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Dual polarization radar rainfall estimation using the mean linear raindrop shape model

E. Gorgucci, L. Baldini, and V. Romaniello
Istituto di Scienze dell'Atmosfera e del Clima, CNR, Roma, Italy

Information about the shape of raindrops is critical for estimating rainfall rate with dual polarization radar. As described in the literature, the relation describing drop oblateness as a function of its equivolumetric diameter is nonlinear. In fact, there is still no consensus regarding the most appropriate equation to use to describe the shape-size relation. However, while these non-linear equations are important for studying raindrop shape, it is not clear whether they are needed to estimate an integral quantity such as rainfall rate.

A rain algorithm using Z_h, and Z_{dr} and an equivalent linear shape-size model with variable slope (β) that can be determined from an equation relating it to Z_h, Z_{dr}, and K_{dp} measurements is analyzed.

To test its performance realistic rain and radar measurement profiles reconstructed from real radar observations were used. Starting from radar profiles collected by the NCAR S-POL dual polarization radar, two different sets of radar profiles were obtained for S-, C-, and X-band assuming the raindrop shape-size relations of Pruppacher and Beard (1970) and Beard and Chuang (1986). The first model is linear and the second is a non-linear one, expressed by a fourth order polynomial.

The performance of the proposed rain algorithms based on β is compared with that of algorithms derived assuming two drop shape relations expressed by a fourth order polynomial recently proposed. The simulation procedure allows the study of the influence of DSD variability as well as the effect of measurement errors on rain rate estimations.

In general, it is possible to conclude that the rain algorithm based on an equivalent linear shape-size model performs better than the THBRS and BZV algorithms, since in worst cases, the performance of the β algorithm is not too far from the performance of the standard rain algorithm obtained assuming the two non-linear shape size relations. In summary, although the literature indicates that the relation between oblateness and diameter of raindrops can be appropriately described by a nonlinear relation, the exact knowledge of this relation is not necessary in the case of estimation of an integral quantity such as the rainfall rate. Is fact, using a simple equivalent linear shape-size model can be convenient to obtain reliable estimations.