Geophysical Research Abstracts,
Vol. 11, EGU2009-13667, 2009
EGU General Assembly 2009

Polarimetric radar observation of ice crystals and aggregates: Backscattering modeling of signatures from C to Ka band

G. Botta (1), M. Montopoli (2), F.S. Marzano (1,2)

(1) DIE – CETEMPS; Sapienza University of Rome, Italy, (2) DIEI – CETEMPS, University of L'Aquila, Italy

Hydrometeor classification using polarimetric Doppler weather radar is based on the characteristic polarimetric signature for each hydrometeor class. This signature can be obtained by either experimental campaigns or by proper electromagnetic modelling. Both approaches have advantages and drawbacks: the experimental approach is not easy to conduct as it requires co-located measurements of a weather radar with in-situ sampler (usually installed aboard an aircraft); moreover, it is generally strictly related to the measurement configuration (e.g., frequency, range) it is performed. Of course, experimental campaigns are needed for definitive validation, but the modelling approach exhibits a high flexibility in terms of system and meteorological parameters very well suited for retrieval algorithm design. On the other hand, a model approach is heavily dependent on the model capability to represent hydrometeor volumes in a realistic way.

Within the electromagnetic scattering modelling of hydrometeor radar response, a well known technique to simulate the radar backscattering from an ensemble of particle is based on the T-matrix algorithm (Kim, 2006). The T-matrix model is based on the equivalence principle and can ensure numerical convergence for a small set of canonical shapes such as ellipsoids. These shapes are useful to represent raindrops and vertically-oriented small crystals, but are largely unrealistic when dealing with ice aggregates and crystals.

In this work we use a different approach to the scattering modelling that fits well for classes like ice crystals and aggregates of different shapes and sizes: the discrete dipole approximation (DDA). The DDA model lets us simulate almost any kind of particle under the hypothesis it can be approximated as a three dimensional array of dipoles that generate the scattering field (the wavelength should be large compared to the distance between dipoles). The DDA code used is DDSCAT, developed by Draine and Flatau (2004), which computes the scattering by a single randomly oriented particle. With this approach a variety of hydrometeor shapes have been simulated: cylindrical ice crystals, aggregates of ice cylinders, snow crystals, mixed-phase particles, etc. From DDA it has been possible to obtain the polarimetric signature for ground-based radars at C and X band for these hydrometeor classes after solving some heavy computational issues. An equivalent spheroid model has been also developed for the ice hydrometeor classes in order to use a T-matrix code, faster than DDA, to simulate ice crystals-equivalent spheroids (Weinman and Kim, 2007). Numerical results will be discussed analyzing the sensitivity of the DDA model to the particle shape, wavelength, size distribution and orientation. The accuracy of T-matrix approximation of the ensemble particle polarimetric signature will be also evaluated within the context of hydrometeor classification schemes based on either fuzzy-logic or Bayesian techniques.