

The manuscript aims to investigate the relationship between BLH and air pollution in different ABL categories. The ABLH is defined based on both a micro-pulse lidar (DDL) and a coherent Doppler wind lidar (CDWL) through wavelet covariance transform method and variance analysis of the vertical velocity. It is well written and the analysis is careful. However, there are some aspects for improvement:

1. Only the relationship between PM<sub>2.5</sub> and BLH before and after one precipitation process is analyzed. The manuscript only presents the phenomena, so what accounts for this difference, what role of the precipitation process, it is unclear;
2. ABL may not belong to different categories before and after the precipitation, in fact, according to the Figure 3(a), the growing process of the CBL after the precipitation is very similar to that before the precipitation;
3. From your manuscript, anti-correlation relationship between PM<sub>2.5</sub> and BLH is found whether before or after a precipitation. The difference is that the relativity weakened after a precipitation. It seems that precipitation plays an important role. That is, the author paid more attention to different weather conditions instead of "different ABL categories".
4. The core content of the manuscripts is the "Relationship Analysis of PM<sub>2.5</sub> and BLH", from the abstract, only the sentence "Negative correlation between BLH and PM<sub>2.5</sub> is analyzed before and after a precipitation." is related to your title. And such conclusion is very common, lower concentration of PM always corresponds to higher BLH if there is no new emission source. The abstract does not show the purpose and innovation point of the study explicitly. Besides, only one paragraph describes the relationship of PM<sub>2.5</sub> and BLH in the text? The abstract and the contents of the manuscripts should be improved.

**Some minor revisions are as follows:**

1. For line 3 on page 2, "The boundary layer height (BLH) is the height of the top layer of ABL", the description makes no sense, please improve.
2. For line 9 on page 2: Explain "ABL categories" here.

3. For line 18 on page 2, “Among these instruments, lidar provides sufficient spatial and temporal resolution, long detection range and high accuracy to determine the BLH.....”, the description should be improved, lidar system provides backscattering signal with sufficient spatial and temporal resolution.....
4. For Lines 20-27 on page 2: Here, please highlight the advantages of two lidars.
5. For lines 22-24 on page 2, “in middle atmosphere via Rayleigh scattering....., in mesosphere and lower thermosphere via fluorescence backscatter.....” The manuscripts focused on ABL, it may be unnecessary to mention the detection principle in middle atmosphere and in mesosphere and lower thermosphere.
6. For lines 25-26 on page 2, “Recently, a micro-pulse direct detection lidar (DDL) was developed to make continuous measurements of aerosol in troposphere.....” In fact, the micro-pulse lidar (MPL) has been widely used to detect ABLH, there are several studies (*He et al., 2008; Sawyer and Li 2013; Li et al., 2017*), not recently, maybe you can describe the advantage of the MPL here, such as detecting with eye-safe laser, small field-of-view removing multiple-layer scattering concerns.....

As well as for description about Doppler wind lidar later.

He Q, Li C, Mao J, et al. Analysis of aerosol vertical distribution and variability in Hong Kong [J]. *Journal of Geophysical Research Atmospheres*, 2008, 113(D14):-.

Sawyer, V.; Li, Z.J.A.E.; Detection, variations and intercomparison of the planetary boundary layer depth from radiosonde, lidar and infrared spectrometer. 2013, 79 (11), 518-528.

Li, H.; Yang, Y.; Hu, X.M.; Huang, Z.; Wang, G.; Zhang, B.J.A.; Application of Convective condensation Level Limiter in Convective Boundary Layer Height Retrieval Based on Lidar Data. 2017, 8 (4), 79

7. For lines 15-16 on page 4, “Considering different vertical spatial resolutions, a dilation of 150 m and 250 m is applied for RCS and CNR, respectively”. The selection of an appropriate dilation is the key for WCT method. So why “150 m” and “250 m” are selected? Should be explained.
8. For line 16 on page 4, “Compared with gradient method, HWCT method has greater adjustability and robustness”. In fact, as extended technique of gradient method, several studies (*Brooks, 2003; Mao et al., 2013; Dang et al., 2019*) have indicated the WCT method is also easily interference by multiple

aerosol layers or cloud layer. So how the paper deals with the interference of the cloud layers on ABLH determination in Figure 3(a)-(b)? No doubt, the signal gradient at the cloud boundary is strongest than at the ABL top on 2 June 2018, the HWCT may capture the cloud top rather than the true height of lower stable ABL.

