Comments on the manuscript entitled "Emerging mobile lidar technology to study boundary-layer winds influenced by operating turbines" submitted to WES

The authors reported a mobile lidar technology (PUMAS) for characterizing wind flows, which has the potential to become a powerful tool for wind assessment in the design and operation of wind energy projects. Measurement results were presented in the paper, demonstrating the capability of the proposed technology. It is an interesting and important work.

The following concerns require proper attention before the manuscript can be accepted for publication.

1. The atmospheric flow evolves as the measurement is taken on a moving truck. There is a characteristic timescale for a specific atmospheric flow event, while the measurement introduced another timescale determined by the speed of the moving truck and the flow event of interest. Choosing a proper path and driving speed seems to be important to ensure the effectiveness of the measurement. What are the authors' thoughts on this issue? What approaches are being taken to cover enough spatiotemporal range in the proposed measurement system? Are there any best practices for measuring typical flow phenomena, e.g., LLJ, wind turbine wakes, and atmospheric flows in complex terrain?

1). The reviewer points out an important interpretation issue, the parsing of along-track variations into spatial and temporal components. We have discussed this in previous papers (Pichugina et a. 2012; Banta et al. 2013b) but did not go into enough detail here, in part because our daytime operations and the relative constancy of the well-mixed boundary layer flow made these issues less of a problem for these analyses. They are, however, important considerations for mobile-platform sampling in general, so we have added a paragraph to the Introduction addressing this point. Specifically for this study, when operating the mobile lidar we used 10–20-minute repeat legs as a guideline to minimize confusion from spatial and temporal evolution. I.e., driving on the King Plains roads eastward and then back westward to the same point took less than 20 minutes so that the atmosphere did not have much time to change temporally, and our measurements were thus more representative of spatial changes rather than temporal. Of course, this assumes some stationarity of the atmosphere, but this is a reasonable assumption for most of the AWAKEN cases given the meteorology and terrain of the area. The longer transects, usually 50-60 min were from the round trips between the hotel, and the AWAKEN study area also consist of two parts: influenced by wind turbines and a free flow (see Fig. 3). That being said, the overarching temporal evolution across hours spent measuring in the wind farms on a given day was much more likely to be subject to large-scale changes that may mask the smaller-scale processes that we are interested in. This is where the other AWAKEN measurements, such as wind profiles upwind of all wind farms from stationary Doppler lidars as well as from the long-term lidar measurements from the nearby ARM SGP sites C1 (15-min data) and E37 (10-min data), are useful for context. Besides, all available NWP models were monitored before the final planning of PUMAS measurement during each day.
In some cases, if any, larger-scale temporal changes may be removed as a time-dependent mean flow, and turbine wakes may be represented as anomalies.
Regarding the “best practices for measuring typical flow phenomena, e.g., LLJ, wind turbine wakes, and atmospheric flows in complex terrain?”. The new text in the Introduction has recommended repeating sampling tracks and mixing in fixed-sensor data into the analyses and

interpretation of the data, and these should be incorporated as key aspects of best practices for the use of mobile sensors for reasons described. The PUMAS operated during AWAKEN over a short period of mid-August-mid-September due to the involvement of the instrument into other NOAA projects. Besides measurements were taken mostly on the late morning-daytime hours to obtain the communication and support (if needed) from the engineers in the office located in a different time zone. The measurement conditions were characterized by low (3-4 m/s) to moderate (10-12 m/s) winds and a rare late-morning remnant of the nocturnal LLJ was observed on Aug 5 and analyzed in the paper. As mentioned in the paper, our goal was to test the instrument along the performance of a motion compensating system in the real conditions driving within wind farm, develop a better driving pattern, and prepare for the future wind experiments.

2. Interpretation of PUMAS measurements is not straightforward. The measurements contain distributions of physical quantities in both space and time directions. The authors plot most of their results in the time-height cross sections. I understand that this is partly for comparison with the measurements from the stationary lidar. On the other hand, one advantage of PUMAS is that it provides variations of wind in space (in both vertical and horizontal directions). Can the obtained measurements be employed to show the spatial variation (not in the vertical direction) of a flow phenomenon, say, the downwind variation of wind turbine wakes (the authors showed some results, but the capability does not seem to be well demonstrated)?

2). Yes, as pointed in the paper, these time-height cross sections represent 3d wind variability, vertical, temporal and spatial. In this paper we did not emphasize the spatial variability along each transect due to the short length of the transects, flat terrain, and more generally due to daytime turbulence masking the signature of turbine wakes. We have done this successfully for other projects in the past, and as in the replies to the previous comment, we have added a paragraph to the Introduction to address these issues.
The added paragraph is "*Profile measurements from a moving platform document the horizontal variability of the flow, which could (for example) be due to turbine wakes or terrain-related flows, within a curtain of data along the track. But also included is variability due to temporal changes during the transect (Pichugina et al. 2012). For instance, a frontal passage halfway through a sampling leg will appear as a difference between the first and second half of the leg. Lacking additional information, one cannot determine whether these measurements show a genuine, persistent difference in the flow between the two regions. Other small-scale phenomena over the sampling track at timescales smaller than the sampling time interval of the leg may similarly appear to be horizontal variations. One approach for clarification is to retrace the path, as in the offshore LLJ example of Pichugina et al. (2012: see their Fig. 15 and accompanying text), to look for persistence of flow structures, indicating stationarity. Another is to use a mix of mobile and fixed-platform sensors to sort out the spatial and temporal variabilities, as proposed by Banta et al. (2013). In the following we use both approaches*"

3. On lines 657-660, the authors stated the capability of the proposed PUMAS technology in predicting flow statistics of different orders. However, the paper mostly focused on the first-order statistics. It is necessary to examine the proposed PUMAS system in measuring higher-order statistics, like variance, skewness, and energy spectrum.

3). The PUMAS lidar measurements can be processed to examine higher orders, similar to a stationary Doppler lidar. We have not examined the obtained higher orders of turbulence such as variance and skewness in this article as we expect or already know that turbine wake effect would just be masked by daytime turbulence. The rich dataset obtained can be used for more analysis and future research papers

4. Some discussions are necessary on the uncertainty of the measurements, like how the measurement accuracy depends on the atmospheric conditions, terrains, and the measuring conditions of the PUMAS itself.

4). The general information on the uncertainty of the measurements was provided in the paper. As mentioned, not much variations in wind conditions and terrain were observed during PUMAS measurements. But all data including as time-series of pitch, roll, lidar height (ASL), measured and motion corrected vertical velocity are available for a future detailed analysis.

5. In the conclusions section, it is suggested to discuss the limitations of the proposed PUMAS technology and potential issues to be addressed.

5). Ideally it would be great to obtain long-term measurements over various seasons and atmospheric events. We do not see much limitation for PUMAS measurements except the very nasty road conditions for driving the truck.