Dear Editor,

We are very grateful to the two referees for their appropriate and constructive suggestions and for their proposed corrections. We have addressed all issues raised and have modified the paper accordingly. We have also submitted a revised version of the paper where all these changes have been incorporated. We believe that, thanks to precious inputs from the referees, the quality of the manuscript has sensitively improved. Below is a summary of the changes we made and our specific responses to the referees' comments and recommendations.

**Summary of the changes**
**(in black is the original comments of the referee and in red our responses)**

**Referee #1**

The study compare the atmospheric boundary layer height determined by radio-sounding temperature profile, IGRA, wind profiler, ERA5 model, BASIL raman lidar backscattering profile. The description of the ABL structure is lacking detailed information, e.g. the term ABLH is use independently of the instrument and method used, even they are referring to different ABL sublayers.

It is indeed true that the term ABLH had been erroneously used to refer to different heights identified with different instruments and methods. This aspect has been now drastically improved (see more specific comments on this point below).

Strong methodological problems further invalidate the found results.

The strong methodological problems invalidating the results have been either clarified (First methodology problem) or solved (Second methodology problem).

**Main comments:**

- The notion of ABL height is used in the whole introduction and attributed to several "heights" measured by various instruments and methods. The authors should really attribute the right ABL (sub)structure to the right layer height detection. For example, the temperature inversion (usually used for nocturnal boundary layer detection), the MLH detected by the bulk Richardson method and the LLJ cannot be assimilated to the same ABL substructure. A revision of all the concepts introduced in the introduction and of the use of these concepts through all the paper is necessary.

It is indeed true that a more careful effort was needed to properly finalize the inter-comparison effort as in fact comparing different sensors using different methodologies, which refer to different definitions of the ABLH is certainly wrong. A strong revision effort was put together to improve the paper in the direction of making the results of the present paper more scientifically founded. Now, a single approach has been applied to all sensors/models, as long as this has been possible. More specifically, ABLH estimates are obtained based to the application of the Richardson number approach i) to the Raman lidar measurements, to the radiosonde measurements, both ii) those launches on-site and iii) those launched from the nearby IGRA station, iv) to the ECMWF-ERA5 reanalysis data. The inter-comparison effort also includes v) ABLH estimates from the wind profiler, which rely on the turbulence method, as well as vi) ABLH estimates obtained from elastic backscatter lidar signals. This approach was considered following the suggestion from the referee to adopt a common single and well recognized methodology (Richardson number approach). In the present inter-comparison effort the Richardson number approach applied to the on-site radiosonde data is taken as reference, again following the suggestion of the referee in this direction.

It is to be specified that the application of the Richardson number method to the wind profiler data and the elastic backscatter lidar signals was not possible as in fact the estimate of the Richardson number requires information on both wind and thermodynamic profiles, which are not available from the wind profiler and the elastic backscatter lidar signals. Consequently, the Richardson number method is applied only to the on-site radiosonde, to the IGRA radiosonde data and to the ECMWF-ERA5 reanalysis data, and different methodologies were applied to the wind profiler data (turbulence method) and the elastic backscatter lidar signals (particle backscatter gradient approach). Additionally, the application of the Richardson number approach to the Raman lidar refers to thermodynamic profile measurements from this sensor and wind measurements from the simultaneous and co-located radiosondes, as the wind measurements are not available from the Raman lidar (see more details below).
As a results of these methodological changes, large portions of section 1 (Introduction), section 2 (Methods considered for the determination of the ABLH), section 3 (Profiling sensors and model data involved in the inter-comparison effort) and section 4 (Results) have been substantially re-written.

- First methodology problem: the ABL is subjected to a diurnal cycle that is clearly described in case of fair-weather day by Stüll (1989). The authors chose to use the mean ABLH over the entire daytime (from sunrise to sunset) to compare the instruments and methods.

Here there was, and we really have to apologize for that, a miscommunication among the authors. The author who finally reviewed the paper (Paolo Di Girolamo) had not properly interpreted the information coming from the other coauthors taking care of the data analysis. In fact, the ABLH is not estimated as a mean over the entire day, but a much shorter time interval (half hour) is considered. The considered approach was to concentrate on the specific times when the RS data were available, typically at 00:00 and 12:00 UTC. So, all considered sensors and models are typically averaged over a half hour time interval centered on the comparison time (00:00 UTC and 12:00 UTC), i.e. 23.45-00:15 UTC for night-time comparisons and 11:45-12:15 UTC for daytime comparisons.
As a results of these changes, the first paragraph of section 4 (Results) has been completely re-written and the following new text has now been introduced: "In this section we illustrate and discuss the results obtained in the comparison of ABLH estimates obtained from different sensors' measurements (Raman lidar BASIL and radiosondes) and model data (ECMWF-ERA5 analysis) through the application of the Richardson number technique. The inter-comparison effort also includes ABLH measurements from the wind profiler, which rely on the turbulence method, as well as measurements obtained from elastic backscatter lidar signals.
We first provide a more climatological assessment, focusing on the evolution of the ABLH throughout the month of October 2012. A separate comparison has been carried out for daytime and night-time cases, at 12:00 UTC and 00:00 UTC, respectively (local time is UTC+02:00 hours in this period of the year). The considered sensors and models are averaged over a half hour time interval centered over the comparison time, i.e. over the interval 11:45-12:15 UTC in daytime and 23:45-00:15 UTC at night. Figure 2 illustrates the time evolution of the ABLH as measured/modeled through the above mentioned sensors/models/approaches, with figure 2a1 focusing on daytime cases and figure 2a2 on night-time cases. The figure includes six distinct ABLH estimates: ABLHs obtained through the application of the Richardson number method to: i) the Raman lidar data, the radiosonde data (considering separately (ii) radiosondes launched on-site and (iii) radiosondes launched from the closest IGRA station) and (iv) the ECMWF-ERA5 analysis data, (v) ABLHs obtained from wind profiler and (vi) ABLHs obtained from elastic backscatter lidar signals. Results reveal a good agreement between the six different estimates both in daytime and night-time, all of them revealing the major features associated with ABLH monthly variability.
The Richardson number approach applied to the on-site radiosonde profiles is probably the most reliable approach (lowest bias) and, assuming this approach as bias-free, it can be considered as

reference. Figures 2b1 and 2c1 illustrate the daytime deviations, expressed both in meters and in percentage (%), respectively, between the five reminder ABLH estimates and the one obtained through the application of the Richardson number approach to the on-site radiosonde profiles, while figures 2b2 and 2c2 illustrate the daytime deviations. These values are also reported in table 1."

Moreover, this average is done without consideration of cloud cover, precipitation or different state of the atmospheric stability. This impeded the authors to identify potential artifacts of the measurements and of the modeled ABLH, e.g. too high or low ABLH maxima, attribution of ABLH to the cloud base, wrong timing of the ABL maxima.

