We sincerely thank the reviewers for their valuable comments and suggestions, which have helped improve the quality of the paper.

----- For clarity: Reviewer comments are shown in black, Author responses are shown in RED. -----

-------------------- *REFEREE 1* --------------------

Summary: The authors have done a good job addressing most of my prior comments in this version of the manuscript. However, I have some additional minor comments that should be addressed before the manuscript is accepted for publication.

General comments*:*

- Lines 28-29: Please add a reference for this statement.

We have cited the reference by Kollias et al. (2011)
Kollias, P., Remillard, J., Luke, E., and Szyrmer, W.: Cloud radar Doppler spectra in drizzling stratiform clouds: 1. Forward modeling and remote sensing applications, Journal of Geophysical Research: Atmospheres, 116, 2011. DOI:10.1029/2010JD015238.

- Line 30: Please mention which variables are minimally impacted by the PSD.

We have changed to "*This is especially evident in the simulations of differential reflectivity (Z_{DR}) where this parameter exhibits very low values and sensitivity to PSD variations (Unal and van den Brule, 2024).*"

- Line 67: Please clarify this statement since white noise is by its nature stochastic.

The sentence is modified to: "*Therefore, the first goal of this study is to explore how different assumptions that are related to atmospheric conditions (turbulence) and white noise of a real radar spectrum, impact the simulated spectral polarimetric variables.*"

- Lines 81-82: Please explain why two different raindrop aspect ratio parametrizations are used in this study. Also, please clarify that the second equation written above is from Andsager et al. (1999) and is their fit to the Beard and Chuang (1987) model.

The use of two different axis ratio parameterizations reflects the fact that small and large raindrops deform differently due to competing physical forces. For small drops, surface tension dominates, and they remain nearly spherical. The Keenan et al. (2001) parameterization is well-suited to describe this regime. For larger drops, aerodynamic forces become more significant, leading to more oblate shapes. The Beard and Chuang (1987) better captures this deformation behavior. We changed the text to: "... *where a/b denotes the ratio of the major to minor axis of the oblate spheroid. The use of two different formulations reflects the physical differences in raindrop deformation regimes. For small raindrops, the axis ratio follows the parameterization by*

Keenan et al. (2001), while for larger drops, the fit of Andsager et al. (1999) to the Beard and Chuang (1987) model is used."

- Line 90: This is the relative permittivity, not the refractive index. Please fix.

The sentence is modified to: *"The raindrops are assumed to be at 10 degrees C and the complex relative permittivity of water at this temperature is 3.2 -1.8j at 94 GHz (Lhermitte, 1990)"*

- Line 121: Please add that backscatter differential phase also depends on size.

The text is modified to *"The differential phase (δ_{HV}) refers to the phase shift introduced at backscattering between the horizontally and vertically polarized components of the received radar signal. This parameter depends on the size of the hydrometeors and provides information about their shape and orientation."*

- Line 137: Please clarify here that a distribution of orientations is needed to reduce RhoHV; a uniform non-zero orientation still gives RhoHV=1.

We have clarified this point in the revised text: *"On the other hand, raindrops with variations in orientation or tilt of the drop axis relatively to the direction of motion (canting) have ρ_{HV} slightly lower than 1, showing a minimum loss of correlation between the two different polarization states."*

- Line 162: Please provide some brief motivation here for why these two methods are presented.

The use of both methods was to ensure that the stochastic perturbations respect the physical relationships between the scattering elements. The fact that both methods demonstrated consistency when producing the polarimetric variables provided confidence in the turbulence generation on the simulations and that the discrepancies in the observations were not due to a simulation artifact. The following is added: *"The use of both approaches ensures that the introduced stochastic perturbations respect the physical relationships between scattering elements. Their agreement increases confidence in the simulated turbulence structure and supports that observed discrepancies are not artifacts of the simulation method."*

- Line 268: This relation assumes that significant shear layers are not present at higher altitudes.

We agree that wind shear can generate mechanical turbulence, particularly in regions with strong wind gradients, such as near jet streams or inversions. However, in the context of our study, turbulence at lower levels, which is primarily driven by surface heating and friction, dominates the signal variability and uncertainty. At higher altitudes, shear layers may exist, but they generally contribute less to the turbulence detected by our system compared to the intense mixing closer to the surface. It is also possible to have higher turbulence at high heights in a convective precipitation system (for example in thunderstorms with large updrafts). Therefore, the sentence *"Higher altitudes are usually characterized by significantly less turbulence relatively to lower levels, because turbulence is often generated by surface heating and friction."* is meant in a relative sense. We modified as following to clarify the turbulence origin: *"Excluding cases of strong wind shear (e.g., jet streams) and deep convective systems (e.g., thunderstorms), higher altitudes are generally characterized by significantly less turbulence than lower levels, as turbulence is mostly generated by surface heating and friction."*

- Line 298: Please clarify if these results are for the PSD parameters fit to the Doppler spectrum in Fig. 7.

The sentence is modified to: *"In Figure 8, the black lines represent the measured spectral polarimetric variables sZ_{DR} (left) and $s\delta_{HV}$ (right), while the blue and red lines are the results of the two simulation methods, by using the above mentioned optimum-fitted Doppler spectrum (see Fig. 7)."*

- Line 302: Maybe I'm missing something, but how is the dependence of the spectral polarimetric variables on the PSD tested if a single PSD is derived from fitting the Doppler spectrum to the data?

