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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics of the summer atmospheric boundary layer height over the Tibetan Plateau and influential factors" *by* Junhui Che and Ping Zhao

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Dear reviewer,

We are grateful for your insightful comments that help us to improve this manuscript. We carefully address issues in your comments. Please see below our point-to-point responses to your specific comments.

Main concerns

1. Although the presentation of the manuscript has good logic flow, descriptions of the data processing or the results can be confusing at places. The clarity of the manuscript

can be improved. I have made some specific suggestions listed in the minor concerns, but the authors should go through the manuscript very carefully or get help from people experienced in writing scientific articles in English.

Response: According to your suggestions, we have modified the text listed in your minor concerns and carefully revised the language.

2. The manuscript can be enhanced if the methodology in defining the ABL types using the PTD are revisited in the discussion section. For the SBL, the mode of the ABL height is around 300 m, suggesting that the PTD represents the temperature gradient in the main body of the stable ABL. For the CBL, since few measurements shows CBL height less than 500 m (except at 20:00 BJT), the 50 m height is likely within the surface layer. The 250 m level, on the other hand, can be in the surface layer or in the well-mixed portion of the CBL depending on the CBL height (assuming the surface layer is $\sim$10% of the ABL). The PTD in this case represent approximately the potential temperature difference in the surface layer or between the surface and the well-mixed CBL. The meaning of the PTD for the NBL should be similar to that in the CBL except with a smaller temperature difference. Clarifications like this should be helpful to the readers. Also, how sensitive are the results to the choice of ðİIJŐ? My general feeling is that their results are not sensitive to the choice of ðİIJŐ since the results of the CBL and NBL are very similar. However, the authors should make appropriate comments on the sensitivity issue.

Response: Firstly, according to your suggestions, we have added statements to characterize the physical criteria that allow choosing and safety to identify the atmospheric boundary layer height. Secondly, we have added some explanations for the physical criteria of the PTD method to identify the types of the atmospheric boundary layer. Thirdly, we have added a detailed procedure for calculating the ABL height, the illustration of idealized atmospheric boundary layer (ABL) regimes and ABL height determination procedure, and some examples of the derived potential temperature (PT) profiles from soundings for the three types of ABL. The associated statements are in lines

137-172 and Fig. 2.

Meanwhile, according to your suggestions, we have added the appropriate comments on the sensitivity issue of the ðİIJŐ in lines 150-152 and 165-166.

3. The overall results in this manuscript is consistent with the diurnal evolution of the ABL with the daytime deep CBLs and night-time shallow SBL. There are also occurrences of daytime SBLs and night-time CBLs although the frequencies of occurrence for both are small. The daytime SBL or night-time CBL are likely results of 'abnormal' forcing associated with certain synoptic conditions or cloud coverage. The authors mentioned a few times throughout the manuscript about the 'diurnal variations' of the SBL or the CBL (e.g., Lines 276, 290). These wordings are misleading and should be revised. It would be interesting to look into the mechanisms of the occurrence of daytime SBL and night-time CBL, but it may be beyond the scope of this paper.

Response: Thank for your comments. According to your suggestions, we have changed the "diurnal variations" to "temporal variations" and added this comment. The associated statements are seen in lines 230-235, 237, 241, and 377.

Minor points

1. Line 14: 'The SBL accounts for 85% of the TP ABL' should add the time frame here to avoid misunderstanding: 'The SBL observed during this time accounts for 85% of the TP ABL'

Response: We have changed in line 19.

2. Line 15: 'The ABL height exhibits. . ..', again, need to specify time: 'The ABL height at noon exhibits. . .'

Response: We have changed in line 20.

3. Line 20: 'For the western (eastern) TP. . .' , make it 'In general, for the western (eastern) TP. . .'

Response: We have modified the text (in line 26).

4. Line 28: change 'convective transmission' to 'convective transport'.

Response: We have changed (in line 36).

5. Line 56: change 'have addressed' to 'found'; also change 'can be as high as 2000–3000 m' to 'can reach 2000–3000 m'.

Response: We have modified the text (in line 78).

6. Line 57: change 'Song et al. (1984) examined the ABL height at Gaize station of the western TP is above 3000 m, while the ABL heights. . ..' To 'Song et al. (1984) found the ABL height at Gaize station of the western TP to be above 3000 m, while the ABL heights. . ..'

