must learn to interpret the differences between the two primary TC analysis frequencies: ~85 GHz (for views of the deep convective bands and overall moisture availability) and ~37 GHz (for views of lower rain band activity) as well as be able to distinguish the sometimes confusing microwave return from the ocean surface. The use of scatterometer data (primarily the current QuikSCAT data set in this paper) as a means to obtain TC surface winds has created almost as much confusion in its interpretation as excitement for its unique ability to ‘see’ under the TC. Analysts must learn to recognize the non-exacting effects of heavy rain on the signal’s path through the atmosphere and upon changes to the backscatter properties from wind and rain on the ocean’s surface. Difficulties exist in interpreting the proper winds speeds and directions under both light and heavy winds as well as under non-TC based automated wind selection schemes that determine the standard wind vector displays. In order to help with the TC interpretation process, several additions to the original wind vector field displays have been added by QuikSCAT sites (e.g. NOAA/NESDIS, FNMOC, and NRL-MRY) including ambiguity plots which show up to four possible solutions for each vector cell and a Normalized Radar Cross-Section (NRCS) image (Edson and Chang, 2003) which provides a gray scale display of backscatter data in a 3km grid. Manual TC-specific procedures have been developed (Edson, et al. 2002) to help analyze the TC using these different displays; however, there still exist no completely satisfying set of rules to handle all the variations in interpretation necessary to fully understand the TC analysis. Hence, examples of ways to combine the views of MI and QuikSCAT data are shown in the next section.

**Corresponding author address:* Roger T. Edson *c/o* WERI, Univ. of Guam, Mangilao, Guam *96923;* email: rogeredson@yahoo.com

3. Examples of COMBINED MI AND QUIKSCAT INTERPRETATIONS IN TCs

a) Positioning. One of the crucial points of any analysis and perhaps one of the easiest to resolve with the combined data (assuming a surface circulation exists). A practical characteristic of many developing depressions is that the low pressure (and circulation) center tends to form within a light wind/rain-free region: two features that are relatively easy to identify in the NRCS and 37 GHz imagery (Fig. 1).

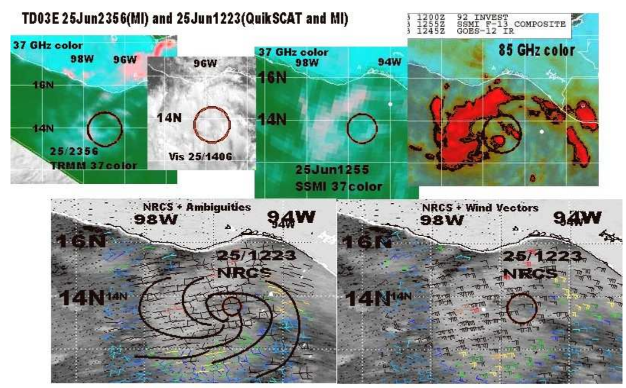

Fig. 1. Initial analysis of TD 03E (Carlos) using combined MI (85 and 37GHz) and QuikSCAT data (NRCS, winds, ambiguities).

b) A ‘minimum’ maximum TC intensity. This is perhaps one of the most difficult assessments to make. For intense TCs (above ~45-65kt), the analyst must understand the QuikSCAT limiting factors to determine high wind speeds such as the wind retrieval process itself, the 25km resolution of the data, and the tendency for heavy rain regions to attenuate the signal. For weaker TCs (below ~30-40kt), QuikSCAT wind retrievals tend to misinterpret heavy rain as a (incorrect) higher wind speed with a isotopic directional signal that is cross-track to the sensor’s view angle. In this situation, the MI has shown promise in distinguishing the proper wind speeds and directions (see Fig. 2).

c) Determining outer wind radii. Information gained from the analyses in a) and b), above, provide a good starting point for determining outer wind radii. This process is also dependent upon the TC intensity (for determining 50kt (or possibly 64kt) wind radii) and relative location and intensity of the rain bands. In Fig. 3, an example is shown where the MI may help in these higher wind radii determinations even when there is no overlapping scatterometer data. In weaker TCs a combination of MI and NRCS imagery may help distinguish the artificially high wind speeds in the heavy rain from the expected environmental wind buildup in towards the center as also revealed in Fig. 2.

