Sensitivity of Typhoon-Terrain Interaction Simulations to Vertical Resolution and Terrain Scale

Paul A. Hirschberg*, Chi-Sann Liou+, and Russell E. Elsberry*

***Department of Meteorology, Naval Postgraduate School, CA**
+Marine Meteorology Division, Naval Research Laboratory, CA

ABSTRACT

In determining the primary physical mechanism of typhoon track deflection by terrain, Yeh and Elsberry (1993)and Zehnder (1993) drew different conclusions from their numerical experiments by different models. Yeh and Elsberry indicated horizontal vorticity advection is the primary mechanism of typhoon track deflection before the landfall in a multi-level model, while Zehnder suggested vortex stretching is more important in a shallow water model. These physical mechanism differences are examined with a vorticity budget in numerical model sensitivity studies using the channel version of Navy Operational Regional Atmospheric Prediction System (NORAPS). To eliminate difference arising from translation by a steering current or beta-effect propagation, a quiescent environment and a constant Coriolis parameter are specified, and the terrain is raised to full elevation over 24 h adjacent to a typhoon circulation separately spun-up with no terrain present.

The sensitivity studies reveal that the shallow water model forces the typhoon to remain vertically coupled and exaggerates the flow forced over the terrain. The longer topography deforms more the typhoon circulation around the terrain that contributes a larger change in the typhoon track. Vorticity budget results show that the typhoon movement in cases without terrain is mainly contributed by the divergence term of the asymmetric flow. With terrain interacting with the outer typhoon circulation, the horizontal vorticity advection becomes more important in determining the typhoon track. The horizontal vorticity advection is more dominant in determining the typhoon track before its landfall with longer topography.