13.29 DUAL-POLARIZATION RADAR RAINFALL ESTIMATION USING A DATABASE OF SIMULATED RAINDROP SIZE DISTRIBUTIONS

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A new radar rainfall retrieval algorithm (Rainfall Estimation using Simulated Raindrop Size Distributions RESID) for dual-polarization radars was developed. There are two types of algorithms typically used by the dual-polarization radars to perform liquid rainfall estimations. The first type of algorithms uses the rain rate estimators as functions of the dual-polarization radar observables (i.e. horizontal reflectivity Z_h, differential reflectivity Z_{dr}, and specific differential phase K_{dp}). The second type of algorithms uses the theoretical rain rate computation equation and the retrieved raindrop size distributions (DSDs). Both types of algorithms typically include parameterizations developed using regression analyses, and as such, they may suffer from the regression uncertainties in the parameterizations. The RESID takes advantage of both types of algorithms and does not utilize a regression analysis. Therefore, the RESID is not subject to regression uncertainties. Moreover, by using a set of carefully selected cost functions, the RESID aims to reduce the effect of the radar measurement noise.

In developing the RESID algorithm, a large database of gamma DSDs was first constructed by varying the values of the normalized gamma DSD parameters (i.e. D0 - median volume diameter, Nw - normalized intercept parameter, and - shape parameter of the gamma distribution) within certain ranges. The corresponding dual-polarization radar observables were simulated using the T-matrix method. Then, the rain rate associated with each of the DSDs was computed using the theoretical rain rate computation equation. A set of cost functions was developed using both the simulated and the measured dual-polarization radar observables to select the representative DSDs from the simulated DSD database. For given values of the measured triplet of radar observables (i.e. Z_h, Z_{dr} and K_{dp}), a cost function was selected following an optimization scheme that was intended for maximizing the performance of the algorithm. Finally, the rain rate for the given triplet of radar observables was estimated by averaging the rain rates calculated from the selected representative DSDs.

The performance of the RESID algorithm was evaluated by comparisons with a benchmark algorithm, WSR-88D QPE (Weather Surveillance Radar 1988 Doppler Quantitative Precipitation Estimation), in liquid rainfall estimations. In these comparisons, the radar and rain gauge measurements from the Mid-latitude Continental Convective Clouds Experiment (MC3E) were utilized. The RESID was found to outperform the benchmark algorithm in terms of estimating the hourly rainfall accumulations. The favourable performance of RESID was attributed to the lack of regression analysis in algorithm development and the optimization scheme in cost function selection. This material is based upon work supported by the National Sci-

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