We would like to thank the reviewers for their valuable comments and suggestions. We have considered all comments carefully which helped us significantly to improve our manuscript. Following the reviewers' comments and suggestions, we revised the manuscript. Our responses to the reviewers' comments are listed below in blue fonts and the changes in manuscript are listed in *blue italic fonts*.

Anonymous Referee #1

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This manuscript presents continuous measurements of PBL structure using a newly developed compact lidar system combined both direct detection lidar and coherent Doppler win lidar, and demonstrates that the PBL height can be accurately retreated by the measurements and the residual BL and stable BL can be distinguished using different signals from the instrument. The relationships between the PM2.5 concentration and the PBL height were also analyzed. The authors found a strong negative correlation between PM2.5 and PBL height before the precipitation event and a much weaker negative correlation after the precipitation.

The manuscript is well organized and written in general. The instrument is demonstrated as very useful in boundary layer research. The quality of the observations is very impressive. The results and analyses are clear and persuasive. Some of the conclusions need to be rephrased under certain contexts. After the following points are addressed, the manuscript is recommended to be published on AMT.

Thanks for your positive comments. We have rewritten some conclusions in the revised manuscript.

1. Page 1, line 17. Suggest removing "Negative".

Corrected as suggested.

Changes: Page 1, line 18-19. "*Correlation between different BLH and $PM_{2.5}$ is strongly negative before a precipitation event and become much weaker after the precipitation*."

2. It is not an ideal location for the weather site to be on the top of a building. The building impacts the temperature, humidity, wind speed and direction. Cautions should be used when analyzing the weather data from such a site.

Thanks for this comment. In fact, there is not any ideal location for the weather site in such an urban area. The overly dense buildings will also impact the temperature, humidity, wind speed and direction on the ground. We will pay attention to these cautions when analyzing these data.

Changes: Page 6, line 33 - page 7, line 1. "*It should be noted that the building where the instrument deployed would have an impact on these meteorological parameters.*"

3. Page 4, line 22. The variance of vertical velocity should just represent the vertical component of the turbulent kinetic energy.

Corrected as suggested.

Changes: Page 5, line 10-11. "*The BLH can also be determined from the variance of vertical velocity* σ_w^2*, which represents the vertical component of the turbulence kinetic energy*."

4. Page 5. Model-simulated PBL height in a relatively coarse grid spacing cannot be used to cross-check the observation even though the reanalysis data have assimilated lots of observations.

Sounding is probably a better source for observation cross-check. I would recommend the authors to show the 12-hourly sounding data in the city and compare them with the lidar observed PBL structure.

Thanks for this suggestion. Unfortunately, there is not any sounding data in Hefei. The nearest sounding station is in Anqing, which is approximately 150 km south to Hefei. A cross-check of BLH retrieved from lidar and sounding data will be carried out in future experiments or observations.

Changes: Page 5, line 22-23. "*The hourly BLH from high resolution realisation sub-daily deterministic forecasts of ERA5 is used to cross-check the BLH retrieved from lidar since there is no sounding data in Hefei.*"

5. Page 6. How strong was the precipitation event? The authors are recommended to provide quantified value of the precipitation either from the met station observation or model-based estimate. The strength of the precipitation impacts the PM2.5 concentration after the event. Usually strong rainfall will scavenge most of the PM2.5 particles while drizzle or light rain can moisten the PBL and facilitate wet growth of smaller aerosols that reach PM2.5.

Thanks for your valuable suggestion. There is no precipitation event as drizzle or light rain recorded by the weather transmitter (Vaisala WXT520) or experimenter on the ground or the top of the building. As you suggested, such precipitation event as drizzles above the ground may increase the aerosol, which consists our observation.

Changes: Page 7, line 1-2. "*There is no precipitation event recorded on the ground by weather transmitter, even during the precipitation in the cloud as shown in Fig. 3c.*"

6. Page 7, line 32. As mentioned in previous comment, there may not be unknown sources but just the wet growth of the existing small particles.

Thanks for this suggestion. The relationships between BLH and $PM_{2.5}$ are affected after the precipitation. The wet growth of small particles may be responsible during the drizzles. However, during the growing process of CBL after the precipitation, the correlation between BLH and $PM_{2.5}$ is weak even after the drizzles as shown in Fig. 5e and Table 2. This weak relationship when there is no drizzle can't be explained by wet growth of aerosols. Thus, both the pollution sources and meteorological conditions should be considered. We modified this description and added some discussions in the revised manuscript.

