Classification of meteorological and non-meteorological targets with new statistical methods applying polarimetric moments and their texture

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Probabilistic classification of the type of scattering medium is a powerful tool for the purposes of quality control (QC) of weather and non-weather radar applications. Fuzzy single bin membership functions are not necessarily sufficient for a detailed classification of radar targets even with the polarimetric moments (dBZ, V, W, SQI, ZDR, LDR, RHO, KDP and PHIDP). In this study 30 classes, e.g., nocturnal songbird migration, anomalous sea clutter and melting convective snow, were defined. Manual selection of about 1000 training areas of single-class examples from 3 polarimetric C-band radars was performed utilizing external weather data. The used classification applies only bins with available dBZ data after Doppler filtering.

Multidimensional probability density functions (PDF) of the measured moments were determined for each class in the training data set. In addition to single bin values PDFs of textural features, applying six generic filters that quantify properties of the local pixel neighborhood like graininess or presence of borders, were determined. The resulting high-dimensional (up to 58) PDF models were studied to identify subsets of dimensions with optimal resolving power for each class. The analysis of PDFs was greatly facilitated by Orthogonal Polynomial Transfer (OPT), a method specifically developed for this task and featuring several advantages over alternative approaches like PCA modeling or neural networks, including verifiability, user-definable modeling accuracy and accommodation of changes in the training set without a complete retraining phase. The OPT-based PDFs also provide a natural metric for non-local class member functions. By studying the resulting confusion matrices it could be shown that some of the original classes were not well separable from each other within the given framework. The classification value of polarization diversity and Doppler capability upon a conventional radar was also quantified. Validation of the method was performed applying independent data samples and an independent classifier.