Dynanmical and Microphysical Properties of Precipitating Clouds in the South of China Based on VPR-CFMCW and Disdrometer Observations

*Zheng Ruan[1], Yang Zhao Huo[2], Feng Li[1], Run Sheng Ge[1]

1. Chinese Academy of Meteorological Sciences, 2. Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters

The vertical structure and evolution in precipitation cloud are rapid and complex, the provided new, unique, and complementary observations not available from the permanent instruments stationed.

Different wavelength ground-based vertically pointing radars(VPRs), include L/C/Ka/Ku bands observed continuously April to September at the same site in Longmen, Guangdong Province, which is the precipitation center of south China, from 2016 , with a goal of observing the dynamical and microphysical properties of precipitating cloud.

This work mainly include the data analysis of the 5530MHz VPR using technology of Frequency Modulation Continuous Wave (VPR-CFMCW) with an OTT Parsivel disdrometer.

The first part is using the two datasets collected from June to July in 2016 and 2017, after evaluate different fitting methods for the gamma fitting function and choose a nonlinear least-squares method to drop size distributions (DSD). Based on the radar reflectivity obtained by VPR-CFMCW, the precipitating clouds that occur during the summer precipitation season in south China are classified into four types, such as convective, stratiform, mixture, and shallow. Different from the usual classification of convective cloud and stratiform cloud, with characteristics of the vertical structure of the clouds was used to add mixture, which has both the characteristics of bright band in stratiform and week convective properties. The other type is shallow clouds which the height of main cloud baby is lower than the height of bright band. The characteristic of the gamma parameters in different precipitation types are compared. The results show that the stratiform precipitation makes up 43.1% of the summer precipitation process in south China, and the contribution of convective precipitation to total rainfall is 62.7%. The precipitation parameters of the four types of precipitation, such as the rain rate (R), the mass-weighted mean diameter (Dm), the radar reflectance (Z), and the liquid water content (LWC), follow the pattern: convective > mixture > stratiform > shallow. The DSD characteristics of the four precipitating types are investigated. For the DSD of convective and mixture precipitation, the spectra width is similar but the rain drop concentration of the mixture is smaller. For the DSD of stratiform and shallow clouds, the rain drop concentrations are similar, but the spectra width of the shallow clouds are smaller. In addition, the relationships between μ-Λ, Dm-Nw, Dm-R, and Z-R are obtained. These new relationships will help improve the accuracy of precipitation estimation and deepen the understanding of the characteristics of surface precipitation microphysical parameters for different types of precipitating clouds in south China.

The second part is retrieval the vertical air motion and rain microstructures in precipitation cloud using the advantage of FMCW technology. The precipitation cloud observed from the VPR-CMFCW can obtain from 30m to 15000m almost the all vertical structure, especially the features near the ground of precipitation cloud .As using the double antennas, transmitting and receiving separated, the advantages of no blind area has unrivaled when compared to pulse radar

The reflectivity-weighted Doppler velocity spectrum measured by VPR-CFMCW include vertical air motion and raindrop motion. The retrieval method is estimated the vertical air motion with modeled the raindrop motion spectrum, and the DSD parameters ware calculated from measure spectrum after the vertical air motion shifted. Thus through the difference mean velocity between the calculated from the measured spectrum and modeled DSD spectrum to estimate vertical air motion, and the DSD microphysics parameters was retrieved after the measured spectrum removed the air motion affects. The retrieval height is from near the surface to just below the melting layer, in this work is from 150m to 4000m. Using gamma parameters from ground raindrop spectrum observed with disdrometer to model the raindrop spectrum for radar at height of 150m. And the raindrop motion spectrum at the higher levels are modeled with the DSD parameters at adjacent lower level retrieval from VPR-CFMCW spectrum observed. The retrieved DSD parameters estimated from the measured spectrum removed the vertical air motion were the normalized number concentration N_w, mean raindrop diameter Dm, and shape parameter m, and the liquid water content LWC ($g \cdot m^{-3}$), rain rate R ($mm \cdot h^{-1}$), The retrieval method applied for the four type precipitation. The primary results is once the vertical air motion is calculated and removed, drop size spectra derived from radar measurements made near the surface agree well with the spectra determined by disdrometer, the performance is batter in stratiform .And the vertical air motion in stratiform rain is minimum ,lightly updraft near 0.5 m s^{-1}, the updraft is larger ,near the 4-5 m s^{-1} and in convective rain . D_m in the stratiform is 1.2-1.5mm, Comparison with convective rain is lower. The work is continued now.

Keywords: VPR-CFMCW, Raindrop size distributions , Vertical structure of precipitating clouds, rain microstructures, Vertical air motion