Mechanisms for the nocturnal development of Mei-yu precipitation over southeastern China within 5-day NHM simulation

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1. Introduction

During May–June, frequent heavy rainfalls and related deadly disasters over East Asia cause a heavy toll on the livelihood of the local residents. Along with seasonal increase, diurnal cycle of rainfall experiences distinct seasonality and regional contrast. Heavy rainfalls, given their great contribution to rainfall budget, can be crucial for determining diurnal cycle of rainfall (Chen et al. 2009). They are attributed to the mesoscale convective systems (MCSs) or intense meso- β systems in the Mei-yu frontal rainband. Studies on the diurnal evolution of these systems are helpful for a better understanding on diurnal variability of the Mei-yu precipitation over East Asia. The objective of this study is to conduct a series of simulations on the heavy rainfalls occurring repeatedly during 12−16 June 1998 to examine the mechanisms supporting regional strong morning rainfall over southeastern China (SEC).

2. Model setup

JMA/MRI non-hydrostatic model is employed in this study. The simulation domain is East Asia with a spatial resolution of 10 km. The Kain–Fritsch cumulus scheme, Mellor–Yamada level-3 closure model, and mixed phase cloud physics are chosen for the parameterization of atmospheric processes. GEWEX Asian Monsoon Experiment (GAME) reanalysis data are used as initial and boundary conditions. There are five cases for a period of 11−16 June 1998, each initiating at 00UTC and integrating for 36 h. Diurnal cycles of 9-33 h are examined, with emphasis on the nocturnal genesis of moist convection and the morning precipitation.

3. Results

Two preferred regions of observed strong rainfall are identified during 11-16 June, one located along the east lees of the Tibetan Plateau and another along the Mei-yu front east of 112ºE (fig. 1a). They are highly similar to the climatological locations of heavy rainfall, are reproduced well by the simulation (fig. 1b). Organized convections

tend to initiate overnight both along the east slopes of the Tibetan/Yun-gui Plateaus and over east domain of SEC. They produce widespread rainfall over SEC through the late night and morning when migrating eastward. It is found that the initiation of nocturnal convection is corresponding to the arrival of high-θ_e air pool to the Mei-yu front in lower troposphere. The high-θ_e air, originating from south China at preceding afternoon, is transported northward by nocturnal low-level jet (LLJ). The Mei-yu front is thus strengthened by the convergence and deformation frontogenesis, which aids in anchoring and sustaining the moist convection. Just to south of the Mei-yu front, the moisture convergence and convective instability are enhanced remarkably, which are followed by the convection initiation varying for regions and events. West domain of SEC is characterized by the well-developed high-θ_e pool and evening intensification of southerly LLJ along the elevated terrain. These low-level processes of supplying the high-θ_e air along with a decay of warm advection in mid-upper layer lead to the most convective stratification at evening, hence an earlier timing of convection initiation. Over the east domain of SEC, however, moist convection tends to develop at midnight or late night. The low-level processes especially the horizontal advection of high-θ_e air contribute to the maximum of convective instability near midnight, while the large-scale forcing is generally weak on diurnal scale.

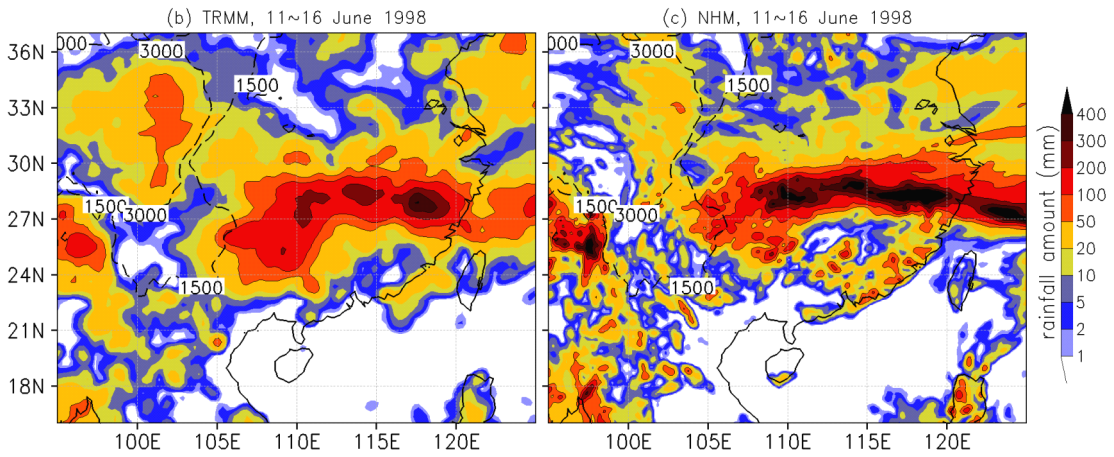

Fig. 1. Rainfall amount accumulation during 11−16 June, 1998. (a) TRMM-3B42 observation and (b) NHM simulation. Dashed lines mark the elevation of 1500m and 3000m.

References

Chen, G., W. Sha, and T. Iwasaki, 2009: Diurnal variation of precipitation over southeastern China: 2. Impact of the diurnal monsoon variability, J. Geophys. Res., 114, D21105, doi:10.1029/2009JD012181.