Reply to comments of Mario Montopoli on Close-range radar rainfall estimation and error analysis

The paper describes a case study in the Netherlands where weather radar and disdrometer acquisitions are compared each other in a configuration where vertical variability of DSD as well as path attenuation can be considered negligible. The final goal is to put evidence (and quantify) on two aspects:
1. Quality in the procedures for the radar signal processing (ground clutter removal, wet radome loss compensation, absolute calibration od the reflectivity factor).
2. Temporal variability of DSD.
The paper reads very well and although the conclusions of the manuscript are not surprisingly new the presentation is good and arguments are convincing me. Using the right level of complexity the Authors quantify the impact of the various radar processing steps to better mimic the evolution of rain accumulations registered by the nearest rain gauge.
I recommend for publication after minor revision.

The authors would like to thank Mario Montopoli for his comments. Below we will give a reaction to each separate comment.

1. *I am expecting a positive impact of an event based Z-R in absence of VPR effects. In the presence of VPR effects we have a problem of repressiveness of the Z-R relationships aloft with respect to those at the ground.*
   Do you have the chance to check at the temporal variation of the VPR at the considered site (i.e. using the rest of the radar antenna elevations) to produce errors, which would be representative of the non-optimal configuration (i.e. when observing rain precipitation at some distance above the ground)? In other word what happen considering Z at different elevations?

   For the event that is studied in this paper, the effects of VPR can be considered insignificant for the lowest 1500 m. This can be seen in the Fig. 1 for the Contoured Frequency by Altitude Diagrams (CFADs). For the total of all phases, but also for the individual phases this is mostly the case. The drop distribution and the division in phases shown in Fig. 1 are shown in Fig. 2. Note that for this study the effect of VPR is negligible because we're only using data at very close range, where the center of the beam is less than 100 m high.

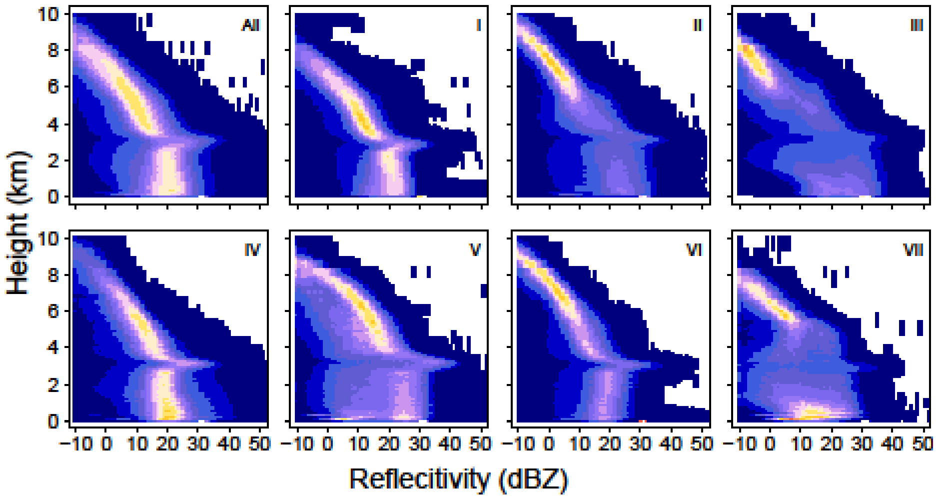

Figure 1. Accumulated Contoured Frequency by Altitude Diagrams. Upper left is the average for all episodes and the following panels represent individual episodes within the event.

