

Atmos. Meas. Tech. Discuss., referee comment RC1  
<https://doi.org/10.5194/amt-2021-68-RC1>, 2021  
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## Comment on amt-2021-68

Anonymous Referee #2

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Referee comment on "Low-level buoyancy as a tool to understand boundary layer transitions" by Francesca M. Lappin et al., Atmos. Meas. Tech. Discuss.,  
<https://doi.org/10.5194/amt-2021-68-RC1>, 2021

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### General comments:

The manuscript describes a method of using buoyancy in the ABL (in particular relatively close to the surface) as diagnostic parameter for process studies in ABL research and applies this method on rather limited data sets from RPAS and radio-soundings gained during two field campaigns (Flux-Capacitor and LAPSE-RATE). Although I clearly see the potential of the proposed method, I would like to be convinced a bit more on the usefulness by also providing some of the classical temperature/potential temperature plots as direct comparison with the more common way of looking into boundary layer development (that could e.g. be done by adding plots with the contours of buoyancy over the temperature/potential temperature field for figures 3, 8 and 9). Having in mind that there might be a radiation error in the temperature (and potentially also the humidity readings), in particular in the beginning of a flight during daytime, it might also be considered to use the observations of temperature and humidity from a fast installed and ventilated sensor at the ground to determine  $T_{par}$  in equation 1, instead of the value taken from the lowest level of the CopterSonde.

The language is not always scientifically concise and leaves some room for mis-interpretation/mis-understanding. I have stated some of the occurrences in the specific comment section, but I also suggest another round on that by one of the more senior co-authors of the manuscript. The figures are also not yet in a high-quality state for final publishing. Here I recommend (in addition to further comments in the specific section below) to consider the following changes:

- I suggest to remove the figure titles that are given in many of the sub-plots; this information is partly given in the axis text and in the figure caption
- I am not sure if the numbering/charactering of the figures in capital letters is the correct format for BLM
- The axis numbers/labels and legends/legend labels are often too small and hard to read

I clearly see a potential of the proposed method, the manuscript will, however, require certain major revisions described above before qualifying for publication in AMT.

Specific comments:

Line 16: sounds like only warm air is transported vertically, I suggest removing "warm" here

Line 20: I feel a bit complicated sentence structure at the end; could "are based off of decades old observation methods" be replaced by "are based on observation methods that are decades old"

Line 58: "Buoyancy is a fundamental principle in fluids caused by density or temperature differences" one example for those scientific inconcise/incomplete statements; buoyancy is related to density, period! It's temperature and humidity that effect density! So mixing density and temperature asdone in this sentence should be avoided.

Line 75: I feel there is a verb missing: "...but few studies have yet to substantiate..."

Line 121: CASS has already be used as abbreviation above, so no need to introduce it here again; but please check if it was introduced properly on first appearance

Line 131: the more appropriate reference here might be Kral et al., 2020:  
Kral, S. T., J. Reuder, T. Vihma, I. Suomi, K. Flacké Haualand, G. H. Urbancic, B. Greene, G.-J. Steeneveld, T. Lorenz, B. Maronga, M. O. Jonassen, H. Ajosenpää, L. Båserud, P. B. Chilson, A. A. M. Holtslag, A. Jenkins, R. Kouznetsov, S. Mayer, E. A. Pillar-Little, A. Rautenberg, J. Schwenkel, A. W. Seidl, and B. Wrenger, Innovative Strategies for Observations in the Arctic Atmospheric Boundary Layer Project (ISOBAR) — Unique fine-scale observations under stable and very stable conditions. Bulletin of the American Meteorological Society, Early Online Release, doi:10.1175/BAMS-D-19-0212.1, 2020

Line 149/150: "with the lowest observed temperature and dew point used", this might be misleading and is at least unclear; do you mean (as I assume) the temperature and dew point at the lowest elevation of your flight, or do you mean the lowest absolute value of temperature and dew point of your profile?

