Response to Reviewer 1

Dear reviewer,

We appreciate the time and effort that you devoted to reviewing our manuscript and are grateful for the insightful comments on improvements to our paper. We have revised the manuscript accordingly. Below, we provide a point-by-point response to each comment.

Point 1: All symbols and acronyms should be defined.
Thank you for the comment. We have corrected the errors in the manuscript. The revised sentence is in italics.

1.1 For frequencies of common weather radars.
Line 45-50: *However, the precipitation intensity and the size of raindrops in the eastern Tibetan Plateau are relatively small compared to those in the middle and lower reaches of the Yangtze River (Pu et al., 2021), and the sensitivity of common weather radars to small particles is limited at their operating frequencies.*

1.2 Define \lambda and \mu. (DSD formula probably needs to defined first.); the expansion of "GSD?"
Line 60-65: *Due to the limited information obtained from single-frequency radar, the methods for retrieval of DSD parameters are generally chosen to fix the μ parameter of the Gamma Size Distribution (GSD) (Kumar et al., 2011), or utilize λ-μ empirical relationships of GSD to constrain the retrieval results (Huang et al., 2021). In which, μ, and λ are shape, and slope parameters of GSD, respectively.*

1.3 Need to define the terms! For example, what is \lambda here? What is Q_b?
Line 60-65: *Where the efficiency factor of scattering (Q_b), backscattering section of radar (σ_b), extinction cross-section (σ_e) and $|K|^2$ are calculated by pyQuickBeam (Haynes et al., 2007).*

1.4 Is the correction term in eq. (7). a polynomial fit in height based on Table 2 of Atlas et al. (1973)? If so, please state so.
Line 105-110: *In Eq. 6, V(D) is the final falling velocity of raindrops considering the correction term of altitude h, which is calculated from Eq.7 (Atlas et al., 1973).*

1.5 The observation uncertainties in ~~the~~ Z, Vr, and LDR are 0.5 dBZ, 0.5 m/s, and 0.5 dB, respectively.
Line 125-130: *The observation uncertainties in Z, Vr, and LDR are 0.5 dBZ, 0.5 m/s, and 0.5 dB, respectively.*

1.6 Which temperature lapse rate?
Line 155-160: *The temperatures at different range gates of the radar are calculated using the*

temperature lapse rate. The temperature lapse rate is set to 6.5 ℃/km (Kattel et al., 2015).

1.7 What does "stratified" mean in this context?

Line *195-200: To validate the effectiveness of the optimal estimation algorithm, a random stratified sampling of 1800 cases of DSD is selected from the historical observations of the ground-based disdrometers. The precipitation cases were stratified according to the distribution range of N_0 and D_m, and 900 cases were sampled for each of the two parameters to ensure that the validation data covered a relatively comprehensive precipitation scenario.*

1.8 You might want to spell this out at least once. CST can also stand for the Central Standard Time of the US.

Line *225-230: The precipitation events occurred from China Standard Time (CST) 00:00 to 08:12 and from CST 10:08 to 12:04, totaling 517 minutes.*

Point 2： A few sentences are missing a verb..

Thank you for the comment. We have corrected the errors in the manuscript.

Line *115-120:* This sentence is missing a verb.

The majority of D_m is less than 1.7

Point 3： We need to provide the necessary details, e.g., the polynomial (in h) correction in eq. (7).

Thank you for the comment. We have corrected the errors in the manuscript.

Line *105-110: In Eq. 6, V(D) is the final falling velocity of raindrops considering the correction term of altitude h, which is calculated from Eq.7 (Atlas et al., 1973)*

Point 4： This is expected. How about the liquid water content? Is it approximately constant?

Thank you for the comment. The plot and discussion on RWC have been added to the article. Since the RWC is related to the 3-th moment of DSD, it increases as the rain intensity increase and exceeds on average about 0.2 g/m³ at strong echoes (30–45 dBZ).

Line *110-120: The calculated Z values are categorized into four intervals: [-10,10), [10, 20), [20, 30), and [30, 45). The $\log_{10}(N_0)$, D_m and Rain Water Content (RWC) in each Z interval are counted separately and illustrated in Figure1. RWC is calculated by,* $\mathrm{RWC}=\frac{\pi}{6}\times 10^{-4}\int_{D\min}^{D\max} N(D)D^3\mathrm{d}D$.

Approximately 113000 samples of DSD are collected. The results show that the distribution of the $\log_{10}(N_0)$ ranges from 1.0 to 5.6. The majority of D_m is less than 1.7 mm. The statistical results indicate that as the Z of precipitation increases, the proportion of larger raindrops of DSD rises, and the concentration of raindrops decreases. Since the RWC is related to the 3-th moment of DSD, it increases as the rain intensity increase and exceeds on average about 0.2 g/m³ at strong echoes (30–45 dBZ).