The reviewer is right in indicating that ABLH estimates in cloudy conditions can potentially be affected by artifacts. A false attribution of the ABLH to a cloud layer is a potential risk, especially when the range corrected signal (RCS) approach based on the detection of particle backscatter gradients is applied. In fact an erroneous identification of the top of the mixed aerosol layer (with aerosol acting as dynamical tracers) can happen when single or multiple cloud layers are present.
However it is to be further specified that only the RCS approach can be potentially affected by my cloud contaminations as in fact all other ABLH estimates are not. In this regard it is to be underlined that 4 out of the 6 ABLH estimates illustrated the in the present of paper are the result of the application of the Richardson number method to i) the Raman lidar thermodynamic profiles, ii) to the on-site radiosonde profiles, iii) to the IGRA radiosonde profiles, and and iv) to the ECMWF-ERA 5 reanalysis profiles. The Richardson number method requires information on both wind and thermodynamic profiles, as in fact the estimate of the Richardson number is based on the knowledge of the horizontal wind-speed components' profiles, and $u^2(z)_z$and $v^2(z)$, and the humidity and temperature profile measurements, needed to determine the virtual potential temperature profile. None of these measurements are affected by the presence of cloud layers. The reminder ABLH estimate considered in the paper comes from the wind profiler data, which are not affected by clouds.
Furthermore, figure 5 has been completely reformulated, with the introduction of the much longer time interval (now from 09:00 UTC on 18 October 2012 to 19:00 UTC on 19 October 2012, while formerly it was from 09:26 to 21:11 UTC on 18 October 2012) and the inclusion of the six selected ABLH estimates. This time interval includes segments with multiple aerosol and cloud layers. Indeed, within this time segment, all six ABLH estimates appear to be in reasonable good agreement, despite the presence of several aerosol and cloud layers. To comment these new results, the following new sentences have been introduced in the text: "Throughout the day on 18 October the six ABLH estimates are all in very good agreement, with values always within 200 m one from the other, with the only exception of a few data points. Throughout the day on 19 October, despite the potential issues/problems associated the with the presence of the thick stratiform clouds and light precipitation, all six ABLH estimates are in reasonable good agreement, with all values always within 200-300 m. On 19 October ABLH estimates from the wind profiler are systematically found to be slightly smaller than all other estimates. None of the six ABLH estimates appears to be affected by the presence of the thick stratiform clouds, not even the estimates based on the use of the elastic backscatter signals."

- Second methodology problem: the authors chose to use the mean of all detection methods (including the measurements and the model) as a reference to estimate the bias of the individual ABLH estimation. This approach does not allow any clear assumptions about the accuracy of the ABLH estimations. Usually the parcel method or the bulk Richardson method applied to the radio-sounding profiles are taken as a reference due to the accuracy of the in-situ measurements.

The approach of estimating the bias with respect to the meaning value of all sensors and approaches is valid only in case a higher reliability cannot be attributed to any of the sensors/approaches. The referee is indeed right in underlying that the Richardson number approach applied to the radiosonde

in situ measurements is probably the most reliable approach, with the lowest bias, and so we can consider this approach as bias-free. All computations and analyses in the paper have now been reformulated considering the deviations and biases of the different sensors/approaches with respect to the ABLH estimates obtained from the application of the Richardson number approach to the on-site radiosonde profiles, which is considered as reference. This change of approach, undertaken following the suggestions from the reviewer, also drastically improved the quality of the comparisons. All linear regression analyses reported in the paper have now improved both in terms of the correlation coefficients $R^2$, with all values now in the range 0.94-0.98, which testifies the high level of agreement between the different ABLH estimates both in daytime and at night, while all values of the slope of the fitting line A are in the range 0.91-1.08 for daytime comparisons and in the range 0.95-1.03, i.e. all values closer to unity, which testifies the very small bias affecting all five ABLH estimates with respect to the reference AHBL estimate.
All the above aspects are now clearly specified in the text, where, among others, the following sentences have been introduced: "The Richardson number approach applied to the on-site radiosonde profiles is probably the most reliable approach (lowest bias) and, assuming this approach as bias-free, it can be considered as reference.  Figures 2b1 and 2c1 illustrate the daytime deviations, expressed both in meters and in percentage (%), respectively, between the five reminder ABLH estimates and the one obtained through the application of the Richardson number approach to the on-site radiosonde profiles, while figures 2b2 and 2c2 illustrate the daytime deviations. These values are also reported in table 1." Additionally, the following sentences have been introduced: "Values of A and $R^2$ for each ABLH estimate are reported in the table 2a for daytime comparisons and in table 2 b for night time comparisons. All values of $R^2$ are in the range 0.94-0.98, which testifies the high level of agreement between the different ABLH estimates both in daytime and at night, while all values of A are in the range 0.91-1.08 for daytime comparisons and in the range 0.95-1.03, which testifies the very small bias affecting all five ABLH estimates with respect to the reference AHBL estimate. Again, slightly larger biases are observed for daytime comparisons with respect to night-time, this confirming the results already illustrated in the preceding part of the paper."

- Moreover, the first analysis shows that ERA5 has the worst results, so that it is removed out of the mean of all methods for the second part of the analysis. It is even not clear if EAR5 is removed for the whole month of October or only during the second half of the month when its results strongly differ from the measurements.

In the revised version of the paper we are no longer making use of the ABLH products directly generated by the ECMWF-ERA5 reanalysis, but we are determining the ABLH by applying the Richardson number approach directly to wind and thermodynamic profile analysis data. The present use of the reanalysis data leads to a ABLH estimate which is in much higher agreement with the other five ABLH estimates. As a result of this modification, all ABLH estimates from ECMWF-ERA5 reanalysis data are used and none of them has been removed. Furthermore,  the mean ABLH of all methods is no longer used as reference, but the ABLH estimate obtained from the application of the Richardson number approach to the on-site radiosonde profiles, so also this potential source of bias has been removed. The description of the ABLH results from ECMWF-ERA5 reanalysis data has been reformulated in the text and all reported possible motivations for the miss-agreement between ABLH estimated from ECMWF-ERA5 reanalysis data and the other five ABLH estimates have been completely removed from the paper.
All the above aspects are now clearly specified in the text. The following sentences have been introduced in the Abstract: "ABLH estimates were obtained based on the application of the Richardson number technique to Raman lidar and radiosonde measurements and to ECMWF-ERA5 reanalysis data."
The following sentences have been introduced in the Introduction: "In the present research effort we compare ABLH measurements obtained through the application of the Richardson number technique to a variety of sensors and model data, namely the Raman lidar BASIL, radiosondes and ECMWF-