Brooks, I.M.J.J.o.A.; Technology, O.; Finding Boundary Layer Top: Application of Wavelet covariance Transform to Lidar Backscatter Profiles. 2003, 20 (8), 1092—1105.

Mao, F.; Wei, G.; Song, S.; Zhu, Z.; Determination of the boundary layer top from lidar backscatter profiles using a Haar wavelet method over Wuhan, China. Optics Laser Technology 2013, 49 (7), 343-349.

Dang, R.; Yang, Y.; Li, H.; Hu, X.-M.; Wang, Z.; Huang, Z.; Zhou, T.; Zhang, T.; Atmosphere Boundary Layer Height (ABLH) Determination under Multiple-Layer Conditions Using Micro-Pulse Lidar. remote sensing 2019, 11 (263).

9. For line 17 on page 4, “In order to reduce the interference from unexpected turbulence and noise”, what is unexpected turbulence? Is the “turbulence” is ambiguous here? Similarly, line 25 on page 4.
10. For lines 19-20 on page 4, “As an example, the measured RCS and CNR after one-minute average (after overlap correction and background noise deduction) at 1 June 2018, 10:40 am is shown in Fig. 2a”, Figure 2 shows an example in clear sky situation, profiles in cloudy situations on 2 June 2008 is suggested.
11. For line 22 on page 4, “.....which represented the turbulence kinetic energy”, the “represented” should change to “represents”.
12. For line 24 on page 4, “In this study, the threshold is set to be  $0.06 \text{ m}^2\text{s}^{-2}$ ”, how the threshold is defined?
13. For line 4 on page 5, “BLH from reanalysis data is always used in boundary layer climatology”, please improve the description.
14. For lines 7-8 on page 5, “The hourly BLH from high resolution realisation sub-daily deterministic forecasts of ERA5 is used here”, is the ABLH defined from ERA used to estimate the results from lidar? The purpose should be stated. In addition, should “realisation” be changed to “realization”?
15. For line 18 on page 5, “..... indicated the BLH derived from.....”, “indicated” should be change to “indicate”.
16. For lines 17-19 on page 5, the description could be rewritten as “The black dotted line in each panel indicate the BLH derived from RCS, CNR and vertical

wind, called as  $BLH_{RCS}$ ,  $BLH_{CNR}$  and  $BLH_{VAR}$  in the study”.

17. For Line 24 on page 5: From the author, stratocumulus exists above the ABL; It can be seen clearly from Fig. 3(b) that signals between CBL top and cloud are relatively small, and the BLHs derived by aerosol method are cloud heights. Here, the authors should notice the influence of cloud in BLH retrieving based on lidar.
18. For line 28 on page 5, “The results observed in RCS can be also found in CNR”, what is the results? The description is unclear.
19. For section 4.1, only the observations of aerosol concentration, the resulted ABLH and meteorological parameters are described, so how do they interact with each other? How does the BLH respond to the meteorological condition?
20. For line 25 on page 6, “in Fig. 3, the BLH results are well retrieved, indicating that the HWCT and variance methods are appropriate for BLH determination.....” The HWT and variance analysis may be interfered by the RL and cloud layer, how does this study deal with the interference of them? Similar to comment 8.
21. For line 29 on page 6, “In turbulence derived CBL, all three BLH results from lidar measurements are comparable when the ABL is fully mixed”, please improve the description.
22. For line 31 on page 6, “a criteria is proposed to classify the ABL as CBL and RL/SBL by the values of  $BLH_{VAR}$  and  $BLH_{RCS}$  in this study.....in the morning, when  $BLH_{VAR}$  meets the  $BLH_{RCS}$ , the type of ABL changes from RL/SBL into CBL. In the Afternoon, when  $BLH_{VAR}$  departs from  $BLH_{RCS}$ , the ABL turns into RL/SBL again.....” When  $BLH_{VAR}$  firstly meets or departs from  $BLH_{RCS}$ ? How to classify if there are several moments that  $BLH_{VAR}$  meets or departs from  $BLH_{RCS}$ ?
23. For section 4.3, only the “relationship between the BLH and PM2.5” before and after a precipitation case is analyzed. It is not enough to illustrate the title of the manuscripts. In addition, before precipitation, it is clear that the PM shows a contrary tendency with the ABLH. After precipitation, although the ABLH is lower than on previous day maybe caused by cloud or others, the growing process of CBL is similar to that before precipitation, however, there is no obvious tendency of PM2.5. Therefore, what caused the difference of relationship between PM2.5 and ABLH is the PM2.5 distribution. What should be considered is the factor contributing to the difference of PM before and after precipitation, what’s role of the precipitation process?