Changes:

Page 7, line 10-11. "*The wet growth of the existing small particles caused by the precipitation above the ground may be responsible for the sudden increase of aerosols.*"

Page 8, line 23-24. "*The relationships between BLH and PM2.5 are changed after precipitation.*"

7. Page 14, figure 3. I would recommend the authors to identify RL and SBL tops and if possible, together with the RL bottom at the same time based on the data. These fine structures are extremely useful for model validation and parameterization development.

Thanks for this suggestion. We identified RL top as red dotted lines with a temporal resolution of 5 min in revised Fig. 3. The dominant aerosol layer top is retrieved based on threshold method. If the difference between aerosol layer top and BLH is larger than a specified threshold, 0.3 km in current study, the aerosol layer is identified as the RL top. For the SBL top and RL bottom, it is difficult to be identified due to elevated aerosol layers, e.g., between 1 June 2018 21:00 and 2 June 2018 03:00. For the turbulence derived SBL, the vertical resolution (60 m) of the lidar used in this study is too coarse for an accuracy SBL near the ground (< 200 m). We have developed a new lidar recently, which has higher spatial resolution of meter-scale to solve this problem in future work (Wang et al., 2019). Therefore, we only identified RL tops in the revised manuscript.

Changes:

Page 5, line 29-30. "*Compared to the BLH retrieval, RL top can be identified through a simply rough threshold which is described in the Appendix.*"

Page 10, line 5-15. "***Appendix: The RL top retrieval method***

Besides BLH, RL top is also important in model validation and parameterization development. A simple method to retrieve RL top from RCS, CNR and variance of vertical velocity profiles is proposed. In order to reduce the interference from noise, the RL top is determined with a temporal resolution of 5 min. Dominant aerosol layer tops are easy to be identified around 2 km altitude as shown in Fig, 3. Thus the aerosol layer tops are limited between 1 and 2.5 km altitude range. A threshold method is suitable for RCS and CNR profiles. For this observation, the threshold is set to be 5×10^{10} *for RCS profile (*1×10^{10} *for resolution of 1 min as shown in Fig. 3a) and -30 dB for CNR profile. For profiles of variance of vertical velocity, the aerosol layer is identified as the altitudes under the minimum altitude where invalid data exists, e.g., ~1.6 km in Fig. 2c. If the difference between aerosol layer top and BLH is larger than a threshold, e.g., 0.3 km in current study, the aerosol layer top is identified as RL top. It should be noted that all the values of threshold used here may varies at different places for different lidars. These values may be only suitable for during this observation.*"

8. Page 16, figure 5e. These relationships are indeed the result of both cloud effect and precipitation impacts not just precipitation causing the differences. A modeling study is needed to untangle these two effects and quantify the contributions to the changes of the relationships.

Thanks for this comment. This is a good suggestion to probe the different effects by using a model. The reasons for the differences in the relationships may result from both cloud effect and pollutant sources not just precipitations. This study is focus on the relationship between $PM_{2.5}$ and BLH based on a hybrid lidar, not the mechanism of the differences in the relationships. More observational and modeling study are needed to solve this question in future work.

Changes:

Page 8, line 23-28. "*The relationships between BLH and PM2.5 are changed after precipitation. Recently, Gei ßet al. (2017) investigated correlations between BLH and concentrations of pollutants (*PM_{10}*,* O_3*,* NO_x*). They found that the correlations of BLH with* PM_{10} *were quite different for different sites without showing a clear pattern. In addition, the reflection and absorption of the incoming solar radiation by the clouds on 2 June 2018 could also affect the diffusion of aerosols. Therefore, BLH with different retrieval methods, pollutant sources and meteorological conditions should be considered in air quality prediction models.*"

Page 9, line 23-24. "*The reasons for the differences in the relationships between BLH and* $PM_{2.5}$ *may result from both cloud effect and pollutant sources not just the precipitation.*"

Page 9, line 26-27. "*To probe the mechanism of the BLH-*$PM_{2.5}$ *relations under different conditions, such as before and after the precipitation, not only such observations, but also model simulation are needed in further studies.*"

References:

Wang, C., Xia, H., Wu, Y., Dong, J., Wei, T., Wang, L., and Dou, X.: Meter-scale spatial-resolution-coherent Doppler wind lidar based on Golay coding, Optics letters, 44, 311-314, 10.1364/OL.44.000311, 2019.