Response to 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： Line 18-19: indicates (missing an s at the end). between 0.1 and 0.12 mm (this reads better).

Thank you for the comment. We have revised it in the manuscript.

Line 18-21: Validation by a field campaign during the summer of 2024 indicates that the mean bias in the $\log_{10}(N_0)$ and D_m derived from the PARSIVEL^2 disdrometer and the retrieved values are 0.12 and -0.1 mm respectively, demonstrating the effectiveness of the retrieved DSD parameters in this region.

Point 2： Line 63: , in which.

Thank you for the comment. We have revised it in the manuscript.

Line 61-664466: 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), where μ and λ are shape, and slope parameters of GSD, respectively.

Point 3： Line 85: for ~~the~~ velocity,

Thank you for the comment. We have revised it in the manuscript.

Line 85: The measuring ranges of the disdrometer are 0.062~24.5 mm for the size of raindrops and 0.05~20.8 m/s for velocity, respectively.

Point 4： Line 89: It is usually called "size bin."

Thank you for the comment. We have revised it in the manuscript.

Line 89-90: Where $n_{i,j}$ represents the number of raindrops in the i-th size bin and the j-th velocity bin, A_i denotes the sampling area, t is the integration time, and $V_{i,j}$ indicates the falling velocity of raindrops in the i-th size bin and the j-th velocity bin.

Point 5： Line 94-95: ; the, is determined, is

Thank you for the comment. We have revised it in the manuscript.

Line 94-95: In Eq. (2), D is the maximum dimension of the particle, N_0 is the concentration parameter, the mass-weighted mean diameter D_m, is determined as the ratio of the fourth to third moments of the DSD. N_0 is calculated from the third and fourth moments of DSD (Smith, 2003),

Point 6： Line 105: calculated using Eq. 7 of Atlas et al. (1973).

Thank you for the comment. We have revised it in the manuscript.

Line 105: Where $n_{i,j}$ represents the number of raindrops in the i-th size bin and the j-th velocity bin, A_i denotes the sampling area, t is the integration time, and $V_{i,j}$ indicates the falling velocity of raindrops in the i-th size bin and the j-th velocity bin.

Point 7: The caption should descibe/explain the figure better. For example, what do the elements in the plots mean? A reader can have a reasonable guess but it is risky to rely on guesses. Similar plot elements appear in other figures too. One must clearly describe/explain them at least once.

Thank you for the comment. We have revised it in the manuscript.

Line 111-113: In the box plot used in this paper, the box indicates the Interquartile Range (IQR, 25th–75th percentiles), the horizontal line inside the box denotes the median, and the whiskers extend to the most extreme values within 1.5×IQR.

Point 8: There should be a more proper way of referencing this edited book.

Thank you for the comment. We have revised it in the manuscript.

Line 40: Maggioni, V. and Massari, C.: Extreme hydroclimatic events and multivariate hazards in a changing environment: a remote sensing approach, Elsevier, https://doi.org/10.1016/C2017-0-02344-3, 2019.

Point 9: a priori

Thank you for the comment. We have revised it in the manuscript.

Line 137: The first guess of x_a, and a priori error covariance matrix S_a are set based on the prior information of the DSD in Hongyuan.

Point 10: It is unwise to use the same symbol, x, for the "variable" and the index.

Thank you for the comment. We have revised it in the manuscript.

Line 153-165: The S_y and S_a are then used to weight the difference of the $F(x_a)$ and y_{obs} for updating the x_a to x_{j+1}. The subscript is the iteration index. X_{j+1} is calculated by:

$$x_{j+1} = x_a + (S_a^{-1} + K_j^T S_y^{-1} K_j)^{-1} K_j^T S_y^{-1} [y - F(x_j) + K_j(x_j - x_a)] \quad (9)$$

Where K_j represents the Jacobian matrix computed at the j-th iteration. The elements of K_j numerically computed by finite differences around the state vector at each iteration of the retrieval, the perturbation is chosen as 1% of the state vector. The typical value of K_j indicate that the Z is sensitive to both $\log_{10}(N_0)$ and D_m, with $\partial Z/\partial \log_{10}(N_0)$ and $\partial Z/\partial D_m$ on the order of 10 and 20, respectively. And V_r is almost insensitive to $\log_{10}(N_0)$ and only affected by D_m, with $\partial V_r/\partial \log_{10}(N_0) \approx 0$ and $\partial V_r/\partial D_m \approx 2.3$. This pattern indicates that the mainly constrains the retrieval of N_0 and D_m, while V_r provides complementary sensitivity to D_m. The iteration ceases when the result of the left side of Eq. (10) falls below the predetermined threshold χ.

$$(x_{j+1} - x_j)^T S_j^{-1} (x_{j+1} - x_j) = \chi \quad (10)$$

χ is typically set to the length of the parameters that are to be retrieved. S_j in Eq. (11) provides the uncertainty associated with the retrieved x_j:

$$S_j = (S_j^{-1} + K_j^T S_y^{-1} K_j)^{-1} \quad (11)$$

If the convergence of retrieval is achieved, the x_j and S_j are the optimal solution x_{op} and corresponding uncertainty S_{op}.

Point 11： above ground level (AGL) height, right?

Thank you for the comment. We have revised it in the manuscript.

Line 168: Unless otherwise noted, heights throughout this paper refer to above ground level (AGL) height.

Point 12： ?

Thank you for the comment. We have revised it in the manuscript.

Line 168: The Z_{h0} and V_{h0} are taken as the y_{obs} for the optimal estimation algorithm to retrieve the $\log_{10}(N_0)$ and D_m of the DSD at the surface.

Point 13： You have used the convention of "Figure 1" and "Figure 2" when referencing figures. Why do you switch the convention between "Figure #" and "Fig. #?" The convention of the captions, however, stays consistent throughout.

Thank you for the comment. We have unified the figure-referencing style throughout the manuscript and now consistently use "Figure #" in the text, consistent with the figure captions.

Line 183: The flowchart of the retrieval method is presented in Figure 3.

Point 14： Do you mean "The maximum Z (value) of the profiles?" I put "value" in parentheses to indicate that it is not necessary and can be omitted.

Thank you for the comment. We have revised it in the manuscript.

Line 164: The maximum Z in the profile is used as an indicator of the heavy precipitation.

Point 15： What about the circles?

Thank you for the comment. We have revised it in the manuscript.

Line 111-113: In the box plot used in this paper, the box indicates the Interquartile Range (IQR, 25th–75th percentiles), the horizontal line inside the box denotes the median, and the whiskers extend to the most extreme values within 1.5×IQR.

Point 16： above ground level (AGL), right?

Thank you for the comment. We have revised it in the manuscript.

Line 168: Unless otherwise noted, heights throughout this paper refer to above ground level (AGL) height.

Point 17： Suggestion: It will improve readability considerably if there were more space between references.

(Authors do not need to address this. I am sure Copernicus' type-setting will handle this for the eventual publication.)

Thank you for the comment. We have revised the reference to make it clear.