ERA5 analysis data. These results are also compared with ABLH measurements from the wind profiler and from elastic backscatter lidar signals.
Again later in the Introduction it is specified: "In the present paper ABLH estimates obtained through the application of the Richardson number technique to two sensors (Raman lidar and radiosondes) and to the ECMWF-ERA5 model reanalysis data are compared with ABLH measurements from the wind profiler and from elastic backscatter lidar signals."
The following sentences have been introduced in the sub-section 2.1 dedicated to the illustration of the Richardson number method: "Vertical profiles of *T(z)*, *P(z)* and $\chi_{H2O}(z)$ are available from all sensors/models involved in the inter-comparison effort, namely the Raman lidar, the radiosondes launched on-site and those and from the closest IGRA radiosonde station and the ECMWF-ERA5 analysis data, with the only exception of the wind profiler. The vertical profiles of the horizontal wind-speed components *u(z)* and *v(z)*, which are needed to quantify the bulk Richardson number are also available from the same sensors/models, with the only exception of the Raman lidar, which only provides the humidity and temperature profile measurements needed to determine the virtual potential temperature profile. In this case, the computation of the Richardson number is completed with the inclusion of wind-speed profile measurements from the simultaneous and co-located radiosondes launched in Candillargues."
Among others, the following sentences have been introduced in section 4 (Results): "In this section we illustrate and discuss the results obtained in the comparison of ABLH estimates obtained from different sensors' measurements (Raman lidar BASIL and radiosondes) and model data (ECMWF-ERA5 analysis) through the application of the Richardson number technique."

- The parcel and bulk Richardson methods could have been applied to the Raman Lidar data allowing a real comparison between the radio-sounding, the model and the lidar ABLH detection. This approach was however not applied by the author.

This has now been done. The bulk Richardson methods has been applied to the Raman Lidar data. As already specified above, in this case the vertical profiles of the horizontal wind-speed components u/(z) and v(z), which are needed to quantify the bulk Richardson number, are not available from the the Raman lidar, which only provides the humidity and temperature profile measurements needed to determine the virtual potential temperature profile. In this case, the computation of the Richardson number is completed with the inclusion of wind-speed profile measurements from the simultaneous and co-located radiosondes launched in Candillargues. This aspect is extensively described in the text. Already in the Introduction, the following sentences have been introduced: "As the estimate of the Richardson number requires information on both wind and thermodynamic profiles, the application of this approach to the Raman lidar relies on thermodynamic profile measurements from this sensor and wind measurements from the simultaneous and co-located radiosondes, as the wind measurements are not available from the Raman lidar." In sub-section 2.1 dedicated to the illustration of the Richardson number method the following sentences have been introduced: "The vertical profiles of the horizontal wind-speed components *u(z)* and *v(z)*, which are needed to quantify the bulk Richardson number are also available from the same sensors/models, with the only exception of the Raman lidar, which only provides the humidity and temperature profile measurements needed to determine the virtual potential temperature profile. In this case, the computation of the Richardson number is completed with the inclusion of wind-speed profile measurements from the simultaneous and co-located radiosondes launched in Candillargues."

- Figure 5: ABLH corresponding to the maximal gradient of aerosol does not at all corresponds to the red points but is visible e.g. at about 3000 m between 10:30 and 16:00. I then concluded that the used algorithm applied to the raman lidar is not valid.

Figure 5 has been completely reformulated, with the introduction of the much longer time interval (now from 09:00 UTC on 18 October 2012 to 19:00 UTC on 19 October 2012, while formerly it was from 09:26 to 21:11 UTC on 18 October 2012). This time interval includes segments with multiple aerosol and cloud layers. Indeed, within this time segment, all six ABLH estimates appear to be in reasonable good agreement. Results from figure 5 are specifically used to underline the strength and weakness points of the different approaches. The following new sentences have been introduced in the text: "Throughout the day on 18 October the six ABLH estimates are all in very good agreement, with values always within 200 m one from the other, with the only exception of a few data points. Throughout the day on 19 October, despite the potential issues/problems associated the with the presence of the thick stratiform clouds and light precipitation, all six ABLH estimates are in reasonable good agreement, with all values always within 200-300 m. On 19 October ABLH estimates from the wind profiler are found to be systematically slightly smaller than all other estimates. None of the six ABLH estimates appears to be affected by the presence of the thick stratiform clouds, not even the estimates based on the use of the elastic backscatter signals."

- The paper is moreover not well written and structured. A lot of elements are not necessary and some descriptions does not allow the reading to understand the methodology (e.g. if the parcel or the bulk Richardson is used in ERA5).

It is indeed true that the paper was previously not well written and structured. We realized that a lot of elements were not necessary and some descriptions were not effective and did not allow to properly understand the applied methodologies. We went through a complete rewriting and reshuffling of a large portion of the paper. In this direction the paper has also been severely shortened. Almost 4-5 complete pages of old text have been removed from the manuscript.

- lines 44-45: "Specifically, potential temperature tends to keep nearly constant with height within the mixed layer." This is not true since the parcel method used the variation of the potential temperature to determine the convective boundary layer

This sentence has now been removed from the paper, together with the paragraph were it was embedded. In fact the paragraph was dedicated to the description of the ABLH estimate approach based on the identification of local maxima in potential temperature vertical gradient profiles, i.e. the temperature gradient method, which is no longer used in the present research effort.

- lines 45-48: " The level of maximum potential temperature vertical gradient identifies the transition from a convectively unstable region to a stable or more stable region": I've never seen such a definition.

This incorrect sentence has been removed from the paper, together with the paragraph were it was embedded paragraph. In fact the paragraph was dedicated to the description of the ABLH estimate approach based on the identification of local maxima in potential temperature vertical gradient profiles, i.e. the temperature gradient method, which is no longer used in the present research effort.

- Line 54-56: to my knowledge, wind profilers are very often used to detect ABLH and their network is not the denser one.

It is indeed true that wind profilers are very often used to detect ABLH. The corresponding sentence was changed as follows: "Wind profilers are quite effective and very often used in long-term ABLH measurements as a result of their unattended operation over extended observation periods and the availability of networks of operational wind profilers over wide areas of the globe."

- Wind profilers are impacted by birds migration but I never heard about artifacts due to insects' swarms

We learnt about this problem with insects' swarms based on a recent corporation with a research group having a long-term experience in developing and operating wind profilers. We refer to the research group which is leaded by Prof. Frédérique Saïd at Université Toulouse-Laboratoire d'Aérologie, Toulouse, France. The presence of insects' swarms was considered as one of the possible motivations for the problems we experienced in retrieving humidity profiles from wind profiler radar measurements. Specific references to this problem are represented by the following literature papers:

- Larkin, R. 1991. Flight speeds observed with radar, a correction: slow 'birds' are insects. Behav. Ecol. Sociobiol. 29: 221–224.
- Chapman, J.A., Reynolds, D.R. & Smith, A.D. 2003. Vertical-looking radar: a new tool for monitoring high-altitude insect migration. Bioscience 53: 503–511.
- Chapman, J.W., Drake, V.A. & Reynolds, D.R. 2011. Recent insights from radar studies of insect flight. Ann. Rev. Entomol. 56: 337–356.
- Gauthreaux, S.A., Jr, Livingston, J.W. & Belser, C.G. 2008. Detection and discrimination of fauna in the aerosphere using Doppler weather surveillance radar. Integr. Comp. Biol. 48: 12–23.

