

Title: Potential use of radar slant-linear depolarization for measuring rainfall microphysics

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Recommendation: minor revision

Summary: This paper addresses the limitation that single-transmit, dual-receive millimeter-wave radars cannot obtain conventional H/V dual-polarimetric observations, and systematically evaluates the potential of slant-linear depolarization ratio (SLDR) for retrieving rainfall microphysics. A comprehensive information content analysis is performed based on T-matrix scattering simulations, multiple raindrop size distribution datasets, and neural network regression diagnostics to clarify the physical origin of SLDR, quantify retrieval errors, and provide observability constraints for field observations. The research topic targets the practical engineering limitations of compact millimeter-wave cloud radars, with well-defined scientific questions, rigorous physical derivations, and a complete design of simulation experiments. The results possess favorable theoretical value and provide important theoretical support for subsequent field observation campaigns.

Major Concerns:

- 1) There is no comparison with traditional physical inversion or Bayesian methods. Include at least one non-MLP inversion baseline to demonstrate whether the direction and magnitude of the SLDR information gain remain robust across different frameworks.
- 2) The present calculations mainly describe the projection of the target backscattering matrix into the slant-linear basis. Actual Ka- and W-band rainfall measurements, however, may be strongly affected by two-way propagation. Differential attenuation and differential phase can modify the polarization state of the transmitted $+45^\circ$ wave and may generate or alter the orthogonal-slant component along both the outgoing and return paths.
- 3) Attenuation and differential propagation effects should be considered more explicitly. Limiting the synthetic dataset to $R \leq 200 \text{ mmh}^{-1}$ removes some extreme cases but does not eliminate appreciable two-way attenuation at 35 GHz, even under moderate rainfall over kilometre-scale paths. Attenuation can reduce Z_+ , while differential attenuation and phase accumulation may also alter SLDR. A simplified path-integrated attenuation model or an order-of-magnitude sensitivity analysis would therefore strengthen the practical interpretation. Alternatively, the conclusions should be limited explicitly to short-range or light-rain applications.
- 4) It is not clear that the retrieval evaluation domain is consistent with the stated observability constraints. Figure 2 displays only samples with $\text{SLDR} \geq -35 \text{ dB}$ and describes this level as an approximate observability floor, whereas the MLP performance appears to be evaluated over the full simulated dataset without an

explicit SLDR or cross-slant SNR threshold. If samples below the practical detection limit are included, the aggregate RMSE values may overestimate the performance achievable by an actual radar. The authors should clarify the filtering procedure and report retrieval metrics conditional on detectability, together with the retained sample fraction and the corresponding range of D_m

- 5) The treatment of differential phase requires further clarification. Because the cross-slant return is proportional to the coherent difference between the complex quantities S_{HH} and S_{VV} , SLDR depends not only on their magnitudes but also on their relative phase. The T-matrix calculations may include the intrinsic backscatter differential phase, but the manuscript does not state this explicitly, and the accumulated two-way propagation differential phase appears to be omitted.

Minor Comments:

- 1) At the beginning of Section 3.4, there is a passage that is repeated almost verbatim (“The preceding retrieval diagnostics establish...”); one of these instances should be removed.
- 2) Figure 2a marks an observability floor of -35 dB. Please briefly state the basis for selecting this threshold in figure caption or main text.
- 3) In Figure 3, please explain the reported bias and correlation coefficient conventions and state whether the metrics are calculated in the transformed or original target space. It would also be helpful to report the number of test samples in the caption or main text.
- 4) Please check the reference list and DOI formatting for consistency. For example, several DOI links appear to contain duplicated URL prefixes or inconsistent punctuation. Please also verify the formatting of dataset citations and access dates.
- 5) Please ensure consistent definitions, units, and logarithmic conventions for all physical variables throughout the text, equations, and figures.
- 6) The notation and assumptions in Eqs. (11) and (12) are need to be varified, particularly the channel-noise ratio and the approximation used to describe polarization leakage.