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

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An experimental study of small-scale variability of raindrop size distribution has been carried out at Wallops Island, Virginia. Three Joss-Waldvogel disdrometers were first operated at a distance of 0.65, 1.056, and 1.706 km in nearly a straight line for about four months and then operated collocated for another four months. The purpose of the study was to examine the variability of raindrop size distribution and its integral parameters of rainfall and reflectivity within a 2 km array: the pixel size of a typical ground based radar. Although the disdrometric measurements during the second phase of the experiment were considered as a reference, there were differences in cumulative distribution of rainfall between the two phases of the experiment as more light rain occurred during the second phase of the experiment.

The composite raindrop size distributions of rain events showed very good agreement among the disdrometers except where there were noticeable differences in the presence of large drops during the first phase of the experiment. This resulted in up to 0.5 mm h^{-1} and 1.6 dBZ differences in calculated rain rate and reflectivity, respectively. The root-mean-square difference of rain rate and of reflectivity increased with distance in most of the convective events and in the composite of all events. This was not necessarily the case in the events where the event mean rain rate was less than 5 mm h^{-1}. Similarly, the correlation coefficient of rain rate and of reflectivity followed the same trend decreasing with distance in most of the convective events and in the composite of all events, but not in some of the light rain events. Percent obser-

vations where the differences in rain rate correlated with distance were only 22-26% for the averaging period of 1- to 15-minutes, respectively. For reflectivity, percent observations were 20-27% for the same averaging periods. We simulated tipping bucket gauge measurements in employing 1-minute disdrometric measurements to determine the role of gauge sampling errors in small-scale variability of rainfall. We recommended that the gauge measurements should be averaged to 10-15 minutes prior to a quantitative assessment of small-scale variability of rainfall. Considering derived rain rate–reflectivity relations through disdrometric measurements, we concluded that the relations are more sensitive to the choice in the method of derivation than the small-scale variability at spatial scales less than 2 km. Since the disdrometric measurements were used in this study, we recognized the sampling issues and presented most of our findings for 1-, 3-, 6-, 10-, and 15-minute averaged disdrometric measurements.