Response to referee #02 (Report #02)

The manuscript has been substantially re-written improving the language and the readability of the text. I'm still not fully convinced about the quality of the language, but, since I'm not a native English speaker, I do not want to focus on this issue. Coming to the scientific side, I see two major issues that the Authors should fix (or, at least, deeply discuss) in the text before the manuscript is accepted for publication on HESS.

Reply: We sincerely acknowledge the reviewer for providing positive view and constructive comments on our manuscript. We have addressed all the reviewer's comments by providing detailed response for each comment, and the necessary modifications are also made (with red color text) in the revised manuscript

Major comments:

1. First, the distinction between TY and NTY spectra is rather weak (fig. 3), and the Authors should show that the spectra variability within TY and NTY classes is smaller than the differences between averaged TY and NTY spectra. The Authors, for instance, could add to the averaged spectra in Fig. 3 the curves of mean spectra +- one standard deviation. Also other results show very similar values between TY and NTY samples. In the conclusion, the sentence: "Likelihood for the diverse microphysical processes between TY and NTY rainfall is exemplified by exclusive separation in TY and NTY rainfall normalized raindrop spectra at $D/D_m > 2$", is not supported by evidence. There is no "exclusive separation" in figure 3b beyond $D/D_m=2$: we can see that there is an evidence that NTY precipitation has higher occurrence of larger drops.

Reply: We thank the reviewer for this comment. As per the reviewer's suggest, Fig.3 is redrawn by providing error bars (± standard deviation) to each drop diameter bin and is given below with Y-axis in logarithmic and linear scale. The figure shows that the spectral variability within TY and NTY classes is smaller than the differences between averaged TY and NTY spectra.

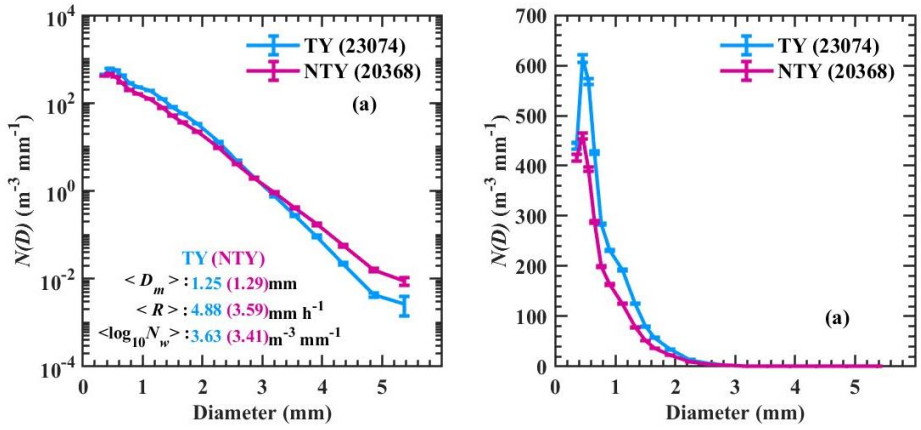

Figure R1. Mean raindrop size distributions of TY and NTY rainfall with Y-axis in logarithmic (left panel) and linear (right panel) scale.

We have modified Fig.3a by providing error bars at each diameter bin in the revised manuscript and the below mentioned sentence is incorporated in the revised manuscript at lines 193-196.

"Despite of weak distinction between TY and NTY mean rain spectra for raindrops of diameter < 2 mm, it can be seen that the spectra variability within TY and NTY classes is smaller than the differences between averaged TY and NTY spectra."

As per the reviewer's opinion, the sentence in the conclusion section is modified as "The mean normalized RSD of NTY precipitation has a higher occurrence of larger drops (at D/D_m > 2) than TY precipitation, which indicates the possibility for diverse microphysical processes between these two weather conditions." in the revised manuscript at lines 424-427.

2. A second issue is on the JW performances under Typhoon weather, i.e. when rain comes together with strong winds. The hypothesis that drops fall vertically at terminal velocity, does still hold under very strong horizontal winds? There are any measurements of wind speed in TY and NTY days?

