Classification of non-meteorological targets with conventional and polarimetric measurements

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Classification of hydrometeor types based on measured conventional quantities (dBZ, V, W, SQI) and polarimetric quantities (ZDR, LDR, ρHV, KDP or ΦDP) at each radar bin has been found to give useful information for the purposes of quantitative precipitation estimation (QPE). Even more significant is the ability of radars equipped with polarization diversity to diagnose and quantify specific precipitation types and phenomena (e.g. hail, melting snow, attenuation) and non-meteorological targets (e.g. birds, insects, sea clutter, external emitters). The type of scattering medium should be diagnosed by applying a probabilistic scheme for the purpose of quality monitoring and product thresholding. A useful application of radars can also be the production of specific diagnostic of e.g. birds and insects for the purposes of flight safety and preventive actions against immigration of pest insects. Thus detailed classification of non-meteorological targets is important but so far not much work has been devoted to it. It also appears that fuzzy single bin member functions are not necessarily sufficient for a detailed classification of radar targets even with the set of polarimetric quantities.

We have extended the existing polarimetric fuzzy classification schemes in two aspects: (1) The number of target classes has been increased to several dozens. Examples of such fine-tuned classes are nocturnal songbird migration, arctic duck migration, anomalous sea clutter, daytime insect migration and melting convective snow. (2) In addition to single bin membership function properties a number of filters that quantify various textural properties of the local pixel neighborhood were designed and applied to a manually selected and classified set of radar observations. The resulting high-dimensional data set was studied with modified Principal Component Analysis (PCA) to identify optimal resolving power for each class (Mäkinen et al. 2010). The selection of training areas from PPI and RHI images of a polarimetric C band radar has been performed by very experienced radar researchers and by applying external weather data. The skill in classification is very good provided that the classes are invariant to the expert used in classification, the radar systems used are stable and produce similarly distributed statistics of the measured quantities and the classified phenomena are statistically similar at all radar sites.

References