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Comparison of different fittings of drop spectra for rainfall retrievals

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The characterization of the raindrop size distribution (DSD) addresses many needs regarding the remote sensing of precipitation, which is becoming central to the estimation and management of water resources. Remote sensing by weather radars involves transmitting a pulse of electromagnetic radiation and measuring the radiation backscattered by raindrops; the amount of backscattered radiation measured by radar receiver depends on the number of hydrometeors, their size, and their absorption qualities such as density and shape. For quantitative precipitation estimation from remote sensing measurements, natural DSDs are customary represented through the three parameters gamma distribution. However, over years several other models have been reported in the literature, and recently efforts have been made to understand the feasibility of the gamma distribution in modelling the observed drop size spectra.

The main scope of this work is to deeper investigate the shape of the natural DSDs. In particular, four different continuous probability distributions (namely Pareto, lognormal, Weibull and gamma) have been fitted to the 1-min measured DSD and then the relative quality of each distribution (relative ranking) has been defined. Furthermore, the straightforward fitting method adopted in this study allows us to evaluate the behavior of the tail of the distribution that can have a relevant impact on the computation of high order moments of the DSD used in the remote sensing of rainfall. Although the latter can certainly be an issue, it has never been addressed systematically in the literature. In this study used are the 1-min spectra collected by two-dimensional video disdrometers (2DVD) during four pre-launch field campaigns of the NASA Global Precipitation Measurement (GPM) mission located in (i) Rome (HyMeX SOP 1), (ii) Central Oklahoma (MC3E), (iii) Eastern Iowa (IFloodS), and (iv) southern Appalachian Mountains (IPHEX). The results obtained from the analysis of the four datasets were consistent with each other. Generally, the lighter-tailed distributions are in better agreement with the observed size spectra than the heavier-tailed distributions. However, a certain departures of empirical drop spectra from light-tailed distributions has been detected, especially when fitting only the tail of the distributions. These departures may imply a dramatic increase of uncertainty in the statistical estimation of high-order DSD moments, thus making the retrieval process unreliable.