General remarks:

This paper examined radar quantitative precipitation estimation (QPE) in typhoon Lekima (2019) by comparing surface-based multiple-observational datasets. The discussion on self-consistency between radar and theoretically derived variables is interesting to me. Also, overall quality-control processes in radar and disdrometer are quite beneficial in the radar community. These should be positive points in this manuscript. However, it would be more interpretation for microphysical processes using polarimetric variables. Also, some sentences (or words) should be revised. To enhance the paper, I have the following more specific suggestions.

Response: We thank the reviewer for the careful review and suggestions that improved this article. We have extensively revised the manuscript based on the reviewer's comments.

Specific comments:

1. The microphysical characteristics would be discussed more in the manuscript, because the part related to microphysical processes was in only one section 3.2. Otherwise, the title and abstract should be revised. The author spends most of the manuscript describing data processing (including radar and disdrometer) and comparing observed radar variables and theoretically derived variables. Also, the microphysical processes are included in the summary.

   Response: Thanks for pointing this out. In the revision, we have included more detailed discussions about the microphysical processes occurred during the landfall of Lekima, including the falling melting solid particles, the overwhelming breakup over coalescence in radar sampling volumes (above the ground), and orographic enhancement of precipitation around the GWS of YDM.

   In addition to the self-consistency/consistency described in the previous version, we have partitioned Section 3.2 into Sections 3.2.1 and 3.2.2 to highlight the microphysical features of the falling melting solid particles and the overwhelming breakup over coalescence. We have also added Section 3.3.3 to discuss the precipitation particle falling processes given the vertical gap between radar sampling volumes and the surface (i.e., Fig. 1c).

   The self-consistency/consistency not only supports the credibility of various measurements but also serves for the verification of the microphysical processes: breakup-dominated Z_{DR} is relatively smaller than that of coalescence-dominated Z_{DR}; therefore, different Z_{DR}-Z_H relationships are anticipated, which is in line with a previous simulation study in Kumjian and Prat (2014).

   Reference:

   Kumjian, M. R., and O. P. Prat, 2014: The Impact of Raindrop Collisional Processes on the Polarimetric Radar Variables, *Journal of the Atmospheric Sciences*, **71(8)**, 3052-3067.

2. Line 83: the reviewer recommends adding more background on why the author chooses the typhoon case. This is because the typhoon case is inappropriate for radar-based QPE related to strong winds and mixed-phase hydrometeor particles. As the author mentioned, there are enormous possibilities for measurement errors in radar, rain gauge, and disdrometer. It could be helpful why the author selected the typhoon case even though there can be large measurement errors.

   Response: Thanks for this very good comment. We agree with the reviewer that radar-based QPE can have large uncertainty due to various reasons. In fact, because of the complex microphysical processes during typhoons, the falling mixed-phase hydrometeor particles were rarely studied before, and how the dominant breakup/coalescence affects the practical performances of radar QPE is unknown. As such, we meant to disentangle this challenging problem by focusing on the microphysical variations during landfall of Lekima, which is the strongest landing typhoon in Zhejiang since 1949. More importantly, it is the first super typhoon landed on the coast of Zhejiang after the polarimetric upgrade of the WZ-SPOL radar. We wanted to use this opportunity to exploit the radar-inferred microphysical processes, including radar QPE.

3. The words are quite not understandable. What is the meaning of "dynamic precipitation microphysical processes"? It seems very complicated to understand the word in the sentences. Please rewrite (or) the words. The others can find as minor suggestions.

Response: Basically, we want to highlight the complicated (and changing) precipitation microphysics. We have rephrased this sentence in the revision. Now it reads "The impacts of dominant collision-breakup or collision-coalescence on radar QPE performance are also quantified in Section 3."

