

Review of “Unsupervised classification of vertical profiles of dual polarization radar variables” by J. Tiira and D. N. Moiseev

Summary:

This manuscript is generally improved from the previous version. However, I still have some general and specific comments to address at various sections of the manuscript. These comments should be addressed before this manuscript is published.

General comments:

Add some discussion about the impact of vertical wind shear on the variability of radar signatures of the same physical processes. The differential advection of hydrometeors at different height levels will produce fall streaks that are only partially sampled by a vertical profile (or an RHI for that matter). As such, gradients in the vertical profiles of the radar variables may be strongly impacted by the wind profile and not reflect purely microphysical processes. I think some caution is therefore warranted in interpreting the microphysical processes corresponding to the centroid profiles.

Specific comments (line numbers here correspond to the updated version of the manuscript with the changes shown):

1. Line 46: More accurate to say that high ZDR is linked to the presence of planar crystals, where the presence of supercooled liquid at these temperatures indicates very favorable conditions for their growth.
2. Lines 48-50 (and elsewhere throughout the manuscript): How can horizontal banded features be determined from a vertical profile? Please clarify.
3. Line 85: Negative KDP has also been documented during periods of conical graupel (see Oue et al. 2015). Also add citation for negative KDP from ice particles aligned by an ambient electric field.
4. Line 88: Please clarify whether the noise and clutter filtering is done on the RHI data or on the binned profiles.
5. Line 105: Add the name of the peak detection function from the SciPy package in a footnote.
6. Line 119: Would these thresholds eliminate dendritic growth zone “bright bands” from being erroneously labeled as melting layers? Aren’t some of the dendritic growth zones revealed by the analysis at heights below 4.6 km?
7. Line 123: Discuss whether the smoothing in time corresponds to a specific temporal scale.
8. Line 139: The phrase “10-km layer from the lowest elevation of 200 m” refers to 0.2-10.0 km, correct? If so, this sentence should be changed to “...layer between 0.2 km and 10 km.” Also indicate whether heights are with respect to the ground or mean sea level.
9. Line 177: Shouldn’t the standard deviations here refer to $P(T_s)$ not T_s ?

10. Line 190: Remove “but non-trivial.”
11. Lines 214-215: I am unsure what this sentence means. Please rephrase so that the reader can understand how the centroid profiles change by adding additional clusters.
12. Lines 230-231: Please add some examples of how the optimal number of classes changes for specific applications. This could be added here or in the conclusions section of the paper where this phrase is also used.
13. 267-268: The seasonal variability of vertical motion with temperature level could also impact the magnitude of the ZDR and KDP enhancements.
14. Line 269-271: Is there a citation the authors can reference to discuss the seasonal climatology of convective precipitation in Finland?
15. Line 279: Rephrase to “With respect to KDP intensity...”
16. Line 316: Add that heights of maximum ZDR between S14 and S15 are different.
17. Figure 8: Remove mention of the melting layer height in the caption for this all-snow case.
18. Figure 9: For panel a2, please label or explain the units. Shouldn’t relative frequencies be less than 1?
19. Line 324: Add the microphysics parameterization used in the Sinclair et al. (2016) study.
20. Line 390: Change “also represent considerable” to “represent more modest.”
21. Line 402: What is meant by “data-driven?” Please elaborate.
22. Line 467: Add some discussion of whether riming is represented in any of the classes produced by the clustering algorithm. If this process occurs with relatively frequency in the region of the observations, it should either be represented in some of the classes or simply not distinguishable from aggregation in unsupervised classification method.

References:

Oue, M., M. R. Kumjian, Y. Lu, Z. Jiang, E. E. Clothiaux, J. Verlinde, and K. Aydin, 2015: X-band polarimetric and Ka-band Doppler spectral radar observations of a graupel-producing Arctic mixed-phase cloud. *J. Appl. Meteor. Climatol.*, **54**, 1335–1351, doi:<https://doi.org/10.1175/JAMC-D-14-0315.1>.