Response: It has been changed in lines 80-81.

7. Line 62: 'These results show that the ABL height over the TP varies greatly with position and season'. Change 'position' to 'location'.

Response: We have changed in line 80.

8. Line 67: change 'and less-developed logistics' to 'logistic challenges'.

Response: It has been changed in line 89.

9. Line 68: remove 'a short-time experimental' from the sentence. Also change 'Thus the interpretation of their results has certain limitations' to 'Thus, the statistical representation of their results is limited'.

Response: It has been changed in line 91.

10. Line 70: change 'climatic conditions' to 'general climate'.

Response: It has been changed in line 92.

11. Line 72: change 'beginning in 2013 has deployed routine sounding systems at

Shiquanhe, Gaize, and Shenzha stations of the western TP (Fig. 1)' to 'has made routine sounding launches at Shiquanhe, Gaize, and Shenzha stations of the western TP (Fig. 1) since 2013'.

Response: It has been changed in lines 94-95.

12. Line 82: change 'Section 4 gives major factors. . .' to 'Section 4 examines major factors. . .'

Response: It has been changed in line 106.

13. Line 94: change 'After the quality of the sounding observational data, we finally select the periods from 15 June to 31 July 2013, from 15 June to 31 August 2014, and from 1 June to 31 August 2015 in this study' to 'After quality control of the sounding data, we selected data from three time periods for this study: 15 June to 31 July 2013, 15 June to 31 August 2014, and 1 June to 31 August 2015'.

Response: It has been changed in lines 118-120.

14. Line 95: change 'There are a total of 11,635 sounding profiles (Fig. 1a) and 4757, 2049, and 4841 profiles separately at 08:00 BJT (Fig. 1b), 14:00 BJT (Fig. 1c), and 20:00 BJT (Fig. 1d) for 19 stations over the TP' to 'There are a total of 11,635 sounding profiles (Fig. 1a) from 19 stations over the TP region consisting of 4757, 2049, and 4841 profiles at 08:00 BJT (Fig. 1b), 14:00 BJT (Fig. 1c), and 20:00 BJT (Fig. 1d), respectively'. Note the numbers do not add up to the total here.

Response: We have modified the text in lines 120-122.

15. Lines 97 and 101: change 'sample number' to 'sample size'.

Response: It has been changed in lines 122, 123, and 127.

16. Line 99: 'Thus we also select the operational observation records that correspond to the intensive observation records'. Unclear sentence. Did you mean you subsampled the original dataset to only take those soundings that were made at the time when

soundings of the test group dataset were made?

Response: According to this comments, we have modified the text. See lines 125-127.

17. Line 105: change 'few obstacles' to 'few vegetation'.

Response: It has been changed in line 130.

18. Line 107: change '02:00 BJT, 08:00 BJT, 14:00 BJT, and 20:00 BJT' to '02:00, 08:00, 14:00, and 20:00 BJT'.

Response: It has been changed in lines 132-133.

19. Line 110: Needs to give more details on how the interpolation of the original sounding data were made? Any filtering or smoothing during the interpolation process?

Response: We have modified the text. See lines 144-146.

20. Line 117: 'For both the CBL and NBL, the ABL height is calculated as the height at which an air parcel rising adiabatically from the surface becomes neutrally buoyant (Stull 1988)'. To be clear about what you are doing, you may want to add: 'Practically, the ABL height is the level where it potential temperature is the same as that at the lowest sounding level'. You also need to clarify the definition of the SBL height. I believe you use the height of maximum wind in the LLJ, not the 'maximum wind shear'.

Response: According to your suggestion, we have added a more detailed discussion about the employed methodology to obtain the CBL height and revised the definition of the SBL height. See lines 154-169.

21. Line 123: change 'and diurnal transitions (from day to night and from night to day)' to 'and day/night transitions'.

Response: It has been changed in line 175.

22. Line 125: how do you define the 'local standard time' for this location?

Response: We use the local solar time as the LST and add this statement in line 177.

23. Line 144: 'the ABL height continues to increase in the WTP'. Is the mean height greater than 14:00 BJT to justify the 'continues to increase'? It does not look like it in the figure.

Response: We have changed in lines 200-202.

