Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-142

Anonymous Referee #2

Referee comment on "Evaluation of convective boundary layer height estimates using radars operating at different frequency bands" by Anna Franck et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-142-RC1, 2021

General Comments

The authors present novel methods for deriving boundary layer height (BLH) estimates from C-, Ka-, and W-band radars using a variety of filtering/masking techniques to parse out Bragg scatter and passive/active insects. These data are then compared alongside ERA5 and Halo Doppler lidar data to draw conclusions about the effectiveness of each radar in estimating BLH. The authors conclude that it is possible to derive BLH estimates from all 3 radar types, though each has its limitations. This manuscript expands upon previous findings in the realm of BLH estimation from radar and provides a beneficial framework for future research, which can hopefully provide a larger dataset and even more robust analysis to determine which radars are most effective at estimating BLH. The authors are to be commended for a scientifically-sound manuscript that is well-organized and easy to understand.

Specific Comments

- The case studies for 9 May and 18 May provide useful context for the reader to understand the differences between various BLH estimation methods. Given that Figures 10 and 11 include 19 days' worth of data, and the paper lists that there are at least 6 other days for which Ka-band data exists outside of those case studies, it would be helpful to include some statistical information/analysis about the performance of each radar relative to the ERA5 and Doppler lidar (if applicable). Figure 12 provides helpful context comparing lidar to W- and C-band, and similar analysis would be beneficial with Ka-band and the ERA5 data. Perhaps you could consider a standard deviation time series throughout the day with ERA5 analysis as the baseline. Presumably this would visually display the errors inherent during the transition period in the afternoon/evening, among other things. Such a statistical analysis would add substantial value to this paper and make the results more robust.
- One of the main concerns with all three radars appears to be the lag time between the ERA5 BLH rise and the successive increase in radar-estimated BLHs. This appears to be a significant finding as well, especially as it relates to past studies that have found radar-estimated BLHs to be somewhat useful, in combination with other data sources, for assimilating into models and helping with convection initiation. At the very least,

this lag time should be highlighted more in the text. I think this could also be added to the conclusion in a paragraph about future direction. Do you have any thoughts on how to mitigate this lag time, which is almost certainly important for forecasting? Could additional case studies and more robust dataset identify a "climatology" for BLH rise start time under given conditions? I think there are several different ways this discussion could go, and you are certainly the experts on the state of using radar to estimate BLH at this time!

- Another interesting point you present is that CBLH retrieval following heavy precipitation overnight is difficult because the amount of insects in the CBL is not sufficient for the radar to obtain the correct CBLH. Is it possible that there is a certain time of day or night by which precipitation needs to cease in order for the CBLH to be estimated? Can you deduce anything from the other cases you sampled? At the very least, it seems like something that could be deduced from future work. This discussion would fit well at the end of line 304. Could you also surmise about why the C- and W-band radars were so much lower than the Ka-band? This conversation leads well into the next point...
- With a manuscript like this that does such a good job of comparing the various methods for determining BLH, I was left wanting a concise explanation for the pros and cons of each method for estimating BLH. Whether this discussion is included in Section 4.4 in a more concise format or added to Section 5, a paragraph laying out the strengths and weaknesses of each radar would be prudent. Such a conclusion can likely be made from this study, subject to modification as additional cases are explored.

Technical Corrections

Line 17 : …in **the** form of a Bragg scatter layer.

Line 32: …vertical distribution**, which** is used…

Line 37-38: …However, Doppler lidars are **also** limited by…

Line 52: …are of **primary** interest for BL studies…

Line 53: …passive flyers as **a** means of conserving energy…

Line 54: Since **the** 1970s…

Line 58: More recently, Chandra et al. **(**2010) made…

Like 69: ...services, **(**e.g. this is the case in Finland**)**.

Line 71: ....retrievals**; m**oreover, to....

Line 75: ..Reanalyses dataset that…

Line 103: ...also provide**s** LDR measurements.

Line 112: ...used to retrieve **the** horizontal wind profile...

Line 118: ...was used for VAD2to determine the MLH

Lines 124-125: We have used a BLH "parameter that" or "parameter, which"....

Was this BLH parameter one of many you could have chosen (that) or the only one available to you (, which)?

Lines 130-131: ...within **a** 40 km radius **of** Hyytiala.

Line 134: ...Leino et al. (2019), **and** Lampilahti et al…

Line 138: ...used. Bragg scatter occurs in area**s** where there are…

Line 142: …"leads to eddies with" or "generates eddies with"

Line 143: Change semicolons to commas and add "and" before Tanamachi

Line 148: Unsure what you mean by smaller numerous. Fewer?

Line 154: Remove comma after water cloud.

Line 182: Add comma after Bragg scatter.

Line 184: ...of values in **the** Bragg histogram…

Line 197: ...can be **either** Bragg or insects…

Line 198: ...area correspond**s** to the entrainment…

Line 203: Should be (Fig. 1**c** and 1d)?

Line 206: Either "quite well**-**seen" or "easily seen" or "seen quite well"

Line 212: Would you call the insect process a filter? Perhaps ...insects **filter** from…

Lines 218-219: ...shown **in** Fig. 6 using…

Line 220: Add comma after Halo lidar

Line 221: Remove "so" after not and before many insects.

Line 227: Interestingly, this zone **is** still present…

Line 230: ...temperature during the **descent**…

Line 236: The transition between Cessna location and noticeable is a bit awkward. What do you intend to say?

Line 237: ...flight days are need to make **a** conclusion on the depth…

Line 240: In **the** presence of low level clouds or precipitation,**<space>**the…

Lines 248-250: The BL started to develop after the rain **had** passed**, which can be seen** in the radars' echoes from 500 m at 06.00 UTC. The **BL derived from** Ka-band, similarly to the first case, show**s** more insects and at a bit higher altitude**<no s>** compared to the other radars.

Line 254: Can you surmise about why that layer of Bragg scatter may have developed? It seems to me that a residual layer is unlikely given antecedent precipitation, but it is curious why that would show up. If possible it would be helpful to add an additional

sentence to that paragraph indicating what it could be, or at the very least ruling out the possibility of a residual layer.

Line 255: Change “between” to “with”

Line 283: Upper left “corner” is a bit too strong of a word, which led my eyes astray from the points you were trying to make. Perhaps “top left quadrant” is a better descriptor.

Line 307: ...Bragg scatter area correspond**s** to the CBLH.

Lines 309-310: ...upper edge was “**up to**” 20 meter higher… Not clear what you’re trying to communicate here, but a bit more clarification would be helpful.

Figure 2: Change “that” to “which” in line 2 of the caption. Change end of sentence to “higher values for insects because of their non-spherical shape”.

Figure 5: Note the date somewhere in the caption.

Figure 8: Add spaces after “b)” and “d)”.

Figure 9: Add spaces after “a)” and “b)”.

Figures 10 & 11: Suggest different colors for ERA and Doppler lidar lines. Grey and black are a bit hard to differentiate.