17A.2 THE INTERACTION OF SUPERTYPHOON MAEMI (2003) WITH A WARM OCEAN EDDY

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1. INTRODUCTION

The Northwest Pacific Ocean (NWPO) is the world's most prolific generator of tropical cyclones, producing about 6-10 category-4 (in Saffir-Simpson scale) or category-5 typhoons each year. These severe typhoons are direct threats to the half-billion people living on the coast of East Asia. The high frequency of strong typhoons in these regions is partly related to the large area of warm sea surface temperature (SST) and correspondingly large potential intensity (Emanuel 1991). Nevertheless, it remains unclear why some storms reach higher intensity than others.

Recent studies (Bender and Ginis, 2000; Shay et al., 2000; Goni and Trinanes, 2003) suggest that one of the major stumbling blocks in current intensity forecast is the lack of detailed upper ocean thermal structure in typhoon models. In particular, warm ocean features, including meso-scale warm eddies and currents have been implicated in the intensification of several Atlantic hurricanes. Shay et al. (2000), and Goni and Trinanes (2003) demonstrated that both Hurricanes Opal (1995) and Bret (1999), rapidly intensified from category 1 to 4 within 24-36 h when passing over warm ocean eddies.

With abundant ocean eddy activities in the NWPO (Yasuda et al. 1992; Roemmich and Gilson 2001), it is interesting to ask what role warm ocean eddies play in the intensity evolution of typhoons in the NWPO. Aside from the recent work on the intensification of Typhoon Imbudo (2003) due to the warm ocean features (Goni and Trinanes 2003), the impact of the NWPO warm ocean eddies on typhoon intensification is not well understood.

This work serves as our first investigation of the impact of a warm ocean eddy on the intensity change of Maemi (2003) in the NWPO, by using the synergy of the multiple remote sensing data and the CHIPS (Coupled Hurricane Intensity Prediction System) model (Emanuel, 1999).

2. EXPERIMENT DESIGN

TOPEX/Poseidon satellite altimetry Sea Surface Height Anomaly (SSHA) data and cloud-penetrating SST data from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) are used to improve the initial and boundary conditions for hindcast experiments using CHIPS.

Four experiments were run with CHIPS: 1. a control experiment using SST data from NCEP; 2. an experiment with the warm ocean eddy (SSHA derived from the TOPEX/Poseidon) included to adjust the mixed-layer depth in CHIPS; 3. an experiment with the SST corrected to include the cold-wake previously induced by Typhoon Dujuan along the track of Maemi; 4. an experiment with both the cold wake and the warm eddy.

3. RESULTS

As shown in Fig. 1, Supertyphoon Maemi, the most intense tropical cyclone in 2003, intensified rapidly from 0000 UTC 9 September to 0000 UTC 10 September, while encountering a prominent warm ocean eddy characterized by a SSHA of more than 35 cm, as observed by the TOPEX/Poseidon satellite altimeter. Within 24 h, Maemi's intensity (in 1-minute sustained wind of the Joint Typhoon Warning Center, JTWC) jumped from category-2 (46 m s^{-1}) to the category-5 strength of 77 m s^{-1}.

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Figure 2 shows the intensity evolution in all the experiments as compared to the JTWC best-track data. We find that when the previous cold-wake is accounted for, the intensity decreases and is in better agreement with the best-track data. This is very much consistent with previous work on the negative influence of storm-induced cold wakes (Bender and Ginis 2000).

In the simulation with the warm eddy, Maemi reaches the intensity about 10 knots higher than without the eddy. A more profound result is that when the eddy is included, the storm intensity is sustained somewhat longer after it reaches peak intensity. This results from smaller SST cooling due to smaller entrainment with the deeper mixed layer in the simulation with the warm eddy. These results imply that the warm ocean eddy may play a more important role in sustaining Maemi than in its rapid intensification. This differs from the current interpretation in the literature, and requires further investigation. We are in the process of evaluating more cases of typhoons encountering warm ocean eddies in the NWPO, using near real-time satellite altimetric data in operational coupled typhoon prediction models, and expect to draw more concrete conclusions about the influence of ocean eddies.

4. REFERENCES

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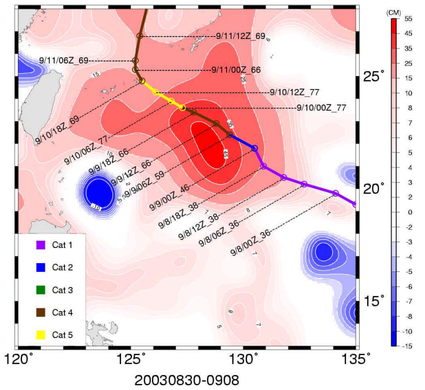

Fig. 1. The best-track of Maemi from JTWC overlapping on the composited sea surface height anomaly (contour interval of 10 cm).

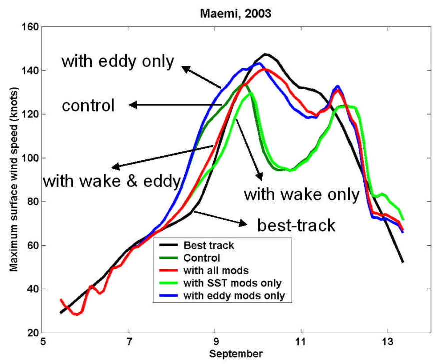

Fig. 2. Time series of the maximum surface wind (in knots) of each experiment as compared to the best track data of JTWC.