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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Continuous monitoring of the boundary-layer top with lidar" *by* H. Baars et al.

Anonymous Referee #1

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This paper discusses the retrieval of Planetary Boundary Layer (PBL) heights from data collected by a compact, automated Raman lidar at Leipzig, Germany over a period of one year. After providing a brief description of the lidar system, the paper then describes four separate techniques for finding PBL heights. A few cases are presented that show comparisons of the PBL heights from these techniques as well as the PBL heights derived from the operational regional forecast model COSMO. Finally, some more detailed comparisons of PBL heights determined from the lidar data using one technique, which was found to be superior, with PBL heights from the COSMO model are presented.

The paper is generally well written and easy to follow. The topic of determining PBL heights from ground based lidar has been published extensively, and the paper does

reference these numerous earlier studies. What sets this paper apart from the earlier studies is the use of the relatively long data set of PBL heights from this lidar to evaluate PBL heights derived from a weather forecast model; in this case the model is the COSMO model. The results of this comparison are appropriate for publication. The abstract presents a good summary of the paper.

A problem with the paper is the lack of comprehensive comparisons among the various techniques of finding PBL heights from the lidar data, as well as comprehensive comparisons of any of these techniques with the other methods of determining PBL height from the other datasets presented. These other datasets include data from a vertically pointing Doppler wind lidar, and radiosonde profiles of temperature and relative humidity. There are three case studies that show comparisons among the various lidar techniques as well as with these other datasets, but this appears to have been the extent of such comparisons. There are no results presented or discussed that show how these techniques would have compared using data from an entire year. The paper does indicate that the Wavelet Covariance Technique (WCT) does appear to provide the best results, but it apparently does so using only the three examples. If in fact only these three cases were used to evaluate the various techniques, then the conclusion could likely be premature. However, if more cases were used for this evaluation, then this should be clearly discussed in the paper and the results presented in tables, graphs, etc. Similarly, were the other datasets (Doppler lidar and radiosonde profiles) used to evaluate the various lidar techniques only for these three cases? If (hopefully) more cases were examined, then the results from these cases should be presented (perhaps as regression comparisons) and discussed in the paper. Therefore, the paper apparently relies apparently only on these three cases to: 1) indicate that the WCT technique provides the best method to derive PBL among the lidar techniques, and 2) that this technique provides PBL estimates that are as accurate, if not more accurate, than other datasets. This is insufficient. It would have been particularly instructive and convincing had the paper shown comprehensive comparison among the lidar techniques (or at least the WCT technique) and PBL heights retrieved from

ACPD

8, S4641–S4645, 2008

Interactive Comment

radiosondes.

1. (page 10751, line 20) In order to measure low PBL tops, a lidar system must also have very high vertical resolution, much better than the 37.5 m resolution of the POLLY system. As explained later in the paper, the WCT would seem to require several data bins below (and above?) the PBL height.

2. (page 10753, last line) Retrieval of nighttime PBL heights is not necessarily easy even if the scattering ratio is used instead of the elastically backscattered 532 nm signal. Nighttime PBL heights would be considerably lower than the daytime heights; consequently, the 37.5 m vertical resolution would likely be too large to represent well the fine scale structure often present at nighttime. Furthermore, the WCT technique would appear to require several data bins below (and above?) the PBL height. Also, elevated aerosol layers just above the nocturnal PBL are fairly common and would increase the difficulty in retrieving PBL height at night.

3. (page 10754, line 4) The statement about large data gaps caused by potential laser damage is not clear. Does this mean the laser only operated between minutes 8-13 of each hour for most days? If so, how many days did the lidar operate more frequently than this? If not, please clarify this statement.

4. (page 10756, line 6) derivation should be derivative.

5. (page 10757, section 3.1) Why was the gradient-Richardson-number scheme used to determine PBL height rather than examining gradients in virtual temperature, virtual potential temperature, and/or water vapor mixing ratio? It would seem that this would have made it easier to compare COSMO PBL heights with PBL heights derived from radiosondes.

6. (page 10759, last line) How was it determined that the optimum value for a is equal to the depth of the transition zone? Can some results be presented and discussed to show how this was found?

ACPD

8, S4641–S4645, 2008

Interactive Comment

7. (page 10761, line 7) How was it determined that a threshold value of 0.05 was found to be sufficient to identify the BL depth? Can some results be presented and discussed to show how this was found?

8. (page 10763, line 22) Earlier in the paper, and in figures (7,9,10, etc.), the minimum measurement height was reported to be 200 meters. However, in this paragraph, the minimum measurement height appears to be reported as 500 m. Which is correct? What is the minimum PBL height that can be found using the WCT technique? The minimum PBL height that could be found from the WCT method would seem to be a few (or several?) altitude bins above the minimum measurement height. What is this relationship?

9. (page 10764, line 4) This statement seems to indicate that radiosondes from German Meteorological Service are made all around Leipzig, but not in Leipzig. However, the discussion regarding the radiosonde data shown in Figure 8 seems to imply that the radiosonde was launched at the Leipzig site. Was the radiosonde corresponding to the data shown in Figure 8 launched in Leipzig? If not, where?

10. (page 10767, line 11) observation should be observations

11. (page 10768, section 6.1) How would the comparison between the PBL heights found from the WCT technique and the COSMO model vary as a function of time after model initialization? This would help address the question of whether the COSMO low PBL height bias is due simply to the infrequent initialization or whether there are other issues (e.g. spatial sampling, model physics, etc.) associated with the model that lead to this bias.

12. (Figures) Figures such as Figure 7, 9, 10 and others like them are small and difficult to read. It is difficult to distinguish the PBL heights from the color images shown in these Figures. It would be helpful if the color scale range was expanded so that the PBL height could be more easily identified in these color images. Also, it is very difficult to identify the PBL height from the color WiLi images.

ACPD

8, S4641–S4645, 2008

Interactive Comment

13. (Figures) Reading through the text, it would appear that PBL height is determined from the WiLi data when the wind speed goes to zero. Is this correct? If so, it is not easy to see these heights in the color WiLi images. The images should be expanded and/or the color scale should be changed to more easily identify the PBL height.

14. (Figure 8) This figure caption should indicate the date and location of these observations.

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ACPD

8, S4641–S4645, 2008

Interactive Comment