We would like to thank the two referees for their constructive and appropriate comments and suggestions. We believe that, based on their suggestions, the paper has sensitively improved. Below is a point-by-point answer to all referee #2 comments and requests. We are also ready to submit a revised version of the paper which addresses all points below.

Anonymous Referee #2

In this paper, the authors present a new approach to determine the height of the planetary boundary layer (PBL) by applying a widely used technique (first order derivative) to range-corrected rotational Raman lidar signals. They compare the results to PBL retrievals from potential temperature soundings as well as range-corrected elastic lidar signals. The new method is tested using the rich BASIL dataset acquired during the COPS campaign in the summer of 2007.
The paper is clear and well written. I also appreciate the fact that the authors continue to analyze the wealth of data that they acquired during COPS (8 days of measurements in this paper).
I think the study proposed here is worth publishing in AMT, but the paper needs a bit more work before I can recommend publication.

Major comments

The authors claim that the new approach proposed in the paper can help overcome the limitations associated with the use of lidar-derived elastic backscatter signal, especially in the afternoon and after sunset in the presence of elevated aerosol layers.
In my opinion, they do not really demonstrate that. They show that the retrievals obtained using all three techniques in a variety of meteorological conditions are in good agreement (as shown by the low bias and the high correlation coefficients detailed in the paper).
However, in case there are discrepancies between the 3 approaches, the authors do not explain which is best and why nor do they discuss the possible origin the differences.
I think this is a major lack of the paper since from the comparisons it is not possible to assess whether one lidar-based approach should be preferred over the other.

We agree with the referee that this important aspect was missing in the paper and we thank the referee for having raised it. We made our best to overcome this deficiency. In the revised version of the paper, we are now dedicating several new paragraphs to the analysis of the discrepancies between the three approaches, trying to attribute those to their possible origins. This allows us to assess when one lidar-based approach leads to more reliable results and has to be preferred over the other. In order to include additional case studies characterized by the presence of discrepancies between the three approaches, the ensemble of case studies considered in the paper has been extended and is now including ten measurement sessions.
When commenting figure 3, the following text has been introduced: “In the final portion of figure 3 c, the PBL height estimates from approach(1) and (2) are found to differ, as in fact approach(2) properly identifies the PBL height, while approach(1) infers the residual layer height which is left behind after the decay of the convective activity. This aspect is further stressed in the forthcoming discussion of figure 4.”.
Further down in the paper, we introduced the following text: “In all three cases, with only one exception (i.e. the final portion of figure 4b), deviations between the PBL height estimates from the three different approaches are typically found to not exceeding 200 m. In the final portion of figure 4b, approach(1) is found to overestimate the PBL height, with deviations between approach(1) and (2) as large as 0.5-0.6 km. As already anticipated above, the failure of approach(1) is caused by the presence of a strong aerosol gradient above the actual mixed layer associated with the presence of a residual layer. In this specific case, approach(2) is still capable to properly estimate the PBL height, thus overcoming the limitations associated with the use of the elastic lidar backscatter signals. The

red squares in figure 4b represent the PBL height estimates obtained from approach(2) applied to the high-quantum number rotational signals $P_{\lambda_{HiJ}}(z)$, these estimates being in very good agreement with those obtained with the application of approach(2) to $P_{\lambda_{LoJ}}(z)$.

As mentioned above, approach(1) is also found to fail in the presence of multiple aerosol layers within the PBL. This situation is represented in figure 5, illustrating the evolution of $R_{1064}(z)$ on 14 August 2007 over the time interval 10:45-18:22 UT; here the black line represents the output of approach(1), the black stars represent the output of approach(2) and the yellow stars represent the PBL height estimates obtained from the radiosonde potential temperature data. As a results of the presence of a marked aerosol layer within the PBL, occasionally topped with clouds, in the altitude region 0.5-1.5 km in the time period till approximately 17:00 UT, approach(1) returns false values of the PBL height, which result to be lower than the ones estimated by approach(2) and from the radisonde data, with deviations between approach(1) and the other two approaches as large as 1 km. The failure of approach(1) is caused by the algorithm revealing the gradient associated with the presence of the aerosol layer within the PBL instead of the gradient associated with the PBL top."

Also the statistical analysis was completely redone to include these aspects. We are now considering three distinct best fit analysis: one including all case studies (now 10), one including all case studies except the one (14 August 2007) characterized by the presence of a marked aerosol layer within the PBL, and one excluding 14 August 2007 and the data points after sunset. This statistical analysis allows us to properly identify the origin of the discrepancies between the different approaches. The following paragraph has now been introduced: "The agreement between approach(1) and the other two approaches increases in case the data points corresponding to the case study on 14 August 2007 (the one with the largest disagreement between approach(1) and the other two approaches as a result of the presence of an internal aerosol layer within the PBL) are removed from the statistical analysis. Specifically, the correlation coefficient *R* for approach(1) vs. the radisonde estimates gets a value of 0.97 (with a slope value of 1.04, i.e. a relative bias of 4 %), *R* for approach(2) vs. the radisonde estimates gets a value of 0.98 (with a slope value of 0.98, i.e. a relative bias of 2 %), while *R* for approach(1) vs. approach(2) gets a value of 0.93 (with a slope value of 0.93, i.e. a relative bias of 7 %). It is to be noticed that the best fit analyses including approach(1) are now characterized by larger values of *R* and slope values closer to 1 (i.e. lower bias).

