Full wave EM calculation of polarimetric variables for the atmospheric scatterers with nonspheroidal shape

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A model of spheroid is commonly utilized to simulate polarimetric characteristics of natural scatterers in atmosphere such as hydrometeors or biota (birds, insects, bats, etc.) The estimates of polarimetric radar variables are usually obtained using either closed form Rayleigh solutions, if size of particle is much smaller than radar wavelength or T-matrix codes otherwise.

Many atmospheric scatterers have the shape which is different from spheroidal (e.g. large hail with irregular rough surface, ice crystals and snowflakes, or biological objects). The existing polarimetric models usually fail to quantitatively reproduce significant reduction of the cross-correlation coefficient ρ_{hv} in hail or wet snow in the melting layer which is likely attributed to a more complicated shape of actual hailstones or wet snowflakes. The observed azimuthal patterns of differential reflectivity Z_{DR} and backscattered differential phase δ in the echoes caused by biological scatterers are most often inconsistent with results of scattering by spheroids. This dictates the need to use scatterer models with more complex or arbitrary shapes that have potential to discriminate between various biological and nonspheroidal scatterers. Our motivation to obtain scattering characteristics of these objects is reinforced by the fact that upgrade of the national network (WSR-88D) of radars is nearing completion.

Herein suggested is a full wave EM approach for computing scattering from giant hail models as well as models of biological scatterers.

Full wave EM modeling has been evolving since ninety sixties and generally refers to different approaches for solving the same class of problems. In this study the MoM (Method of Moments) software (WIPL-D) is used to compute scattering from resonant objects observed by polarimetric weather surveillance radars. The MoM has demonstrated great capability in modeling scattering for complex geometries such as airplanes but this is the first application to weather radar. The WIPL-D requires topology of the scatterer as well as it EM properties. Here we suggest specific topologies, orientations, and EM properties for the sampled scatterers. Specifically we suggest a model of giant hail resembling observations to replicate ρ_{hv} drop observed by weather radars. Furthermore scattering coefficient of highly eccentric prolates and oblates are accuraly obtained with WIPL-D. Computations from an ensemble of scatterers are made in an attempt to replicate the observed polarimetric variables. The aforementioned methodology has also been applied to some biological scatterers.