Reply: We thank the reviewer for this comment. Before considering the JWD measurements in the analysis, we compared daily rainfall amounts from JWD with the collocated rain gauge for both TY and NTY rainy days as shown in Fig.2. The rainy days with large discrepancy between JWD and rain gauge measurements were already discarded in this study, however, we didn't mention this statement in the manuscript. We noticed four TY rainy with larger discrepancy between JWD and rain gauges measurements and were excluded in the analysis, and there were no NTY rainy days with much discrepancy between JWD and rain gauge measurements.

As per the reviewer's suggestion, we compared the daily rainfall amounts of JWD with rain gauge for different wind speed conditions (daily maximum wind speed: 0-8, 8-14, 14-18, > 18 m s^{-1}) and the results are given in the below table.

Table R1. The JWD and rain gauge comparison results (n: number of rainy days, CC: correlation coefficient, RMSE: root mean square error) for different wind speed conditions (daily maximum wind speed: 0-8, 8-14, 14-18, > 18 m s^{-1}). Note: there were no NTY rainy days with daily maximum wind speed > 14 m s^{-1}.

Wind speed (m s^{-1})	TY			NTY		
	n	CC	RMSE (mm)	n	CC	RMSE (mm)
0-8	21	0.989	6.305	113	0.956	3.853
8-14	27	0.99	5.153	18	0.942	3.482
14-18	8	0.953	18.112	-	-	-
>18	3	0.996	7.448	-	-	-

Below mentioned sentences are added in the revised manuscript at lines 152-159

"The rainy days (TY: 04 days and NTY: 0 days) with larger discrepancy between JWD and rain gauge measurements were discarded in this study. Further, we compared the JWD measurements (for both TY and NTY rainy days) with the rain gauge for different wind speed conditions (daily maximum wind speed: 0-8, 8-14, 14-18, > 18 m s^{-1}), and the results are provided in Table 1. For the considered NTY rainy days, the daily maximum wind speeds were less than 14 m s^{-1}, however, there were TY rainy days with wind speed > 18 m/s. A good agreement between JWD and rain gauge measurements for both TY and NTY days (Fig.2 and Table 1) provided the trustworthiness of the JWD data for further analysis"

Table 1. The JWD and rain gauge comparison results (n: number of rainy days, CC: correlation coefficient, RMSE: root mean square error) for different wind speed conditions (daily maximum wind speed: 0-8, 8-14, 14-18, > 18 m s^{-1}). Note: there were no NTY rainy days with daily maximum wind speed > 14 m s^{-1}.

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Minor comments:

1. Lines 122-113. "if a typhoon was invaded…" does it mean that the "typhoon center" invaded, or simply some piece of the cloud structure invaded the box?

Reply: To provide more clarity to the sentence, we modified "if a typhoon was invaded" with "if a typhoon center was invaded" in the revised manuscript at lines 128-129.

2. Line 175. I do not thing that "formidable" is the right adjective here.

Reply: The "formidable" is modified to "difficult" in the revised manuscript at line 197.

3. Line 226. In my opinion "weather system" cannot be an attribute of NTY cases, since many different weather systems can occur in NTY days. I suggest to use "weather condition" or "weather settings", instead.

Reply: As per the reviewer's suggestions, we have modified "weather systems" to "weather conditions" throughout the revised manuscript.

4. Lines 393-395. This sentence needs rewriting, in this way is unclear.

Reply: As per the reviewer's suggestion, the sentence is modified as "Besides disdrometer data, other auxiliary data sets (remote-sensing, re-analysis, and ground-based radar) have been used to discuss the disparities in RSDs between TY and NTY rainfall." In the revised manuscript at lines 422-423.

5. Table 2. Please, report the unit for RMSE

Reply: The units for RMSE are J m^{-2} h^{-1} for KE_{time}-R relations and J m^{-2} mm^{-1} for KE_{mm}-R relations and the same "Note: Units for RMSE are J m^{-2} h^{-1} for KE_{time}-R relations and J m^{-2} mm^{-1} for KE_{mm}-R relations" is provided in table (Table #3) caption of revised manuscript at lines 705-706.