The above references have now been introduced in the text and the corresponding sentence has been partially revised as follows: "Additionally, ABLH estimates from wind profilers are sensitive and occasionally affected by the presence of insects' swarms (Larkin, R. 1991; Chapman et al., 2003; Chapman et al., 2011; Gauthreaux et al., 2008)."
Conversely, the accuracy of Doppler radar wind retrievals can also be assessed using insects as targets (among others, Rennie, S.J., Illingworth, A.J., Dance, S.L. and Ballard, S.P. (2010), The accuracy of Doppler radar wind retrievals using insects as targets. Met. Apps, 17: 419-432. https://doi.org/10.1002/met.174).

- Identification of fluctuation in wind: why is RS the only accurate method ?

The referee is right to highlight that the RS is not the only accurate method for the identification of wind fluctuation. Wind fluctuations can also be identified in wind lidar data, in wind profiler data and, for example, in in-situ sensors measurements from tethered balloons or sensors on-board scientific aircrafts. The corresponding sentence has been changed as follows: "Such fluctuations can be identified in wind lidar and wind profiler data, but measurements can also be performed with radiosondes and tethered balloons or in-situ sensors on-board scientific aircrafts."

- Line 84: The stable layer at the top of the mixed layer stops the turbulent eddies from further rising. Is it the right answer ?

The sentence is former line 84, together with a large portion of the paragraph were it was embedded, has now been removed from the text.

- Line 87-88: "Additionally, radiosonding data can provide a long observational record, which is particularly suited for ABLH climatological studies (Madonna et al. 2021)." This does not matter for this paper since only one month of observation is used.

The present sentence, together with a large portion of the paragraph were it was embedded, has now been removed from the text.

- Line 92-93: so called “bulk Richardson number for the entire ABL”: the bulk Richardson number is well defined. I do not see why it is called here “bulk Richardson number for the entire ABL” ? Why to add “ for the entire ABL”?

We agree that it was not correct to specify “ for the entire ABL”, so this portion of sentence has been removed. Now the sentence reads: “This method assumes the ABLH to be the level where the so called “bulk Richardson number” exceeds a specific threshold value, $Ri_{bc}$.”

- Line 95-96 “Such gradients can be revealed in wind lidar, wind profiler, radiosonde and aircraft in- situ sensors’ profile data (Sicard et al., 2006).” This sentence is not completely right. First, the bulk Richardson cannot really be considered as a gradient. Second the wind lidar and the wind profiler does not suit, alone, to the Rib calculation, that needs temperature and wind compounds. Radio-sounding does not need further wind measurement (wind profiler/lidar) since it usually also measures wind.

This incorrect sentence has now been removed from the text.

- Line 97-98: the low-level jet cannot be considered as an ABLH.

This sentence, together with a large portion of the paragraph were it was embedded, has been removed from the text. In fact, the description of the wind shear profile approach to estimate the ABLH, which relies on measurements of the vertical wind profile, in the revised version of the paper is no longer present.

- In the introduction, it is not mentioned that the raman lidar BASIL also measured temperature profiles.

It is indeed true that the temperature measurement capability of the Raman lidar BASIL had not been mentioned in the Introduction of the paper. This gap has now been filled. The following sentence has now been introduced in the paper. “As the estimate of the Richardson number requires information on both wind and thermodynamic profiles, the application of this approach to the Raman lidar relies on thermodynamic profile measurements from this sensor and wind measurements from the simultaneous and co-located radiosondes, as the wind measurements are not available from the Raman lidar.” Further down in the introduction, the following sentence has also been introduced: “The capability of the Raman lidar BASIL to perform high-resolution and accurate profile measurements of atmospheric temperature and water vapour, as well as particle backscatter profile measurements, allows to obtain ABLH estimates based on both the application of the Richardson number approach and the use of elastic backscatter lidar signals.”

- Line 120: it would be nice to have detailed information on the applied vertical and temporal smoothing applied to the water vaoupe and temperature profiles.

This information has now been introduced and the text has been changed as follows: “Data are sampled with a rough vertical and temporal resolution of 7.5 m and 10 sec, respectively, but vertical and temporal smoothing is typically applied when processing water vapour, temperature and particle backscatter measurements for the purpose of estimating the ABLH. In the present study we considered a vertical and temporal resolution of are 30 m and 5 min, respectively. Based on these vertical and temporal resolutions, water vapour and temperature profile measurements from BASIL extend from the proximity of the surface (50-100 m above station level) up to ~4/~10 km (day/night) and ~6/~20 km(day/night), respectively.”

- Line 127: the strongest echoes in the ABL are due to higher aerosol concentration. Aerosol is the real measured parameter, not the echoe.

The sentence has been changed as follows: "An extensively used methodology relies on the detection of vertical gradients in elastic backscatter lidar signals, associated with aerosol concentration gradients"

- Line 138-140: the sentence at line 140 is completely right, but this does not correspond exactly to equation (3). The sentence line 138 is not precise enough, even it is complete thereafter at line 140.

The sentence in line 138 has been changed as follows: "As the larger vertical variability of the RCS is associated with aerosol vertical gradients, the ABLH is estimated from the height derivative of RCS through the expression: $ABLH = min\left\{\frac{d}{dz}\left[\log\left(RCS(z)\right)\right]\right\}$ (5)". The sentence in line 140 has been changed as follows: "Transitions between different aerosol layers are identified with the minima in expression (5), with the highest amplitude minimum, i.e. the largest aerosol gradient, typically indicating the ABLH."

- 2.2 the ABL layers detected by the described gradient method correspond to CBLH in the mid-day and to RL during the night. This should be better described and explained. This comment complement the first main comment.

This aspect has now been properly stressed in the paper, where the following sentences have been introduced: "This approach relies on the strong sensitivity of elastic backscatter lidars to suspended aerosol particles and their gradient and on the property of aerosols to act as tracers of atmospheric motions. It is to be specified that ABLH estimate determined through this approach identifies the convective boundary layer height during the day, when convective activity is on, and the residual layer during the early morning, the late afternoon and the night, when convective activity is strongly reduced or suppressed."

- Line 143-144: why the wind profiler impeded the detection of shallow ABLH and no the lidar overlap effects ? Please be more precise in your descriptions.

