Reviewer 1

The authors have appropriately addressed all of my concerns and comments. However, a few issues, mostly technical and stylistic, are still present in the manuscript. I recommend their work for publication in AMT after these further minor points are solved. Please find the remaining issues listed below, all line numbers refer to the revised manuscript:

Response: We appreciate the reviewer's detailed edits. All the corrects have been made in the revised manuscript.

- line 39: "Doppler spectrum can be used to simulate rain Droplet Size Distribution", I believe the term "simulate" is used improperly and should be replaced.
Done

- line 51: "fully understanding" → "full understanding"
Done

- line 196: the text states that the simulation is set up "with initial velocity set as 0 ms-1"; however the velocities displayed in Fig. 4 are not equal to 0 ms-1 at time = 0s. This needs to be clarified/fixed.

Response: We thank the reviewer for the detailed observation. Figure 4a shows the simulated duration from 10 to 110s. We want to apologize for the oversight.

- line 223, within the caption of Fig. 4: "velocity filed" → "velocity field"
Done

- line 249: I believe "Lhermitte, 2002" should not be in parentheses.
Done

- line 253: "m2 m-3 (ms -1)" → "m2 m-3 (ms -1)-1"
Done

- lines 259-262: following the revision the concepts illustrated at these lines are now explained also at lines 178-187. It's not necessary to repeat them.

Response: We have rephrased the sentence as follows:
"…The contribution of turbulence on Doppler spectrum broadening is commonly parameterized as σ_t…"

- line 277: "specifc" → "specific"
Done

- line 293: "depended" → "dependent"
Done

- line 296: “configerations to guide the chosen” → “configurations to guide the choice”
Done

- line 298: “appromiately” → “approximately”
Done

- lines 311-313: I find this sentence unclear and I recommend it is rephrased.

Response: This sentence has been rephrased as follows:

Specifically, according to the Mie scattering theory, radar backscattering cross section varies in an oscillatory manner with particle size (Mie, 1908). With the 3.2 mm wavelength radar, the backscattering cross section as a function of droplet size is characterized as several local minimal values with diameter of 1.66, 2.86 mm, which are corresponding to still-air terminal fall velocity of 5.83, 7.89 ms-1. This unique feather is known as “Mie notches” in the radar Doppler spectrum (Kollias et al., 2002;Kollias et al., 2007;Courtier et al., 2022).

- line 357: “both two simulators” → “both simulators”
Done

- Figure 6: I believe it is not explained what the blue area represents. I assume it represents the uncertainty in the Doppler spectrum produced by the uncertainty in sigma, but it should be anyhow explained in the caption.

Response: We have added the description in the caption.
“…The blue shaded region represents the uncertainty of the simulated Doppler spectrum produced by the uncertainty in σ_t based on the convolution method….”

- line 461: the term “resolving” is used inappropriately here, and I recommend it is replaced with “simulating”.
Done

- lines 473-474: “simulator can correct ...” and “simulator can also be utilized …”, since the simulator performance has not been validated I recommend that the authors refrain from such certain statements and phrase these sentences more carefully.

Response: We have deleted these two sentences in the revised manuscript.

- line 535, within the Cheynet (2020) reference: in the doi there is a space after the dot.

Response: Corrections have been made in the revised manuscript.

Reviewer 3

The current version is easier to follow. But there are still questions to address.

1. Fig. 1. A fit was made to the data given in Gunn and Kinzer (1949) which is known for a milestone of raindrop velocity measurement. But in their work, C_d and Re were calculated instead of directly measured. Loth (2008) has made a review on this topic. Have you checked the applicability of C_d and Re of Gunn and Kinzer (1949)?