Caption figure 1: for a) and c) are the colors messed up! CopterSonde should be blue and Parcel red!

Figure 1, profiles for 15:15 UTC (lower panels): I assume the lowest 200 m indicate the mixed layer of the developing CBL after sunrise. I am a bit puzzled over the super-adiabatic slope of the environmental curve over the whole BL/ML depth. I can't explain this other than by a systematic bias from your measurements, e.g due to sensor time lag!

Line 167: There should be an "and" before "then". Or did I mis-understand the meaning of this sentence

Line 175: replace "greater" by "higher"

Line 176: replace "radiosondes" by "radiosonde ascents" or "radiosonde releases"

Figure 2: legend by far too small font size! I also suggest to plot the CopterSonde data also only as dots (as for the radiosondes) and not as line; the time labels should be limited to hours:minutes and the font should be increased; this last comment applies for all plots with corresponding time axis labelling

Line 180/181: "This is a consequence of the shell being heated by the sun before takeoff."

Could this be an explanation for the superadiabatic slope observed in figure 1; the enclosure leads to an overheating in the beginning of ca. 1 deg C that is then slowly reduced due to ventilation during ascent; would perfectly explain an artificial super-adiabatic slope.

Line 182: "Moreover, the warm bias reduces to near-zero at 2103 UTC." For me this is already the case for 18:30! It would be nice to have the time series of global irradiance to see e.g., the effects of cloudiness in the afternoon reducing/avoiding this warm bias.

Line 199/200: this sentence is very hard to read, I suggest to replace "as potential temperature method, CopterSonde derived heights" by "as those derived from the CopterSonde data."

Line 203/204: "The CopterSonde is more likely to find these sharp gradients near the surface because of the increased data resolution at lower levels." However, the CopterSonde could also pick up artificial gradients here, just due to the fact that the potentially overheated sensor compartment slowly adapts to real ambient temperatures during flight.

Line 259/260: the statement "the potential temperature is independent of the surface conditions" is at least highly disputeable! Maybe you should specify in more detail what you want to achieve with this sentence.

Lines 263 and 272: replace "Radiational" by "Radiative"

Line 267/268: "Figure 9 shows how deep the stable layer is until 1400 UTC."; How deep would you diagnose the SBL at that time? At around 600 m where the buoyancy gradient seems to disappear, or somewhere between 200 and 400 m, where the gradient becomes distinctly weaker? I miss a bit more explanation how the buoyancy concept can be used as diagnostic tool for SBL height.

Line 269/270: "Not until 1530 does the wind direction shift to southerly, generating some positive buoyancy (Fig. 9, 10)."; This sounds like the wind direction shift is causing the change in buoyancy, I would argue that the change in wind direction is a result of the processes (e.g., differential surface heating) that affect buoyancy; maybe worth of rephrasing this sentence.

Line 279: replace "more" by "a more detailed" or "an in depth"

Line 280/281: "below the ABL", that should either read "in the ABL" or even in the "mixed layer of the ABL" or "below the capping inversion"

Line 306/307: "There are countless applications for RPASs **to sample previously difficult aspects of the atmosphere.**" This is a very oversimplified formulation, please write a bit more detailed what you mean, e.g. something along the lines "to collect atmospheric measurements for processes that are still not adequately understood"

General comment for the references; check citation of pages, sometimes with pp.! mostly without; so please homogenize

Line 330: journal name should be upper case

Line 333: reference Båserud is incomplete (journal name, volume, pages etc)

Line 345: journal name should be upper case

Line 354: journal name should be upper case

Line 360: journal name should be upper case

Line 373: journal name should be upper case

Line 396: journal name should be upper case

Line 406: journal name should be upper case

Line 407: journal name should be upper case

Line 419: journal name shouldn't been abbreviated

Line 429: journal name should be upper case

Line 434: journal name should be upper case

Line 439: journal name should be upper case

Line 457/458: journal name should be upper case

Line 464: journal name should be upper case