Simulation Study of Heavy Rainfall Events in Northern Taiwan During the 2022 TAHOPE Period

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The unique topography and land-sea distribution in the Taiwan region facilitate the development of local circulations such as sea-land breezes and valley winds. Appropriate environmental wind patterns and vertically unstable conditions are often crucial factors inducing convective systems over the terrain. During the Mei-Yu front period, the complex topography of northern Taiwan becomes a significant factor in triggering the development of mesoscale convective systems.
On May 31, 2022, northern Taiwan was influenced by the Mei-Yu front, leading to sustained intense convective activity starting at 10 a.m. and gradually diminishing until 7 p.m. On that day, the Taiwan-Area Heavy rain Observation and Prediction Experiment (TAHOPE) initiated an intensive observation experiment. Analysis of the synoptic weather map, skew-T diagrams, and various intensive observation data for the day revealed that the atmospheric conditions over northern Taiwan were conducive to the generation of strong convective systems. The wind at different levels in the morning at the Banqiao sounding station was predominantly southwest, with a CAPE value of 2,331 m^2s^2. Various indices and intensive observation data all indicated favorable conditions for the development of strong convective systems in northern Taiwan.
Using the WRF model with a spatial resolution of 200 m, the study of this intense precipitation event showed a northeastward movement and development tendency of convection in northern Taiwan. Analysis of surface stations and sounding observations indicated that the southwest winds generated near the approaching front caused convergence in the northwest and east offshore areas, becoming a significant mechanism for triggering convective cloud systems northeast of offshore areas. Additionally, as the convective cloud system moved northward with the front, it altered the surface wind field in the northern region, strengthening the development of convective cloud systems in northern Taiwan.
The merging and enhancement mechanism of convective cells in mountainous areas further intensified the development of the convective system, leading to locally heavy precipitation.

Keywords: Mei-Yu Front, TAHOPE, Local Circulation, Mesoscale Convective System

