

# **The Secondary Low and Heavy Rainfall Associated with Typhoon Mindulle (2004)**

**Yi-Chin Liu   Cheng-Shang Lee**  
**Department of Atmospheric Sciences, National Taiwan University**  
**Fang-Ching Chien**  
**Department of Earth Sciences, National Taiwan Normal University**

## **Abstract**

This paper presents an observational and numerical study of Typhoon Mindulle (2004) as it affected Taiwan. Mindulle made landfall on the east coast of Taiwan on 1 July 2004, and after 13 h, it exited Taiwan from the north coast. During the landfall of its main circulation, a secondary vortex formed over the Taiwan Strait but dissipated overland after Mindulle left northern Taiwan.

The development of the secondary vortex can be divided into two stages: before Mindulle's landfall and after. Before the typhoon made landfall, low pressure developed on the lee side of the CMR as a result of downslope adiabatic warming associated with the over-mountain easterly flow of the typhoon circulation. The wind shear vorticity associated with the typhoon airflow that circled around the northern tip of the CMR was transported into the low pressure region. These two processes resulted in the formation of a secondary vortex over the Taiwan Strait. After Mindulle made landfall, the remnants of the typhoon vorticity along the eastern coast of Taiwan were transported into the region of the secondary vortex. The mid- and high-level positive vorticity associated with the typhoon passed over the CMR and coupled with the low-level vorticity that developed upward near the secondary vortex. Consequently, the secondary low intensified and reached its mature stage. These formation processes of the secondary vortex were further illustrated in the thermal budget and vorticity budget analyses.

Besides the southwesterly flow, the secondary vortex and the typhoon circulation also played an important role in the heavy rainfall. We show that without the secondary low and the typhoon circulation, the convections near the leading edge of the southwesterly flow were weak and there was no heavy precipitation in Taiwan. The circulation of the typhoon and the secondary vortex provided provide extra convergence, resulting in strong east-west oriented convections and heavy rainfall.