This part is modified to: *"Next to the radar elevation angle, the primary physical factors influencing the spectral polarimetric variables are the axis ratio–diameter relationship, the canting angle distribution (Unal and van den Brule, 2024), and variability in air motion, characterized by σ_t. The values of sZ_{DR} and $s\delta_{HV}$ do not depend on the raindrop size distribution (Unal and van den Brule, 2024). However, what may vary in Figure 8 is the terminal velocity range—for example, under low turbulence conditions, the velocity range narrows when D_m is small, as in the case of light rain."*

In the following figure, we have computed sZ_{DR} and $s\delta_{HV}$ with different PSDs keeping the same turbulence, canting angle distribution and axis ratio-diameter.

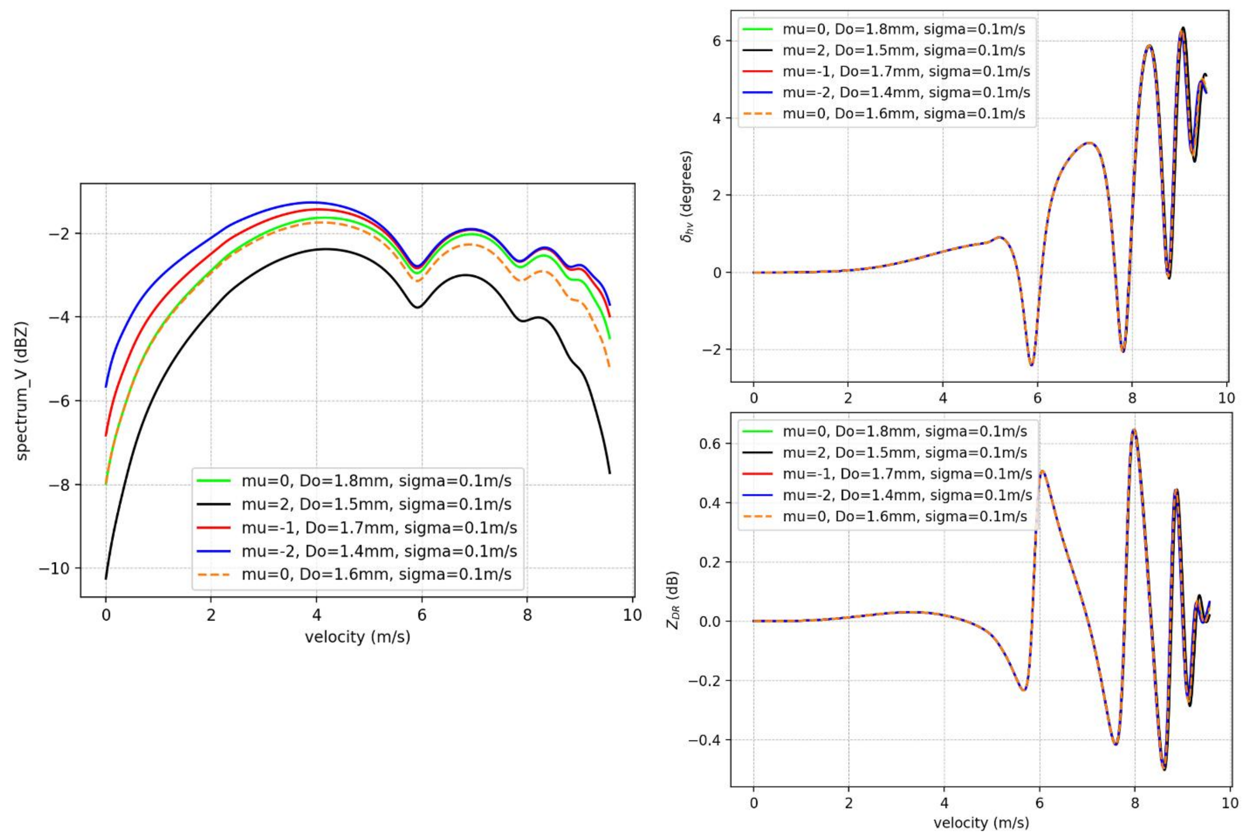

*Figure 1 Doppler spectrum, spectral Z_{DR} and spectral δ_{HV}, computed with the same turbulence (σ_t =0.1m/s), canting angle distribution and axis ratio-diameter relation, but with **different PSDs**.*

----- For clarity: Reviewer comments are shown in black, Author responses are shown in BLUE. -----

---------------- *REFEREE 2* (Alexander Myagkov) ----------------

Summary: I would like to thank the authors for thoroughly considering my suggestions to improve the manuscript. All of my concerns have been properly and comprehensively addressed.

I kindly request one final wording correction: in line 262 (sec. 2.2.5) of the revised manuscript, please replace the word "proposed" with "demonstrated". This better reflects the aim of the cited publication, which is to show that widely accepted polarimetric variables complicate accurate estimation of the effects of random errors.

After this correction, I fully recommend the manuscript for publication.

We have changed from "proposed" to "demonstrated".