Antenna pattern requirements for 3-Pol weather radar measurements.

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The polarimetric measurement of weather targets is very demanding on terms of antenna parameters. In particular, it has been found that in order to have valid measurements of the reflectivity, Z, the differential reflectivity, ZDR, and the copolar correlation coefficient, ρhv their respective biases should be less than 1 dB, 0.1 dB and 0.005. Achieving these biases requires well matched antenna patterns of the two antennas used for transmission/reception and very low cross-polar radiation. It has been demonstrated that if the simultaneous transmission simultaneous reception (STSR) algorithm is used the cross-polar radiation required is significantly lower than if the alternate transmission simultaneous reception (ATSR) algorithm is used [Y. Wang and V. Chandrasekar, "Polarization isolation requirements for linear dual-polarization weather radar in simultaneous transmission mode of operation," IEEE Trans. on Geosc. and Rem. Sens., vol. 44, pp. 2019–2028, 2006.]. To achieve this very low cross-polar radiation pattern requires a very careful design of the reflector antennas used in the mechanically scanned weather radars and it is challenging the development of phased array radars for weather surveillance that need the same low cross-polar radiation for all scanning directions [A draft report on Issues and challenges for polarimetric measurement of weather with an agile-beam phased array radar, D. S. Zrnic, V. M. Melnikov, and R. J. Doviak, www.nssl.noaa.org].

A fully polarimetric and Doppler measurement scheme (3-PolD) based on alternate transmission of three different polarizations while receiving with two differently polarized antennas has been proposed. This measurement scheme provides the minimum variance unbiased linear estimates of the polarimetric covariance matrix elements from the available measurements. Its results compare well with those obtained with the STSR or ATSR method while not requiring any assumption on the Doppler or polarimetric characteristics of the target. Initial results have shown that antenna requirements for the cross-polar pattern can be relaxed with this measurement scheme. Besides, the flexibility in choosing the three different polarizations to transmit helps to meet the demanding cross-polar level requirements for all scanning directions. Detailed derivations and results will be presented.