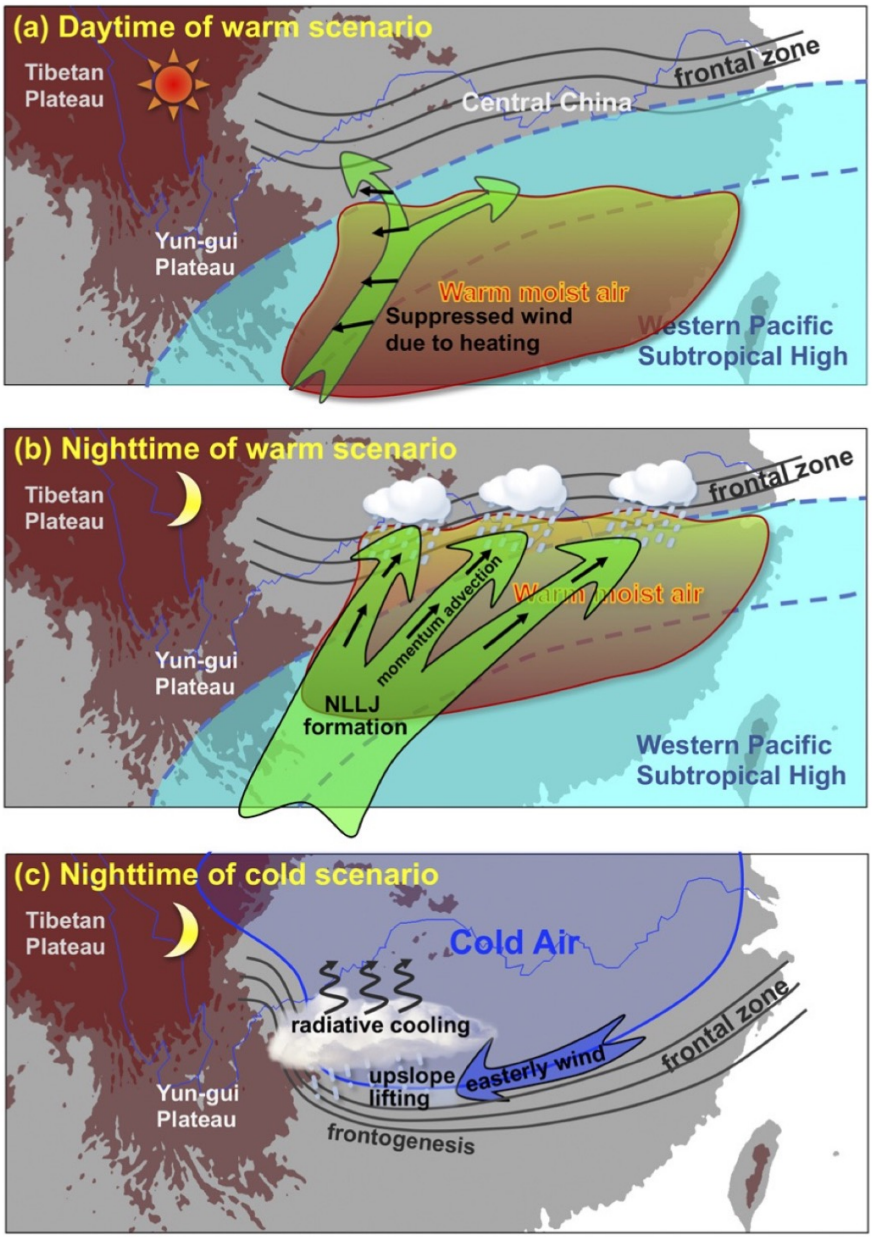
Diurnal Variations of Low-Level Winds and Precipitation Response to Large-Scale Circulations during a Heavy Rainfall Event

*Wenxin Zeng[1], Guixing Chen[1], Yu Du[1], Zhiping Wen[2]

1. School of Atmospheric Sciences, Sun Yat-sen University, 2. Department of Atmospheric and Oceanic Sciences, and Institute of Atmospheric Sciences, Fudan University

A succession of MCSs developed during the last week of October 2016 and produced extreme heavy rainfall in central China. The event underwent an evident shift from a mei-yu-like warm scenario to an autumn cold scenario. Diurnal cycles of rainfall and low-level winds may be modulated by the shifting of large-scale at- mospheric conditions. We conducted observational analyses and numerical experiments to examine how large-scale circulations influenced rainfall systems through diurnally varying processes. The results show that, in the first half (warm) period of the event, intense rainfall mostly occurred in eastern-central China with an early morning peak. It was closely related to a nocturnal southwesterly low-level jet (NLLJ) on the flank of the western Pacific subtropical high. The NLLJ formed near midnight in southern China where ageostrophic wind rotated clockwise due to Blackadar’ s inertial oscillation. The NLLJ extended downstream to central China during the predawn hours due to the horizontal advection of momentum. Both the formation and extension of the NLLJ were supported by an enhanced subtropical high that provided relatively warm conditions with surface heating for boundary layer inertial oscillation and strong background southwesterly winds for mo- mentum transport. The NLLJ induced MCSs at its northern terminus where the low-level ascent, moisture flux convergence, and convective instability were enhanced during the predawn hours. In the second half period with an intrusion of cold air, the diurnal amplitude of low-level winds became small under relatively cold and cloudy conditions. Moderate rainfall tended to occur in western-central China with a peak after midnight, most likely due to frontogenetic processes, upslope lifting, and nighttime cloud-top cooling.

Keywords: Diurnal cycle, Nocturnal low-level jet, Subtropical high, Rainfall systems



Conceptual model of the rainfall-producing processes in (a) daytime and (b) nighttime of the warm period and (c) nighttime of the cold period. The light blue area denotes the WPSH in (a),(b). The bold arrows denote the low-level winds with the black vectors denoting their diurnal deviations. The red area in (a),(b) denotes the warm and moist air mass, while the dark blue area in (c) denotes the cold air with high pressure. The nocturnal MCSs in the frontal zone are marked in (b). The clouds and rainfall are marked in (c).