Review report of

By H. -L. Kim, M.-K. Suk, H. -S. Park, G. -W. Lee, and J. -S. Ko: Dual-polarization radar rainfall estimation in Korea according to raindrop shapes using a 2D Video Disdrometer (amt-2016-14)

General comments

The paper by Kim et al. aims at demonstrating the improvement dual polarization radar quantitative precipitation estimation through: a) defining rainfall algorithms using DSD from 1 year of 2D video disdrometer measurements and defining an optimal shape-size relation based on the same 2DVD measurements; b) using 2DVD measurements to compensate bias in Zh and Zdr. The performance of radar rainfall algorithms is tested by comparing 2DVD rainfall estimates to rainfall obtained from intrinsic polarimetric measurements obtained by applying T-matrix simulation to 2DVD-estimated DSD and using measurements collected by the S-band Bislan radar.

Radar rainfall algorithms are derived and tested using the same DSD dataset and therefore should be optimal. Differences in performance should point out the benefit of using the new shape-size relation. The improvement is not very evident and seems overwhelmed by error measurements, especially those related to the estimation of K_{dp}, which appear very high. Results are summarized by a couple of tables, but the advantage of using the new shape-size relation is not evident at all. Table 3 shows that only in the case of the $R(K_{DP}, Z_{DR})$ algorithm there is an improvement. Moreover, using actual radar measurements, improvement is only appreciable for $R(Z_H, Z_{DR})$. A step that is missing is a simulation including effects of biases and fluctuations. However, several papers are available on

A calibration of radar using disdrometer measurement is obtained using disdrometer-derived measurements of Z_h and Z_{dr} and corresponding radar measurements While there are some doubts about the meaningfulness of this calibration, especially as Z_{dr} is concerned, calibration should be applied before evaluating the performance of rainfall algorithms.

Summarizing, the paper does not present any significant improvements with respect to the state of the art. More important is not clear what is the actual aim of the paper. Although understandable as a whole, at least for evaluation purposes, the paper presents several unclear sentences and some typos.

Specific comments

Pag. 1, lines 19-21: It is not clear the link of the sentence starting with “therefore” with the previous one

Pag. 2, lines 16-18: Potential and actual advantages of polarimetry applied to radar systems have been analyzed in the literature. However, this sentence is not very precise.

Pag. 2, lines 20-21: Dual polarization rainfall algorithms use K_{dp} or combinations of Z_h, Z_{dr}, and K_{dp}.

Pag. 2, lines 24-25: This is wrong: maybe "allowing correct interpretation of polarimetric measurements in rain" or "an important feature of rain microphysics".
Pag. 2, lines 26-28: Authors should cite also more recent work on the drop-shape topic.
Pag. 3, lines 1-3: “Thus,..” Again, I do not see how this conclusion follows from the previous sentence.
Pag. 3, lines 14-17: Cited studies by Goddard et al. aimed at demonstrating the inadequacy of the Pruppacher and Beard shape-size relation.
Pag. 3, line 19: Formulation of self-consistency by Gorgucci et al. 1992 was based on Z_h,Z_{dr} and K_{dp} and not on Zh-K_{dp}.
Pag. 3, line 21: A recent paper by Chandrasekar et al. (2015) is more appropriate and update than Atlas (2002).

Pag. 3, line 24: Replace “four” with “three”
Pag. 4, line 20: Please add the height ASL of the radar
Pag. 5, lines 1-2: A 0-deg elevation allows small distances between measurements aloft and ground measurements. For most installations measurements collected at such small elevation angles are prone to effects of nearby obstacles. Please demonstrate that for the Bislan radar, this elevation does not implies beam blocking/ground clutter effects or that they are negligible.
Pag. 5, lines 2-5: Please explain how averaging of PHI_{dp} is obtained.
Pag. 5, line 21: What does it mean “beyond the normal distribution” ?
Pag. 6, line 10-11: Why do Authors use the velocity-size relation by Brandes et al. (2002) and Atlas et al. (1973) to filter 2DVD measurements? Note that, starting from 2DVD counts, such relation is not necessary for computing R.
Pag. 7. Section “Raindrop axis ratio”: There are a number of questions about the fitting (4). First, what is the accuracy of the fitting. Second, is this fitting more appropriate for certain events (i.e. is there an event-by-event variation?).
Pag. 7. Section “Disdrometer-rainfall algorithms”: I think it is more appropriate to Z_h, Z_{dr} K_{dp} “variables” or “measurements” instead of “parameters”
Pag. 8, line 12. Likely values of mean and standard deviation are switched.
Pag. 9, section 3.4. What is the point of using light rain ? Z_{dr} near zero ? Please explain. What is the accuracy expected with this calibration ?
Pag. 10, “Variability of DSD in rainfall estimation” I would like to see also some relative performance factors, such as the ratio of RMSE and average value of R.
Pag. 10, line 21: Corr = 0.1 ?????
Pag. 11. Line 3. “A summary of …..” The beaviour of the different algorithms with intrinsic dual-pol measurements is what is expected (eg. Bringi and Chandrasekar, 2001). What is strange is that only $R(K_{DP}, Z_{DR})$ takes advantage from the new shape-size relation.
Pag. 11. Line 21-22. Now, it is $R(Z_H, Z_{DR})$ the best algorithm and is the only one that take advantage from new shape-size relation. This is also not surprisingly. A simple exercise consisting in adding a properly modelled error to intrinsic measurements would reveal how algorithms are sensitive to random measurement fluctuation and/or calibration biases (see again Bringi and Chandrasekar, 2001). The bad performance of $R(K_{DP}, Z_{DR})$ can be ascribed to the an unappropriate K_{DP} estimation (see the increase in the error of radar $R(K_{DP})$. From Figure 7 compared with Figure 6, I would expect worst MAE and RMSE values than those in Table 4. Finally, it is not clear to me whether Z_h and/or Z_{dr} bias correction was applied or not here.
Pag. 12, section: “Correction of calibration bias”: What is the accuracy of this calibration ? Can the event-to-event variability of the bias be related to variation of radar performance ? Figure 9 shows clearly that the estimation of Z_{dr} bias is extremely poor.

References

E. Gorgucci, G. Scarchilli, and V. Chandrasekar, Calibration of radars using polarimetric techniques, IEEE Trans. Geosci. Remote Sens., vol. 30, no. 5, pp. 853–858, Sep. 1992
Chandrasekar V., Baldini, L., Bharadwaj N., Smith, P.L., Calibration Procedures for Global Precipitation-Measurement Ground-Validation Radars, TheRadio Science Bulletin No 355 (December 2015), pp. 45-73 [http://www.ursi.org/files/RSBissues/RSB_355_2015_12Corrected.pdf]
V. N. Bringi and V. Chandrasekar, Polarimetric Doppler Weather Radar: Principles and Applications . Cambridge, U.K.: Cambridge Univ. Press, 2001, p. 648