The Evolution of Typhoon Zeb (1998) in a Non-Hydrostatic Mesoscale Model

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ABSTRACT

Typhoon Zeb was one of the most damaging typhoons that affected Taiwan, as well as Phillipine and Japan, in 1998. Besides the serious damages, several interesting scientific questions are also identified associated with Zeb: 1) the merger process of Zeb and Typhoon Alex; 2) eyewall evolution during Zeb's landfall at Luzon; 3) effects of Luzon and Taiwan topography on Zeb; and 4) interaction between Zeb and the mid-latitude baroclinic trough. Numerical integrations using the fifth-generation Penn. State/NCAR Mesoscale Model (MM5) were performed to address some of the above scientific issues.

In order to investigate the capability of MM5 model, we used triply nested grids to simulate typhoon Zeb as it approached Taiwan. A series of experiments with or without the terrain of Luzon or/and Taiwan was conducted to investigate the impact of the terrain of Luzon and Taiwan on the track, intensity and rainfall simulation. Potential vorticity inversion were also performed to evaluate the impact of the mid-latitude trough on Zeb's movement.

Results indicate that MM5 can capture several features during Zeb's life period as Zeb approached Taiwan, such as Zeb's making landfall over Luzon, turning northward to Taiwan, and accelerating northeastward while interacting with the mid-latitude upper-level trough. Detailed analyses also indicate that the model simulation produced the main feature of eyewall breakdown and reformation during the period when Zeb moved over Luzon. The mesoscale phenomenon, Foehn, was also simulated over southeastern Taiwan when Zeb approached Taiwan.

It is shown that the presence of both Taiwan and Luzon affected Zeb's track, intensity and rainfall distribution over Taiwan. As to the track and intensity, both the presence of Taiwan and Luzon terrain tended to decelerate the movement of Zeb and to reduce its intensity. For rainfall simulation, the model produced similar rainfall distribution as compared to observation. It is demonstrated that the simulated rainfall distribution is affected by the model resolution, while the amount of simulated rainfall correlated negatively with the translation speed of Zeb. Finally, the PV diagnostics indicate that the mid-latitude upper-level trough led to a northward steering flow during the periods when Zeb accelerated northward and left Taiwan area. This flow accounted for about 20% of the total steering of Zeb.

Key words: Typhoon Zeb, MM5, Eyewall breakdown, PV inversion