Response: We thank the reviewer for providing the review paper, which is helpful for consolidating our work. The review from Loth (2008) deals with more complicated shapes of solid particles instead of raindrop which can be considered as perfect sphere when the diameter is small and oblate particles beyond. Instead, the experiment-based estimation of Cd and Re from the Gunn and Kinzer (1949) is widely applied in the cloud physics and radar community, especially for estimating terminal fall velocity from particles (Bartholomew, 2020;Lhermitte, 2002). In Lhermitte (2002, P 91), a comparison is made showing that the Cd estimated from Gunn and Kinzer (1949) is consistent with the one derived from the stokes law as droplet diameter small than 2mm but deviate for large diameter caused by the oblate particle effect. We hereafter considered the experiment-based Cd-Re relationship is applicable for our objective. Moreover, the diameter-terminal fall velocity relationship we adapted in our simulator (i.e. Eq. 9) is also derived from the Gunn and Kinzer (1949), the adapted fitted Cd-Re makes the dynamical framework of the simulator self-consistence. A detailed validation of the Cd-Re relationship can also be found at the interactive discussion with one of the reviewers:
https://editor.copernicus.org/index.php?_mdl=msover_md&_jrl=400&_lcm=oc108lcm109w&_acm=get_comm_sup_file&_ms=109202&c=242211&salt=14626878041751600723

2. Fig.5. It is good that different turbulence intensities were assumed. In (a), the turbulence is rather weak. We can see that the spectrum generated by the convolution method almost overlaps the still-air condition, as expected. But detectable deviation found in PBS. To my understanding, the inertia effect makes the spectrum of large drops less broadening, therefore better matching with the still-air condition. Why the reddish curves in Fig.5 systematically move towards the slow-falling parts?

Response: We appreciate the reviewer for the detailed observation. However, we would not interpret the PBS-based Doppler spectrum is systematically moving towards the slow-falling part. First, for the right edges, the red line (i.e. PBS-based spectrum) overlaps with the black line instead of the blue line (i.e. convolution-based spectrum), this indicates that even with small σ_t as 0.05ms^{-1}, the over broadening effect of the Doppler spectrum from the convolution method can be identified. Second, the location of the first notch of the PBS-based spectrum also consistent with other two.

We however noticed the inconsistency between the spectra at the second notch and the left edges. This is due to the generated PBS-based Doppler spectrum is depended on the applied turbulent velocity field, which is generated numerically and may include truncation error regarding the $\sigma_t$intensity. Nevertheless, the difference of the left edge location between the PBS-based and the convolution-based spectrum in Fig.5 (a) is around 0.02 ms^{-1}, which is considered as the uncertainty of the PBS-based Doppler spectrum. In contrast, what we want to highlight in this study is the over broadening effect which is manifested as the large velocity difference at the right edge which can reach to 1m/s as shown in Fig.5 d.

3. I understand that the authors want to highlight the importance of inertia effect to spectrum simulation. However, the conclusions left me the impression that if the inertia effect is considered, we are good with the spectrum simulation. As I commented before, the current study assumes the absence of many other factors contributing to the spectrum broadening. If all factors are considered, would not the convolution method work? As far as I could see, Tridon et al have a serial of works using the convolution method, and they obtained rather good results. I believe the adequacy of the convolution method should be discussed.

Response:

We thank the reviewer's comments. We have modified the conclusions in the revised manuscript. Specifically, we agree with the reviewer that the convolution approach is a well-established and an efficient method to simulate Doppler spectrum, particular in the light precipitation and weak turbulence condition:
"…In the case of light precipitation mostly happening in marine boundary layer cloud, the droplet inertia effect on Doppler spectrum is negligible and the traditional simulator generates consistent results with the proposed simulator…"

The objective of our work is to bring awareness to the community that in the presence of heavy precipitation and especially strong turbulence environment, the over broadening issue of the convolution approach should be considered.

"…The comparison indicates that the traditional Doppler simulator without considering the inertial effect generates an artificially broader Doppler spectrum. This inertia effect becomes more noticeable as turbulence intensity increases. This finding suggests that special caution should be taken when applying convolution-based approaches to represent DSD-turbulence interaction in heavy precipitation…"

Overall, we think this work may be helpful for the radar and cloud physics community for a better interpretation of the results generated from the Doppler spectrum simulator. We have also published our simulator codes at https://doi.org/10.5281/zenodo.7897981 and anticipated more upcoming applications.

Reference

Bartholomew, M.: Laser Disdrometer Instrument Handbook, DOE Office of Science Atmospheric Radiation Measurement (ARM) Program …, 2020.
Lhermitte, R. M.: Centimeter & millimeter wavelength radars in meteorology, Lhermitte Publications, 2002.