1.14 FINGERPRINTS OF PRECIPITATION PROCESSES REVEALED BY UNSUPERVISED CLASSIFICATION OF PROFILES OF POLARIMETRIC RADAR VARIABLES

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The broad spectrum of snow particle types with different microphysical properties pose a challenge to radar retrievals of e.g. precipitation rate. Due to the typical sparsity of radar networks, often a large fraction of observations of precipitation particles originate from above the melting layer even with low elevation angles. The ability to automatically deduce snow particle types or the growth processes that generate them would have a great potential in improving such retrievals. In this study we develop an unsupervised classification method of dual-polarization radar profiles to facilitate the detection of growth processes along a vertical column.

The size, shape and degree of riming of a growing snow particle depend mainly on ambient temperature, supersaturation and presence of liquid water. As these ambient conditions are not constant through a vertical column, the significance of different growth processes vary along the paths of growing snow particles. Although, with remote sensing techniques we cannot directly measure which growth processes are taking place in a vertical column, dual polarization radar measurements of vertical columns can be viewed as containing fingerprints of these processes. Currently there are studies of individual features in the profiles, e.g. enhanced values of specific differential phase (K_{dp}) or differential reflectivity (Z_{dr}), but no attempts have been made so far to create objective documentation of such profiles.

In the present study, an automated classification method for vertical profiles of dual polarization radar observations is developed using profiles derived from RHI scans in southern Finland. The proposed method is based on k-means clustering of dimensionally reduced combination of vertical profiles of equivalent reflectivity factor (Z_e), Z_{dr} and K_{dp}. Since snow growth processes are of the main interest, separate approaches are taken for the profile classification in rain and snow. In rain, only the parts of the profiles that are above melting layer are used as input to the classification process. In case of snowfall, the whole profiles are used and ground temperature is included as an extra classification parameter.

We look at vertical profiles over Hyytiälä forestry station in Juupajoki, Finland using Ikaalinen weather radar which is located 64 km west from the station. Measurements have been performed during the Biogenic Aerosols Effects on Clouds and Climate field campaign in early 2014, and the winter of 2014/2015. Preliminary results show that the method can be used for producing profile classification schemes with distinct, physically meaningful classes many of which represent characteristic precipitation properties such as liquid water equivalent (LWE) precipitation rate, prefactor of Z_e-snowrate power-law relation and degree of riming. In this investigation we link the classification results and class characteristics to precipitation properties and show how this can be used for identifying snow growth processes.