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On the Multi-Scale Factors Contributing to the Evolution of a Long-Lived Quasi-Stationary Rainstorm During the 2022 TAHOPE IOP#1 Revealed by a 4DVar System

Abstract

The Taiwan-Area Heavy Rain Observation and Prediction Experiment (TAHOPE) field campaign was carried out from late spring to summer in 2022 to enhance the understanding and forecasting of extreme rainfall events in Taiwan area. During late May to June, Taiwan is frequently affected by the quasi-stationary Mei-Yu front, which can contribute to torrential rainfall. A mesoscale convective system (MCS) which caused extreme rainfall over Central Taiwan (CT) for several hours on 26 May during intensive observation period #1 (IOP#1) of TAHOPE is investigated by high spatiotemporal analyses produced by the rapid-update 4DVar analysis system (IBM_VDRAS). When the Mei-Yu front was positioned to the north and a strong southwesterly low-level jet (LLJ) over CT transported abundant moisture, it continuously supported the widespread development of MCS and sustained its intensity. As the southwesterly flow weakened with reduced moisture, the Mei-Yu front began moving southward and the local conditions became unfavorable, thereby shifting the MCS southward and causing it to become relatively smaller in scale. During this long-lived MCS, several convective cells were repeatedly triggered at different but nearby upstream locations, propagated downstream over the same area, and merged with mature convective cells downstream, suggesting a back-building system. Multi-scale factors influencing the MCS are further examined. Our results show that the LLJ was driven by the local horizontal pressure gradient force as the southwesterly flow impinged on the southern mountain range, while the MCS was blocked and remained quasi-stationary for a prolonged duration over CT due to the Mei-Yu front to the north and the mountainous region to the east.

Keywords

Back-building/quasi-stationary system, low-level jet