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## Comment on amt-2021-173

Anonymous Referee #1

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Referee comment on "Instabilities, Dynamics, and Energetics accompanying Atmospheric Layering (IDEAL): high-resolution in situ observations and modeling in and above the nocturnal boundary layer" by Abhiram Doddi et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-173-RC1>, 2021

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Doddi et al. provide a manuscript about the IDEAL measurement campaign. The IDEAL program and the associated campaign target a very relevant and interesting topic of atmospheric research, which is the structure of the lower troposphere in strongly stable conditions. New ways of sampling stability and turbulence with multiple UAS were explored in the campaign which could contribute significantly to a better understanding of the dynamics under such conditions.

I think the authors are not very clear with the concept of the manuscript. While the title and abstract suggest a focus on the observational campaign, the introduction and section 5 suggest that they want to give an overview of the research program IDEAL as a whole. I think the manuscript should be revised in either of the two directions. If the authors decide to focus on the observations, I request some major revisions as described in the general and specific comments below, before I can recommend the manuscript to be published in AMT. If they decide to describe the whole research program, they might want to consider resubmitting to ACP instead.

General comments:

- The introduction is very much focused on the sheat & layer research. If the focus of the paper should be the description of the observational campaign and in particular the UAS measurement system and flight strategies, there should also be some references to similar campaign setups and other UAS systems. UAS have been excessively used in boundary-layer research for vertical profiling, but also turbulence measurements and even combinations of both with multiple systems operating simultaneously. The IDEAL campaign should be put into some context, including not only other DataHawk campaigns.
- Section 2 gives a lot of details about the UAS which reads a bit like a datasheet or advertisement. On the other hand, the dataset is not very well presented. For a description of the campaign, I expect at least a list of days of measurements with corresponding conditions and flight strategies. It is mentioned later that several different flight strategies were performed with aircraft A2 and A3, but it is never presented when and how often they were performed. This would be important to understand the database better.

- The figures in the manuscript look a lot like copy and pasted from quicklooks of the individual instruments. Labels are often small, much information is included that is not described in the caption. I think the authors can do better to prepare them adequately well for a publication. There is also no consistent nomenclature. Examples are zonal and meridional wind vs. eastward and northward wind. Figure labelling is sometimes wind direction, sometimes w\_dir. Although the latter are minor issues, they make the manuscript hard to read.
- It appears to me that all the examples of measurement data are from 6 November 2017, but they are mostly presented separately without connecting them. It would be nice to maybe give an introduction to the conditions on this day which serves as a case study and then lead the reader through the findings from different instruments.
- The section about DNS is very much detached from the rest of the manuscript. If the authors decide to focus on the observational campaign, I think the section is not really necessary. If they decide to present the whole project, including the simulations, they should better connect the goals or the findings of the campaign to the presented simulations. I think this is not done very well.
- The conclusions are very brief and vague. Are there any lessons-learned from the campaign? What were the highlights? What can be done with the dataset as a whole, not only with slanted UAS flights?

#### Specific comments:

- p.2, l.47: I am not sure what is meant by "dexterity" of measurement platforms.
- p.2, l.48f: I agree that spatial information could yield many new insights beyond single-point vertical profiles. However, the only data that are presented later in Section 4 are such vertical profiles.
- p.3, l.58: 72 flights in which time frame? Does this mean single flights, or flights with three UAS in parallel?
- Figure 1: If an elevation map is available, it would be really nice to show the site with contour lines, or color-coded elevation.
- p.5, l.86: "Unbreakable wing trailing edges" - unbreakable seems a bit unrealistic.
- p.5, l.97: when wind speed exceeds airspeed, the aircraft moves backwards with respect to the ground. What does it mean that the flight is stabilized in that case? If airspeed is controlled, there is in general no flight stability issue, but maybe an issue with navigation.
- p.5, l.98: Synoptic wind means geostrophic wind? What is meant by "aloft"? And why does it limit the ceiling to 3 km exactly?
- p.6, l.116ff: Is there a reference for this procedure?
- p.7, l.124ff: As above, a reference that describes the sensor fusion and turbulence measurement would be great.
- p.7, l.128f: Is there a reference to the wind algorithm? With GPS and airspeed only, the wind can typically not be retrieved.
- Table 2:
- How can the resolution of the vector wind be 0.001 m/s, if airspeed can only be resolved at 0.05 m/s?
  - unit for dissipation rate and structure parameter accuracy missing. What does the range-value mean in this case?
  - degree symbol missing for all temperature units.
- Figure 3: It would be great if a better quality of the figures could be provided.
- Figs. 4&5: I do not think these figures are really necessary if they are only there to illustrate data that is presented at weather briefings.
- p.10, l.170f: The top right panel of Figure 6 does not show wind speeds. It cannot be read from the figure where the first week starts and ends.
- Figure 6: I think it is a bit irritating that the x-axis shows sequential soundings and - to my understanding - does not give any information about the time of these soundings. It should at least be clearly indicated which soundings are released in close succession and

where there are larger time gaps. It looks as if the plots even feature some interpolation between the profiles, which does not make much sense if the time spacing is not equidistant. I also do not understand why the colormap range is so large for temperature and wind speed.

p.12, l.178f: Where can the stability be seen in the plots and where the intermittent turbulence and sheet structures?

p.13, l.191: I assume "Granite Peak" equals "Granite Mountain"?

Figure 7, caption: I do not see a hodograph as is written in the caption.

p.14, l.207: In Figures 8,9,10 it looks like the UAS are ascending/descending continuously during the racetrack patterns, but in the text it sounds like they were supposed to stay at dedicated heights. What is correct? Probably what is shown in the figure, but in that case, I do not fully understand the strategy.

p.16, l.210: Ok, so now it is mentioned that the flight strategies for A2 and A3 vary significantly. This was not so clear before and should maybe be mentioned at the beginning of the section.

p.17, l.219: "DH2 identified": How were the stable sheet structures identified? What are the criteria, how is the data processed. A description of this is missing.

p.17, l.223: "Altitude undulations": In the flight path? Is this shown somewhere? Is it reflected in wind or temperature measurements as well?

p.18, l.225: I think this enlarged inset in Figure 12 is not very conclusive. What is this supposed to show?

p.18, l.228: In my opinion the nighttime inversion layer only extends to approximately 100 m. Interestingly, the UAS and radiosonde measurements differ quite significantly in this area. This should be discussed.

p.18, l.230: Unit missing for  $N^2$

p.18, l.231f: I do not see from these plots, where undulating temperature and humidity is observed at 800m and especially 1300m.

p.23, l.248: Why is an analysis of A2 and A3 flights not presented? I think this is the essential and new part of the experiment, right?

Figures 11-14: The time evolution of the profiles is not really discussed. I wonder if it would not be easier to read the plots if only single profiles were shown.

p.24, l.253f: What DNS code is employed? I realize the references, but if the simulations are introduced here, it would be good to give some basic information.

p.25, l.262: "expanded such MSD studies are contributing" - something seems wrong here.

Figure 17: It would be good to explain somewhere, why the plots are tilted.