UNDERSTANDING THE PROCESSES RESPONSIBLE FOR HEAVY RAINFALL IN TWO MEI-YU FRONT CASES

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ABSTRACT

This presentation analyzes numerical simulations to examine the mesoscale conditions associated with heavy rainfall in two mei-yu frontal events near Taiwan. For the first case, from early June 2017, the simulation reasonably reproduces the frontal progression and heavy rainfall surrounding northern Taiwan from the event. The front is identified through time using a clustering algorithm, which enables analysis of the characteristics of the rainfall, surrounding environment, and underlying mechanisms through space and time. Heavy rain is produced by a series of eastward propagating MCSs and maximizes on the eastern side of the Taiwan Strait. Convective available potential energy (CAPE), counter-rotating vortices spanning the front, and two-dimensional frontogenesis are not well correlated with the rainfall intensity. Meridional moisture flux, influenced by the low-level barrier jet, and potential vorticity (PV) are better correlated with the rainfall intensity. The results suggest that low-level moist air ascending adiabatically along isentropes towards the front provides an important contribution to the rainfall intensity.

In the second case, a peak measurement of 600 mm of rainfall and widespread accumulation over 100 mm were observed near Yonaguni, Japan on June 09, 2020. Global model forecast skill was poor in both the rainfall location and intensity. A 40-member ensemble of numerical simulations showed liminal conditions between heavy rainfall or little to no rainfall. The two most accurate and two least accurate ensemble members are selected for analysis via validation against estimated rainfall totals from the Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPESUMS) system. Synoptic conditions of both the most and least accurate ensemble members are quite similar, featuring moisture-rich environments, moist neutral soundings with low levels of free convection (LFC), and sufficient instability for deep convection. Our analysis reveals that the location and intensity of the shallow near-surface frontal boundary are key to ensemble member accuracy. In the two best members, south-southwesterly flow ascends over the sloped isentropes, rises above the LFC, and produces back-building deep convection. In the two worst members, the near-surface gradients are weaker and more confined along Taiwan's coast, which leads to less rainfall located west of the observed rainfall. In addition, as the least accurate simulations progress, stronger southerly winds advect drier mid-level air into the region of interest and shift the near-surface boundary further north and west. Winds in the best performing members are weaker and more southwesterly with less dry air advection and frontal displacement. The analyses suggest that subtle details in the simulation of frontal boundaries and meso-scale flow structures can lead to bifurcations in producing extreme or almost no rainfall.

Keywords: mei-yu front; heavy rainfall; modeling