Pseudo-radar algorithms with two extremely wet months of disdrometer data in the Paris area

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Abstract:
Disdrometer data collected during the two extremely wet months of May and June 2016 at the Ecole des Ponts ParisTech are used to get insights on radar algorithms. The rain rate and pseudo-radar quantities (horizontal and vertical reflectivity, specific differential phase shift) are all estimated over several durations with the help of drop size distributions DSD) collected at 30 s time steps. The pseudo-radar quantities are defined with simplifying hypotheses, in particular on the DSD homogeneity. First it appears that the parameters of the standard radar relations $Z_h - R$, $R - K_{dp}$ and $R - Z_h - Z_{dr}$ for these pseudo-radar quantities exhibit strong variability between events and even within an event. Second an innovative methodology that relies on checking the ability of a given algorithm to reproduce the good scale invariant multifractal behaviour (on scales 30 s – few h) observed on rainfall time series is implemented. In this framework, the classical hybrid model ($Z_h - R$ for low rain rates and $R - K_{dp}$ for great ones) performs best, as well as the local estimates of the radar relations' parameters. However, we emphasise that due to the hypotheses on which they rely these observations cannot be straightforwardly extended to real radar quantities.

Key words: rainfall, disdrometer, radar algorithm, multifractal

1) Introduction

Disdrometers are rainfall point measurement devices that give access not only to rain rates but also to information about the size and velocity of drops falling through the sampling section. They are commonly implemented for research purposes and their operational use is spreading. Weather radars are basically the only devices providing volumetric rainfall data almost instantaneously, but in a less direct measurement. Indeed a radar transmits a wave and actually measures the power of the wave backscattered by the hydrometeors of the atmosphere, and not the rain rate which is the quantity hydrometeorologists are interested in. With the strong simplifying hypothesis that the drop size distribution (DSD) is homogeneous in the radar scanned volume and corresponds to the one measured with the help of disdrometer, it is possible to define pseudo radar quantities based on the pointwise disdrometer measurement. This furthermore assumes incoherent scattering, i.e. there is no clustering of the drops inside radar pulse volumes, whose radial scale is usually in the range of 100 m to 1 km. In other words that drop centres are homogenously distributed. It has been shown that this hypothesis may lead to strong statistical biases (Lovejoy et al, 1996, Schertzer et al., 2012). These hypotheses enable to partially inverse the retrieval algorithms from radar backscattering to rain rate. This approach was implemented by numerous authors (Gires et al. 2016; Jaffrain and Berne 2012b; Leinonen et al. 2012; Ryzhkov et al. 2005; Verrier et al. 2013,). Others relied on synthetic DSD functions and ran various simulations using