Precipitation and latent heating distribution in extratropical cyclones observed by the Global Precipitation Measurement Dual-frequency Precipitation Radar

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Extratropical cyclones (ETCs) contribute to more than 90% of precipitation climatology in some area of midlatitude in winter (Hawcroft et al. 2012). Latent heating associated with precipitation affects structure and development of ETCs through diabatic potential vorticity production. However, almost no statistical studies about precipitation and latent heating distribution in ETCs have performed. In this study, horizontal distribution and vertical profiles of precipitation and latent heating in extratropical cyclones are statistically investigated using four years of the Global Precipitation Measurement (GPM) satellite radar observation data. Over 1200 ETCs in both hemispheres occurred in winter are used in this study.

The results of composite analyses aligning ETC centers show that precipitation distribution during developing stage of the northern hemisphere ETCs are similar to that in the idealized ETC shown in previous studies. Convective precipitation is dominant in a cold front, whereas stratiform precipitation is dominant in a warm front. The convective precipitation in the cold front is unclear in the southern hemisphere ETCs. The fronts are not observed in composites for ETCs in decaying stage for both hemispheres, in which shallow and isolated precipitation is dominant.

The maximum latent heating is observed at an altitude of 3.5 km. Cooling is observed below 750 m. These characteristics are maintained during the life cycle of the ETCs in both hemispheres. Maximum heating is observed at 24 hours before the time when the ETCs reach its minimum pressure. After reaching the maximum heating, the peak values of heating decreases with time, whereas change of the low-level cooling is small. The maximum heating value for the southern hemisphere ETCs is a half of that for the northern hemisphere ETCs.

We also performed analyses dividing ETCs into explosively developing cyclones and non-explosively developing cyclones. In the northern hemisphere, composites of the explosively developing cyclones show clear warm and cold fronts in developing stage. In contrast, the cold front in the composite of the non-explosively developing cyclones is unclear. The cold front is unclear in the composite of southern hemisphere explosively developing cyclones.

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