4. The reviewer suggests that the authors can use three-dimensional structures to understand microphysical processes. Also, it would be helpful if you plot contoured frequency by altitude diagrams (CFADs) with the dual-polarimetric variable in analyzing microphysical processes. There are many works of literature to understand microphysical processes in deep convective clouds. Below is one piece of literature the authors can refer to, Friedrich, K., Kalina, E. A., Aikins, J., Gochis, D., & Rasmussen, R. (2016). Precipitation and Cloud Structures of Intense Rain during the 2013 Great Colorado Flood, *Journal of Hydrometeorology*, *17*(1), 27-52.
Response: Thanks for this great suggestion. In fact, we started from the CFADs, which are hard to compare when we have too many of them. Another reviewer suggested using RHIs, CAPPIs, or QVPs. In the revision, we decided to use the time series of vertical polarimetric variables (Figs. 12-17) to analyze the microphysical processes during the landfall of Lekima. The main reasons are (i) RHIs are only available along one radial direction; QVPs account for the microphysical process in an average way (azimuthal average through radar measurements at high elevation angles), and their representativeness for one pixel is uncertain. (ii) Radar observes hydrometers above the ground, and the near-surface level measurements are not available (that is also why we need to use other instrument such as rain gauge and disdrometers to verify surface measurements). (iii) The combined analysis of vertical polarimetric radar time series and the surface DSD-simulated counterparts is very useful in checking the microphysical evolutions of precipitation.

5. Lines 375-394: it would be helpful if the author could show some figures with vertical structures with polarimetric variables in their microphysical processes (i.e., accretion, coalescence, and breakup).
Response: Vertical structures of polarimetric radar measurements (at the selected meteorological stations) are included as suggested! Thanks for this great suggestion!

6. Figure 10: the differences of K_{DP} and Z_{DR} were quite significant in interpreting some microphysical processes. It seems that the author needs additional quality control in the radar variable.
Response: Originally, we want to use this figure to emphasize the self-consistency between radar variables, and consistency between rain gauges and disdrometers, since these would demonstrate the credibility of radar and surface measurements. After seeing this comment and checking the residual differences in Fig. 10, we decided to interpret the differences in a more thorough way. After extensive analysis of the quality control in the radar variables, we concluded that both radar and surface measurements are reliable robust, the residual Z_{DR} differences can be attributed to the microphysical processes. Three polarimetric radar signatures account for the dominant breakup: (i) radar-measured Z_{DR}^{C}-Z_{H}^{C} scattergram infers breakup-dominated small size drops since small Z_{DR}^{C} is expected for a given Z_{H}^{C}, which agrees well with the simulation in Kumjian and Prat (2014). (ii) without strong updrafts, the vertical column of Z_{DR} also presented more decreasing trend in the lower atmospheric layers (see Figs. 12-17). (iii) In the time series comparison (Fig. 10), radar-measured Z_{H}^{C} and K_{DP} agree well with DSD-derived counterparts, but radar-measured Z_{DR}^{C} is larger than DSD-derived Z_{DR} at HJ, XJ, and LH due to the dominant breakup. If coalescence dominates in the vertical gap between radar measurements and the surface, the latter would be larger than the former.

Reference:
Kumjian, M. R., and Prat, O. P. 2014. The Impact of Raindrop Collisional Processes on the Polarimetric Radar Variables, *Journal of the Atmospheric Sciences*, **71(8)**, 3052-3067.

7. Line 376-377: the melting graupels (or hail) are important in their change size for ZDR measurement. It would be helpful if the author could analyze with thermodynamic profiles.
Response: We totally agree with the reviewer. Unfortunately, we (operational weather forecast office) did not collect any radiosonde observations in this interesting study domain during this event. We did have temperature and other meteorological datasets at surface meteorology stations. According to the following figure, WL, YH, and DT suffered from a temperate dropdown (the minimum temperature was 24.9°) before the center area

of the typhoon landed on WL, indicating that some cooler hydrometeors were falling. But whether these hydrometeors are ices/graupels/hail is not clear.

