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A stochastic simulator of range profiles of raindrop size distributions

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Climatological, meteorological and hydrological studies require accurate precipitation estimates. Because of its spatial and temporal resolution as well as the extended coverage, weather radar is very suitable for such purposes. However, the radar measurement is indirect and its interpretation in terms of quantitative estimates is based on the raindrop size distribution (DSD). Because rainfall is strongly variable at all scales, the DSD is considered as a random function, that is its parameters are random variables. To investigate the uncertainty in radar rainfall estimation due to the spatial variability of the DSD, a stochastic model has been developed to simulate range profiles of DSDs and consequently profiles of various DSD derived variables (e.g. rainfall intensity R or radar reflectivity Z).

A first application concerns the attenuation affecting the radar signal in rain, an important source of error for weather radars operating at C- or X-band frequencies. Attenuation correction techniques are based on power-law relations between the integrated radar variables Z, R and k (the specific attenuation coefficient), which are assumed to be deterministic. The simulator, via a Monte Carlo technique, has been used to analyze the influence of the stochastic nature of the spatial variability of the DSD on the robustness and the accuracy of attenuation correction algorithms. In particular, the uncertainty due to the use of deterministic power-law relations, which are not fully consistent with the stochastic nature of the raindrop size distribution, has been quantified.