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Atmospheric Measurement Techniques Discussions

Interactive comment on "X-band dual-polarized radar quantitative precipitation estimate analyses in the Midwestern United States" *by* Micheal J. Simpson and Neil I. Fox

Anonymous Referee #1

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Review of: X-BAND DUAL-POLARIZED RADAR QUANTITATIVE PRECIPITATION ESTIMATE ANALYSES IN THE MIDWESTERN UNITED STATES Author(s): Micheal J. Simpson and Neil I. Fox Journal: Atmospheric Measurement Techniques (AMT) MS No.: amt-2017-439

General comments:

This study presents a two-year evaluation of available X-band rainfall relationship performance for a Midwestern US location. The paper falls under the AMT scope as a validation manuscript. An objective is to analyze performance to extended ranges. Overall, the manuscript is not recommended for publication at this time. A resubmis-

sion (rather than revision) is recommended. Several points for the authors to consider.

Extended comments:

1) Conclusions are counter to many published Xband studies. An author statement that initially caught my attention was, "This is surprising since ZDR has not been calibrated for the MZZU radar". While newer radars may have built-in controls to mitigate several issues, it is not typical. My experience is that radar quantities (Z, ZDR, KDP) out-of-the-box are usually not suitable for hydrological applications (esp. over a two-year window). This is a dirty little secret of radar rainfall studies (all wavelengths), e.g., the processing effort to achieve their performance – increasingly problematic when others attempt to replicate performance. This is partially why manuscript "data/code availability" sections are of importance for journals such as AMT (is this now required?).

For a single X-band radar, handling data is nontrivial (attenuation corrections, influences from backscatter differential phase). This reviewer is skeptical, indications are that the authors opted for many tools/methods poorly matched to Xband. For example, superior performance for Z, ZDR-based estimators to longer distance (at X-band) – Z, ZDR can be highly problematic, less informative for 'real-world' rainfall estimation owing to detrimental attenuation corrections in rain, calibration uncertainties, complications in hail, nonuniform beam filling, etc. KDP-based algorithms are typically known for unbiased estimates and most accurate for cumulative (areal, total) studies. The study does not report hourly accumulation comparisons (most common way of visualizing rainfall performance), instead opting for many nonstandard comparisons. For 'false alarm' or detection-type concepts, it is unclear whether cross-correlation coefficient filters (or similar) are used to remove contaminants, other biological/insect echoes, etc. These concepts (thresholds) also change at X-band.

This manuscript indicates that "WDSSII" is used. This is an S-band reference – perhaps NOAA X-POL developments have provided modifications, but these are not obvious; older Ryzhkov technical reports are also S-band references, not X-band.

Note, there has been recent effort put into Xband available to the authors – CSU-Chandraseker, NSSL collaborations (Ryzhkov, Germany – uses of specific attenuation-based estimators), available open-source options. Z and ZDR offsets (e.g., modest 1 dBz or 0.1 dB type) alter performance 20%, moreso with larger coefficients associated with ZDR parameters – also may have other 'hot spot' or similar DSD-related influence modifications, etc., that impact shorter wavelength processing (e.g., Gu et al. 2011). It would be helpful for the authors to demonstrate that basic radar quantity estimates are proper, e.g., scatterplots, or dual-polarization self-consistency examples – as well as details on the typical attenuation corrections (radial examples?), associated coefficients and differential phase processing performed.

2) Given the availability of extended gauge networks, others (including NSSL) have considered rainfall performances to longer distances. For Missouri, I would anticipate that other gauge networks (HADS type, e.g., https://hads.ncep.noaa.gov/) are also available. It would seem that this topic (performance to longer ranges) is still a useful, but needs better support. For an effort that does not introduce a new approach, there is an underwhelming number of gauges / comparisons (as compared to studies that benefit from mesonet gauges, iFloods, etc.). Besides, X-band 'gap filling' idea / motivation is usually not suggestive that X-bands would provide estimates to longer distances, but fill-in and outperform S-band radars in 'gaps' in coverage (lower-levels, etc.). Xband radars are typically not expected to provide rainfall beyond 40 km.

3) Red flag: S-band algorithms. Missouri should be climatologically comparable to Oklahoma, Iowa, Colorado, which have many Xband studies to draw from. There is never justification for S-band algorithms at X-band (e.g., KDP is substantially larger, e.g., 3 times, at X-band than at S-band, etc., and Z, ZDR having different and unique shorter-wavelength nonRayleigh implications, etc.). One would also expect vastly different 'matched' R(Z), R(KDP) relation coefficients (e.g., as from disdrometer, etc).

4) Confusion may also be attributed to selection of metrics (multi-year cumulative comparisons can appear correct for incorrect reasons). Providing performance contingent

on rainfall rate intensity or hourly comparisons is preferable for many reasons, e.g., if the parts to the dataset primarily contributing were 'light' rainfall (R < 5 mm/hr, or hourly accumulation < __ mm, etc.), it may be more acceptable/believable that R(Z, ZDR) was outperforming other methods than in the presence of heavier rainfall, etc. For example, it may be fair to expect R(Z,ZDR) should perform better in light rain to closer (or lengthier) distances, provided there was not much precipitation along that path (aka, attenuation in rain to that location). Many dual-polarization methods tend to work optimally in heavier rainfall, etc.

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