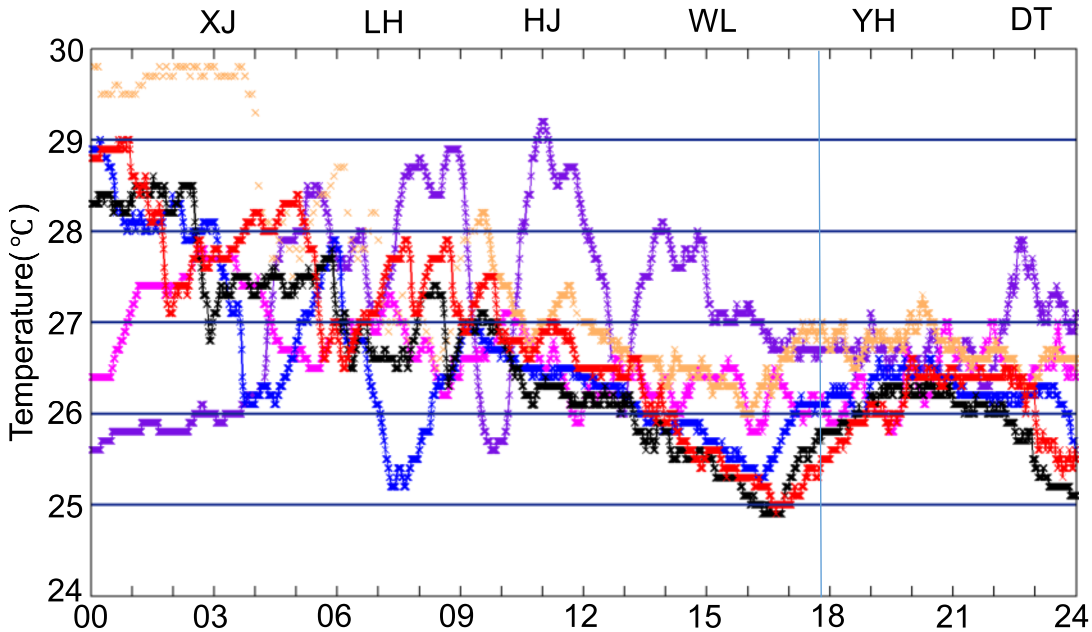

Fig. 1. The time series of temperature at six national meteorological stations on 09 August 2019 (UTC). The vertical light blue line indicated the landfalling time of Lekima.

Minor comments:

1. Line 39: this sentence would not be correct. As far as I know, dual-polarimetric variables are used for the operational purpose in radar QPE. For instance, MRMS has used available dual-polarimetric variables in radar QPE. Please see the below reference,
   - Ryzhkov A, Zhang P, Bukovčić P, Zhang J, Cocks S. Polarimetric Radar Quantitative Precipitation Estimation. *Remote Sensing*. 2022; 14(7):1695. https://doi.org/10.3390/rs14071695

   Response: Sorry for this mistake. We have fixed this in the revision.

2. Line 99: what is the "special microphysical processes"?
   Response: Based on our latest analysis, Z_H and Z_{DR} in radar sampling volumes above the GWS of YDM are characterized by the breakup-dominated small size drops. Raindrops transitioned to coalescence-dominated large-sized raindrops near the surface around the GWS of YDM due to topographical enhancement. We have clarified this in the revision.

3. Line 109: what is the "regional central cities"?
   Response: The regional central city is an official way of dividing cities in mainland China according to the urban system planning. It refers to provincial capital cities and sub-provincial cities with important regional significance. We have removed this term in the revision to avoid possible confusion.

4. Line 127–128: please rewrite this sentence. "only gauge observations without any interruptions are utilized in this study"
   Response: We have rephrase this sentence, now it reads "Only gauges with continuous measurements (no interruptions due to malfunction and network issues) are used in this study."

5. Line 131–141: please consider that these sentences could move to the introduction section.
   Response: Changed as suggested!

6. Line 156: why did the author select the threshold (Freq>50%)? I think the ground clutter could be well identified in clear air conditions.
   Response: Thanks for this great point. Yes. We have actually included some clear air echoes in the map in Fig. 3a to mitigate residual clutters left after applying the CMD algorithm in Hubbert et al. (2009). A threshold on

Z_H(Z_H>0 dBZ) and Freq>50% was used mainly to incorporate the potential fluctuations of Z_H around the ground clutters.

Reference:

Hubbert, J., M. Dixon, and S. Ellis, 2009: Weather Radar Ground Clutter.. Part II: Real-Time Identification and Filtering. *J. Atmos. Ocean. Technol.*, **26**, 1181–1197.

7. Line 357: please add more interpretation about this sentence. What is the meaning of microphysical composition?
Response: The microphysical composition refers to either large size or small size raindrops dominant in radar sampling volumes, which will determine the distribution of radar-measured $Z_{\mathrm{DR}}^{\mathrm{C}}$ versus $Z_{\mathrm{H}}^{\mathrm{C}}$. We have further explained this in the revision (Line XXX in the revised manuscript).

8. Figures 9-13: which radar elevation did you use for these analyses?
Response: The 0.5° scan elevation angle is primarily used in these analyses. We have clarified this in the revision (Line XXX in the revised manuscript).

9. Figure 10: Lines are not clear. Please replot the figure.
Response: Done!