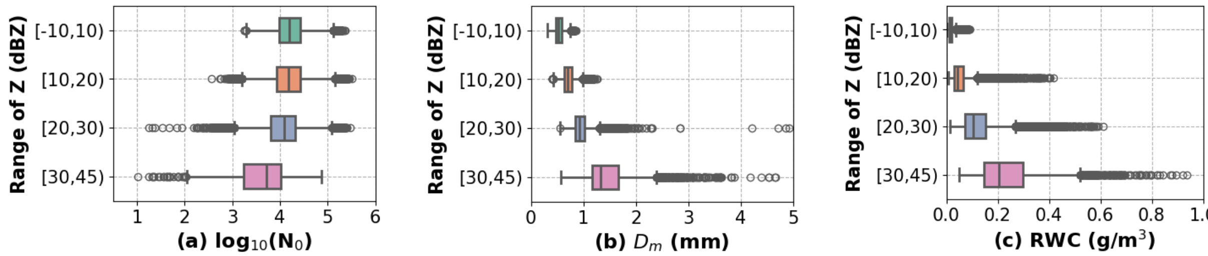


Figure 1. Box plots of the parameters of MP size distribution in different Z intervals. (a) $\log_{10}(N_0)$. (b) D_m. (c) RWC.

Point 5: It appears that extinction (and backscatter) efficiency is calculated using a temperature-dependent index of refraction m≡m(T), but the dielectric factor K, which also depends on m, is kept as a constant, i.e., no temperature dependency. Within 0-10 °C, |K|2 (used in calculating Z) has a ~2% variation, considerably smaller than the variation of m in the same temperature range. Is this the reason that a constant |K|2 is assumed?

Line 105; 190; 220-225: Thank you for the comment. When we verified the radar forward calculation, the dielectric constant of the Quickbeam script was set to the default value, the value for 35 GHz band radar is 0.88. We have corrected the error. We modified the scripts and reran the calculations. The calculated value of $|K|^2$ at 287.15 K is 0.903. In section 3.2, as shown in the modified Fig. 3, The The ME of Z is decreased from 3.63 to 3.48. In section 3.2, as shown in the modified Fig. 5, the JSD values of the retrieved D_m and the distribution of the observations of the ground-based disdrometer decreased 0.01. Other minor changes in the results are not reflected in the plotted figures.

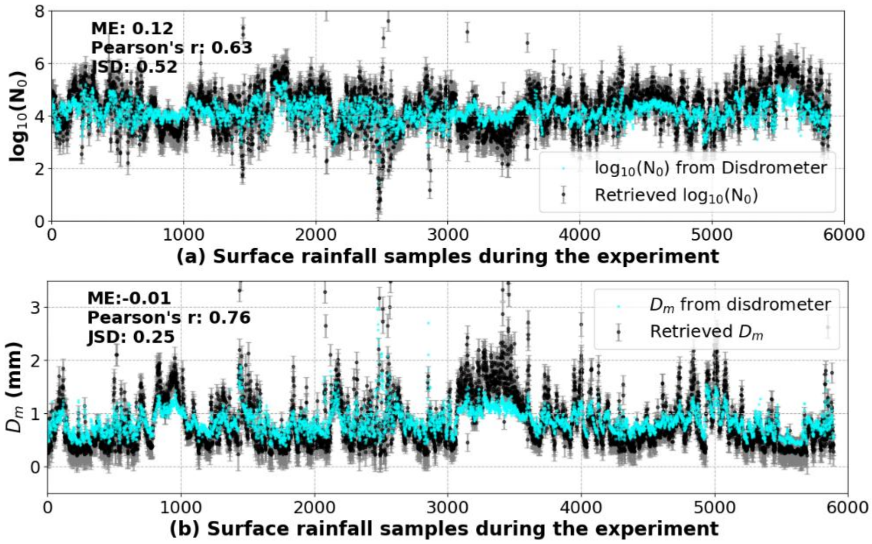
Point 6: The extinction efficiency Q_e) is calculated using temperature dependent m \equiv m(T). Why is the square of the dielectric factor |K|^2 kept at a constant 0.88 (Eq. 5)? Doesn't this introduce inconsistency? It may also be a cause to the difference between calculated and observed Z, right?

Line 105; 190; 220-225: Thank you for the comment. When we verified the radar forward calculation, the dielectric constant of the Quickbeam script was set to the default value, the value for 35 GHz band radar is 0.88. We have corrected the error. We modified the scripts and reran the calculations. The calculated value of $|K|^2$ at 287.15 K is 0.903. In section 3.1, as shown in the modified Fig. 3, The The ME of Z is decreased from 3.63 to 3.48. In section 3.2, as shown in the modified Fig. 5, the JSD values of the retrieved D_m and the distribution of the observations of the ground-based disdrometer decreased 0.01. Other minor changes in the results are not reflected in the plotted figures.

Point 7: Blue on black (Figure 5) is difficult to see. Consider using a lighter color than the blue used.

Thank you for the comment. We have redrawn the figure to improve its clarity.

Line 220-225:



We hope that the revised version meets the requirements, and looking forward receiving your further comments and suggestions.

Best regards,
Pingyi Dong
on behalf of all co-authors