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Rain microstructure information from 2-D video disdrometer

M. Thurai (1), **M. Schönhuber** (2), V.N. Bringi (1) and W.A. Petersen (3)

(1) Colorado State University, Colorado, USA, (2) Joanneum Research, Graz, Austria, (3) University of Alabama, Huntsville, USA

It has been shown in the recent past that images from 2-D video disdrometer (2DVD) of each individual hydrometeor can be processed to define the precipitation microstructure in terms of size, shape, orientation angle and fall velocity. Here, we report on the analysis of 2DVD data taken during several heavy rainfall events in Huntsville, Alabama. The 2DVD images were processed to derive the rain microstructure parameters for each individual drop. As in a previous study (Thurai et al, J. Atmos. Oc. Tech., 2007, vol. 24, pp. 1019-1032) on the analysis of rain microstructure from 2DVD data in artificial rain, the 'probability' contours were derived from the drop images for various diameter intervals, such as (a) 3-3.25 mm, (b) 4.-4.25 mm and (c) 5-5.25 mm. For case (a) there were several thousands of drops, for case (b) there were 1760 drops and for case (c) there were 247 drops in total. The fitted equations for the mean contours derived from the previous study with artificial rain data were superimposed on the probability contours from the Alabama data in natural rain. Excellent agreement was obtained for all cases. It is worth noting that this is the first time that significant flattening of the base (as predicted by the Beard-Chuang numerical model) has been observed for large drops (i.e. case (c) for 5-5.25 mm) in natural rain.

Also derived are the canting angles from the 2 fast line-scan cameras of the 2DVD for one event. They showed a symmetric distribution with zero degree mean and a standard deviation of around 12-13 degrees. From the individual canting angles, histograms of drop orientation angles were obtained in terms of the local zenith and azimuth angles. The former showed an expected Fisher distribution which is appropriate to describe statistics on a spherical surface whilst the latter indicated that the drops are oriented uniformly over 0 to 360 deg.

Individual drop information was used as input to an enhanced version of the T-matrix method to compute the forward and back scatter amplitudes of each drop at C-band for the same rainfall event. The polarimetric radar variables were then calculated from the individual drop contribution over a finite time period, for example 30 seconds. The calculated radar reflectivity, differential reflectivity, specific differential propagation phase and the co-polar correlation coefficient were compared with simultaneous measurements from a C-band polarimetric radar, located 15 km away. Time series comparisons show very good agreement for all four quantities, the agreement being better than computations using 30 second drop size distribution and bulk assumptions on rain microstructure (such as mean shapes and model-based assumptions for the drop orientation).