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Comment on amt-2022-8

Anonymous Referee #1

Referee comment on "Sensitivity analysis of attenuation in convective rainfall at X-band frequency using the mountain reference technique" by Guy Delrieu et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-8-RC1>, 2022

This is a useful, well written paper that describes estimates of the attenuation-corrected radar reflectivity factor from a ground-based X-band radar using radar returns from the surrounding mountains as a path-attenuation constraint. I recommend publication.

One advantage of having a fixed radar and fixed targets, as opposed to airborne/spaceborne radar geometry, is that measurements of the reference target can be made before and after the rain event so that an assessment can be made as to how the target reflectivity might have changed during the event. Although dry and wet mountain targets can have different radar reflectivities, I would expect that a good assessment of the accuracy of the PIA estimate can be made.

A disadvantage of this geometry is that the mountain targets do not exist along all rays so that, I would imagine, some assumptions must be made to transfer information from estimates along rays/range-profiles with reference data to those without. Perhaps this is where the cost function becomes necessary. Another difficulty is that the reflectivities of the targets are not all the same so the dynamic range of rain rates that are observable will vary from target to target. Similar issues arise with air/spaceborne platforms since the strength of the radar return from the surface depends on incidence angle and surface type. The authors note that most of the targets have a Z_{ref} value of at least 45 dB. For very strong target returns, I would guess that it's possible to see the mountain return even when the nearby rain signal is lost. (I realize that the authors address some of these issues in lines 311-331 and in some of their previous papers.)

What about rain that occurs beyond or above the ranges at which targets are present. Do the methods work well in these areas? Visual comparisons of the PPIs in Figs. 1 and 2 seem to indicate the existence of radar returns from rain beyond the mountain returns. These plots also seem to show some rays that contain multiple targets that are widely separated in range. Can these methods be generalized to rays having multiple reference targets?

The modified α (eq. 2.21) or C methods (eq. 2.17) depend on the unknown attenuation factor to range r_0 whereas the final-value method (eq. 2.26) does not. This would appear to be an advantage of the final-value. However, it doesn't seem to be possible to apply the final-value method to rays that do not contain a reference target.

I had some difficulty understanding the motivation for the cost function given by eq. (3.1) so let me ask the following question. Assume that modified α 's from, say N, mountain targets are obtained, at a given time step, and the mean is taken. This modified mean α could then be used to obtain attenuation-corrected Z profiles over the full volume scan of the radar, including rays with no reference target. Would these profiles be significantly different from the profiles obtained by minimizing the cost function? The same procedure could be done for the C-adjustment approach but it would be difficult to interpret this physically since C should be independent of the viewing angle - unless this adjustable C could somehow account for radome losses that change with look-angle.

Again, this kind of approach probably wouldn't work for the final-value (Marzoug-Amayenc) method as the equation doesn't have an adjustable parameter.

In Fig. 3, results from 6 methods are shown but it's sometimes difficult to track the behavior of the individual methods. For example, the HB estimate seems to diverge for ranges beyond about 6 km. In fact, the blue line (HB) in panel a is only visible around 5 km; for closer ranges, it probably exists but is hidden by the other curves.

Z_0 is defined at bottom of p. 10 as the measured reflectivity in the vicinity of the radar site, which is the range which is greater than the blind range and any clutter. If Z is the attenuation-corrected reflectivity at this range, then is the following equation correct: $Z = Z_0 + \text{PIA}_0$? (where Z_0 , Z are in dBZ units).

It seems that the phi-DP measurement has greater information content than the MRT in the sense that it provides an estimate of path attenuation to any range whereas the mountain return yields only a single path-attenuation estimate between the radar and the target. Is it correct to say that the phi-DP used in this paper is the value near the reference target? Couldn't it be used as a continuous variable to help validate the MRT estimates or is it too noisy? (Not sure if I'm making myself clear: if, at an arbitrary range, r, the phi-DP is used to estimate the two-way attenuation to that range, $A(r)$, then $Z(r) = Z_m(r) + A(r)$, where Z, Z_m are in dBZ units.)