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Diurnal variations of two mountain-plain solenoid (MPS) circulations associated with highlands ("first step" and "second step" terrain) in China and the impacts of these two MPS circulations on Southwest vortex (SWV) and Mei-yu front vortex (MYFV) are investigated through the semi-idealized simulation by mesoscale numerical model (WRF) with 10-day average fields (Mei-yu period case of 1-10 July 2007) as initial field and cyclically diurnal lateral boundary fields. The simulation results obtain general geographic distribution of the precipitation and its diurnal variation. The successful simulations reproduce two MPS circulations related to "first step" and "second step", diurnal variations from the eastern edge of the Tibetan Plateau (TP) to Yangtze-Huai River Valley (YHRV) and two precipitation maximum centers related to SWV, MYFV and upward branches of two MPS circulations in the rainbelt consistent with corresponding observations. The averaged final 7-days simulation analyses show the different diurnal peaks of precipitation at different regions: from the afternoon to early evening (06-18UTC) at the eastern edge of the TP, in the early evening to the next early morning (10-21UTC) at Sichuan Basin (SCB), and in the late evening to the next early morning (12-02UTC) over the Mei-yu Front (MYF). The individual 2-day case analyses confirm that the upward branches of nighttime MPS circulations (AS1 and AS2) enhance the precipitation of SWV and MYFV, and reveal that the eastward extending of SWV and its convections are conducive to the trigger of MYFVs. The eastward-propagation of rainfall-streak from the eastern edge of the TP to east coastal line region is mainly due to convective activities of several systems in series from west to east, including MPS between the TP and SCB, SWV, MPS between "second step" terrain and "east plains", MYFV.