Cover Letter

Dear Editor,

We thank you and the reviewers for your feedbacks.

We would like to note that we have answered as much as possible to Reviewer#2 concerns. However, although stated as « major », the comments of Rev#2, as they were formulated, did not allow us to precisely understand what should be modified for the article for it to be significantly improved.

Only one comment seemed indeed major, and could have actually been pointed at the first review: the usefulness of the three illustrating examples. For this point, we are quite convinced that those examples are indispensable to the understanding of how the algorithm works, and make it more accessible and concrete than without. So, we did not wish to remove them. The manuscript would lose a lot of clarity and interest without those examples.

We therefore made a revision that corresponds to every formal point that seemed to need clarification or stress.

To answer to Rev#1 single comment (only addressed to the Editor) about Figure 4 (and 6, 8), we changed the symbols to make them clearer.

We hope those changes will enable this manuscript to be accepted.

Best regards,

Alban Philibert and co-authors.

Reply to Reviewer #2

General Comments

This manuscript reports on an algorithm to estimate the height of the atmospheric convective boundary layer (CBL) using measurements from a radar wind profiler (RWP). Measurements were taken at two locations for a period of 22 years.
→ Note that, as mentioned in the previous reply on the same statement of Rev#2, the sentence « Measurements were taken at two locations for a period of 22 years » is not correct.

We had already given in the first reply the following statements:
"22 years is the total length of this UHF RWP time series at P2OA-CRA (with some breaks when it is moved to external field campaigns). But only the 2015-2022 time period was used for the algorithm development. 2018 is a year taken for the configuration optimization (common, year with the CT25k ceilometer). 2011 is the year of the BLLAST field campaign.

We made all this clearer in the manuscript. "

The manuscript indeed clearly specifies what period is used at one or the other location, and for what purpose (see Table 1).

The algorithm is validated by comparison with radiosonde observations. The topic addressed by this manuscript falls within the scope of Atmospheric Measurement Techniques since it concerns the use of ground-based observations to estimate the height of the lowest layer of the atmosphere.

The title reflects the contents of the paper, and the revised (and improved) abstract provides a concise and complete summary.

The methods used in this work are based on valid physical concepts that have been used extensible to estimate planetary boundary layer heights by many researchers since 1994. Illustrative (limited) results are discussed in detail. The algorithm uses information provided by the RWP measurements and meteorological data to handle most (or as many as possible) conditions that can be encountered in the boundary layer (clouds, precipitation, other interference such as birds, etc.). This approach provides restrictions that may make the automatization of the method rather cumbersome.
→ It is true that several criteria are considered in order to optimize the detection of the convective boundary layer, and properly detect the various interfaces of the low atmosphere in case of complex situations. For now, there is no easy and straightforward algorithm that can disentangle this complexity.
There are such a variety of situations, and many of them can be so complex that it is already very interesting (and a clear advancement) that this algorithm helps in detecting such complex cases and in attributing the nature of each detected interface. Finding it « cumbersome » seems to be a judgement that does not lead to a proposition of improvement of the algorithm or manuscript. Contrary to this, one can find the algorithm complex, reflecting the complexity that it attempts to catch.

The authors have responded to reviewers' comments of their initial submission by significantly improving the manuscript with respect to structure and proper attribution to previous (pertinent) works, including more discussion of those works. I note in particular the clarity and conciseness of sections 2.1 and 2.2.
→ We thank the reviewer for acknowledging this revision work.

The authors in the revised version indicate their own contribution more clearly.
→ The revised version is the same as the submitted version for this specific point. Contributions were already clear at the submission stage.

The lengthy discussion section about flags is hard to follow, perhaps it can be made more concise.
→ Flags are defined in section 3.3.3, lines 324 to 337 p.14-15. There are actually only defined here, with the minimum of information, that is necessary to understand them. We do not think this part is too long and hard to follow.
Maybe the « lengthy discussion » that Rev#2 mentions here is the previous paragraph that defines the various estimates made with the algorithm. (Note that it is also a definition, rather than a discussion.) Those different estimates enable us to detect the complexity of the low layer, and are used to define the flags. The simpler the low troposphere (no multiple interfaces detected), the smaller the flag, the higher the confidence in the estimate of the CBL top. **We have revised the wording of this part, and simplified the sentences**. But we kept the level of information, which is the minimum information for a precise definition of all estimates and their interpretation as main or secondary interfaces.

