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Atmospheric Measurement Techniques Discussions
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Interactive comment on "How to estimate total differential attenuation due to hydrometeors with ground-based multi-frequency radars?" *by* Frédéric Tridon et al.

Anonymous Referee #1

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This paper discusses a new approach to estimate the total differential attenuation in cloud/precipitation radar profiles, a key constraint for attenuation correction, which is needed with multi-frequency radars using higher frequencies. The authors use the regions of small hydrometeors at the top of the cloud-precipitation column, where different frequencies should have the same radar reflectivity, to derive the total differential attenuation. They propose a robust way to estimate where the small hydrometeors are located based on the vertical gradient of the dual-frequency ratio.

This paper is well written and clear, with good visualizations to illustrate the method used. The proposed technique shows promise to be a significant contribution to dealing with the issue of (differential) attenuation. I only have a few comments and suggestions for improvement and thus recommend to accept the paper with minor revisions.

General comments:

1. The paper could use some discussion of the applicability of the limitations of the method:

1a: Most importantly, almost all the discussion seems to implicitly assume that the radar is zenith-pointing, but this is not actually mentioned (as far as I can see) in the text until line 164. Do you expect the method to be applicable to non-vertically pointing radars?

1b: Also, are there conditions where the algorithm will/might fail? For example, if there is very heavy attenuation in the lower part of the column, I imagine that this might prevent the radar from detecting the small-particle region altogether. Multiple scattering might also be an issue in such cases. I'm not demanding that the authors solve all these problems in this paper, but they should at least be discussed because they are important issues to deal with if this algorithm is ever to be used in an automated or semi-automated fashion to process large datasets.

2. The authors promote the method as an improvement compared to the earlier technique of estimating the baseline differential attenuation from low-reflectivity regions. It would make this paper more convincing if they actually compared the (quite impressive) results obtained with their method to those obtained with the older method. For example, Fig. 5c would be a good place to put such a comparison.

Specific comments:

Line 91: "While attenuation mainly limits the maximum range of possible radar observations": Doesn't it also introduce errors to the retrievals because you have more uncertainty in the reflectivity?

Equation 1: "cw" here means cloud water? Please specify.

Figure 1 caption: I realize that 1 μm is used here as a "small-particle limit" but it seems a little odd given that 1 μm droplets aren't even stable (also, it's not mentioned if 1 μm is the radius or the diameter...)

Line 151: How is EWC defined?

Lines 209-210: Related to my general comment #2 above, what do you do if a Rayleigh plateau satisfying the conditions is not found?

Discussion of Fig. 5: You should discuss a little bit the apparent negative PIAs in Fig. 5c (e.g. between 05:00 and 05:20). This is surely not physical. What causes these artifacts and how do you handle them?

Figure 6: The circles seem to overlap each other quite a bit here, using different size or shape markers might be better.

Figure 7c: Here we see not only negative PIA but also negative LWP in the first minutes of the time series. Why?

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