

Interactive comment on “Characteristics of convective boundary layer and associated entrainment zone as observed by a ground-based polarization lidar” by Fuchao Liu et al.

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General Comments: This manuscript is one part of an increasingly long list of papers simultaneously investigating the evolution of both planetary boundary layer (PBL) height and entrainment zone thickness for the haze events in China. Most have focused on CBL; this is one of the few to deal with EZ. It is of essence to investigate the variation of EZT near the PBL top, since it concerns the formation of cloud, the interaction of land-atmosphere, and the vertical mixing of scalars. The retrieval methods are scientifically robust, and the results interpretation makes sense, as far as I can tell. Therefore, I recommend acceptance for publication after addressing the following

C1

concerns.

Authors' response: We greatly appreciate this Referee for the thoughtful considerations on the manuscript as well as encouraging and valuable comments to our work. In response to all the Referee's constructive suggestions, we have made necessary modifications point by point in the revised manuscript.

Major comments: 1. The title of this manuscript seems overstated. Actually, the authors only dealt with two cases from lidar measurements in Wuhan. Therefore, the title should be revised.

Authors' response: We thank the Referee for the pertinent comment on the title. Along the Referee's suggestion, now the renewed title reads "Characteristics of clear-day convective boundary layer and associated entrainment zone as observed by a ground-based polarization lidar over Wuhan (30.5°N, 114.4°E)" to state that the results are limited to clear-day weather conditions and to the observational location of Wuhan.

2. Most of the sentences are almost the same in both Conclusion and Abstract, especially regarding the statistic results of EZT evolution at different stages for both winter and summer cases. This should be avoided. The authors are suggested to highlight the major findings as well as the importance or implications of their work in Abstract, rather than simply duplicating the numbers.

Authors' response: We greatly appreciate the Referee for the valuable comments on the Abstract. Following the Referee's suggestions, the Abstract has now been modified as "Knowledge on the convective boundary layer (CBL) and associated entrainment zone (EZ) is significant for understanding the interaction of land-atmosphere and assessing the living conditions in the biosphere. A tilted 532-nm polarization lidar (30 degree off zenith) has been used for the routine atmospheric measurements with 10-s time and 6.5-m height resolution over Wuhan (30.5°N, 114.4°E). From lidar-retrieved aerosol backscatter, instantaneous ABL depths are obtained by logarithm gradient method and Harr wavelet transform method, while hourly-mean ABL depths

C2

by variance method. A new approach utilizing the full width at half maximum of the variance profile of aerosol backscatter ratio fluctuations is proposed to determine the entrainment zone thickness (EZT). Four typical clear-day observational cases in different seasons are presented. The CBL evolution is described and studied in four (formation, growth, quasi-stationary and decay) developing stages; the instantaneous CBL depths exhibited different fluctuation magnitudes in the four stages and fluctuations at the growth stage were generally larger. The EZT is investigated for the same statistical time interval of 0900-1900 LT. It is found the winter and the late autumn cases had overall smaller mean (mean) and standard deviation (stddev) of EZT data than those of the late spring and early autumn cases. This statistical conclusion was also true for each of the four developing stages. Besides, compared to those of the late spring and early autumn cases, the winter and the late autumn cases had larger percentages of EZT falling into the subranges of 0-50 m but smaller percentages of EZT falling into the subranges of >150 m. It seems that both the EZT statistics (mean and stddev) and percentage of larger EZT value provide measures of entrainment intensity. Common statistical characteristics also existed. All four cases showed moderate variations of mean of EZT from stage to stage. The growth stage always had the largest mean and stddev of EZT and the quasi-stationary stage usually the smallest stddev of EZT. For all four stages, most EZT values fell into the 50-150 m subrange; the overall percentages of EZT falling into the 50-150 m subrange between 0900 and 1900 LT were >67% for all four cases. We believe that the lidar-derived characteristics of the clear-day CBL and associated EZ can contribute to improvement of understanding the structures and variations of the CBL, as well as providing quantitatively observational basis for EZ parameterization in numerical models" to highlight the major findings as well as their importance.

Minor comments: 1. L17: the first "FWHM" is redundant and can be deleted.

Authors' response: The first "FWHM" has already been removed in the revised manuscript.

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2. L54: "despite of" -> "despite"

Authors' response: Now "despite of" has been changed to "despite" (Line 57 in the revised manuscript).

3. L77: "EZT" is a geophysical parameter rather than an approach. The authors mean "the determination of EZT"?

Authors' response: We thank the Referee for pointing out our inaccurate expression. Now the relevant sentence has been corrected to "The entrainment zone thickness (EZT) provides a possibility for parameterizing the entrainment rate" (Line 82 in the revised manuscript).

4. L181: "Jan" is not official acronym for "January", and should be given full spelling. All instances should be corrected throughout the MS.

Authors' response: Following the Referee's suggestion, now all "Jan" has been replaced by "January" in the revised manuscript.

5. L193: "measuring"-> "measurement"

Authors' response: We have changed "measuring" to "measurement" in the revised manuscript (Line 214 in the revised manuscript).

6. L245:"convinced"-> "confirmed"

Authors' response: Now "convinced" has been replaced by "confirmed" in the revised manuscript (Line 268 in the revised manuscript).

7. L432: "This new approach is designated as FWHM method in this work." can be deleted.

Authors' response: The sentence "This new approach is designated as FWHM method in this work." has now been removed in the revised manuscript.

C4

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-963/acp-2020-963-AC3-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-963>, 2020.