Dear Anonymous Referee #2,

Thank you very much for your comments.

We believe that your major comment is about the power and loads analysis of the retrofitted wind turbine. The current manuscript presents the quantitative power and loads analysis results through simulations. We will expand this section by incorporating the power and loads analysis through field tests as well. However, it is important to note that this addition does not impact the results of the wake analysis presented in the manuscript, which is considered as the main result. The post-processing chain ensured a robust comparison between the wake of the baseline and retrofitted wind turbines, as detailed in lines 169 through 173.

Next, we believe that the comments about uncertainty quantification and CNR thresholds are justified with existing literature and are also further explained in this document below.

We will revise the manuscript to address your above-mentioned comments and the other minor specific comments. Below are the author responses in red and anonymous referee #2 comments in blue.

Replies to specific comments:

The manuscript entitled, "Segmented Gurney Flaps for Enhanced Wind Turbine Wake Recovery" by Nirav Dangi, Koen Boorsma, Edwin Bot, Wim Bierbooms, and Wei Yu endeavors to describe differences in wind, turbine week aerodynamics introduced by the presence of a gurney flaps. On the trailing edges of wind turbine Blade tips. There is a long history of flaps as passive or active control, mechanisms for wind, turbines, and a great deal of debate in the literature as to their merit. The authors are strongly encouraged to review this literature and contextualize their work within the spotty before presenting this for publication again.

We acknowledge that, however, please note that we are not focussing on studies which use plain flaps for active or passive control. Instead, we focus on the use of Gurney flaps mainly with the purpose to influence wake breakdown, and references studying this aspect are included in the manuscript.

35 Overall the manuscript reads like a section of a thesis. By itself, the study is not
36 sufficiently detailed or explained and the claims about results are not adequately
37 quantified or justified. There are several sections (regarding the free vortex
38 simulations and the power and loads of the turbine) of the paper that provide no
39 meaningful input and should be removed entirely.

40 Perhaps it would help if the statement 'reads like a section of a thesis' is clarified, i.e.
41 what is meant exactly (e.g. wording, structure). We will improve the readability and
42 add the details which we did not provide in the manuscript. The power and loads
43 analysis will be expanded. The free vortex wake simulations will be omitted , and
44 referral will be made to the corresponding project report, for the interested reader.

45 Please order references by year published (older to newer) and by last name of the
46 first author.

47 Noted, we will make the corresponding change.

48 Why qualitative? The abstract has an adequately defined and quantifiable metric for
49 wake recovery.

50 Noted, we will reword the statement.

51 it is difficult to see the actual Gurney flaps in this picture due to low contrast with the
52 rest of the trailing edge. It may be more useful to show an airfoil cross-section with
53 the geometry of the flaps.

54 Right, we will incorporate that.

55 This seems like an important aspect of the study.

56 Noted; for the field tests' power and load analysis we previously referred to the
57 corresponding project report, but now we will include it in the revised manuscript.

58 black?

59 Apologies for the confusion, we will reword it as 'black arc' within the brown lines.

60 This section is difficult to follow. Along with the information provided in Table 1, I take
61 it that the scanning lidar was collecting line of site wind speed in a large volume that
62 included the turbine and the wake. The scan is relatively highly resolved in space, but
63 the revisit time is 2.8 minutes, which much contribute to the uncertainty in the
64 description of wake turbulence as information is smeared in time. Is this correct? It
65 would be extremely helpful to have a plan view of the experiment and a perspective
66 drawing of the lidar, scan geometry, and turbine.

67 Noted, we will reword it. That is indeed correct.

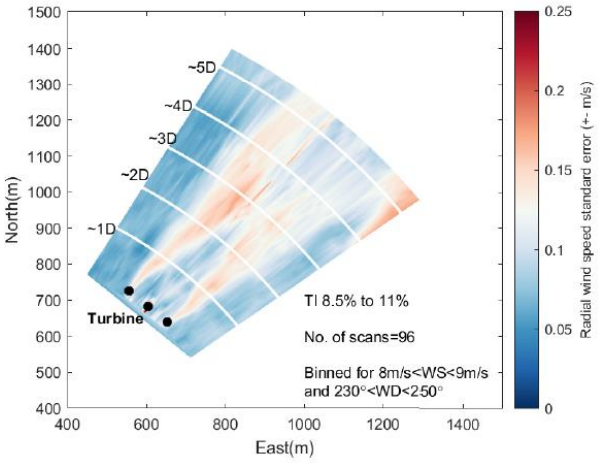
Please also note that the Figures in Appendix A provide a detailed view of the scan pattern in cartesian co-ordinates and also a side view which presents the pattern in relation to the wind turbine.

This sort of hard filtering based on CNR may be overly conservative and reject viable data or overly generous and keep outliers or spurious data. The dynamic procedure proposed by Beck and Kuhn (2017) offers a more localized approach to filtering and is more likely to provide better flow estimates.

Thank you for the suggestion- this is out of scope of the study at this stage, and will be added as a recommendation for future work. Previous studies which incorporate the hard CNR filter were included in the manuscript. Below is another reference for the same:

1. Bodini, N., Zardi, D., & Lundquist, J. K. (2017). Three-dimensional structure of wind turbine wakes as measured by scanning lidar. Atmospheric Measurement Techniques, 10(8), 2881-2896. -Section 3.1

Nevertheless, we believe in the robustness of the results with the post processing chain used. The standard error is indicated below for the hub height for one of the results (Figure 11a). Overall the standard error is quite low and as expected, typically around the wake edges it is higher because of probe volume averaging in the region of wake interaction with the freestream.



