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Atmospheric Measurement Techniques Discussions

Interactive comment on "Unraveling hydrometeor mixtures in polarimetric radar measurements" *by* Nikola Besic et al.

Anonymous Referee #1

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Title: Unraveling hydrometeor mixtures in polarimetric radar measurements

GENERAL COMMENT

This paper presents a statistically-based approach to reveal different hydrometeor types present within the same radar resolution volume (de-mixing). While general hydrometeor classification is devoted to the identification of the dominant particle type, the aim of this work is to use statistical techniques to further exploit the information provided by dual-polarization weather radar observations. The topic is of substantial interest for the radar community and the manuscript presents original contributions, building up on previous work by the same authors. My main concern is that the proposed method is heavily relying on statistics, without an in-depth consideration of the physics behind hydrometeor classification. I consider that some discussion about the

key physical factors should be introduced, in order to allow the reader to better understand and evaluate the relevance of the specific statistical techniques adopted in this context.

The manuscript in general well written, although the reading is sometimes made difficult, due to an exposition in my opinion unnecessarily complicated. I do not understand in particular the need for the SAR discussion (specifically, around eq. 4), since the proposed method is in the end substantially different (it does not consider the scattering matrix). This appears an unnecessary complication in the illustration of the method. The analogy with SAR may just be mentioned in the introduction. I consider that suppressing this discussion would be beneficial for the clarity of the exposition.

Literature: reference to other unsupervised or semi-supervised classification methods for weather radar could be included (e.g. Bechini and Chandrasekar, 2015; Weng et al., 2016), in addition to the authors previous paper, to provide a more general overview of the main topic. For a more physically-based de-mixing approach I also suggest mentioning the paper by Keat & Westbrook (2017), showing a physical de-mixing technique for the specific case of ice aggregates and pristine ice crystals.

The figure quality is good in general, with the exception of figure 8, which I recommend to split in two separate figures. The labels are way too small (especially for panel b1).

In the first part of the paper (bin-based de-mixing) a synthetic dataset is generated, "created by linearly mixing different pairs of hydrometeor classes in equal proportions". It is not clear how the polarimetric parameters are mixed, i.e. linearly mixing the polarimetric parameters is not the same as mixing in equal proportions hydrometeors, due to different scattering behaviors and varying sensitivity of the radar parameters to concentration, shape, density, orientation, etc. Please explain better. This is an example where the reader may be missing an adequate discussion about physical factors linking scattering, radar observations and classification.

For the second part of the paper (Section 4, the neighborhood-based analysis) I found

that the theoretical basis is not sufficiently clear. The two concepts of incoherency in backscattering (what about forward scattering, i.e. Kdp?) and correlation among radar moments are mixed without a clear definition and explanation of the relative background. The purpose of the method seems to use PCA and ICA to remove the residual correlation between radar moments, allowing to detect potential incoherency. Although it is well known that the co-polar correlation coefficient provides an indication about mixtures within the radar resolution volume, what should we expect about correlation between different radar moments? How do you justify the assumed relation with incoherency? I recommend to critically revise this part, providing more sounding arguments to support the presented approach. Alternatively, I suggest to consider dropping this part and focus on the first bin-based classification and de-mixing. In fact, this part alone could be a nice paper on its own.

MINOR COMMENTS / CORRECTIONS

- P2, L30: “hydrometeorly” sounds awkward

- P3, L26: Normalization of radar variables. What is the impact of the arbitrary choice of min-max values for the scaling? The radar parameters may span very different dynamic ranges in different events. Could this result in an event-dependent classification performance?

- P11, L21: “fourth element vector” -> “four element vector”

- P5, L9: define “POLSAR”, later spelled as “PolSAR” (P6, L13)

- P10, L7: maybe “comparing” is more appropriate here, instead of “confronting”

- P14, L3: “The following four figure..”. Provide figure number

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