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Comparison Study of Raindrop Size Distributions and Their Retrieved Polarimetric Radar Parameters Characteristics of Three Typical Heavy Precipitation Systems in Southern China

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The raindrop size distribution (DSD) is a fundamental microphysical property of precipitation. Understanding the variability of DSD is important for analyzing microphysical processes of precipitation, improving radar quantitative precipitation estimation (QPE) and microphysics parameterization in numerical weather prediction models. As the DSD varies with precipitation systems and seasons, for the first time, the characteristics of DSDs and polarimetric radar parameters retrieved by T-matrix for three typical heavy rainfall systems in different seasons (heavy rainstorm in presummer rainy season (PSHR), typhoon rainband in summer (TPHR), heavy rainfall in winter (WTHR)) are studied and compared based on DSDs data observed with 2DVD distrometers in Southern China. Based on rainfall intensity and variation, the observed spectra are divided into convective and stratiform rain types. Over 85% of total rainfall was contributed by convective rain for PSHR. Convective and stratiform rain contributed almost the same for WTHR. The PSHR, TPHR and WTHR‘s raindrop spectra showed significant differences, with highest concentration of middle and large raindrops for PSHR, lowest concentration of middle and large raindrops for WTHR. The logarithm generalized intercept parameter (log10Nw) and mass-weighted mean diameter of raindrops (Dm) values were 3.75 and 1.55 mm for PSHR, 3.89 and 1.27 mm for TPHR, and 4.59 and 0.89 mm for WTHR. Whether for convective or stratiform rain, PSHR has the highest average Dm value for the same rain rate, followed by TPHR, and the smallest was WTHR. The shape-slope relationships observed during the three precipitation processes were very close to the fitted curve obtained in Southern China. It was robust to retrieve polarimetric radar parameters by T-matrix. There were exponential relationships between radar reflectivity factor (ZH) and differential reflectivity (ZDR) at S-band for all three typical precipitation systems, as well as the relations between ZH and specific differential phase (KDP). For a given ZH, the mean value of ZDR (KDP) is the largest in the PSHR (WTHR) case, the smallest in the WTHR (PSHR) case and in the middle in the TPHR (TPHR) case. Three different radar rainfall estimators, R(ZH), R(ZH, ZDR) and R(KDP), were derived from one-year 2DVD observations in the same area. Both R(ZH, ZDR) and R(KDP) polarimetric rainfall estimation relationships are more accurate than the Z-R relationship, especially R(ZH, ZDR).