A Study of the Influence of Mid-level Circulation on TC Formation: Toraji(2013)

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Abstract

The formation of Tropical Storm Toraji (2013) is a rare case involved with mid-level cyclonic circulation which is a remnant of Tropical Storm Kong-Rey (2013). When Kong-Rey (2013) was moving northward to the east of Taiwan on Aug 28, 2013, its low- and mid-level cyclonic circulation decoupled due to the strong vertical wind shear. The low-level circulation center kept moving northward, while the mid-level circulation moved west-northward and across the central mountain range of Taiwan. The mid-level circulation became stationary for 1 to 2 days when it moved to the Northern Taiwan Strait. As has been analyzed by Liu (2016), this mid-level circulation might have played an important role on the formation of Tropical Strom Toraji.

Although there are several theories about how a mesoscale MCV might affect TC formation. The role that the mid-level circulation plays during TC formation remains unclear especially in a real case. Liu (2016) has discussed the synoptic environment and mesoscale process during the formation of Taraji's pre-disturbance and speculated that the remnant of Kong-Rey's mid-level circulation might have created a favorable environment for the formation of Toraji's incipient vortex. However, the actual role that the mid-level circulation plays during the formation of Toraji remains unclear and is the major purpose of this study. The piecewise potential vorticity inversion (PPVI) method is applied to figure out the contribution of the mid-level cyclonic circulation to the low-level wind field under quasi-balanced assumption. In addition, sensitivity numerical experiments designed to weaken the mid-level circulation gradually by different removing factors had also been conducted. The result of PPVI shows that the mid-level positive PV anomalies contribute most positive vorticity to the low-level before the low-level circulation reformed. And the sensitivity experiments show a significant declining trend of the reformed TC intensity when the removing factor gets larger. In the weaker initial mid-level circulation case, there were less convection events occurred during the formation of Taraji's pre-disturbance which may lead to a weaker TC formation case. As a result, the mid-level circulation plays a crucial role in the formation of Toraji.