14A.3 INTENSITY OF RECURVING TYPHOONS FROM A PV PERSPECTIVE

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1. INTRODUCTION

Improvements in forecast models have reduced track errors, but intensity forecasts have not shown significant gains. Numerical models dealing with intensity change are not much better than CLIPER models, and statistical models do not address rapid deepening. Intensity studies have focused on three areas: air-sea interaction, internal dynamics, and external (environmental) interactions.

Since the work of Hoskins et al. (1985), potential vorticity (PV) has gained popularity as a research tool for tropical cyclones. PV has been used to understand internal (Shapiro and Franklin 1995) and external (Molinari et al. 1995; Bosart and Bartlo 1991; Montgomery and Farrel 1993) influences on tropical cyclone formation and intensity. Little is known about the causes of intensity changes of recurving typhoons. This study will use PV to examine intensity changes of recurving typhoons.

Upper level analysis has been useful in examining trough interactions where there is a pronounced PV gradient. Little work has been done without a trough interaction where PV gradients may be weak. This study will look at both situations.

Most PV gradients in the middle levels will occur around the mesoscale environment of the cyclone. This is where PV strength may be due to the storm's intensity. We will look to see if there is a correlation between intensity and PV magnitude around the storm. Due to coarse resolution, any PV values would be representative of the outer part of the typhoon, and will not show inner structure.

Most recurving typhoons take their track due to a weakening of the subtropical ridge. A trough may be present, but most interactions would be classified as a distant interaction (Hanley et al. 2001). Thirteen isentropic levels from 310K-370K will be examined to see if PV is useful in explaining intensity changes in recurving typhoons.

2. DATA AND METHODS

Typhoon track and intensity data were obtained from the Annual Tropical Cyclone Reports (Joint Typhoon Warning Center 2000). PV was calculated with reanalysis data obtained from the European Centre for Medium-Range Weather Forecasts. The data set has a horizontal resolution of 1.125 X 1.125 degrees and a vertical resolution of 13 pressure levels.

From 1988-1997, 71 typhoons recurved. Recurving time in this study is defined to be when the storm heading is between 315 degrees (where the storm will be moving more north of west) and 45 degrees (where the storm will be moving more east of north). Figure 1 shows Shanshan, an example of a recurving typhoon that will be discussed below.

The Dvorak method is used to determine intensity changes. Typhoons are split into three classes; those that intensify (31 cases), those that weaken (28 cases), and those whose intensity remains constant (18 cases).

3. PRELIMINARY RESULTS

Mid level PV behavior is counterintuitive in weakening storms during recurvature. One particular example was Shanshan. Shanshan started recurving around the subtropical high as a minimal super typhoon (65 m/s), and exited recurvature at 45 m/s. As the storm's latitude increased, it interacted with an approaching trough. The trough had a large longitudinal and vertical extent. As the storm's distance from the trough decreased, it encountered more vertical shear and started to weaken.

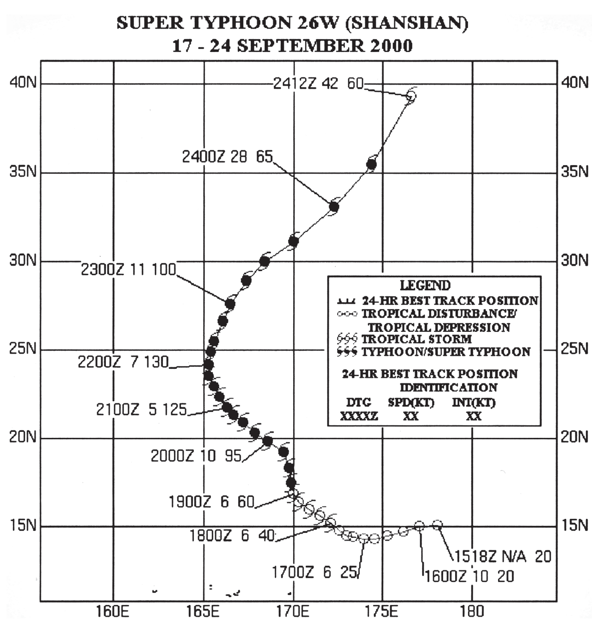

Figure1. The track of a recurving typhoon from the Annual Tropical Cyclone Report.