24. Line 150: 'The ABL height reaches the maximum in the late afternoon.' This is not clearly seen in the data in Figure 2. You may want to change to: 'Figure 2 shows continued increase in BLH in the west-most stations from 14:00 to 20:00 BJT.'

Response: According to your suggestion, we have modified. See lines 205-206.

25. Line 165: 'Figure 4 shows the distribution of occurrence frequency of different ABL types at 08:00 BJT, 14:00 BJT, and 20:00 BJT. It is clear that the occurrence frequency shows significant diurnal variations for the SBL and CBL'. This statement is misleading. There should not be diurnal variation of SBL and CBL. The results are simply consistent with the diurnal evolution of the ABL with prevalent CBL during the sunlight hours and SBL at night. Similarly, the discussion of the 'diurnal variation' of NBL should be done with caution. It also would be helpful to provide the sunrise and sunset hours at representative sites of WTP and ETP to illustrate the time difference in the CBL SBL or SBL CBL transition. See also my comments in the list of 'Major Concerns'.

Response: According to your suggestions, we have changed in lines 225, 229, 237, and 241. Moreover, we have added this comments in the discussions in lines 230-235.

26. Line 209: why are the RMSE in percentage here?

Response: This RMSE is for the occurrence frequency. In our revised manuscript, we have changed "with root-mean-square errors (RMSEs) between 1.1% and 2.7%" to "with root-mean-square errors (RMSEs) of the occurrence frequency between 1.1% and 2.7%" in lines 282-283.

27. Line 216: change 'larger NBL and CBL heights' to 'deeper NBLs and CBLs'.

Response: It has been changed in line 291.

28. Line 221: change 'A lot of studies' to 'Many previous studies'.

Response: It has been changed in line 295.

29. Line 225: change '. . .observations at SQH, NQ, and LZ stations, analyzing the. . .' to '. . .observations at SQH, NQ, and LZ stations to analyze the. . .'

Response: It has been changed in line 300.

30. Line 228: Any reasons for doing the '6-hour mean' in Figure 8? Which 6-hour window did you use, or was it a running mean? Please clarify.

Response: We have added the reasons for doing the '6-hour mean' and modified the text in lines 308-310.

31. Line 230: remove 'That is'. Change 'which supports the. . .' to 'which is consistent with the. . .'.

Response: It has been changed in line 312.

32. Line 233: 'The maximum value of SHF is. . .'. You should use the mean values, not the maximums.

Response: It has been changed in lines 315-316.

33. Line 237: 'It is clear that the peak of the SHF diurnal variation occurs earlier compared to that of the ABL height at SQH station.' Unclear sentence. Reword.

Response: It has been changed. See lines 320-321.

34. Line 238: again, how was the LST defined?

Response: We use the local sidereal time as the LST and add this statement in line 177.

35. Line 239: 'This difference in SHF between SQH and LZ stations is possibly asso-

ciated with more cloud cover (reducing the solar radiance at the surface)'. It is better to make your statement about cloud cover after the next paragraph, if it is true.

Response: We have deleted this content on cloud cover in lines 318-325 because it is discussed in the next paragraph.

36. Line 260-265: Good discussions about the soil moisture effects on SHF. What about latent heat flux (LHF)? Unless LHF is in general small, which may be true in your case for both WTP and ETP, it is also an important forcing for the ABL. But you should at least mention latent heat in this discussion.

Response: We have calculated the mean LHF at three stations (not included in the text). The result indicates that the kinematic moisture flux (KMF) is general small for both WTP and ETP. See lines 303-308.

37. Line 300: change 'That is, in' to 'In'.

Response: It has been changed in line 386.

38. Line 311: 'for providing the data available', delete.

Response: It has been changed in line 406.

39. Figure 1. Larger font size is needed for axis labels, station names, as well as the number of soundings. In figure caption: change 'Some letters are for the abbreviated names of stations. The green line is for the topography above 3 km.' to 'Some station names are given as abbreviations in (a) and the green lines shows the contour of terrain height at 3 km'.

Response: It has been changed in lines 571-573.

40. Figures 2 d,e, and f, needs larger font size for axis labels and legends.

Response: It has been changed in lines 583-587.

41. Figure 8 caption, change 'radiation flux' to 'irradiance'.

Response: It has been changed in line 614.

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