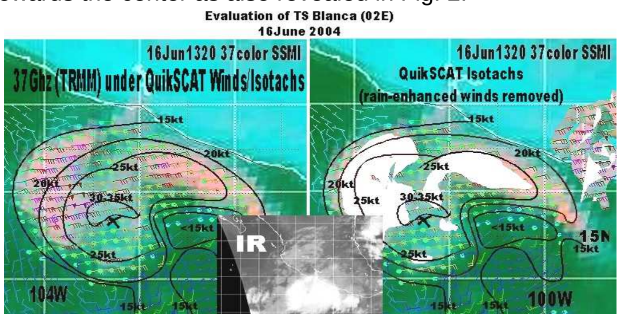

Fig. 2. Determining intensity by eliminating possible rain-enhanced winds for TS Blanca (02E).

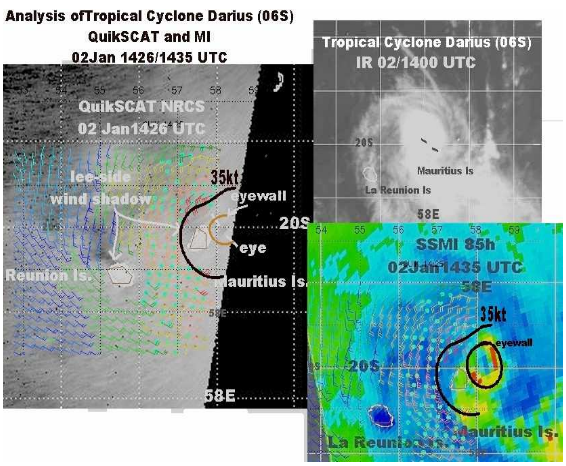

Fig. 3. Wind radii determination in intense TCs.

d) Identifying TC formation. Similar to the discussion in 3a, above, a light wind/rain-free center surrounded by increasing winds and organized rain is common in TCs from the earliest stages of developments (Fig. 4).

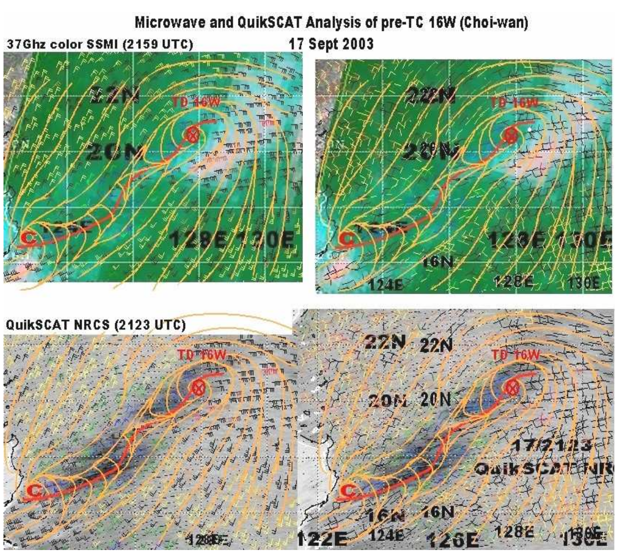

Fig.4. Formation of TY 16W (Choi-wan) 17 Sept 03.

e) Evidence of extratropical transition (ET). Loss of deep (ice seen in the 85 GHz) convection near the TC center and expansion of the winds away from the center and into a horseshoe-like appearance are some of the characteristics of ET in the MI data (Fig. 5).

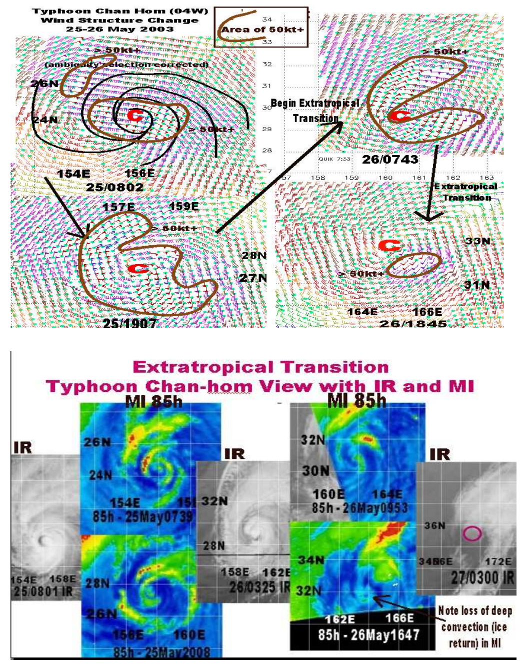

Fig. 5. MI characteristics of ET for TY Chan-hom.

4. FUTURE WORK AND REMARKS

This paper offers some suggestions to where the added use of the combined QuikSCAT data set (winds, ambiguities, and NRCS) and the two MI frequencies at 85 and 37 GHz provides a higher confidence analysis to obtain operationally significant TC positions, formation signals, relative intensity and outer wind structure.

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