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From the levels 310K to 330K, PV values around the typhoon's environment continued to increase symmetrically, even though the intensity decreased. In addition to the rise in PV values, the gradient of PV around the storm environment also increased. PV was greater than 1 PVU out to about 450 km radius from the center of the storm. Figure 2 shows the PV field on the 320K surface as the storm was at 63 m/s, and figure 3 shows the PV field on the 320K surface after the storm weakened to 45 m/s. PV values doubled in the storms environment even though the maximum winds decreased significantly.

4. DISCUSSION

PV values should increase below a positive heating anomaly, and decrease above the anomaly. The symmetric increase in PV is not likely due to convection, given that strong convection occupies only a small part of the storm at any time. The increase in PV values may be due to vertical advection of high PV from the lower levels. This may also show a discontinuity between the storm core, and its outer wind field; i.e. the outer winds may increase even though the inner core spins down.

5. REFERENCES

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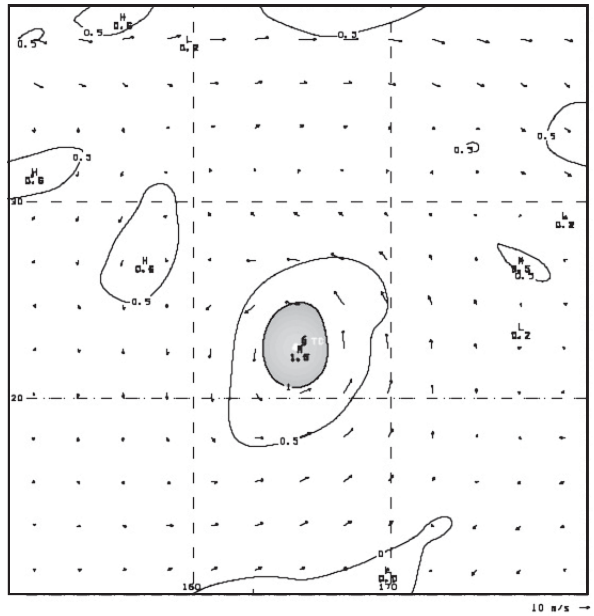

Figure 2. PV field on 320K surface at 000921/12Z. Storm intensity was 63 m/s. PV values greater than 1 PVU are shaded.

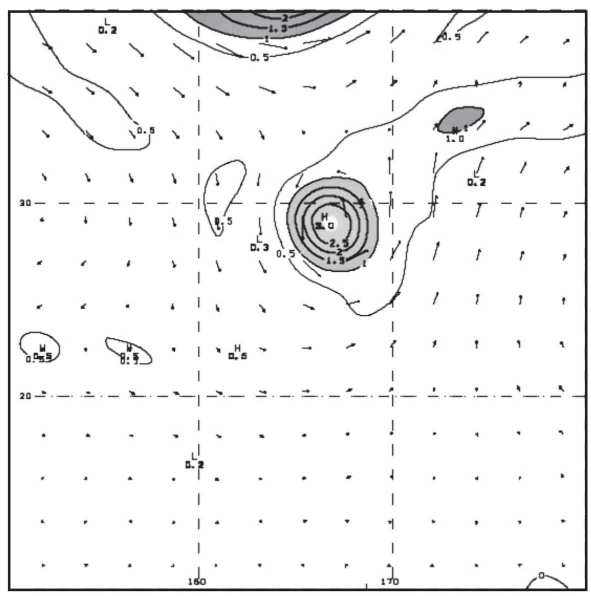

Figure 3. PV field on 320K surface at 000923/12Z. Storm intensity was 45 m/s. PV values greater than 1 PVU are shaded.