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A fast and reliable procedure for fitting gamma models on observed raindrop size distributions

M. Schleiss and A. Berne
EPFL-LTE, Lausanne, Switzerland

The drop size distribution (DSD) is a fundamental information about rainfall. It describes the number of drops per unit volume and per unit size interval of equivolumetric spherical drop diameter. Previous work showed that the DSD can be adequately described by a three parameter Gamma model. These parameters must be fitted on DSD spectra measured by disdrometers using reliable and fast fitting procedures. The method of moments and the maximum likelihood are the most used procedures. They perform very well on large samples and have been extensively studied in the literature. However, there are some cases where traditional fitting methods cannot be applied due to physical limitations in the sampling procedure. For example, disdrometers may not be able to measure very small or very large drops, causing depletion in one or both ends of the distribution. Furthermore, high sampling frequencies (less than 1 min) often produce small samples for which more robust estimates should be considered.

In this work, two new and more robust estimates are proposed: the first is a modified version of the maximum likelihood that corrects for drop losses at one or both ends of the distribution. The second takes into account the classification of the drops into different diameter classes. Although they are time consuming, these estimates are significantly better for small samples than weighted moments or maximum likelihood. Since fitting each observed DSD spectrum with this method would take a significant amount of time, the proposed procedure identifies the optimal fitting method for each observation. The choice of the method depends on a prescribed tolerance level on the error. Confidence regions for different sampling resolutions are computed using numerical simulations of a Parsivel disdrometer, providing the guidelines for the optimal application of each fitting method.