Response to reviewer 2 (RC2, Anonymous Referee #3)

Reviewer's comments are presented here by italics

Comments:

The manuscript reported on the microphysical processes of precipitating hydrometers that occur at altitudes ranging from the parent cloud base down to the near surface for two warm-frontal precipitation episodes. The results are based on the simultaneously observed sequential profiles of the range-corrected signal X, volume depolarization ratio v and water vapor mixing ratio qv from the combination of a 355-nm polarization lidar and water vapor Raman lidar at Wuhan University atmospheric observatory. The observational period ranges clear-sky, cloud to precipitation, allowing for the process analysis. The observational result could potentially contribute much to the application of convection forecast. More importantly, something interesting is revealed for the first time for both light and moderation rainfall from warm-front mid-level stratiform clouds in Wuhan, Central China. To minimize of the water accumulation impact of lidar roof window on lidar signals, the authors conducted an artificial water splashing experiment, showing promising results for its height-independent lidar signal. The observational methodologies are novel, and the analysis seems scientifically sound to me. Therefore, findings are convincing and deserve rapid acceptance for publication at ACP. Nevertheless, fruitful discussion regarding the warm front is still lacking. Besides, there are other minor issues that need to be addressed prior to formal acceptance, which are listed as below:

Authors' response:

The authors sincerely thank this reviewer for evaluating this manuscript and clearly pointing out its novelty and significance as well as drawbacks. In light of the reviewer's suggestions, more discussions about the warm front have been added and the listed issues have been addressed in the revised manuscript.

Major comments:

1. WARM FRONT: More discussion is required. Except for the prevailing wind, a variety of other meteorological variables can be used to characterize the warm front, including air pressure level, the temporally varying cloud properties. For instance, when a warm front is approaching, the barometric pressure begins decreasing, the wispy and high cirrus clouds appear. Then, the layer of clouds tends to thicken along with raindrop falls from the cloud base as it arrives, meanwhile, nimbus, cumulus, and stratus clouds can be observed. Generally, the precipitation associated with the warm front is light and steady, and thus its intensity is moderate, and can last for several days. Under some special conditions, the warm fronts also accounts for the thunderstorms and intense precipitation. Alternatively, to better illustrate of the two warm-front rainfall cases, the authors may take a look at the composite synoptic map showing surfacee-level geopotential height and surface potential temperature, in *which the warm front is supposed to be marked.*

Authors' response:

Taking the reviewer's suggestion and another reviewer's opinion (reviewer 3: Sect 3.1.1 is too long), some brief descriptions about the observed warm-front characteristics have been added in the revised manuscript.

"The temporally-varying cloud properties (e.g., falling cloud base, increasing cloud thickness and variable cloud types) between 2000 LT on 26 December and 2000 LT on 27 December 2017 coincided with the classical picture of preceding upglide clouds of an advancing warm-front system." (please see lines 183-186 in the revised manuscript)

"Furthermore, the radiosonde data exhibited that the southwesterly wind mostly prevailed at the cloud altitudes (Figs. 3d, 3e and 3f), and the air pressure at altitudes of ~0−5 km dropped continuously by ~3−5 hPa in the period (not shown here), which did belong to the typical warm-front features." (please see lines 189−191)

"The air pressure from the radiosonde data at Wuhan showed a persistent decrease (by ~2−4 hPa at altitudes of ~0−5 km) during the observational period from the precursor clouds to precipitation (between 0800 LT on 4 March to 0800 LT on 5 March), that reflected the warm front passage." (please see lines 409−412).

Since the synoptic maps are currently unavailable, the warm-front characteristics are recognized by the temporally-varying cloud properties, decreasing air pressure and southwesterly winds during each of the two cloud/precipitation episodes (please see lines 182-198 and lines 396-412).

Major comments:

2. Verification of LiDAR-measured cloud layer is of importance to the result interpretation, since most of the results presented here are from LiDAR. Given the availability of simultaneously observed radiosonde during both case studies, the authors may make a compare analysis of cloud layers from radiosonde and LiDAR based on the RH threshold methods. This will enhance the readership of this work, in my point of view.

Authors' response:

In light of the reviewer's suggestion, the relative humidity values (over ice) at the lidar cloud base (except cirrus) have been compared with the relative humidity threshold that is conventionally used to determine the cloud base heights.

"At the cloud base (except cirrus), the relative humidity over ice had values close to the relative humidity threshold of 84% that is conventionally used to determine the cloud base heights (Wang and Rossow, 1995; Zhang et al., 2018)." (please see lines 187-189)

In the example of the moderate warm-front rain, it was difficult to determine the relative humidity value at cloud base altitude since the apparent source cloud of the virga was invisible by lidars around radiosonde launch time (due to strong optical attenuation at ~2000 LT on 4 March 2019).

Minor comments:

1. L60-63: "An artificial water splashing…. was altered" reappears in L110-114, which seems redudant and one can be kept.

Authors' response:

The authors sincerely thank the reviewer for his friendly reminding. In the revised manuscript, the sentences (L60-63) in the previous version have turned to "According to an artificial water splashing experiment, water accumulation on the lidar roof windows yielded nearly height-independent lidar signal (*X*, range-corrected signal) attenuation, whereas neither the *X* vertical structure nor the profile of the volume depolarization ratio δ_v (the magnitude and vertical structure) were altered." (please see lines 60-63 in the revised manuscript), while the sentences (L110-114) have changed to "An artificial water splashing experiment was performed on the lidar roof windows to examine the effects of water accumulation. A comparison of the lidar profiles with and without water accumulation on the lidar roof windows is given in Figure 1..." (please see lines 128-138), according to another reviewer's suggestion (reviewer 1: showing a plot of the artificial water splashing experiment).

Minor comments:

3. L92: "Based on a method developed by Newsom et al. (Newsom et al., 2009; Zhang et al., 2014), " can be rephrased as "Based on a method originally proposed by Newsom et al. (2009) that was further developed by Zhang et al. (2014),"

Authors' response:

We thank the reviewer for his friendly suggestion. The statement has been rephrased (please see lines 92-94).

Minor comments:

3. L122: "A comparison" -> "A comparison analysis"

Authors' response:

"A comparison" has changed to "A comparison analysis" in the revised manuscript (please see line 147).

Minor comments:

4. L134: "Nash 2011" -> "Nash et al., 2011"

Authors' response:

In the revised manuscript, the "Nash 2011" has been replaced by "Nash et al., 2011" (please see line 159).

Minor comments:

5. L136-137: More details about the measurements by tipping-bucket rain gauge are suggested to be added, such as the sampling intervals or frequency.

Authors' response:

Taking the reviewer's suggestion, more details about the tipping-bucket rain gauge have been added in the revised manuscript.

"It has a sampling interval of 1 min. For each 0.1 mm of precipitation, the bucket tips and empties, yielding an output signal." (please see lines 162-163)