Response to Referee # 03 (Report #01)

GENERAL COMMENTS

The manuscript mainly analyzed RSD data collected in north Taiwan during Typhoon and non-typhoon events. Furthermore, a brief analysis of additional data (reanalysis, remote-sensing, and ground-based datasets) is also provided. The manuscript is well written and easy to follow. I suggest the publication on Hydrology and Earth System Sciences after addressing my minor comments.

Reply: We sincerely acknowledge the reviewer for providing encouraging and precise comments. We have addressed all the reviewer's comments by providing detailed response for each comment, and the necessary modifications are made (with red color text) in the revised manuscript.

SPECIFIC COMMENTS:

1. Lines 192-194: the sentence need to be further explained. Please add some details

Reply: As per the reviewer's suggestion, the sentence is modified as: "Further, a statistical Student's t-test (used to determine whether two data sets are significantly different from each other or not), is executed between TY and NTY rainfall D_m values. The test results rejected the null hypothesis at 0.05 and 0.01 significance levels, which confirm that the D_m values in TY rainfall are different from that of the NTY rainfall. Similarly, the Student's t-test performed for other three parameters ($\log_{10}N_w$, $\log_{10}R$, and $\log_{10}W$) also showed that these parameters in TY rainfall are different from that of the NTY rainfall." in the revised manuscript at line 212-218.

2. Figure 5: check the y-label of Figure 5c & d

Reply: We thank the reviewer for this comment. The y-label of Fig. 5c & d are changed to "Percentage of N_t (m^{-3})" and "Percentage of R (mm h^{-1})" and the modified figure is provided in the revised manuscript.

3. Lines 221-224: Please explain better the separation criterion for typhoon and non-typhoon events, so that it can be easily applied also to other researchers.

Reply: We thank the reviewer for this comment. The sentence in lines 221-224 describes the criteria for considering each rainfall rate class (C1: $0.1 \leq R < 1$, C2: $1 \leq R < 2$, C3: $2 \leq R < 5$, C4: $5 \leq R < 10$, C5: $10 \leq R < 30$, C6: $30 \leq R < 50$, and C7: $R > 5$, where R is in mm h^{-1}; please refer to table 1), but not the "separation criterion for typhoon and non-typhoon events".

The typhoon (TY) and non-typhoon (NTY) rainfall events separation criteria is provided at lines: 115-118, i.e., During summer seasons, if there is any typhoon track within 500 km radius from the disdrometer site, the corresponding rainfall is considered as typhoon (TY)

rain event, and the rest of the rainfall events in summer seasons are considered as non-typhoon (NTY) rain events.

4. Lines 231-232: please write the equation! It will be more clear to the reader

Reply: As per the reviewer's recommendations, Equation is provided for the percentage parameters as given below in the revised manuscript at lines 258-265.

"The percentage parameter of *N(D)* for different rain rate class, $\delta(D, R) = \delta(D, R_{Ck})_{TY/NTY}$ is given as

$$\delta(D, R_{Ck})_{TY} = \frac{[N(D)_{TY}]_{Ck}}{([N(D)_{TY}]_{Ck}+[N(D)_{NTY}]_{Ck})} \times 100 \quad \text{----------(1)}$$

$$\delta(D, R_{Ck})_{NTY} = \frac{[N(D)_{NTY}]_{Ck}}{([N(D)_{TY}]_{Ck}+[N(D)_{NTY}]_{Ck})} \times 100 \quad \text{----------(2)}$$

Where $[N(D)_{TY}]_{Ck}$ or $[N(D)_{NTY}]_{Ck}$ represents the mean N*(D)* of TY or NTY rainfall for the rain rate class "Ck", with k=1, 2, 3, 4, 5, 6, 7 (C1: $0.1 \leq R < 1$, C2: $1 \leq R < 2$, C3: $2 \leq R < 5$, C4: $5 \leq R < 10$, C5: $10 \leq R < 30$, C6: $30 \leq R < 50$, and C7: $R > 50$, where R is in mm h^{-1}; please refer to table 1)."

