Review: "A multi-instrument fuzzy logic boundary-layer top detection algorithm"

This study advances the fuzzy logic methodology initially introduced by Bonin et al. (2018) for the detection of boundary-layer top by integrating data from multiple remote-sensing instrument observations including both kinematic and thermodynamic observations. The research demonstrates that this novel approach yields reasonable estimations of boundary-layer height under both daytime and nocturnal conditions. The utilization of a synergy between multiple instrument measurements is critical for enhancing and ensuring the accuracy of boundary-layer top estimations. Consequently, this study scientifically significant and aligns well with the journal's scope. However, the manuscript is now well organized. Noteworthy concerns are outlined in major comments provided below. Significant revisions are needed before the manuscript be accepted for publication.

Major comments:

1. Given the new approach expand upon the work of Bonin et al. (2018), it is essential to include BL estimations by the Bonin et al. (2018) method in the comparisons with radiosonde BL estimations, to show and validate the improvement of the new approach.
2. Figure 1 lower panel: the Entrainment Zone is misleading in the plot. Is the entrainment zone the region between the capping inversion and free atmosphere, with values of ~ 1km?
3. Figure 2: Caption: what are the names and units of the variables in panels (a)-(j)? What's the definition of 'high-frequency' vertical velocity variance? Figure 2 comprises eight panels, but only panels 1-4 were discussed in the text. Why different color schemes are used for different panels. The plots and color schemes make it difficult to see boundary layer structures. What information should reader get from these panels?
4. Page 5 line 154: How the sensitivity of the Haar wavelet dilation was examined and why it is low? From Sawyer and Li (2013), the dilation length is critical to find the signal peaks.

   References:

   Sawyer, V., & Li, Z. (2013). Detection, variations and intercomparison of the planetary boundary layer depth from radiosonde, lidar and infrared spectrometer. *Atmospheric environment*, *79*, 518-528.
5. Page 6 line 161: what physically is P? Is it the peak height or the peak magnitude?
6. Page 8 line 233: Is 'high-resolution' radiosonde refer to vertical or temporal resolution? How frequent was radiosonde launched each day? Similarly, how coarse is the coarse radiosonde data, e.g., what's the resolution?
7. Figure 5: For cases when smoothed-radiosonde PBLH are deeper than radiosonde PBLHT, how to determine/make sure that the deeper values are better/more accurate?

8. Page 9 Line 272-286: This paragraph is confusing. Line 275 states that 'this comparison appears to support the Seidel et al. (2010) findings' that 'high-resolution data can change the estimate in statistically significant ways', while line 285 states that 'there is no indication…using high resolution data yields more accurate BL height values'. Aren't these two statements contradicting with each other?
9. Exclusion of cases were done manually for the four criteria. These criteria are subjective and not well defined. For example, how to determine cases that BLH height was ambiguous (criteria 1)? How to determine at what height CLAMPS observation not reliable to detect PBLH (criteria 2)? When radiosonde and CLAMPS methods identified different parts of the transition region, which one should be trusted (criteria 3)? How to define 'complex/non-canonical BL structures (criteria 4)? Practically, how do users know when to trust or not trust CLAMPS PBLH estimations? Suppose CLAMPS will be run automatically, how to qc label CLAMPS PBLH estimations from the 'bad atmospheric conditions?
10. Are all the comparisons for clear-sky conditions, e.g., no clouds and precipitation?
11. Figure 10 and Figure 11 could be consolidated into a single figure for better clarity and coherence.
12. Figure 11: Even after all exclusions, CLAMPS PBLH is generally still lower than radiosonde PBLH, any speculations of the causes?

Minor comments:

1. Page 1 line 19: Given numerous past studies of atmospheric boundary layer and various of BL height estimation methods, it is unrealistic to claim that BL 'yet is also one of the least observed portions of the atmosphere'.
2. Page 2 line 49: it is not clear what does the 'positive impacts' mean.
3. Page 3 line 72: what are buoyancy processes within nocturnal stable boundary layers?
4. Page 3 line 77: Repeating words 'such as the'.
5. Page 5 line 129: what is a 'complete failure to detect a buoyancy-driven BL'? is the 'buoyancy-driven BL' similar as the buoyancy processes within nocturnal stable boundary layers? Under what conditions and how often does the 'complete failure' occur?
6. Page 10 line 303-304: Description of Fig.8 is repeating as in the line 294-295.