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Using mixtures of distributions for fitting in-situ cloud drop size distribution and interpretation of cloud radar-lidar data

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The interpretation of radar and/or lidar data of cloud measurements requires the parametrization of the drop size distributions (DSD). For this purpose, usually some unimodal statistical approximation like exponential, gamma or log-normal distributions is used. The standard methods for parameter estimation of such model distributions take into account only the first two or three statistical moments of the in-situ distribution. At the same time cloud radar reflectivity is proportional to the 6th moment of the drop size distribution. The analysis of in-situ cloud drop size distributions and their fitting using the above mentioned models show considerable difference between calculated reflectivities. For CLARE'98 data, for example, equality between such reflectivities occurred only for values up to -20dBZ. For reflectivity values above this threshold, the gamma and log-normal distributions underestimate the reflectivity by values up to 40 dB. This can be explained by the presence of a secondary maximum in the drop size distribution that describes the drizzle particles. For a mathematical description of this effect there are two possible methods: approximation of in-situ DSD using multimodal statistical distributions (like Pearson or Johnson multimodal distributions) or using mixtures of distributions. In this work the second method, based on the model: "in-situ DSD = gamma/log-normal DSD + remainder DSD", is used. For the parameter estimation of the gamma/log-normal distributions, statistical procedures based on relations between moments of different order are used. Then, these parameters are used for the calculation of the "remainder" DSD and estimations of its statistical parameters. Also we have compared the accuracy of different approximations for the "remainder" DSD and the correlation between statistical parameters of the components in the mixture.

The results of this work can be used for increasing the accuracy of the remote sensing retrieval algorithms of micro-physical cloud parameters.