5. Line 251: Why the Authors did not use the C1-C7 rain classes in Figure 8 as in Figure 6 and Figure 7?

Reply: To have a consistency among Fig. 6, Fig. 7 and Fig.8, the seven rainfall rate classes (C1-C7) are used in Fig.8 and the modified figure is provided in the revised manuscript.

6. Lines 274-276: Why the Authors did not use the Bringi et al. method described and analysed in the previous section? Please use that method or eliminate it and include Me et al. method in the analysis reported in the previous section of the manuscript or justify why you analysed your data with respect to the Bringi et al. method and then you used the Ma et al method for classification.

Reply: We thank the reviewer for this meticulous comment.

The main purpose plotting Fig. 8 is to know how D_o (mm), and $\log_{10}N_w$ (N_w in m^{-3} mm^{-1}) distributions vary at different rainfall rate classes for both TY and NTY rainfall and then to notice the performance of Bringi et al. (2003) and Thompson et al. (2015) rain classification methods. From Fig.8 we noticed that in classifying the TY and NTY rainfall into stratiform and convective type, Bringi et al. (2003) classification method is superior to that of the Thomson et al. (2015).

In Bringi et al. (2003) rain classification, 5 consecutive 2-min (or 10 consecutive 1-min) RSD samples are considered to as stratiform type if the mean value of rainfall rate (R) $\geq$ 0.5 mm h^{-1} and the standard deviation of R (σ_R) $\leq$ 1.5 mm h^{-1}, and convective type if the mean value of R > 5 mm h^{-1} and the standard deviation of R (σ_R) > 1.5 mm h^{-1}. However, with this method, we may miss some RSD samples that can't satisfy the above two conditions.

On the other hand, the Ma et al. (2019) rain classification method is the modified form of Bringi et al. (2003) ["*if the standard derivation of rain rate for a consequent 10 min is greater than 1.5 mm h^{-1} and the rain rate is greater than 5 mm h^{-1}, it is classified as convective rain; otherwise, it is classified as stratiform rain."* : from Page # 4157, Section 3.2 of Ma et al. (2019)].

As there is possibility for losing some RSD samples while classifying the precipitation into stratiform and convective type using Bring et al. (2003) method, to accommodate all RSD samples into stratiform or convective category, we adopted the modified form of Bringi et al. (2003) rain classification procedure as mention in Ma et al. (2019), i.e., "*if the mean value of rain rate for a consequent 10 min is > 5 mm $h^{-1}$and the standard derivation of rain rate is > 1.5 mm h^{-1}, it is classified as convective rain; otherwise, it is classified as stratiform rain"*

Hence, the sentence is modified as given below in the revised manuscript at lines 304-306.

"In separating the TY and NTY rainfall into stratiform and convective type, we adopted the modified form of Bring et al. (2003) classification method as mentioned in Ma et al. (2019)."

7. Line 298: "is due the presence" instead of "is due the presence"

Reply: The typo error is corrected by replacing "is due the presence" with "is due to the presence" in the revised manuscript at line 329.

8. Line 303: please see Adirosi et al. (2018) for the effects of different disdrometer types on the Z-R relation.

Adirosi, E., Roberto, N., Montopoli, M., Gorgucci, E., & Baldini, L. (2018). Influence of disdrometer type on weather radar algorithms from measured DSD: Application to Italian climatology. Atmosphere, 9(9), 360.

Reply: We thank the reviewer for suggesting this article that provides the information about how different types of disdrometers influences the weather radar algorithms. We have gone through this article and we mentioned it the revised manuscript at line 334.

9. Line 357: please specify the meaning of CER

Reply: We have mentioned the meaning of CER as "cloud effective radii (CER)" in the revised manuscript at line 173.