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Atmospheric Measurement Techniques Discussions

Interactive comment on "Lidar measurement of planetary boundary layer height and comparison with microwave profiling radiometer observation" *by* Z. Wang et al.

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Response to Referee 3

We thank the reviewer for these useful and constructive comments. We address the comments below.

-The selection of measurement dates presented in this paper is not described. Apparently all instruments run (almost) continuously, which shall provide for a much larger data base, than is presented here. Why only selected days are presented, why is there no statistical analysis?

It is true that both lidar and microwave radiometer run continuously. While the BLH can be derived from microwave radiometer in most case it is not the case for lidar. In the case of lidar, the BLH is derived from the vertical distribution of aerosol that is indirectly related to the thermal condition in boundary layer, which represents aerosol mixing layer height. When aerosol distribution is mainly controlled by turbulence transport in the BL, the aerosol can trace the evolution of the BL and not while other action such as advection dominates. The good cases are not enough to give a statistic analysis. This may be owing to drawback of lidar itself or the method we used. -There are 2 lidar instruments mentioned, CE370-2 and MPL-4, but their data is not compared. When is which data used here? -There is a spatial distance between SACOL-Main and SACOL-Lanzhou. How big is it and what's the influence on this analysis? While some BLH results are presented for both stations, the combined methods may be available for one only. This needs to be explained and discussed.

The CE370-2 is operated at SACOL-Lanzhou, and MPL-4 at SACOL-Main, which is 48 km far from SACOL-Lanhzou. Maybe doing some comparison is interesting, but not the goal of this manuscript. For the BL above Lanzhou the CE370-2 is used and MPL-4 for the Main site. The microwave radiometer is only operated at SACOL-Main, so the combined methods is just available for one only.

-Mostly, the term boundary layer height (BLH) is exclusively used for the aerosol mixing layer height as determined by lidar. A definition (or explanation) of different boundary layer height values shall be provided: - meteorological (wind profile, e.g. from meteorological data, or analyses) - from temperature profile, as used for the microwave data - from aerosol backscatter lidar Each of these methods has drawbacks and they need to be evaluated, before a comparison can be made and additional information can be provided from the combination of these methods. -Please use different terms for BHL for each of these methods, to make clear, from which they have been determined.

Thanks for this useful suggestion. The meteorological data are not available so we just add the definition for BLH from temperature and aerosol backscatter ldiar. In this paper,

the parcel method is used to derive BLH from temperature profile. Its basic idea is to follow the dry adiabate starting at the surface with the measured temperature up to its intersection with the temperature profile. It determines the BLH as the equilibrium level of a hypothetical rising parcel of air representing a thermal. It is strongly influenced by the surface temperature, so in the afternoon it decline rapidly owing to the decrease of surface temperature, however maybe it does not necessarily mean stopping of thermal convection. In the case of lidar, the BLH is derived from the vertical distribution of aerosol that is indirectly related to the thermal condition in boundary layer, it represents aerosol mixing-layer height. It does not always reflect the thermal structure of the BL. In the revised manuscript BLHaerosol and BLHtemp are used to represent the BLH from aerosol distribution and temperature profile, respectively.

-There are too many general statements, where just individual data from selected days are shown, for example: Fig 1 caption can be misleading, it should state: Temporal evolution of aerosol layer height on 2 days in Jan. 2007. It does not necessarily show typical examples during a winter same for Fig. 2: It shows two examples of the diurnal evolution of BLH (or is it aerosol layer height as in Fig. 1?) during summer of 2008.

We agree with this comment, corresponding changes have been done.

- page 1235 line 13: work of Morille et al needs to be explained in a few sentences, before the difference of this method shall be explained. - page 1237 lines 3-4: how is thre1 defined / determined? This needs to be explained. - examples of CWT1 and CWT2 should be shown, together with the corresponding range corrected backscatter profile. - same for thre2, thre3, thre4: how are they defined and determined? Please be precise here in order to avoid the impression that this calculation is not following an objective procedure. - page 1238: line 8: what does "seems reasonable" mean, who is making such judgement?