Figures have been improved. Some aspects of the figure are still hard to follow.
Without any precise remark on the difficulty to read the figures, how to still improve them, and which figures are concerned, we did not change them. **However, we took account of Rev# 1 suggestion on making the symbols of Fig. 4 clearer, by changing them from '+' signs and crosses to squares and circles, respectively.**

Figure 4 is surprising and may merit further scrutiny; why the CBL height diurnal cycle does not show a more canonical behaviour given that "The shortwave radiation shows that this day was mainly clear, with only a few thin and occasional cirrus clouds in the afternoon."?
→ This example actually shows that even in clear air, there may be conditions that lead to non-canonical CBL. This is very common though, especially at P2OA near the Pyrénées mountains. For example, heat waves, or foehn situations, the surface sensible heat flux can be very small, or even negative during daytime, leading to very thin CBL. Also in clear sunny days, convection over the all range of the Pyrénées ridge can lead to a significant subsidence in the foothills area. Where P2OA-CRA site is, which prevents the CBL to deeply grow (Pietersen et al 2014). The example shown in Figure 4 is maybe not a « textbook » case, but remains typical of the area. This case also remains a clear sky case, which shows the classical retrieval of Zi top from Cn2 maximum (« typical » and « textbook » was also used for this aspect in the text). **We have modified the text to avoid confusion on « textbook » terminology, and removed this term. We also have discussed in the conclusion about the complexity of the CBL in the Foothills of the Pyrénées.**

The discussion of the three cases mainly based on these figures is cumbersome and to some extent not completely justifiable with these results. Specifically, the existence (or evidence for) of "pre-residual layers" and the possible identification of the top of turbulent internal boundary layers are at best 'indicated' in these data.

→ We do not agree with Rev#2 on this point. The three examples are key illustrations of the way the algorithm works, and of its ability to deal with the complex vertical structure of the low troposphere. Without those examples, the reader would not be able to easily catch the complexity we are talking about, and the various aspects that we are taking into account like clouds, multi-interfaces (or multi-layering), afternoon and morning transitions, ...

About the pre-residual layer, note that this is a result that is coming from the studies associated with the BLLAST field experiment and project (Lothon et al 2014), which took place on the same site in 2011. Cited references are given for more details.
It is the idea of the various estimates given in CALOTRITON to be able to follow this transition phase, with both a residual inversion and a descending top of turbulence layer, before the surface layer is stabilized.

It remains unclear to this reviewer that the algorithm proposed here can be applied easily to other

locations with only a radar wind profiler available and/or that it will yield the seemingly rich results discussed at length in the cases presented.

By showing the results in a totally different area and forcing, we show that the algorithm can be applied at other locations. It is clearly stated in section 4.3, lines 404-405 p.19, that the LIAISE example illustrates the test of CALOTRITON on a different location. Moreover, the chosen area of LIAISE actually reveals a high complex boundary layer structure that CALOTRITON is able to deal with.

This is also stated on lines 448-452 p.26 of this section. Line 518 p.26 also states: « In conclusion, we have also shown that CALOTRITON is not specific to one UHF RWP and one observational site. » In the conclusion, lines 569-571 p.27, are also related to this aspect.
We have nevertheless further commented in the conclusion about the complexity of the CBL at both P2OA (foothills of the Pyrénées) and in LIAISE area.

We have also showed in this article that if limitations of the capacity of CALOTRITON arise, there are mainly due to the high complexity of the low troposphere itself, like what can be found in complex terrain. But this would not be intrinsically due to the algorithm. The flag system and various estimates though, enable us to identify the complex situations, and to characterize them.

Technical Corrections – Minor Comments

Some editing, mainly for clarity in English, will help the text.
We have had the manuscript read again carefully, a few spelling mistakes have been identified and corrected. The document showing the differences between the versions helps to identify them clearly.