**Wind Energy Science** paper 11/13/25 - reviewer **RC2**

**Review** of "Emerging mobile 1 lidar technology to study boundary-layer 2 winds influenced by operating turbines"

The paper is motivated to demonstrate that the PUMAS system can be a powerful and promising measurement device. The technical design of the system is presented with good details and clear narrative.

The selection and interpretation of examples from the measurement campaigns, however, do not yet bring enough confidence in PUMAS as a tool for quantitative wind resource assessment or wind farm effects studies. Therefore, while the technical development is promising, the scientific analysis and validation are not yet sufficient for publication in their current form. A revised manuscript focusing on measurement validation and clearer data–physics consistency would be of value.

*Reply*: The PUMAS was developed mainly for Air Quality tasks, but we had the opportunity to test the instrument for wind measurements around wind farms. We are fully satisfied with results of our objectives including testing the performance of the motion compensation system, the ability to obtain continuous measurements during various times of the day and various roads conditions. We also were able to compare data obtained in stationary position and while moving. Also, we want to bring to your attention the following:

1. The selected period of PUMAS measurements during AWAKEN dictated by the time and crew availability between two major CSL/NOAA experiments. That is why it was hard to find a significant difference in the meteorological conditions between measurement days. All days were mostly like 7 Sep with low winds and relatively steady wind directions. The 5 Sep was different, as clearly shown by stationary lidars. So, we concentrated on these days.
2. We continued the instrument updates such as developing lower-angle scans compared to the existing 15 degree of zenith and adding the ability of RHI (slice) scans.
3. Yes, the data do not “bring enough confidence in PUMAS as a tool for quantitative wind resource assessment or wind farm effects studies”, but it is a first experiment, and measurements during stronger winds or over different seasons are needed. Also the results will be used to develop better driving pattern. To our knowledge, the development and updates of stationary lidars to provide fully reliable, remote data took about a decade.

**Specific comments**

The interpretation of vertical profiles in at least one case (Section 4.2) appears to be inaccurate and should be carefully revisited.

*Reply*: Thanks for pointing this out, we revisited and corrected this section as follows:

1. Lines 426-432 are removed from the text.

2. We've gotten rid of the L plots (Fig. 10 e, f) that didn't seem to make sense, and the relevant stability information is shown by virtual temperature from the ASSIST retrievals.
3. Line 437. The text "(e, f) Obukhov length from the PNNL flux station at Site A2 for these days" is removed from the Fig. 10 caption.

Moreover, the connection between Section 4.2 and Chapter 5 is unclear—Chapter 5 seems to begin with a dynamic interpretation of measurements already presented in Section 4.2.

*Reply*: Section 4 provides the context of the measurements from the (traditional) fixed-sensor point of view. To clarify it we changed name of Section 4 (Line 374) to "**4. 5 and 7 September case studies: Fixed-site context measurements**".

1. Section 4.2 discusses the TROPoe retrievals from thermodynamic profiler (ASSIST) for two days (Sep 5 and Sep 7)
2. Section 5 presents the mobile PUMAS analyses and discussion.

We have added a sentence at line 378 to clarify this: ... stability. In this section we characterize the boundary layer evolution these days based on fixed-location sensor measurements. Figure 8 shows ...

1. P4, L106: The phrase "... decreases the weight and the size of both modules" is unclear. Presumably, the two-part design connected by an umbilical cord makes each module lighter and easier to handle, although the total system mass may remain similar or even increase. Please clarify whether this is the intended meaning and how the umbilical design reduces the total weight, if at all.

*Reply:* The actual phrase in question reads, "This design, along with significant decreases in the weight and size of both…" which we feel does make it clear that the novel aspects of this lidar system are both that it is separated into two smaller modules and that each module has been made more compact, and, therefore, that the mass of each component (and thus of the total system) has been reduced. Besides, the two-part design allowed better use of space, for example inside the aircraft.

1. Here is a quote from Schroeder et al, 2020, who lead this design "The new instrument has enabled greater flexibility in field campaigns where previous instruments would have been too costly or space prohibitive to deploy".
2. Line 108. similar "design" is changed in the text to similar "capability"

2. P20-21, sec. 4.2, Fig. 10: The classification of 7 September as unstable does not appear to be supported by the data. A Monin–Obukhov length near zero is inconsistent with the strongly positive vertical gradient of potential temperature. Furthermore, the similar behavior of the ABL top on both days suggests that conditions were not drastically different. This interpretation should be reviewed. A simple plot of the potential temperature profiles (e.g., at 10 UTC for both days) would be very helpful. Also, check whether panels (e) and (f) might have been inadvertently swapped.

*Reply:* Yes, there appear to be issues with the Obukhov lengths L in Fig.10e-f—thank you for pointing this out. We have deleted these two panels from Fig.10 and eliminated the discussion of them from the text. Our discussion of these plots applies only to PUMAS measurement period (shaded in gray on Figs.10c and d), and we have added the parenthetical phrase "(gray shading)" to the text to make this more clear. We believe the rest of the text accurately describes conditions during those periods, but we have added the following sentence (Line 423) to further highlight important aspects of the data, as suggested by the reviewer. A new sentence is added after words for 5 Sep and 7 Sep. "The time-height cross sections show cooler temperatures near the surface prior to 16 UTC and warmer daytime surface temperatures after 17 UTC, and also the growth of the convective layer (black line) after 15 UTC, on both days." Stability estimates ...

3. P25, L514-517: This statement is puzzling—it implies that the experimental setup may be inadequate to provide data consistent with physical expectations. The same issue arises in the discussion around Figure 14. The authors' explanations of these differences seem somewhat ad hoc and do not convincingly account for the observed inconsistencies.

What we are really seeing is that the significant variability in the ambient flow, due to the strong turbulence in the daytime convective boundary layer and the variations of topography along the track of measurements, is larger than the horizontal variations due to turbine waking, which are also being reduced by rapid mixing out by the turbulence. The result is that horizontal variations due to the wakes are mixed out and jumbled up with turbulence and terrain variability, so that often one can't tell the difference, or sometimes even counterintuitive effects may be seen. We have amended the text to make these points better.

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