The ABLH estimate from the wind profiler is based on the turbulence method, with the turbulent region being determined by tracking the fluctuations of the different wind components (*U*, *V*, and *W*). Such tracking becomes ineffective within the surface atmospheric layer as a result of the lack of sensitivity in wind measurements in this region. On the other hand, overlap effects in elastic backscatter lidar measurements may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective. This aspect is now more clearly specified in the text, where the following sentences have been introduced: "In fact, overlap effects may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective. Overlap effects are more pronounced when determining the night-time ABLH, especially when this height is within a few tens of meters and may fall in the lidar blind region."

- Line 170-172: Is it possible to have an uncertainty estimation on the ABLH from the uncertainty in the temperature profile?

This sentence, together with a large portion of the paragraph were it was embedded, was dedicated to the description of the approach to estimate the ABLH based on the application of the temperature gradient method, which relies on the identification of maxima in the potential temperature vertical gradient. The illustration of this approach has been removed from the paper because it is no longer used in its present version.

- Line 181 “agin”?

The sentence where this typing error was present has been removed from the paper.

- Line 199-201: the reader does no more know, which method is used in EAR 5.

As already illustrated above, in the revised version of the paper we are no longer making use of the ABLH products directly generated by the ECMWF-ERA5 reanalysis, but we are determining the ABLH by applying the Richardson number approach directly to wind and thermodynamic profile analysis data. So, the ABLH estimate from ECMWF-ERA5 reanalysis data reported in the present paper are indeed determined based on the application of the Richardson number method, as clearly stated in the sentence in lines 199-201. However, this sentence has now been removed from the text, together with a large portion of the paragraph were it was embedded, in order to shorten, lighten and increase the readability of the text.

- Line 201-204: it the authors want to speak about the uncertainties of the algorithm used in ERA5 (the parcel method as given at line 198), the considered uncertainties have to be described. The examples given at lines 203-204 are, to my knowledge, never considered in the parcel method.

This sentence, together the paragraph were it was embedded, has now been removed from the text. As already mentioned above, we are now are no longer making use of the ABLH products generated by the ECMWF-ERA5 reanalysis, but we are determining the ABLH by applying the Richardson number approach directly to wind and thermodynamic profile analysis data.

- Line 205: finally, the bR method is used ?? then what is the usefulness of lines 198-2004 ?

The reviewer is right: in the previous version of the paper there was some useless text related to the description of the standard ABLH products generated by the ECMWF-ERA5 reanalysis. As already mentioned above, this paragraph has been now removed as in fact the ABLH estimate presently reported in the paper is obtained from the ERA5 reanalysis by applying the Richardson number approach directly to wind and thermodynamic profile analysis data.

- Line 208-2010: it seems that the authors have not really understood the method. Rib is compute for all heights and not only for the ABLH. ABLH is given when Rib= the chosen threshold. This comment is another complement to the first main comment. It really seems that the authors have a too low knowledge of the ABL structure and the methods used to measure it.

This paragraph has been completely rewritten and moved into a dedicated sub-section (2.1 Richardson number method) within a new section (2 Methods considered for the determination of the ABLH) dedicated to methods used throughout the paper to determine the ABLH. This sub-section has been reformulated as follows:

“This method assumes the ABLH to be the level where the so called “bulk Richardson number” exceeds a specific threshold value, $Ri_{bc}$. $Ri_b$ at height $z$ can be calculated from the wind speed and the potential virtual temperature values at $z$ and at surface level, as originally reported in Hanna

(1969) and extensively described in e.g., Stull (1988) and Garratt (1994). In the present research effort the bulk Richardson number has been computed through the following expression:

$$Ri_b(z) = \frac{\left(\frac{g}{\theta_v(0)}\right)(\theta_v(z) - \theta_v(0))\, z}{u^2(z) \quad + v^2(z)} \tag{1}$$

where $\theta_v(0)$ and $\theta_v(0)$ is the virtual potential temperature at surface and at height $z$, respectively, $\frac{g}{\theta_v(0)}$is the buoyancy parameter, and $u^2(z)_z$and $v^2(z)$ are the horizontal wind-speed components at height z, respectively.

The threshold Richardson number $Ri_{bc}$ have been reported in a variety of literature papers (Zilitinkevich and Baklanov, 2002; Jericevic and Grisogono, 2006; Esau and Zilitinkevich, 2010). Reported values are in the range 0.15 to 1.0, with most widely used values in the range 0.25-0.5. One important cause of the large variability of $Ri_b$ is the thermal stratification in the ABL. For example, Vogelezang and Holtslag (1996) reported the $Ri_{bc}$ values of 0.16–0.22 in a nocturnal strongly stable ABL and 0.23–0.32 in a weakly stable ABL. For unstable ABLs, a $Ri_{bc}$ value larger than 0.25 is usually needed (Zhang et al., 2014).

The ABLH is found by assessing the altitude level where $Ri_b(z)$ reaches the $Ri_{bc}$. In the present research effort we are considering $Ri_{bc}$=0.25 in stable boundary layers and $Ri_{bc}$=0.45 in convective boundary layers. The main uncertainty affecting the ALBH estimate based on the application of Richardson number is related to its sensitivity to atmospheric stability conditions and to sounding vertical resolution (Seidel et al., 2012). The ABLH is obtained from both the radiosonde and model data using the above described algorithm, which is applied from the surface upwards. In case the ABLH falls in between two levels, a linear interpolation is applied to determine its exact position.

In the determination of the bulk Richardson number through the expression (1) the virtual potential temperature and horizontal wind-speed components profiles are needed. The vertical profile of the potential virtual temperature can be expressed as:

$$\theta_v(z) = T(z)\left(\frac{P_0}{P(z)}\right)^{0.286}[1 + 0.622 * \chi_{H2O}(z)] \tag{2}$$

where $P_0$ is the standard pressure (1 atm), *T(z)* is temperature profile, *P(z)* is the pressure profile and $\chi_{H2O}(z)$ is the water vapour mixing ratio profile.

Vertical profiles of *T(z)*, *P(z)* and $\chi_{H2O}(z)$ are available from all sensors/models involved in the inter-comparison effort, namely the Raman lidar, the radiosondes launched on-site and those and from the closest IGRA radiosonde station and the ECMWF-ERA5 analysis data, with the only exception of the wind profiler. The vertical profiles of the horizontal wind-speed components *u(z)* and *v(z)*, which are needed to quantify the bulk Richardson number are also available from the same sensors/models, with the only exception of the Raman lidar, which only provides the humidity and temperature profile measurements needed to determine the virtual potential temperature profile. In this case, the computation of the Richardson number is completed with the inclusion of wind-speed profile measurements from the simultaneous and co-located radiosondes launched in Candillargues."

- Line 208: please give a reference for the applied Rib equation.

