

Dual-polarization radar rainfall estimation in Korea according to raindrop shapes using a 2D Video Disdrometer

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Summary:

The accuracy of different dual-polarization rainfall retrieval algorithms is quantified using data from the Bislsan S-band weather radar and independent measurements from a nearby video-disdrometer and co-located rain gauge. A new raindrop axis-ratio model that better reflects the characteristics of rainfall on the Korean Peninsula is derived (using the 2DVD data) and its influence on the rainfall retrievals is tested. The results show that drop-axis ratios have a small yet non-negligible impact on radar-retrieval algorithms. The most important factors affecting the accuracy seem to be (1) the calibration of the weather radar and (2) the comparison of the gauge and 2DVD data with a relatively large radar volume.

General Comments:

The results are interesting but not exactly new or groundbreaking. In particular, it is unclear whether the new axis-ratio proposed by the authors is actually necessary or not (given the strong uncertainties and large errors affecting radar measurements). There is nothing wrong with the approach. But the conclusions are relatively weak and the central message of the paper needs to be stated more clearly.

Recommendation: Minor revision

Specific Comments:

- Page 3, ll.29-30: “*Thereafter, improvement of quantitative rainfall estimation was investigated by applying derived calibration bias.*” This sentence is not clear. Please reformulate.
- Page 4, Section 2.1 (Disdrometer): It might be worth mentioning here that the 2DVD is considered one of the best and most reliable disdrometers on the market today.
- Page 5, Section 2.3 (Rain gauge): Please provide the brand/make and model number of the tipping bucket and specify if the data were quality controlled or not.
- Page 6, ll.10-11: Please explain why the rain rates from the 2DVD data are computed using the Brandes et al. (2002) velocity model while the older Atlas et al. (1973) velocity model is used to filter the 2DVD data.
- Page 6, ll.24-25: “*Therefore, the 2DVD data within 20% percent error were used in this study.*” I’m not sure to fully understand what you mean by this. Are those 20% with respect to hourly accumulations or on an event basis?
- Page 7, ll.22-23: Here, it might be worth to say what you actually mean by “drop diameter” in this context. I assume you are referring to the diameter of a sphere with equal volume.
- Page 7, ll.27-28: Please provide at least one good reference for the T-matrix method.
- Page 9, l.2: “*The polarimetric radar contains systematic bias of the radar itself.*” Not sure what you mean by this. Please reformulate.
- Page 10, ll.5-6: “*This means that raindrops in South Korea are more oblate than the others.*”. This statement needs to be reformulated. There are many possible explanations for this and it would be premature to conclude that raindrops in South Korea are more oblate than in other places. The differences in axis-ratio might also be the result of instrumental effects, drop filtering and event selection. Please reformulate.
- Page 10, l.21: The correlation value of 0.10 mentioned in the text seems to be incorrect.
- Page 11, Eq.(12) and (13): There is no need to repeat the definition of the MAE and RMSE here.
- Page 12, ll.6-7: “*In addition, the radar rainfall estimations from $R(Kdp)$ and $R(Kdp,Zdr)$ perform better than those of $R(Zh,Zdr)$ for rain rates exceeding 5 mm/h*”. This is not obvious from the graph.

Please provide hard evidence to back up this statement (e.g., in the form of an additional table or RMSE values for $R > 5$ mm/h).

- Page 12, ll.14-15: “Therefore, rainfall characteristics should be reflected in polarimetric rainfall relations.”. This is too vague. Please reformulate.
- Page 20, Table 3: Please check if the low correlation values (0.10) are correct.

Typos and English: (this is not an exhaustive list)

- Page 1, ll.15-16: The shapes of raindrops play an important role in ~~inducing~~ polarimetric rainfall algorithms ~~with~~ based on differential reflectivity (Zdr) and specific differential phase (Kdp).
- Page 1, l.21: In this study, we ~~presented~~ present a method ...
- Page 1, l.23: First, a new axis ratio of raindrop relations ~~was~~ is developed ...
- Page 1, ll.24-27: Second, polarimetric rainfall algorithms ~~were~~ are derived using different axis ratio relations, and estimated radar-point one-hour rain rate for the differences in polarimetric rainfall algorithms ~~were~~ are compared with the hourly rain rate measured by ~~gauge~~ a rain gauge.
- Page 1, ll.27-28: In addition, radar rainfall estimation ~~was~~ is investigated ...
- Page 2, ll.1-2: The R(Kdp,Zdr) algorithm based on a the new axis relation ...
- Page 2, ll.24-25: This is because the shape of raindrops is one of the most sensitive parameters for representing the scattering properties of rain ~~DSD properties of the rain~~.
- Page 3, l.17: In addition to ~~use of~~ disdrometers, there are ...
- Page 3, ll.22-23: In this study, we developed a mean axis relation and polarimetric rainfall algorithms using 2-Dimensional Video Distrometer (2DVD) measurements ...
- Page 3, l.24: The four raindrop shape assumptions ~~shapes-assumption~~
- Page 3, ll.26-27: accurate polarimetric rainfall retrieval algorithms ~~relation for rainfall estimation~~.
- Page 3, l.28: with simulated Zh and Zdr obtained from the 2DVD.
- Page 4, l.15-16: From these, one can calculate the DSD and all related quantities such as the rain rate, total drop number concentration and liquid water content.
- Page 4, l.22: The BSL S-Band radar ~~measured~~ measures polarimetric variables ~~parameters~~ such as Zh, Zdr, Kdp and rho_{hv}. The considered data ~~obtained were~~ are taken from six elevation angles.
- Page 6, l.10 is the drop interval.
- Page 6, l.18: The 2DVD recorded 13.14 mm and the rain gauge ...
- Page 6, l.27: over the ~~Korea~~ Korean Peninsula.
- Page 7, l.1: compared to ~~in suit~~ in situ rain gauges.
- Page 7, ll.6-8: The overall agreement ~~rainfall distribution~~ between the 2DVD and the rain gauge ~~was~~ good. The total accumulated rainfall recorded by the gauge was larger than that of the 2DVD by about 0.81%.
- Page 7, l.17: could reach axis about 8 mm, ...
- Page 8, l.17: there is a space missing between Table and 3.
- Page 8, ll.15-16: ... are derived when the rain rate is ...
- Page 10, l.15: where R is the rain rate from observed 1-min DSDs and Re is the rain rate from ~~estimated~~ various combinations of polarimetric parameters.
- Page 13, l.5: was improved by about 13.71%.
- Page 13, l.6: The recorded accumulated rainfall ~~recorded~~ was
- Page 13, l.8: was improved by about 10.25%.