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Variability of raindrop size distributions and radar reflectivity-rain rate relations in extreme Mediterranean precipitation

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Relationships between radar reflectivity and rainfall intensity can be derived by correlating weather radar and raingauge measurements. However, one should be cautious in applying such methods because of differences in the sampling characteristics of both instruments. A more appropriate manner to establish such relations is to employ raindrop size distributions sampled by a disdrometer. In literature different methods have been applied using such disdrometer data, all leading to different results. In this paper, closer attention is given to four of such techniques. The main assumption is that there exist a power-law relationship between the radar reflectivity and rainfall intensity. Two of them are based on statistical least-squares regression methods. The other two methods apply a normalization theory for the raindrop size distribution (DSD), which assumes that all DSD variability can be related to one reference variable. Here it is assumed that the normalized DSD either follows an exponential or a gamma distribution. A new method is presented to estimate the parameters of this normalized distribution, which is easy to calculate and has a shorter overall calculation time with respect to previously reported methods. Although the four different methods obtain different power-law relationships, especially for convective storm systems, they all produce appropriate results. As such, no single optimal relationship is valid but there exists a larger optimal region in the space of the Z-R relationship parameters. Those parameters obtained by the least-squares methods contain a larger amount of uncertainty. For stratiform type of events both micro-physical techniques perform less good as a result of intra-event rainfall variability.