The applied $Ri_b$ equation was taken from Stull (1988) and Garratt (1994). The threshold Richardson number values $Ri_{bc}$ were taken from a variety of different literature papers (Zilitinkevich and Baklanov, 2002; Jericevic and Grisogono, 2006; Esau and Zilitinkevich, 2010, Vogelezang and Holtslag, 1996).

Stull, R. B.: An Introduction to Boundary Layer Meteorology, Dordrecht, Kluwer, 666 pp., 1998.

Garratt, J. R.: The Atmospheric Boundary Layer, Cambridge Atmospheric and Space Science Series, Cambridge Univ. Press, 335 pp., 1992.

Zilitinkevich, S., Baklanov, A. Calculation Of The Height Of The Stable Boundary Layer In Practical Applications. Boundary-Layer Meteorology 105, 389–409 (2002). https://doi.org/10.1023/A:1020376832738.

Jericevic A and Grisogono B, The critical bulk Richardson number in urban areas: verification with application in NWP model, Tellus, 58, DOI: 10.3402/tellusa.v58i1.14743, 2006.

Esau, I. and Zilitinkevich, S.: On the role of the planetary boundary layer depth in the climate system, Adv. Sci. Res., 4, 63–69, https://doi.org/10.5194/asr-4-63-2010, 2010.

Vogelezang, D.H.P., Holtslag, A.A.M. Evaluation and model impacts of alternative boundary-layer height formulations. Boundary-Layer Meteorol 81, 245–269 (1996). https://doi.org/10.1007/BF02430331.

All these references have now been introduced in the text.

- Equation 6 is not needed since it's the same as equation 5 at another level.

Former equations 5 and 6 has now been removed from the text.

- Line 222: mothers ?

This sentence has been corrected and moved to the Conclusions (section 5).

- Line 232: I really do not see the scientific meaning to average the SBLH from 09:00 to 21:00 UTC ? if you want to describe the ABL dynamic, you should describe the growth, the maximum and, if the method allows it, the decrease of the ABLH. To compare mean over the complete convective diurnal cycle does not bring any reliable information.

As already specified above, and we really apologize for that, there had been a miscommunication among the authors. The author who finally reviewed the paper (Paolo Di Girolamo) had not properly interpreted information coming from the other coauthors taking care of the data analysis. In fact, the ABLH is not estimated as a mean over the entire day, but a much shorter time interval (half hour) is considered. The considered approach was to concentrate on the specific times when the RS data were available, typically at 00:00 and 12:00 UTC. So, all considered sensors and models are typically averaged over a half hour time interval centered on the comparison time (00:00 UTC and 12:00 UTC), i.e. 23.45-00:15 UTC for night-time comparisons and 11:45-12:15 UTC for daytime comparisons.

- Moreover, the gradient method applied to the Raman Lidar aerosol range corrected backscattering will monitor the residual layer during part of the morning and in the late afternoon, allowing no comparison with the other methods.

This aspect has been now clearly specified in the text, where the following sentence has been introduced: "It is to be specified that ABLH estimate determined through this approach identifies the convective boundary layer height during the day, when convective activity is on, and the residual layer during the early morning, the late afternoon and the night, when convective activity is strongly reduced or suppressed."

- Figure 2a: the y labeling should be ABLH and not only altitude

The y labeling has been corrected.

- Figure 2b and c, Fig. 3: why to choose the mean of all method as a reference ? usually the most reliable method (often the radio-sounding) is taken as the reference.

As already specified above, following the suggestion of the referee, we are now using the Richardson number approach applied to the on-site radiosonde data as reference.

- Line 241: Up to now the authors claimed to analyze the month of October. Why August is now mentioned? There cannot be any influence of August weather conditions on the ABLH of October.

This misprint has been removed, together with all the paragraph where it was embedded. The paragraph had been originally introduced to motivate the miss-agreement between ABLH estimates from ECMWF-ERA5 reanalysis data and all other ABLH estimates, miss-agreement that – as specified in detail above - is no longer present.

- Lines 252-254: is the EAR5 removed for the whole period or only for the second half of October

As already specified above, in the revised version of the paper we are no longer making use of the ABLH products generated by the ECMWF-ERA5 reanalysis, but we are determining the ABLH by applying the Richardson number approach directly to wind and thermodynamic profile analysis data. The present use of the reanalysis data leads to ABLH estimates which are in much higher agreement with the other five ABLH estimates. As a result of this modification, all ABLH estimates from ECMWF-ERA5 reanalysis data are used and none of them has been removed. Furthermore, the mean ABLH of all methods is no longer used as reference, but the ABLH estimate obtained from the application of the Richardson number approach to the on-site radiosonde profiles is used as reference, so also this potential source of bias has been removed.

- Line 263: if ERA5 is the only method removed from the mean to make the correlation, it is obvious that it will obtained the lowest $R^2$. (new value are present now)

This sentence has been removed for the motivations already illustrated in the previous point.

- Lines 265-275: this is not the right way to present results in an attractive way.

This paragraph has been completely re-written and now results are presented in a more attractive way, underlining the qualitative value of those results that had been previously reported only in a quantitative way. In addition, this paragraph has been expanded with the introduction of the comparisons between daytime and night-time performance for all sensors/models/approaches.

- Line 306-307: All remote sensing observation figures are always constructed like that. There is no use to describe this in the text and in the figure caption.

This sentence has been now modified both in the text and removed in the figure caption.

**Referee #2**

1) I recommend that you add some analysis of the results so they are not only quantitative but also qualitative. What does it mean that the ABLH estimates are similar? What does this say about

thermal, kinematic and aerosol definitions of ABLH? What do the results say about the model ability to measure ABLH? Is there some time of day that the results differ? It might be interesting to show an hourly composite comparison. Are there some specific weather conditions that the results differ?

We went through a complete rewriting and reshuffling of a large portion of the paper. As a results of this, results are now presented in a more attractive way, underlining the qualitative value of the results that had been previously reported only in a quantitative way. Aspects related to the similarity of the ABLH estimates and the significance of the different (thermal, kinematic and aerosol definitions) are now carefully stressed in the paper and an assessment of the model ability to simulate the ABLH and its evolution is also provided. We have now extended the inter-comparison to both daytime and night-time data, with results revealing slightly larger biases affecting daytime comparisons with respect to night-time. The use on an extended time case study covering two daily cycles and different weather conditions allow to assess the performance in monitoring the short-term variability of the ABLH. See more details below and in the revised text.

2) Why do you use the mean of the ABLH estimates as the reference ? This may need some more justification, especially since the ERA5 method has such poor results.

