Reply to comments of Gianfranco Vulpiani (editor) on Close-range radar rainfall estimation and error analysis

The authors would like to thank Gianfranco Vulpiani for providing useful comments that will improve our paper. Below we respond to each comment.

Error sources

Some error sources (the main, as stated in the manuscript) affecting the radar rainfall estimate are listed in the Abstract and Introduction. In my opinion, there are some additional sources that should be mentioned: ***1) beam blockage, 2) W-LAN interferences and 3) hail contamination****.*

- *The first is definitely among the main error sources in complex terrain scenarios, even more than attenuation (at least at C-band) considering the latter as a transient phenomenon whose effects over medium to long accumulation intervals might not be detrimental, even if not corrected. Beam blockage, despite quantifiable and correctable to a given extent, affects the adopted scan strategy, the height of measurement above ground, the impact of melting hydrometeors. This is the main problem caused by orography, ground clutter returns being relatively easy to identify.*

- *The second is being a really bothersome issue, it is not rare to observe returns higher than 30 dBZ.*

- *Hail, that is definitely not a rare hydrometeor type, especially for some climatological conditions, heavily affects radar observations in terms of both scattering and absorption enhancement. At C-band, small hail is responsible for resonance, including attenuation enhancement in case of melting hail that can lead to signal extinction even in short range path (see the related works by Meteo France and NSSL among others).*
  The list of error sources should unequivocally mention the vertical variability of precipitation (in terms of size, particle size distribution and refractive index) in place of VPR, the latter being a direct effect of the first. This is correctly done in page 2 lines 27-32 but not in the abstract.

We agree that these sources of error are also important. We will discuss them in both the abstract and the introduction.

Z-R derivation

This is the most "critical" comment I have.
For the sake of clarity, I think the authors should mention and possibly deal with some of the issues related to the use of the Parsivel observations. Most of them have been clearly outlined by Thurai et al. (2011), Tokay et al. (2013).
Is there any impact on the present analysis?
Also, to my knowledge, the Parsivel processing assumes a constant raindrop axis ratio for diameters larger than 5 mm. This assumption might have an impact on the convective rain events you have considered. Could you please say something on this topic?

We are indeed aware of the problems with first-generation Parsivel disdrometers as reported by Tokay et al., (2013). The most notable Parsivel overestimates occur for higher rainfall intensities, and large raindrops. Tokay et al. (2013) note that the Parsivel starts to overestimate the number of drops larger than 2.44 mm diameter when intensities exceed 2.5 mm/h and the drop concentrations exceed 400 per minute. The number of drops in this diameter class (i.e., larger than 2.44 mm) is limited throughout the event (see Fig. 4 of the manuscript), so we expect the effect to be minor. The rainfall peak of episode 3 is most prone to this error, but even then the number of drops is limited, especially compared to the number of small drops. So even for this peak, the effect will be limited. We will add a short description of the problem and the fact that the effects are very minor to the text (including references to the papers mentioned above).

Miscellaneous

- *Referring to **attenuation correction** methodologies the Authors did not mention very important works for ground-based radar applications, i.e., Bringi et al., (1990), Testud et al., (2000) (derived by the rain profiling algorithms), that represent the basic platforms for any existing operational attenuation correction algorithms. If I am not wrong, the approach proposed by Delrieu et al., uses the returns by fixed obstacles (mountains) to constraint the correction. However, it can only be applied to a limited portion of the radar domain.*

We will include these important references in the paper.

- *Figure 9, currently the title of vertical axes is "Reflectivity (Z)", maybe the units of Z should be explicited.*

We will modify the figure so that the units of Z are displayed: "[mm^6 m^{-3}]".

References

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Testud, J., E. Le Bouar, E. Obligis, and M. Ali-Mehenni, 2000: The rain profiling algorithm applied to polarimetric weather radar. J. Atmos. Oceanic Technol.,17,332–356

Thurai, M., Petersen, W. A., Tokay, A., Schultz, C., and Gatlin, P.: Drop size distribution comparisons between Parsivel and 2-D video disdrometers, Adv. Geosci., 30, 3-9, doi:10.5194/adgeo-30-3-2011, 2011.

*Tokay, A., W. A. Petersen, P. Gatlin, M. Wingo, 2013: Comparison of Raindrop Size Distribution Measurements by Collocated Disdrometers. Journal of Atmospheric and Oceanic Technology, **30**, 1672–1690, doi: 10.1175/JTECH-D-12-00163.1.*