The explaining about the work of Morille et al. have been added. The method used here is mainly based on the work of Morille et al, which consists of a set of criteri-

ons and threshold. the thre1 is used to differentiate the true particle layer from noise fluctuation. They recommend ten times of noise level. For our current application, a rough estimation is enough since the true particle layer is very different from the noise fluctuation. For thre4, only these maximums of cwt(a,b) larger than this threshold are considered as corresponding to some feature of boundary structure other than noise fluctuation. The oldblh is calculated as the five successive BLHS with their time before present lidar profile, the thre2 is used to exclude the outlier in selection of the five successive BLHs.

-page 1239: line 2, 3: BLH is calculated 1. from lidar data 2. from temperature profiles (from radiometer?) This needs to be explained much further, here is one of the important aspects of this paper, by bringing together 2 completely independent methods to determine BLH (see general remark above)

The contents of line 2 and 3 have been expanded and remove to a new part for introduction of results in the revised version of manuscript(Sect. 4).

-it needs to be explained, why only 4 days are selected for analysis here, what is special about these days, compared to all other days of measurements? The meteorological situation shall be explained in sentences, not bullets alone, or a table could be used instead.

For the case of SACOL-Lanzhou, we present four fine day results. There is not special reason for this. The meteorological situation is deleted in the revised manuscript since it contain only little information and other meteorological data are not available.

-Page 1240, line 23 What does “true BLH” refer to? Which BLH is true and which one is not? Please avoid such terms and write e.g. BLHaerosol

We agree, the term BLHaerosol is better.

-Page 1241, line 1-3 I cannot follow this statement. If there is no objective method to determine the “correct BLH” from this type of measurements, then they are not very

useful at all. The goal of this paper shall be to use the different instruments to resolve just such cases.

We agree and the statement has been deleted. But it will not influence the goal of this paper since it is just the case for SACOL-Lanzhou. As have been said the lidar detection of BLH works for the situation with strong convection and aerosol distribution is controlled mainly by thermal condition within the BL, not for others. For SACOL-Main the situation becomes better.

-Page 1241, chapter 4.3 Please be precise, which lidar data is used here, MPL or CE370? Which SACOL is meant, SACOL-Main or SACOL-Lanzhou?

It is the MPL and SACOL-Mian.

-Line 11, 14: “up limit height” means “upper limit height”?

Yes, it should be “upper limit height”

-Again, this chapter is at the centre of this paper, discussing the different methods to determine BLH. It needs to be expanded and clear rules need to be developed, under which conditions which methods appears to be best suited for determining the “correct BLH”.

The BLH from microwave radiometer can describe the development of convective BL in the morning when thermal turbulence dominates very well. But BLH from lidar does not always trace this development, which may still denote the height of aerosol layer formed at night. In the afternoon the convective BL departs into residual layer and stable layer, the BLH from lidar likely represent the height of residual layer. In the revised paper the discussion about this has been expanded.

-Page 1241 Line 22: again, which lidar data is used here?

The lidar (MPL) is used here.

-Page 1242 The entrainment zone thickness is a quantity given in meters. Please

provide the different results derived from the different instruments not only as formulas, but also as quantities, to better appreciate their variability.

The entrainment zone thickness is related to the BL and surface properties, such relationship is described by so-called parameterization theory on it. These theories only roughly state how is the entrainment zone thickness related to other quantities without giving details such as power and coefficients and so on. In this manuscript, these parameterization theories are used to check the consistency between derived quantity and these theories. The formulas is fitted expression according these theories, usually the correlation coefficients are enough to describe the goodness of fitting. It is not necessary to provide the results.

-Results from fig. 6 need to be explained in more detail. -Fig. caption of fig. 6 needs to be more specific, what is shown in each sub-figure?

The explanation and figure caption have been expanded.

-Conclusions: -Line 15: “The comparison between measured quantity and that predicted by several theories reveals that some consistence exists in them but the difference is also obvious.” Such a sentence is without meaning. You need to detail when consistence exists, and when not and why. -Page 1243: Conclusions drawn here are very important, but they are not supported by results described in chapter 4. Therefore chapter 4 needs to be expanded accordingly.

The part about conclusion has been rewritten completely, hopefully to avoid such problem. These conclusions that are not supported by results have deleted.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 1233, 2012.