Author's reply to the Anonymous Referee #1

We thank the Referee for the constructive comments to help us to improve the manuscript. Below please find our answers to the comments.

Overview

In this manuscript the authors present a method for determining boundary-layer height from clear-air radar returns during the summer months. They test this method using data from collocated vertically pointing cloud radars at three different frequencies in Hytiälä, FInland and compare the resulting BLH values between the three radars as well as with ERA reanalysis and lidar-derived boundary-layer heights.

General comments

This paper is interesting and well written. It is great to see more researchers making use of the insect 'clutter' on cloud radars. The method described in the manuscript is robust and should provide a good platform for future studies in other areas or over a more extended time period. The figures are clear and helpful to the reader.

I have only minor comments and a few technical corrections that should be addressed prior to publication.

Minor comments

1. L147: Suggest also including Luke et al. (2008) here [Luke, E. P., Kollias, P., Johnson, K. L. and Clothiaux, E.E.(2008) A technique for the automatic detection of insect clutter in cloud radar returns. Journal of Atmospheric and Oceanic Technology, 25, 1498–1513]

   We have added the reference as suggested by the Referee.

2. In the schematic shown in Fig. 3, following in from the 'how many Bragg pix around' box, the options are >4 or <4. What happens if there are =4 Bragg pixels surrounding the pixel in question? Or should one of the options in the figure read ≥4 or ≤4? Similarly, the situation when LDR = -14 or Ze = -5 are undefined, so maybe there should be a ≤ or ≥ in those boxes somewhere too?

The schematic was corrected as noted by the Referee. In the code the algorithm was correct. Also there was supposed to be '-' in front of 20 in the second to the left box, which was also corrected.

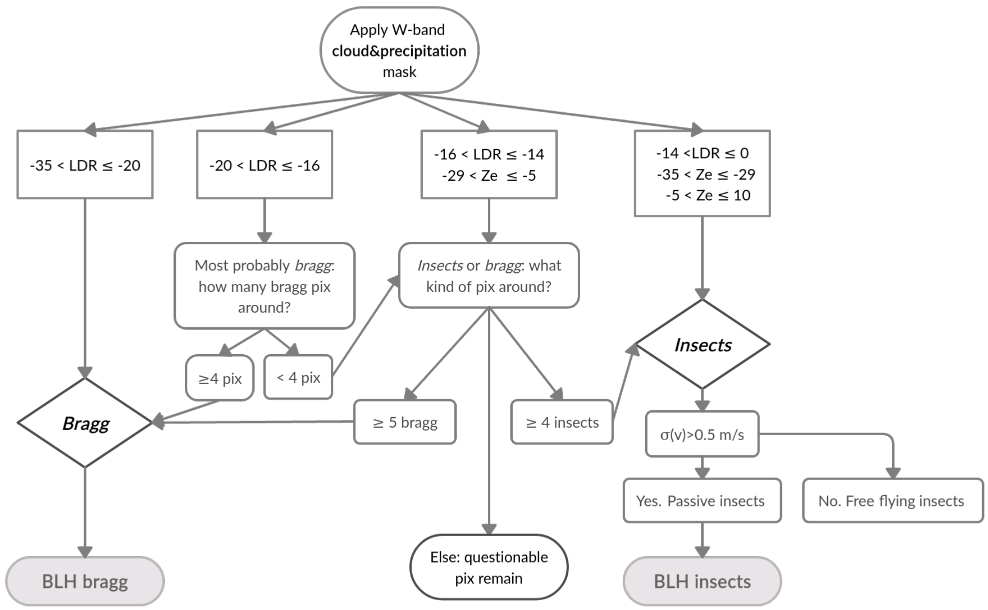

Figure 1: Corrected infographic.

3. How was the 0.5 m/s threshold between passively or actively flying insects determined? Was this done visually based on Fig. 5, and were other threshold values tested to see how much difference this value made?

   *Yes, it was done visually, taking into account the profile of ERA5 reanalysis BLH as seen in the attached figure. Text was changed to include that it was done visually: "**Based on a visual inspection,** we set a value of 0.5 as a threshold for passive insects:.."*

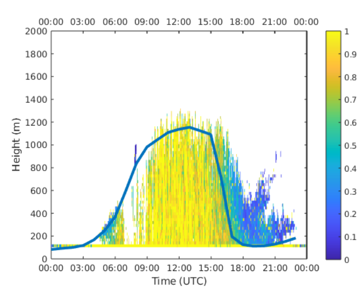

Figure 2: Comparison of sigma from the W-band radar and ERA5 re-analysis.

4. Since it is generally thought that the threshold temperature for insect flight is closer to 10 degrees C (e.g., Drake and Reynolds 2012), how does this impact your data? Do you think that part of the cause of the method not working as well during the morning transition might be due to the temperature at the CBL top being lower than 10 degrees C?

   Temperature definitely plays an important role in insects flight patterns. We have added text to the section 4 (line 222): ***"Moreover, it has been shown that insects prefer temperatures of higher than 10°C for comfort flying (Wilson et al, 1994; Drake and Reynolds, 2012), therefore, the lag between the CBLH derived from radars and that obtained using other methods might be due to the low temperature at the CBL top."***

   And also we have added to the conclusions to highlight the potential for future improvements (line 301): ***"Another difficulty appears during morning hours, where in some cases the time lag was identified between the CBLH derived from the radars and other methods, which might be due to the temperature threshold of comfort insects flight."***

5. You mention that Wood et al. (2009) find that insects are sometimes present at heights beyond the CBL top. This effect is also visible in Banghoff et al. (2018) and Contreras and Frasier (2008). How would you expect the presence of insects above the CBL to impact the performance of your algorithm? This seems to more commonly occur in regions with high temperatures and I appreciate that it may not have occurred in your dataset, but it is an important consideration for researchers who would like to apply this method in regions with very high summertime temperatures.

   Some insects present higher in the BL are independently flying insects, that should be identified by the sigma threshold. If these are passively flying insects, then some more testing of the algorithm should be done and may be some additional parameters, for example spectral width together with sigma. However, it is hard to speculate without proper dataset and the next step would be to test our method in different geographical locations. We have added to the conclusion (line 290): ***After validating our method with data from different geographical locations, it will be utilized at the ACTRIS stations.***

Technical corrections

Technical corrections were implemented according to suggestions:

L37-38: "Doppler lidars are also limited"

L40: “due to large gradients”

L52: “are of main interest”

L54: “Since the 1970s”

L56: “insect echoes”

L58: “More recently, Chandra et al. (2010)”

L64: “In recent years”

L70: “insect echoes”

L71: “compare the consistency”

L71: “observed by the C-band radar”

L95: “The radar uses a 0.5 ms pulse”

L104: “this cloud radar also provides LDR measurements”

L132: “steady ascent and descent”

L145: “For mm-wavelength radars”

L146: ”to act as volume radar targets”

L176: “from the insect echoes”

L195: “is shown in Fig. 4”

L206: “we set a value of 0.5” - please add units here

L230: “during the descent”

L307: “corresponds to the CBLH”

L281: Should these values of R be R^2?

We have calculated values of R, so it is correct in the text.