Reply to the comments provided by the Anonymous Referee #2 on the manuscript amt-2020-227 entitled "LiSBOA: LiDAR Statistical Barnes Objective Analysis for optimal design of LiDAR scans and retrieval of wind statistics. Part I: Theoretical framework", by S. Letizia, L. Zhan and G.V. Iungo

The authors thank the Reviewer for the constructive comments. Our replies are reported in the following. References to pages and lines are based on the latest marked-up manuscript.

Comments:

I would like to thank the authors for their reply to my comments, although some of the comments were not fully addressed.
R: We thank the Referee for thoroughly reviewing our rebuttal. We have now implemented the suggested modifications.

Specific Comments:

1. On comment 1, I agree that this method has potential to improve the current techniques for lidar data analysis. However, this has not been shown. It should be quite straightforward to use the LES data set to show that the LiSBOA retrieved winds and turbulence intensity are closer to the true wind field than other methods.
R: We agree with the Reviewer and added a paragraph in Sect. 6 (L 659) and Fig. 20 where mean streamwise velocity and streamwise turbulence are retrieved with LiSBOA, Delaunay triangulation, linear interpolation, and window average. The analysis shows that LiSBOA enables the largest spatial coverage for the retrieved flow statistics for a given LiDAR scan (double than the window average technique). Overall, all the methods have similar accuracy in terms of MAPE for the retrieval of the mean velocity, yet LiSBOA shows the highest accuracy. Furthermore, LiSBOA does not show artifacts in the retrieval of the turbulence intensity, such as unexpected peaks or enhanced turbulence intensity, as for the remaining methods.

2. The response to comment 2 does not respond to the question. If the outer scale non-turbulent eddies (see e.g. Fig. 1 in O'Connor et al., 2010) cannot be filtered out with this method, it should be stated in the manuscript.
R: That's correct. At L 403, it is now reported: "Furthermore, LiSBOA allows calculating velocity statistics including contributions of eddies with different sizes, which span from the largest eddy advected within the total sampling time, to the smallest eddy detectable for a given accumulation time (Puccioni & Iungo 2020). Therefore, a careful pre-processing of the LiDAR data should be eventually performed to remove contributions due to non-turbulent mesoscale eddies (Högström et al.; 2002, Metzeger et al., 2007; O'Connor et al., 2010)."

3. On comment 5, the authors clarify the use of equal spacing for azimuth and elevation angles in the optimisation in this case. However, my request to include both angles in the optimisation process is not implemented. Furthermore, I note that in Part II the authors use a scan schedule where they first set elevation angle spacing to [5, 6, 7, 8, 10, 12, 15] and then optimise the azimuth angle. In Part II also the sampling time per profile is decided prior to applying the LiSBOA optimisation. So it seems that only a subset of the scan parameters are provided through LiSBOA, though optimal scan design is one of the main arguments for using LiSBOA.

R: LiSBOA can optimize all the parameters involved with the scanning strategy. Further constraints can be added based on physics knowledge and existing literature. The choice of equal azimuth and elevation resolution was based on the physical consideration that the wavelength in *y* and *z* are comparable. However, we agree that exploring combinations of the ratio $\Delta\beta/\Delta\theta$ other than 1 can be interesting. We added two additional Pareto fronts with $\frac{\Delta\beta}{\Delta\theta} = 0.5$ and $\frac{\Delta\beta}{\Delta\theta} = 2$ in Fig. 11. At L 540 it is now reported: "For the optimization of the LiDAR scan, the LiDAR angular resolution, $\Delta\theta$, is evenly varied, for a total number of 7 cases, from 0.75° to 4°, whereas three values of the ratio $\Delta\beta/\Delta\theta$, namely 0.5, 1 and 2, are tested separately". Also, at L 544 it is now reported: "Changing the ratio $\Delta\beta/\Delta\theta$ affects the optimal $\Delta\theta$ (circled in black in Fig. 11); however, it has a negligible effect on the magnitude of the optimal ϵ^{I} and ϵ^{II}. For the rest of the discussion, we focus on the setup $\Delta\beta/\Delta\theta = 1$, as suggested by Fuertes Carbajo and Porté-Agel (2018)." Part II has also been revised according to the suggestions of the Reviewer to clarify the choice of the elevation angle and the role of LiSBOA in the scan design process.

4. On comment 6, the reply to comment 2 seems more relevant, i.e. zero instrument error appears to be assumed. This is a major drawback, as lidar measurement will always have some instrumental error. However, by filtering out small-scale variability LiSBOA possibly allows using relatively noisy measurements, increasing the amount of useful data. Therefore, the effect of instrumental error must be investigated in more detail. Please use the LES data to determine maximum acceptable instrumental uncertainty in radial wind measurement. It should be relatively simple to add random noise to the lidar simulator (Eq. 17 in the revised manuscript) to find limits for acceptable noise. This will also determine minimum CNR threshold, which is essential for determination of sampling time per profile.

R: We agree with the Reviewer that the effects of noise of LiDAR data for the retrieval of the statistics is an interesting topic to be investigated; however, this topic is out of the scope for this manuscript. Although it is true that the spatial averaging connected with the Barnes scheme may be beneficial for the suppression of short-wavelengths noise from the mean field (Barnes 1973, Pauley and Wu, 1991, Barnes 1994), effects on higher-order statistics are more unpredictable because they are affected by the noise variance, pdf, and its modeling as a function of the SNR of the LiDAR signal, the specific LiDAR system used, probe length, and variability on the background turbulence (see e.g. Frehlich and Kavaya, 1991). This is clearly the scope for future research.

5. On comments 7 and 8: The code is still not available. L682-683: "Code availability. The LiSBOA algorithm is implemented in a publicly available code which can be downloaded at the following URL: https://www.utdallas.edu/windflux/." This seems to be a group home page. Underneath it there is a page "Software/Datasets": https://www.utdallas.edu/windflux/software-datasets/ but even that does not contain the codes used here. Please use a permanent repository for *the code or include it as supplement so that it is permanently stored. Group home page is ok for keeping the latest version available, but it is not a permanent storage.*

R: We uploaded the codes for scan design and statistics reconstruction on GitHub https://github.com/UTD-WindFluX/LiSBOA. We made sure that the URL is permanently available now at https://www.utdallas.edu/windflux/software-datasets/. We apologize for the inconvenience with the previous upload.

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