Mon. Wea. Rew., 126, 2692-2712

The Development of An Intense East Asian Summer Monsoon Disturbance with Strong Vertical Coupling

C.-P. Chang and S. C. Hou

Department of Meteorology Naval Postgraduate School, Monterey, California

H. C. Kuo and G. T.J. Chen

Department of Atmospheric Sciences National Taiwan University, Taipei, R.O.C.

Abstract

The East Asian summer monsoon (Mei-yu) disturbance of 17-25 June 1992 was the most intense 850-hPa low centers of such systems during a 7-yr period. Due to the moisture fluxes associated with southwesterlies from the warm tropical oceans, diabatic heating has generally been considered the main energy source of these heavy-precipitation disturbances as they propagate eastward from the eastern flank of the Tibetan Plateau across southeastern China and move into the East China Sea. In this study piecewise potential vorticity inversion is used to analyze the physical mechanisms of this intense case, particularly the possible roles of midlatitude baroclinic processes in its development and evolution.

The development of the low-level vortex involved the coupling with two upper-level disturbances, one at 500 hPa that also originated from the eastern flank of the Tibetan Plateau, and another at 300 hPa. Both disturbances appeared later than and upstream of the low-level vortex. Faster eastward movements allowed them to catch up with the low-level vortex and led to a strong vertical coupling and tropopause folding. Initially, diabatic heating was the dominant mechanism for the low-level vortex while the tropopause process opposed it. Both mechanisms supported the 500-hPa disturbance, and tropopause folding was the dominant mechanism for the 300-hPa disturbance. As the vertical coupling developed, the tropopause process reversed its earlier role in the low-level disturbance and contributed to its development. Boundary layer and adiabatic effects also became contributive as the disturbance moved out of eastern China to the oceanic region.

The vertical coupling of the three disturbances was a major factor in the development. The timing and position of the middle-tropospheric disturbance was critical in bridging the upper- and the lower-level disturbances and a deep tropopause folding. This midlatitude-originated process compounded the diabatic heating effect that was sustained by tropical moist air, leading to the strong intensification.