The approach of estimating the bias with respect to the mean value of all sensors and approaches is valid only in case a higher reliability cannot be attributed to any of the available sensors/approaches. However, the Richardson number approach applied to the on-site radiosonde measurements is probably the most reliable approach among those considered in the present research effort, with the lowest bias, and so we can consider this approach as bias-free and take it as reference when assessing the bias of all other ABLH estimates. Consequently, in the revised version of the paper that we have just submitted, the mean of the ABLH estimates is no longer used as reference.
Additionally, in the revised version of the paper we are no longer making use of the ABLH products directly generated by the ECMWF-ERA5 reanalysis, but we are determining the ABLH by applying the Richardson number approach directly to the wind and thermodynamic profile analysis data. The present use of the reanalysis data leads to ABLH estimates which are in much higher agreement with the other five ABLH estimates. As a result of this modification, all ABLH estimates from ECMWF-ERA5 reanalysis data are used and none of them has been removed.

3) Why do you average results over a 12 hour period ? Perhaps hourly averages would be more interesting so that you could compare the measurement techniques during the boundary layer evolution.

Here there was, and we really apologize for that, a miscommunication among the authors. The author who finally reviewed the paper (Paolo Di Girolamo) had not properly interpreted information coming from the other coauthors taking care of the data analysis. In fact, the ABLH is not estimated as a mean over the entire day, but a much shorter time interval (half hour) is considered. The considered approach was to concentrate on the specific times when the RS data were available, typically at 00:00 and 12:00 UTC. So, all considered sensors and models are typically averaged over a half hour time interval centered on the comparison time (00:00 UTC and 12:00 UTC), i.e. 23.45-00:15 UTC for night-time comparisons and 11:45-12:15 UTC for daytime comparisons.

**Specific comment:**

Lines 45-48 : This is a confusing description of ABLH.

These confusing sentences have now been removed.

Lines 93-96 : This is unclear to me : The Richardson number gradient method requires observations of profiles wind speed and potential temperature. Perhaps you could clearly state that it can be calculated using radiosondes but only at limited times during launches. And it can be calculated using in situ aircraft profiles but only during ascent and descent. The wind lidar and wind profile continuous observations do not provide the potential temperature information. Please be more clear in that discussion.

These aspects are now more clearly specified in the text. In the revised version of the paper we are now comparing six ABLH estimates, i.e. the ABLH estimates obtained based on the application of the Richardson number technique to Raman lidar and radiosonde measurements and to ECMWF-ERA5 reanalysis data to the ABLH measurements from the wind profiler, which rely on the turbulence method, and from elastic backscatter lidar signals.
The Richardson number can be calculated from the wind speed and the potential virtual temperature profiles. The vertical profile of the potential virtual temperature can be determined from the vertical profiles of atmospheric temperature, pressure and water vapour mixing ratio. These profiles are available from all sensors/models involved in the inter-comparison effort, namely the Raman lidar, the radiosondes launched on-site and those and from the closest IGRA radiosonde station and the ECMWF-ERA5 analysis data, with the only exception of the wind profiler. The vertical profiles of the horizontal wind-speed components u/(z) and v(z), which are needed to quantify the bulk Richardson number are also available from the same sensors/models, with the only exception of the Raman lidar, which only provides the humidity and temperature profile measurements needed to determine the virtual potential temperature profile. In this case, the computation of the Richardson number is completed with the inclusion of wind-speed profile measurements from the simultaneous and co-located radiosondes launched in Candillargues.

Lines 97-99 : Why do you describe the ABLH using the LLJ technique ? Do you use this technique ? Is that valid only at nighttime ? You do not show any nighttime ABLH measurements in your comparisons. Perhaps you mention this information for completeness ? If so, please state that.

These sentence, together with a large portion of the paragraph were it was embedded, has been removed from the text. In fact, the description of the wind shear profile approach to estimate the ABLH, which relies on measurements of the vertical wind profile, is no longer present in the revised version of the paper. Additionally, in the revised version of the paper the inter-comparison is extended to both daytime and night-time cases, with slightly larger biases observed for daytime comparisons with respect to night-time.

Line 121 : What is the minimum and maximum height range for BASIL ?

The minimum and maximum height range for BASIL may vary in dependence of the application. For example, measurements of the vertical profiles of atmospheric temperature and water vapour mixing ratio, which are based on the application of the rotational and vibrational Raman lidar techniques, respectively, are obtained by ratio-ing two signals, i.e. the low- and high-quantum number rotational Raman signals from molecular nitrogen and oxygen in the case of temperature measurements and the water vapour and the molecular nitrogen roto-vibrational Raman signals in the case of water vapour mixing ratio measurements. As the ratio-ed signals have very similar overlap functions (and this is guarantee by the very compact optical design of the system), overlap effects tend to cancel out and temperature measurements and the water vapour may extend down to the blind region (50-100 m above station level).

The text has been integrated as follows: "Data are sampled with a rough vertical and temporal resolution of 7.5 m and 10 sec, respectively, but vertical and temporal smoothing is typically applied when processing water vapour, temperature and particle backscatter measurements for the purpose of estimating the ABLH. In the present study we considered a vertical and temporal resolution of are 30 m and 5 min, respectively. Based on these vertical and temporal resolutions, water vapour and temperature profile measurements from BASIL extend from the proximity of the surface (50-100 m above station level) up to ~4/~10 km (day/night) and ~6/~20 km(day/night), respectively."
For what concerns the ABLH estimate from elastic backscatter lidar signals, it is to be specified that overlap effects in elastic backscatter lidar measurements may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective.
This aspect is now extensively addressed in the text and the following sentences have been introduced: "Overlap effects affect lidar signals in the lower few hundred meters, but have marginal effects on gradient measurements and consequently the accuracy of ABLH estimates. In fact, overlap effects may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective. Overlap effects are more pronounced when determining the night-time ABLH, especially when this height is within a few tens of meters and may fall in the lidar blind region."

Line 143 : If there are no data in the lower few hundred meters, could that limit your observations of nocturnal ABLH ? Perhaps you could state here that you are not measuring nocturnal ABLH ?

As already specified in the previous point, this aspect has now been extensively addressed in the text and the following sentences have been introduced: "Overlap effects affect lidar signals in the lower few hundred meters, but have marginal effects on gradient measurements and consequently the accuracy of ABLH estimates. In fact, overlap effects may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective. Overlap effects are more pronounced when determining the night-time ABLH, especially when this height is within a few tens of meters and may fall in the lidar blind region."

