Cloud Ice Crystal Classification Using a 95 GHz Polarimetric Radar

K. Aydin and J. Singh
Penn State University
Department of Electrical Engineering
University Park, PA 16802
Phone: (814)865-2355
Fax: (814)863-8457
E-mail: k-aydin@psu.edu

The identification of various ice crystal types within a cloud, as well as the estimation of their ice water content are important goals with applications to cloud microphysical studies and to understanding the effect of clouds on the Earth's radiation budget. Millimeter wave polarimetric radars have the potential for accomplishing both of these goals. There are several millimeter wave radars operating at 95 GHz for the remote sensing of ice clouds from ground-based and airborne platforms. This paper brings together observations from experiments and modeling studies, and focuses on 95 GHz polarimetric radar signatures of ice crystals. Results from simulations and experimental data for the reflectivity factor Z_h, differential reflectivity Z_{DR}, and linear depolarization ratio LDR are combined to generate different ranges of values for each observable corresponding to different crystal categories. A fuzzy classification algorithm (including the air temperature to separate columnar crystals from the small aggregates) is developed to classify ice crystals as follows: (i) columnar crystals, (ii) planar crystals, (iii) planar crystals and small aggregates or rimed planar crystals, (iv) planar crystals and large aggregates or densely rimed planar crystals or graupel like snow or small lumpy graupel, and (v) graupel. Measurements with the University of Wyoming's airborne 95 GHz radar system and particle probes (2D-C cloud and 2D-P precipitation probe) obtained in 1997 are used to demonstrate the technique. During these experiments the aircraft penetrated through the clouds and the onboard radar and particle probes collected data. Ice crystals throughout the cloud were classified according to this technique and the closest range gates compared very well with the 2D probe images of the crystals.

1. Commission F : F5 Remote sensing of oceans and atmosphere
2. A new technique for ice crystal classification in clouds using a 95-GHz polarimetric radar is presented.
3. There are a number of papers focusing on 95 GHz polarimetric radars for cloud remote sensing. This paper brings together modeling and experimental results for using such radars to classify ice crystals in clouds.