

A study on the physical process involved in the genesis of a severe tropical tornado

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Hainan Island was hit by an EF2 tornado on 5 June 2016. In order to study the structure and formation of the tornadic storm and the tornadogenesis under weak vertical wind shear condition, the Haikou Doppler weather radar data, surface AWS observations at 10-minute interval and wind profile data are analyzed. The first storm was initiated by the sea breeze and moved eastward to reach the sea. It is a single cell storm. When the convergence of the sea breeze intensified, the storm turned to move westward and reached the island while new convections were initiated along the sea breeze front, leading to the formation of the Wenchang multicellular storm. The Haikou storm was also initiated by the sea breeze. When the outflows of the above two storms intersected along the powerful sea breeze front, the tornadic storm with weak echo region and strong high-level mesocyclone was initiated. The tornado embryo formed in the boundary area where the two outflows intersected. The stretching of the deep, strong updraft above the tornado embryo is the main physical process involved in the tornadogenesis. There are three factors contributing to the extremely strong lifting, i.e., the outflow boundaries intersection, the ambient large positive buoyancy and the vertical perturbation pressure gradient associated with the low pressure induced by the strong mesocyclone in the upper level. The mesocyclone of the tornadic storm was located at 6-9 km above the ground and extended upward when the tornado occurred, which indicated that the tornado was not formed due to the descending of the high-level mesocyclone. The tornado embryo formed before the tornadic storm occurred, thereby it was not similar to classic mesocyclonic tornado. It was also different from the non-mesocyclonic tornado. The tornado vortex signature (TVS) extended up to 6 km. The low-level vortex was not a mesocyclone (less than 4 km and lower than 2 km high). It was suggested to classify the tornado as a non-typical mesocyclonic tornado. This was a tropical tornado formed under weak synoptic-scale forcing with weak vertical wind shear. The sea-breeze and the storm generated outflow boundary played a critical role for the tornadogenesis.

Keywords: Tornadogenesis, Tornado vortex signature, Sea-breeze, Mesocyclone