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# Scale effects on the variability of the raindrop size distribution

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The raindrop size distribution (DSD) is of utmost important to the study of rainfall processes and microphysics. All important rainfall variables can be calculated as weighted moments of the DSD. Qualitative precipitation estimation (QPE) algorithms and numerical weather prediction (NWP) models both use the DSD in order to calculate quantities such as the rain rate. Often these quantities are calculated at a pixel scale: radar reflectivities, for example, are integrated over a volume, so a DSD for the volume must be calculated or assumed.

We present results of a study in which we have investigated the change of support problem with respect to the DSD. We have attempted to answer the following two questions. First, if a DSD measured at point scale is used to represent an area, how much error does this introduce? Second, how representative are areal DSDs calculated by QPE and NWP algorithms of the microphysical process happening inside the pixel of interest?

We simulated fields of DSDs at two representative spatial resolutions: at the 2.1x2.1 km$^2$ resolution of a typical NWP pixel, and at the 5x5 km$^2$ resolution of a Global Precipitation Mission (GPM) satellite-based weather radar pixel. The simulation technique uses disdrometer network data and geostatistics to simulate the non-parametric DSD at 100x100 m$^2$ resolution, conditioned by the measured DSD values. From these simulations, areal DSD measurements were derived and compared to point measurements of the DSD.

The results show that the assumption that a point represents an area introduces error that increases with areal size and drop size and decreases with integration time. Further, the results show that current areal DSD estimation algorithms are not always representative of sub-grid DSDs. Idealised simulations of areal DSDs produced representative values for rain rate and radar reflectivity, but estimations of drop concentration and characteristic drop size that were often outside the sub-grid value ranges.