Very little information is provided as to how this scan pattern was designed or what it was designed to prioritize. It is especially important with scanning lidars to carefully assess the goals of the observations against the limitations of the lidars themselves (i.e., what makes these the ideal scans for this study?). Please see more in Letizia, Zhan, and Iungo (2021) and related works.

Thank you for the reference. Please note the Figures that were provided in Appendix A. We will now also expand the section to indicate the priority of the scan pattern.

This reads like a thesis, rather than the methods section of a peer-reviewed journal article. I recommend reducing the parts of the methods that are considered common practice and rely on citations instead.

Noted, we will reword it accordingly.

The subscript 'samples' can be removed for the sake of clarity. It is defined in the text in the same sentence.

Noted, it will be removed.

Please increase the font size for figures so that they are easily readable. It is difficult to interpret these graphics due to their size.

Apologies for the same, the sizes will be increased.

How many observations go into each of the curves shown in the figure? Are the shaded regions error or measurement uncertainty? Are the dashed lines the hub height of the turbine? What should we as readers of your work take from these figures? Perhaps it would be helpful to pull out distributions of the hub-height wind speed and turbulence intensity from the measurements to help readers understand the variability in the sample.

The number of observations in each is linked to the number of scans indicated in the Figures 11 and 15. We will now provide the values for the inflow profiles as well.

Noted, we will now provide the absolute values of the hub height inflow metrics.

Throughout the manuscript, the shaded regions are represent by standard errors, specifically, 1 times the standard error on each side. This will now be made more clear by giving the figures extended captions.

The Betz limit is approximately 59.3%. Does the figure quoted in the text refer to the limit on velocity deficit? Please review and update.

Yes, we refer to the limit on the velocity deficit. We will indicate the same to avoid confusion.

This figure appears to show velocity deficit. Please update the caption and use throughout the text for consistency.

Noted, relevant changes will be made.

This is not undertaken in the current study. This manuscript effectively omits any information about power and loads.

As mentioned above, the field tests' power and loads analysis of the retrofitted turbine will be included in the revised manuscript. The simulation results for power

and loads analysis of the retrofitted which were provided in the manuscript, will be expanded as well.

There are new substantial correlations made between the alleged changes in wind, turbine week, aerodynamics and variations in power and loads. Without the state, it is impossible to say, whether the addition of Gurney flaps has any real purpose or meaningful affect on a winter vine. It is not sufficient to say that a change in momentum deficit is enough to justify their presence.

We are not entirely clear about this comment. So, we would like to clarify that the main focus of the study was to prove the use of segmented Gurney flaps for faster wake recovery, thus, have a meaningful impact on the downstream wind turbine, which is highlighted by the results. In regard to the upstream turbine, we assess the power and loads, the results of which, as indicated in the manuscript, highlight that the upstream turbine is not affected considerably.

Example of six observations is sufficient to quantify average statistics, or measuring uncertainty. Without the presence of some indication of variability. Due to the nature of the skin design, the standard error is not an appropriate metric for uncertainty as it does not factor in the temporal and spatial averaging included in the lidar returns.

Noted, we will not mention it as a limitation now. As mentioned to referee #1 as well, we have seen that the standard deviation or error is used frequently to present the scanning LiDAR results. See below list of references:

1. Aitken, M. L., R. M. Banta, Y. L. Pichugina, and J. K. Lundquist, 2014: Quantifying Wind Turbine Wake Characteristics from Scanning Remote Sensor Data. J. Atmos. Oceanic Technol., 31, 765–787, https://doi.org/10.1175/JTECH-D-13-00104.1 - Figure 18, for example
2. Krishnamurthy, R., Reuder, J., Svardal, B., Fernando, H. J. S., & Jakobsen, J. B. (2017). Offshore wind turbine wake characteristics using scanning Doppler lidar. Energy Procedia, 137, 428-442. – Figure 9, 12, for example
3. Baker, R. W., & Walker, S. N. (1984). Wake measurements behind a large horizontal axis wind turbine generator. Solar Energy, 33(1), 5-12. Figure 9, 10, 11, for example

Nevertheless, we will add a recommendation which states about further investigation into sources of uncertainty.

Does this refer to aeroacoustic noise? If not quantitatively assessed in this work, I recommend moving this to a discussion section about other possible impacts that arise from the Gurney flaps.

Yes, it does. Noted, we will move it.

This section appears to be purely conjecture, based on theoretical relationships between wind speed and power production. Without the measurements to support

these claims, including wake loss mitigation on a downstream turbine, this sort of discussion should be omitted.

Noted, we will reword it: "The results of this study indicate a reduction of the spanwise averaged velocity deficit by 10%, at 5D downstream. This enhanced wake recovery was seen when the upstream wind turbine, in free stream conditions, was retrofitted with segmented Gurney flaps. Such application of segmented Gurney flaps on wind turbines in the outer rows of a wind farm could potentially enable closer wind turbine spacing, yielding a higher energy density. Dedicated farm simulations are recommended to investigate this and further confirm the promising potential of segmented Gurney flaps".

This is a purely qualitative description of the model outputs and are difficult to reconcile with the limited measurements from the lidar provided above. No effort is made to describe the details of the simulation setup, the inflow conditions, or the state of the turbine, so it is impossible to infer whether the simulation results pictured in Figure 18 even represent the same case.

Indeed, it was the same set up as the 3.8MW research wind turbine tested on field. Apologies for not providing adequate information about the free vortex wake simulations. We have now removed this section as per your suggestion in the beginning, and only referred to the detailed setup in the corresponding project report, for the interested reader.