Line 157-159 : You note that the applicability of the ABLH technique from a wind profiler can be limited by strong reflectivity peaks due to temperature and humidity gradients. I must be misunderstanding the wind profiler technique because I thought the gradients are what determines the reflectivity peaks. Please further explain the wind profiler technique and how the reflectivity peaks are different from the temperature and humidity gradients. Also please describe how « This aspect will be carefully accounted for .. . »

We apologize for the misleading content and inaccurate writing of these sentences, which have now been removed. As suggested by the referee, we have now also further explained the wind profiler technique and how the reflectivity depend on atmospheric thermodynamic properties. The corresponding sentences have been changes as follows: "The methodology applied to determine the ABLH relies on the identification of a distinctive strong peak in the WPR time-height reflectivity plot (Gage et al., 1990), which is associated with turbulence-generated radio refractive index fluctuations, associated atmospheric thermodynamic parameters' fluctuations, though the strength of this peak may depend also on other factors. Wind profiling radars are sensitive to scales of turbulence that equal half the radar wavelength. At 1.274 GHz, this wavelength is ~20 cm. Therefore the wind profiler is sensitive to turbulent eddies with spatial dimensions of ~10 cm causing fluctuations in the radio refractive index. In the boundary layer, essentially all scales of turbulence exist from 1-cm wavelengths up. Wind velocity measurements rely on the detection of the Doppler shift, assuming that fluctuations in the radio refractive index, dependent on atmospheric thermodynamic parameters, are carried along the mean wind flow."

Figure 5a : Could you please add the results of the other methods of determining ABLH to this figure ? Why does the red line appear to be significantly lower than the maximum aerosol gradient ?

All six ABLH estimates considered in the paper have now been introduced in both figures 5a and 5b.

Figure 5b : Could you please also add the ABLH results on Fig 5b ?

All six ABLH estimates considered in the paper have now been introduced in both figures 5a and 5b.

**Technical and typographical comments:**

Line 52 : Please change to « . . . of recent technological progress. . . . »

This portion of sentence has now been removed from the text.

Line 53 : Please insert « such » into here : « . . .atmospheric variables, such as particle. . . . »

Modified in the way suggested by the referee.

Line 144 : Please add 'and' here « . . . meters and have marginal . . . »

Corrected

Line 144 : Please quantify « marginal effects ».

This aspect is now properly addressed in the text, where the following sentences have been introduced: "In fact, overlap effects may determine a compression of the elastic signal dynamics, and consequently a reduction of the amplitude of the detected range-corrected signal gradients, but will not cancel these gradients, making the detection of the ABLH still effective. Overlap effects are more pronounced when determining the night-time ABLH, especially when this height is within a few tens of meters and may fall in the lidar blind region."

Line 173 : Please delete « again ».

This sentence, together with the paragraph where it was embedded, has been removed from the text. This sentence referred to operation details in the application of the temperature gradient method, which is no longer considered in the present research effort among the approaches applied to the measurements/model data.

Line 173 : Also, what are marginal effects ? Please be more quantitative.

This sentence, together with the paragraph where it was embedded, has been removed from the text. This sentence referred to operation details in the application of the temperature gradient method, which is no longer considered in the present research effort among the approaches applied to the measurements/model data.

Line 181 : Suggested modification : « . . .radiosondes are obtained by using the temperature gradient method. »

This sentence, together with part of the paragraph where it was embedded, has been removed from the text. This sentence referred to the application of the temperature gradient method, which is no longer considered in the present research effort among the approaches applied to the measurements/model data.

Line 185 : I recommend that you delete « again »

This portion of sentence has been removed. It was referring to the application of the temperature gradient method, which is no longer considered in the present research effort among the approaches applied to the measurements/model data.

Line 185 : Please quantify what you mean by « negligible uncertainties »

This portion of sentence has been removed. It was referring to the application of the temperature gradient method, which is no longer considered in the present research effort among the approaches applied to the measurements/model data.

Line 209 : Please correct the typo at the end of the line and change « here » to « where »

Corrected in the sentence, but the text of this paragraph has been partially reshuffled.

Line 216 : I recommend that you delete « being the »

Corrected in the sentence, but the text of this paragraph has been partially reshuffled.

Line 222 : Please delete « the » between « observed » and « in »

This sentence has been removed from the text, together with part of the paragraph where it was embedded.

Line 222 : What is meant by « and sensors and mothers » ?

This sentence has been corrected and moved to the Conclusions (section 5).

Line 232 : Please tell us the LT for 0900 – 2100 UTC.

As already specified above, the time window from 9:00 to 21:00 UTC was an erroneously reported information. In fact, the ABLH is not estimated as a mean over the entire day, but a much shorter time interval (half hour) is considered. The considered approach was to concentrate on the specific times when the RS data were available, typically at 00:00 and 12:00 UTC. We are now considering a separate comparison for daytime and night-time cases, at 12:00 UTC and 00:00 UTC, respectively. Local times for these UTCs have now been specified in the text and the corresponding sentence reads as follows: “A separate comparison has been carried out for daytime and night-time cases, at 12:00 UTC and 00:00 UTC, respectively (local time is UTC+02:00 hours in this period of the year).”

Line 234 : Please correct the typo in the word « its » here : « activity, from its activation . . . «

The present sentence has been removed from the text.

Line 234 : I recommend that you remove the words « a quite ».

Corrected.

Line 257 : I suggest you change it to « scatter plots ».

Corrected.

Line 286 : Please change to « . . .50-100 ».

Corrected.

Line 287 : I think that « unfavorable » should be one word.

Corrected.

Line 303 : Please modify to : « . . .corresponding relative humidity values. »

Corrected.

Line 306 : I suggest you change the word « map » to « figure ».

Corrected.

Line 332 : Please remove the word « the » before « them. »

Corrected.

Line 334 : Please correct the typos : « . . .computed from different sensors are in the range. . . »

Corrected.

Line 343 : There are two periods at the end of the sentence.

Corrected.

Figures 2b and 2c : It would be helpful to add a horizontal line at bias=0.

A black dashed horizontal line has now been introduced in all four figure panels illustrating bias values (panels $b_1$ and $c_1$ for daytime comparisons and panels $b_1$ and $c_1$for night-time comparisons).

Line 487 : Suggested modification : « . . .expreseed in terms of scatter plots, . . . »

Corrected.

Figure 3 caption : It looks like the font in the lines 487-488 is different from the font in the rest of the manuscript.

Corrected

Figure 3b : Where is the best fit line in Fig. 3b ?

In the previous version of figure 3, we had introduced in all panels the 1:1 bisector line for the purpose of highlighting the deviation between the fitting lines and those corresponding to zero bias. In the case of figure 3 b the agreement was so good that the fitting line was hidden by the 1:1 bisector line. In order to avoid such hiding, 1:1 bisector lines have now been removed from these figure panels.

Figure 5 : Please add (a) and (b) to the figure panels.

The indication (a) and (b) has been added to the figure panels.

Figure 5b : The x-axis is missing the first « 9 ».

The time labels in figure 5b have been corrected.

Figure 5 caption suggestion : « Figure 5 : (a) Time-height . . . ., (b) and water vapour mixing ration over the time . . . »

Corrected following the suggestions of the referee.