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The Effect of Taiwan Terrain on Typhoon Gladys (1994) Part II: Numerical Simulation

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ABSTRACT

Due to the complex terrain and elevated Central Mountain Range (CMR) in Taiwan, a typhoon often experiences great change in its movement and circulation when it moves over Taiwan. An observational study of Typhoon Gladys (1994) has been shown in Part I. In this paper (Part II) we also perform numerical integrations using Geophysical Fluid Dynamics Laboratory (GFDL) hurricane model. To understand the effect of Taiwan topography on Gladys, four numerical experiments are performed. The first serves as the control experiment which makes a 72- hour forecast using the full GFDL hurricane prediction system with a bogused Gladys's vortex; the second excludes the Taiwan topography; the third removes the bogused vortex; the fourth contains a bogused vortex with doubled size and intensity.

Results from the above numerical simulations indicate that the movement of Gladys mainly follows the environmental steering current. Existence of the Taiwan topography results in the deceleration of Gladys's translation speed when it approaches Taiwan, then the acceleration after it passes Taiwan. In general, a cyclonic track induced by the Taiwan topography is found. Although the GFDL hurricane model forecast underestimates Gladys's intensity, the model can capture the evolution of Gladys's intensity, especially the weakening of Gladys during landfall. Other meso-scale phenomenon, including the pattern of heavy precipitation and the formation of secondary lows, are well simulated from the model, though their locations are somewhat different from those in observations. These differences may be resulted from the inadequate resolution of the model topography. Note that small errors in predicting the large-scale flows can result in large errors in the meso-scale features above the high terrain.

Results from the comparison of the model experiments indicate that two secondary lows to the west of CMR form due to the environmental easterly flow over CMR, but the secondary low near the southeast of Taiwan occurs due to the warming effect from the downslope current associated with Gladys's circulation. The experiment with a stronger and larger typhoon vortex shows that the motion of such vortex is affected by stronger beta effect, thus leading to different track. The evolution of Gladys is also studied from the potential vorticity perspective . It is shown that the Taiwan topography affects Gladys's intensity primarily through its cutoff of the water vapor supply, which is the essential energy source for storm maintenance.

Key words: GFDL hurricane model, Secondary low, CMR, Bogus