Measurements of Circular Depolarization Ratio with the Radar with Simultaneous Transmission / Reception

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Circular depolarization ratio (CDR) is a polarimetric variable which was historically among the first measured by dual-polarization weather radars transmitting and receiving waves with circular polarization. One of its advantages is that it is primarily determined by the shape and phase composition of atmospheric particles and weakly depends on particle orientation as opposed to linear depolarization ratio (LDR) which is also considerably lower than CDR and difficult to measure for low signal-to-noise ratio. It was shown in the series of studies by S. Matrosov that the CDR dependency on antenna elevation angle can be used to distinguish between planar and columnar types of crystals in the ice parts of clouds.

One of the drawbacks of the "classical" CDR is that it is heavily biased by propagation effects and differential phase in particular which precluded its operational utilization so far. This was one of the reasons why the choice of operational polarimetric radar was made in favor of the radar with simultaneous transmission / reception which measures differential reflectivity ZDR, differential phase ϕDP, cross-correlation coefficient ρhv but not CDR.

In this study, we suggest the method which allows measuring CDR by the radar with simultaneous transmission / reception along with traditionally measured ZDR, ϕDP, andρhv without slowing down or compromising the standard mode of operation. Moreover, the method automatically eliminates the impact of propagation effects on CDR at the signal processor level. This, however, requires control of system differential phase on transmission ϕDP(tr) using high-power phase shifter to ensure that the polarization state of transmitted wave is close to circular.

Polarimetric C-band radar with such configuration was built by the Enterprise Electronics Corporation and numerous examples of the data collected in Alabama will be shown in the presentation. We will also show some results of CDR fields directly measured and retrieved from other polarimetric variables at S band and discuss the use of CDR for microphysical retrievals.