The agreement between approach(1) and the other two approaches also increases in case the data points after sunset are removed from the statistical analysis. Specifically, *R* for approach(1) vs. the radisonde data gets a value of 0.98 (with a slope value of 0.97, i.e. a relative bias of 3 %), *R* for approach(2) vs. the radisonde estimates keeps a value of 0.98 (with a slope value of 0.98, i.e. a relative bias of 2 %), while *R* for approach(1) vs. approach(2) gets a value of 0.94 (with a slope value of 0.97, i.e. a relative bias of 3 %). Again, best fit analyses including approach(1) are characterized by larger values of *R* and slope values closer to 1 (i.e. lower bias). All new statistical parameters are included in table 2." All the above aspects have been also emphasized in the section "Conclusion".

Finally, the issue raised by the referee has now also been addressed from a methodological point of view. Now, in section "Results" - where the considered PBL estimate approaches are described – the following new sentences have been introduced: "It is worth pointing out that either the low- and the high-quantum number rotational Raman signals are dependent on both temperature and molecular/particle extinction. However, vertical changes in molecular extinction are very smooth with limited effects on rotational Raman signal gradients, while the sensitivity of rotational Raman signals to temperature gradients is much larger than their sensitivity to particle extinction. In this respect, it is to be specified that typical temperature gradients observed at the top of the boundary layer (0,03-0,05 K/m) lead to low/high-quantum number rotational Raman signal gradients which are a factor of 2-5/10-50 larger than those associated with the typical particle extinction gradients observed at the top of the boundary layer ($2\text{-}3\text{x}10^{-8}$ m^{-1}/m). Based on this consideration, we can

state that this technique is primarily sensitive to temperature gradients and far less to particle and total extinction gradients. This aspect makes the approach particularly effective and useful in the determination of the PBL height as it results to be successfully applicable also in the afternoon-evening decaying phase of the PBL, when the effectiveness of the approach based on the use of the elastic backscatter lidar signals may be compromised or altered by the presence of the residual layer. Additionally, this approach allows an unambiguous determination of the PBL height also in the presence of aerosol stratifications within the PBL.
It is worth pointing out that the direct use of the lidar measurement of the temperature gradient would have certainly been a valid alternative to approach(2). However, the determination of the temperature profiles from the rotational Raman signals, and consequently their gradients, would have implied the use of a more complex analysis scheme, requiring the application of a dedicated calibration procedure. Furthermore, we wished to verify the possibility to extend to the rotational Raman signals the same simple algorithm applied to the elastic backscatter signals (identification of the minima in the derivative of the logarithm of the lidar signals)."

In the COPS dataset, the authors should identify cases when the PBL retrievals based on elastic backscatter fail to identify the PBL top height and demonstrate that the approach based on the Raman lidar signal is more efficient in such cases to properly detect the PBL height.

As suggested by the referee, we have identified cases when the PBL retrievals based on elastic backscatter fail in identifying the PBL top height and tried to demonstrate that in those cases the approach based on the Raman lidar signal is more efficient: these are the case studies on 30 July and 14 August 2007. Specifically, in the late afternoon portion of the measurement session on 30 July we identified a marked discrepancy between the PBL height estimates from approach(1) and (2), which is associated with the failure of former approach; this failure is caused by the presence of a strong gradient associated with the formation of a residual layer on top of the PBL. Additionally, on 14 August 2007 (a case study which was not present in the previous version of the paper) approach(1) is found to fail because of the presence of presence of a marked aerosol layer within the PBL. These cases are discussed in detail in the revised version of the paper and several new paragraphs have been introduced in the paper: see text included in the comments to the previous point.
Additionally, the statistical analysis was completely redone in order to properly identify the origin of the discrepancies between the different approaches and quantify the degree of disagreement and the bias present when the PBL retrievals based on elastic backscatter fail in identifying the PBL top height. As already mentioned above, we are now considering three distinct best fit analysis: one including all case studies (now 10), one including all case studies except the one (14 August 2007) characterized by the presence of a marked aerosol layer within the PBL, and one excluding 14 August 2007 and the data points after sunset. With respect to this issues, several new paragraphs have been introduced in the paper: see text included in the comments to the previous point.

Finally, I think it is a bit illusive to claim that one retrieval technique has an edge over all the others... With the nice capabilities of BASIL, the authors have a chance to show how both lidar based approaches can be used together to provide a reliable continuous monitoring of the PBL height.

The referee rises a good point. None of the approaches can be in absolute terms defined as better than the other. Each has its advantages and disadvantages. The possibility of applying the two approaches together is certainly a big plus of the considered ground-based Raman lidar system. In general, in the convective portion of the day, approach(1) should be preferred to approach(2) as in fact the former approach, in the absence of multiple aerosol layers, leads to more accurate estimates of the PBL height as a result of the smaller random error affecting the strong elastic signals in daytime with respect to the rotational Raman signals. This aspect is now properly stressed in the text of the paper, where the following text has been introduced: “Finally, we wish to point out that neither approach(1) nor approach(2) can be considered to be preferable, each of them having specific advantages and disadvantages. In general, in the daytime convective portion of the day, approach(1) should be preferred to approach(2) as in fact the former approach leads to more accurate estimates of the PBL height as a result of the smaller random error affecting the strong elastic signals in daytime with respect to the rotational Raman signals. However, after sunset or in the presence of marked aerosol layers within the PBL, approach(2) is to be preferred for its unambiguous response. The possibility of applying these two approaches together is certainly a big plus of the considered ground-based Raman lidar system.” This aspect is also emphasized in the section “Conclusion”, where the following sentences have been introduced: “As neither approach(1) nor approach(2) can be considered to have an edge over the other approach, each of them having specific advantages and disadvantages, the possibility of applying these two approaches together is certainly a big plus of the considered ground-based Raman lidar system. In this respect, it is to be pointed out that the dataset collected by *BASIL* during COPS provides a unique collection of data for the study of boundary layer structure and evolution.”