Development Processes of Baiu Frontal Depressions

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The sub-tropical quasi-stationary front, called the Baiu front in Japan, extends from south China to the northwestern Pacific through Japan Islands in the rainy season in Japan, which is the period from June to July. The features of the Baiu front are different between the western and eastern regions (Matsumoto et al. 1971). In the western region (hereafter, region W) west of 140 E, the Baiu front is characterized by the weak meridional gradient of temperature and the strong meridional gradient of water vapor, while in the eastern region (hereafter, region E) east of 140 E, it is characterized by the strong meridional gradient of temperature. A large number of depressions develop in the Baiu frontal zone. This difference must influence the development of the Baiu frontal depression. In this study, categorizing Baiu frontal depressions into two groups on the basis of the location of the depression development; the depression that develops in the region W (hereafter, DW) and the depression that develops in the region E (hereafter, DE), we investigated the development processes of the Baiu frontal depressions in each region.

First, we performed the composite analysis superposing on the centers of the vorticity (PV) at 850 hPa in each depression. The vertical structure of PV indicates that both the DW and DE couple strongly with the upper level troughs and have the deep structures. The low-level baroclinicity in the region E is stronger than that in the region W. In contrast, the convergence of water vapor flux in the region W is larger than that in the region E, resulting in producing the larger diabatic heating in the DW.

Next, we carried out two case studies, which are typical cases of the DW and DE. In the DW, the vorticity due to the moist-induced PV in the mid-level accounts for 70% of the total vorticity at 850 hPa of the depression. The low-level southerly induced by the upper-level PV advects the anomaly of the high potential temperature (PT) and the water vapor to the depression. In contrast, in the DE, the vorticity due to the moist-induced PV in the mid-level accounts for 50% of the total vorticity at 850 hPa of the depression. The low-level southerly induced by the upper-level PV also advects the high PT anomaly to the depression. The advection of the high PT anomaly in the DE is larger than that in the DW.

Further, sensitivity experiments are performed using a three-dimensional nonhydrostatic model, WRF. The sensitivity experiments consist of the full-physics simulation (CNTL) and the simulation in which the effect of latent heating is excluded (NOLH). Both the DW and DE in the CNTLs agree with the observations. The DW in the NOLH does not develop and the structure of the depression is decayed. On the other hand, the DE in the NOLH does not develop but the structure of the depression is maintained.

The results in this study suggest that the latent heating plays an important role in the development of the DW and a complementary role in the development of the DE.

Reference

[1] Matumoto, A, K. Ninomiya and S. Yoshizumi, *J. Meteor .Soc. Japan*, **49**, 267-281 (1971).