Dear Referee #3,

We thank you for the initial review of our manuscript and your remarks. Unfortunately, it seems that there was a problem which prevented a full review of our study, particularly the results section. Further, we had difficulties in understanding the exact meaning and background of some of your remarks. Therefore, we would like to address your major concerns here in an immediate reply. Hopefully our response can enable a further review of the manuscript.

You find our remarks on your main concerns below. We will address the rest of your questions adequately in the full review. Please do not hesitate to voice any further findings.

Many thanks for your work so far and kind regards, Philipp Gasch and Co-authors

Major comments:

1. The LES domain is too short for this type of study. In the 5 km x 5 km x 1.8 km domain, the authors only use 2 points within to do the analysis for a given trajectory. And approximately 20 trajectories are used in their analysis. The authors also mention that they do not have enough statistics, which is a big concern in such a study. The authors base their methods based on Stawiarski 2014 2015, which is for a ground-based Doppler Lidar and who were looking at detection of coherent structures and the ability of Lidars to resolve those structures. But here, the authors are trying to assess the accuracy of the in-homogeneity, and more simulations and larger domains are a necessity. I can understand that the authors want to have high-resolution LES model data to validate their simulator, but statistically these results cannot be taken seriously. Again, it is very well known that flow in-homogeneity causes errors in Doppler Lidar retrievals, but quantifying the amount for airborne Doppler Lidar measurements is key. And the reviewer feels, that the quantification part is missing here, which is key.

It seems that a misunderstanding occurred. Because the error due to flow inhomogeneity is a well-known issue, we do use the simulator to quantitatively assess this error. (We are not trying to validate the simulator and/or assess the accuracy of the inhomogeneity, further we don't state that our statistics are insufficient). To our knowledge, the LES-based analysis is new, which is why we present the first LES-based airborne Doppler lidar simulator.

In the study we are using 16 different flight directions (called trajectories by you) through the LES domain. Each flight direction yields 2 retrieved wind profiles. The 16 flight directions are repeated 25 times at 1-minute temporal spacing (the wind field is not assumed to be frozen during each passage but evolving instead). Thereby, this procedure yields 800 independent wind profiles for each of the four background wind cases (3200 wind profiles overall). Additionally, each of the wind profiles consists of 12 wind speed retrievals at different vertical levels (these 12 wind profile *points* of each wind profile are indeed correlated, as they are in reality), giving a total number of 9600 wind profile points for each background wind case (38400 wind profile points overall). If you are concerned about the spatial and temporal independence of the wind profiles we would like to refer you to our short reply to referee #1.

The 3200 independent wind profiles (38400 retrieved wind profile points) are much more than what is typically used in real world measurement comparisons (e.g. 1612 wind profiles in Weissmann 2005, approx. 10 wind profiles in DeWekker 2012, a single profile in Kavaya 2014, 2056 wind profile points in Bucci 2018).

We would thereby like to know what is insufficient about our statistical database and what you would consider a sufficient statistical database for a quantitative error analysis.

2. The optical effects of the laser beam due to motion has not been considered in the results. It is just demonstrated that the simulator can do motion correction. It would complicate the analysis and make it more realistic and interesting to study such realistic effects (Kavaya 2014 Hill 2008) rather than only flow in-homogeneity (again its a well known issue). Maybe the authors can take motion data from a real aircraft and simulate the effects of wind retrieval accuracy.

As you noted, we do consider the geometric transformations applicable to real world airborne Doppler lidar measurements. Further, we also investigate the effect of a measurement system imperfection. We do this through an assumed scanner pointing inaccuracy (called beam pointing inaccuracy by us), which is likely to occur in real world measurements. We are thereby able to analyze the effect of an imperfect scanner and/or aircraft inertial navigation system, which is done in Sec. 4.1. Further, we also analyze the effect of an imperfect laser system by adding a random radial velocity fluctuation to the measured radial velocities.

We do not see an advantage in using real world aircraft motion data, as the actual motion of the aircraft does not influence the VVP (not VAD) wind speed retrieval quality (only the accuracy with which the motion is known, which we take into account through the beam pointing inaccuracy).

We would thereby like to know what optical effect of the laser beam due to motion you are referring to.

3. The article has several repetitive statements all over the document and is extremely long. I feel a large portion of this article can be moved to the supplement section or deleted. The sentence formations are very abrupt, which sometimes I feel are unnecessary and not adding any additional information. I have noted a couple below, but I would urge the authors to take a deeper look at the entire article.

We will make sure to have another critical look at the wording of the manuscript. Further, we will also shorten its length.

4. The Figures are not very helpful in understanding the results. They all are dumped into one figure with results from several simulations and different type of statistics. Figures 6-16 are very confusing and do not make it obvious without reading the winded text. I can understand the authors sentiment in showing a lot of information, but they need to use smarter approaches such as Taylor's diagram or similar.

We are sorry for the inconvenience. It is very difficult to convey the amount of information we present without a detailed description in the text. We will make sure to have a look at alternative forms of displaying the information as well as a more compact wording.

References

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Kavaya, M. J., Beyon, J. Y., Koch, G. J., Petros, M., Petzar, P. J., Singh, U. N., ... & Yu, J. (2014). The Doppler aerosol wind (DAWN) airborne, wind-profiling coherent-detection Lidar system: overview and preliminary flight results. *Journal of Atmospheric and Oceanic Technology*, *31*(4), 826-842.

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