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Stochastic simulation experiment to assess radar rainfall retrieval uncertainties associated with attenuation and its correction

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Abstract. As rainfall constitutes the main source of water for the terrestrial hydrological processes, accurate and reliable measurement and prediction of its spatial and temporal distribution over a wide range of scales is an important goal for hydrology. We investigate the potential of ground-based weather radar to provide such measurements through a theoretical analysis of some of the associated observation uncertainties. A stochastic model of range profiles of raindrop size distributions is employed in a Monte Carlo simulation experiment to investigate the rainfall retrieval uncertainties associated with weather radars operating at X-, C-, and S-band. We focus in particular on the errors and uncertainties associated with rain-induced signal attenuation and its correction for incoherent, non-polarimetric, single-frequency, operational weather radars. The performance of two attenuation correction schemes, the (forward) Hitschfeld-Bordan algorithm and the (backward) Marzoug-Amayenc algorithm, is analyzed for both moderate (assuming a 50 km path length) and intense Mediterranean rainfall (for a 30 km path). A comparison shows that the backward correction algorithm is more stable and accurate than the forward algorithm (with a bias in the order of a few percent for the former, compared to tens of percent for the latter), provided reliable estimates of the total path-integrated attenuation are available. Moreover, the bias and root mean square error associated with each algorithm are quantified as a function of path-averaged rain rate and distance from the radar in order to provide a plausible order of magnitude for the uncertainty in radar-retrieved rain rates for hydrological applications.

Final Revised Paper (PDF, 625 KB) | Discussion Paper (HESSD)

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