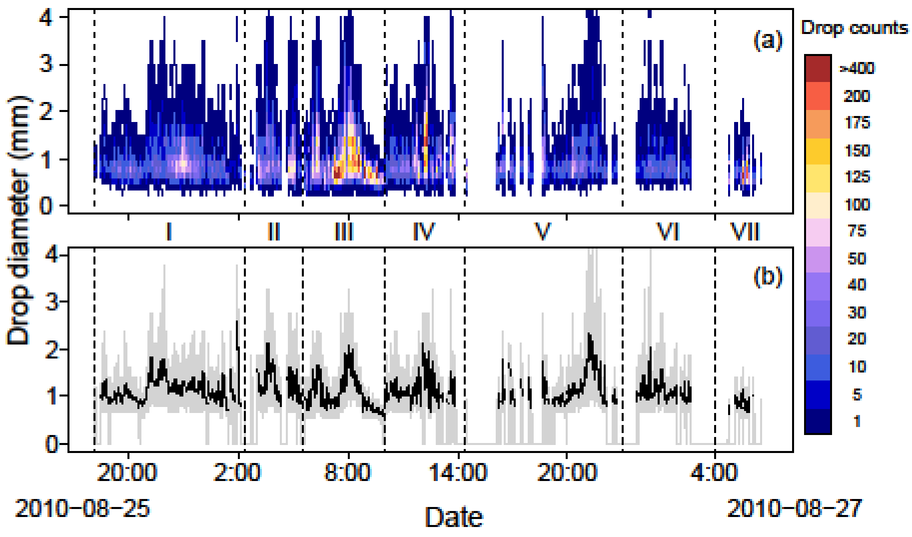

Figure 2. Illustration of the drop size distribution measured by the distrometer. Upper panel shows the number of raindrops per diameter size and the lower panel shows the median and 10-90 percentile drop diameter.

2. *pag. 1. line 4. Abstract . : "5) vertical profile of reflectivity" more in general I would say vertical variability of DSD. Not only the reflectivity is affected by the vertical variations, although in this paper only the reflectivity is used.*

   The authors agree that this would reflect a more general statement and this will be changed.

3. *pag 2, line 5 On the NUBF I would cite ALEXANDER V. RYZHKOV, The Impact of Beam Broadening on the Quality of Radar Polarimetric Data, JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY MAY 2007*

   This reference will be added

4. *After, at line 33 of the same page, I would explain more which are the effects of NUBF on Z (reduction?). Have you checked NUBF effects for the considered case of study. Is the spectral width available for the considered event? Please explain.*

   The effect of non-uniform beam filling of course depends on the vertical profile of the DSD. In general, if we're interested in the rain intensity (or reflectivity) at ground level, the effect could either be an enhancement of Z in case of a bright band, or a reduction of Z in case of shallow precipitation or measurements above the melting layer (where Z decreases with height). We assume that the effects of NUBF are negligible in this study because of the close range we're using (the 1-degree beam is only about 50 m wide at a 3-km range).

5. *pag 6, line 30. Reading this sentence it seems that you have not considered the effects of the calibration, ground clutter and wet radome as well. This is not the case of course. I think the phrase need to me modified.*

   We will rephrase this sentence to better reflect that we're not taking these error sources into account because of the close range we're using.

6. *pag 8. It would be useful to show the map of the clutter map cited in the text.*

   The principle of a clutter map is usually applied to each individual pixel of a radar image, but in this study only a single bin was used. We did not derive a clutter map for the entire radar image. The term "clutter map" might be a bit misleading because of this and we will reword to avoid confusion. The baseline clutter level for this location is shown in Fig. 6 of the manuscript.

7. *pag 9. line 4. "Subtraction of the mean value of Z (i.e. not in dBZ)". I would expect a subtraction in dBZ, which implies a division in linear units. Am I wrong?*

   We deliberately choose to subtract Z in linear units. The rationale behind this is that we assume that the power returned by a clutter target and that returned by precipitation are independent, and can be added. Since the retuned power and Z (in linear units) are linearly related, we substract the derived clutter power in linear units.

8. *pag. 12 figure 9. Could you please a different color for the black curve?*

   We will use a different color for these lines.

9. *pag 12. eq. 2. How is calculated sigma_B in your equation? Please explain in the main texts.*

   We assume here that the backscattering cross-section is:

$$\sigma_B = \frac{\pi^5 |K|^2}{10^6 \lambda^4} D^6$$

   So that the equation for Z will be:

$$Z = \int_0^\infty D^6 N(D) dD$$

   We will modify Eq. (2) accordingly, so that the backscattering cross-section will no longer appear.