How adequate is gamma model for representing raindrop size distributions?

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The raindrop size distribution (DSD) is of fundamental importance for understanding the microphysics of rainfall and retrieving reliable precipitation estimates using radars. Among the various distributions that have been proposed, the gamma model is the most common choice in the radar community; even though previous studies have shown that it is not general enough to represent the natural DSD variability in all meteorological situations. In this work, a comprehensive evaluation of the adequacy of the gamma model for representing raindrop size distribution is carried out, using DSD observations from an optical disdrometer. In order to check the adequacy of the model a combination of Kolmogorov-Smirnov goodness of fit test and Kullback-Leibler divergence is presented. The results show that most DSDs are not strictly distributed according to a gamma, while at the same time they are not far away from it either. For a deeper and more complete understanding the effect of the sampling resolution needs to be taken into account. A new adaptive DSD sampling technique which is capable of determining the highest possible temporal sampling resolution at which the gamma model provides an adequate fit is proposed. According to our iterative procedure, the gamma model proves to be an adequate choice for representing raindrop size distribution for the majority (85.81%) of the DSD spectra at resolutions up to 300 seconds. At the same time, it also reveals a considerable number of DSD spectra (5.55%) which do not follow gamma at any resolution (up to 1800 seconds). These are attributed to transitional periods during which the DSD is not stationary and therefore cannot be modeled using a gamma. Our algorithm is capable of automatically identifying and flagging these periods, providing new valuable quality control mechanisms for DSD retrievals in radar.

Keywords: Raindrop size distribution, Optical disdrometer, Gamma model adequacy, Kolmogorov-Smirnov goodness of fit test, Kullback-Leibler divergence, Adaptive DSD sampling technique