A Radar-Cross-Section Database Driven Radar Time-Series Simulator

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Numerical simulations allow us to study various aspects of a complex process because they provide us a fully controllable environment. In an effort to study various scattering characteristics of tornadic debris, hoping to better understand the radar signatures of different debris types, a numerical polarimetric radar time-series simulator that uses a radar cross section (RCS) database and physical modeled atmospheric wind field has been developed. The RCS database is developed using anechoic chamber measurements of actual debris and other representative objects. The atmospheric wind fields has been developed from previous effort in atmospheric modeling, which is based on a Large-Eddy Simulation (LES) model of tornado vortices that provides a wide range of vortex flows (e.g., vortex breakdowns or suction vortices). Based on the Monte Carlo integration method, a finite enclosing volume with millions of scatter bodies is populated. The scatter bodies change positions and orientations based on trajectory calculations of particles in the LES wind field. At each time step, based on the position and RCS values of the scattering bodies, the composite radar echo is derived by summing contributions from all scattering bodies, which are weighted based on user-supplied range and antenna patterns. The radar simulator is implemented in a massively parallelized architecture using OpenCL (Open Computing Language) since the evolution of the scattering bodies is inherently parallel. A computational improvement of over 80-fold was realized compared to a conventional multi-processor CPU architecture. Some preliminary results of simulations and comparisons to actual radar data will be presented.