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An Experimental Study of the Small-Scale Variability of Raindrop Size Distribution

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The variability of raindrop size distribution (RSD) and of integral rainfall parameters in space and time has been studied through a network of disdrometers at the National Aeronautics and Space Administration (NASA) Wallops Flight Facility, Wallops Island, Virginia. The disdrometer network included four sites that were separated from 0.4 to 5 km and positioned in a line. The sites included an impact type Joss-Waldvogel (JW) disdrometer and a tipping bucket (TB) rain gauge. One of the sites had two additional JW disdrometers and one additional TB gauge which helps to determine the measurement accuracy. The experiment was conducted in September and October 2004 during which about 130 mm of rainfall fell in 3,550 1-minute observations. There were six major rain events which featured the remnants of Hurricane Jeanne (2004), isolated convection, and frontal systems.
The maximum separation distance between the disdrometers coincides the footprint size of the NASA's Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Measurement (GPM) precipitation radars. Considering the rain rate thresholds of these radars, it was found that 55% of the time, at least one of the four sites did not report rainfall indicating the importance of partial beam filling. The differences in event average DSD demonstrated the importance of spatial variability within the footprint scale of the precipitation radars. The calculated rain parameters from composite DSD showed 65% difference in total concentration and 2 dBZ in reflectivity in one of the events. A three-parameter exponential function was applied to 1-minute observation-based correlations of DSD and rain parameters. The correlation distance of rainfall rate, for instance, ranged from 2 to 15 km, corresponding to convective and stratiform rain events, respectively.