The impact of raindrop collisional processes on the polarimetric radar variables

Matthew Kumjian
Penn State University, USA

Olivier Prat (Cooperative Institute for Climate and Satellites, North Carolina State University, and NOAA/NCDC, Asheville, North Carolina, USA)

E-mail: kumjian@psu.edu

The impact of the collisional warm-rain microphysical processes on the polarimetric radar variables is quantified using a coupled microphysics-electromagnetic scattering model. A one-dimensional bin-microphysical rain shaft model that resolves explicitly the evolution of the drop size distribution (DSD) under the influence of collisional coalescence and breakup, drop settling, and aerodynamic breakup is coupled with electromagnetic scattering calculations that simulate vertical profiles of the polarimetric radar variables ZH (reflectivity factor at horizontal polarization), ZDR (differential reflectivity), and KDP (specific differential phase). The polarimetric radar fingerprint of each individual microphysical process is quantified as a function of the shape of the initial DSD and for different values of nominal rainfall rate. Results indicate that individual microphysical processes (collisional processes, evaporation) display a distinctive signature and evolve within specific areas of ZH-ZDR and ZDR-KDP space. Furthermore, a comparison of the resulting simulated vertical profiles of the polarimetric variables with radar and disdrometer observations suggests that bin microphysical parameterizations of drop breakup most frequently used are overly aggressive for the largest rainfall rates, resulting in very "tropical" DSDs heavily skewed towards smaller drops.