

Interactive comment on “Close-range radar rainfall estimation and error analysis” by R. van de Beek et al.

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The paper attempts to quantify some of the error sources in weather radar observations (such as ground clutter, radome attenuation and Z-R variability) by comparing radar observations at very short range (1-2 km) with raingauge and disdrometer measurements. The paper is very interesting and AMT readers would benefit from this paper. The paper is well written and it should be published after the authors address some minor issues as discussed below. 1- An important source of “error” between radar and raingauge measurements is due to the fact that radar observations are areal (in fact volume) rainfall measurements whereas raingauges provide point rainfall mea-

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surements (Kitchen and Blackall, 1992; Ciach & Krajewski, 1999; Bringi et al, 2011). This produces some differences when comparing both sets of observations even at short range because the radar spatial resolution is relatively large (1km along-range in your case) compared to the raingauge sampling area. Please comment on this and give an indication of how much of the observed difference between radar and gauge measurements is due to the point to area variance. 2 - Another source of error in radar measurements is due to the fact that the radar provides instantaneous measurements whereas raingauges provide measurements integrated in time. Operational weather radars usually perform volume scans (i.e. several PPI scans at different elevations) and therefore the sampling time interval of the surface radar rainfall measurements is relatively large (5min in your case). Errors due to the sampling time interval can be large especially in convective situations (see e.g. Fabry et al, 1994). Interpolation techniques can help to mitigate this (e.g. using nowcasting). How much of the observed difference between radar and gauge measurements is due to the radar temporal sampling? Please comment on this. 3 – Radome attenuation. The correction for the radome attenuation was performed using a fixed clutter target, but ignoring the effect of wetting of the clutter target and precipitation at the clutter location. The authors also highlighted the fact that radome attenuation depends on wind speed and direction. Please give an indication on how reliable is the proposed radome attenuation correction, perhaps by making reference to other papers. 4 – Z-R variability. The study concludes that applying an event-based Z–R relationship obtained from disdrometer observations improves the radar rainfall estimation. Although this is true for the location under consideration, it is well known that the Z-R equation changes in space and time. Please comment on this. 5 – The study was performed on a limited data set (only 3 days), but it is likely that the radar errors will depend on the precipitation type (e.g. stratiform rain, convective rain, winter storms, etc). Please comment on this.

Minor Comments:

Fig 3. Please be consistent with the use of colours in fig 3 (radar measurements

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were shown in red in top panel and in black in bottom panel). Similarly for gauge measurements.

Page 8 “zero-isoDop”?

Section 4.1. It is unclear which azimuthal angle is used for the comparisons.

References.

Ciach, G. J., and W. F. Krajewski, (1999): On the estimation of radar rainfall error variance. *Adv. Water Resour.*, 22, 585–595.

Fabry, F et al (1994): “High resolution rainfall measurements by radar for very small basins: the sampling problem reexamined,” *Journal of Hydrology* , vol. 161, pp. 415–428.

Bringi, VN, et al (2011): ‘Rainfall Estimation with an Operational Polarimetric C-band Radar in the UK: Comparison with a Gauge Network and Error Analysis’ *Journal of Hydrometeorology*, vol 12, pp. 935 – 954.

Kitchen, M., and R. M. Blackall, 1992: Representativeness errors in comparisons between radar and gauge measurements of rainfall. *J. Hydrol.*, 134, 13–33.

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