

## Author Response to Review Comment #2

Dear Reviewer,

Thank you for reviewing the manuscript. Your comments were very helpful and improved the quality of the manuscript. The author responses can be found below each reviewer comment.

RC 2.1 One area I feel could use more discussion in particular is missed detections and false alarms. What is the probability of a false detection of wake impingement from the experiment, and the same for missed detections when wake impingement actually occurred? How were these probabilities accounted for when deciding which thresholds to use for the detection algorithm?

AC Currently we cannot make any statements about the probability of a false detection. The purpose of the manuscript is to introduce the method to the community and show that it gives satisfactory results for the experiment considered here.

RC 2.2 The other area that I believe should be discussed more is the applicability of the algorithm to different wind turbines, sites, and wind conditions. This research demonstrates that the LOS Doppler spectrum can be used to detect waked conditions well for the site and conditions analyzed. Although briefly discussed in the conclusions, it is unclear what steps would need to be taken to implement the method at a different site with a different rotor size, turbine spacing, or atmospheric conditions. For example, simulations of the algorithm for different conditions using CFD would be a useful approach. Further analysis of the wind conditions during the experiment, such as turbulence intensity and atmospheric stability, would help show how applicable the algorithm is to a variety of wind conditions.

AC A paragraph at the end of the conclusion section has been added that discusses the topic of different site parameters. We believe that more data is needed to make statements about the generality of the linear relationship found in this experiment.

RC 2.3 Section 1: There could be value in identifying when a turbine is waked for purposes such as wind farm control, but this is not discussed much in the paper. Do you have any ideas about the potential usefulness of the algorithm in wind farm control strategies?

AC Yes, we have added a paragraph at the end of the introduction section that discusses the idea of using wake detection results for wind farm control.

RC 2.4 Pg. 5, Ln. 18: "The effect is strongest for negative turbine misalignments" From Fig. 2 it appears that the impact of increasing wake deficits on the measured direction bias is roughly equal for all misalignments. Can you explain this statement further?

AC This statement has been removed.

RC 2.5 Pg. 5, ln. 18: "The kinks that appear for the negative turbine misalignments" In Fig. 2, it appears that the kinks are for some "positive" misalignments.

AC Yes, this has been corrected.

RC 2.6 Pg. 6, ln. 20: "high frequency components of the streamwise component increased fourfold in the wake" How far behind the turbine was this increase found?

AC This was at three rotor diameters behind the turbine and has been added to the text.

RC 2.7 Eq. 12: By using the LOS Doppler spectrum TI to detect wake impingement, what would happen if a naturally occurring gust was present on one side of the rotor but not the other? Even if the turbulence is the same at the two beams, the lower velocity at one beam would cause an increase in TI, which could trigger a wake detection.

AC This observation is correct. However, we believe that the occurrence of a gust that will only affect one measurement location on averaging time of one minute is quite unlikely. We have not seen evidence of such an event in the data analyzed here.

RC 2.8 Pg. 7, ln. 2: "calculated from one minute average spectra." Did you look at the sensitivity to different averaging times, and how did you settle on one minute?

AC Yes, we have also tried shorter averaging times, but we concluded that one minute averages gave the best performance. This fact has been added to the text.

RC 2.9 Pg. 7, ln. 11: "At the initialization the algorithm requires some observations to establish correct values of the running averages." Explain in more detail how the initialization of the algorithm is performed. Does the algorithm require that the wind conditions during operation be similar to the conditions during initialization? And how frequently does the algorithm need to be calibrated? Especially for detecting full wake conditions when the absolute TI is used to detect wakes, how do you account for the possibility of the freestream TI increasing after the algorithm is initialized, in which case higher freestream TI could be detected as a full wake?

AC More details to the initialization have been added.

Yes, the conditions during operation need to be similar to conditions during operations. This fact has been added to the text.

From our experience no calibration is need with the data we have processed.

The algorithm assumes that all changes in small-scale turbulence stem from upstream wakes.

RC 2.10 Fig. 5: How comparable are the wind conditions for these two spectra? For example, was the freestream TI the same for both periods, so that the difference should be due to the impact of the wake? Some further discussion would be appreciated.

AC The two spectra were measured during the same one minute interval and thus the ambient turbulence conditions can be assumed equal. This has been added to the text.

RC 2.11 Pg. 13, Ins. 1-5: Does the empirical relationship used to correct wind direction measurements when wakes are detected need to be determined for every site where the algorithm is used? Or is the relationship found valid in general? Additionally, after correcting the wind directions, how does the RMS error between the corrected lidar wind direction and the sonic anemometer compare to the error during freestream conditions? Although the corrected directions look reasonable, some quantification of the error would strengthen the results.

AC To validate the generality of the linear relationship more empirical data is needed. This is mentioned at the end of the conclusion section and was also mentioned by RC1 in comment RC 1.13 & 1.14. We currently have some indication that the relationship at different site is also well described by a linear fit. However, the offsets is close to zero (as found in this study), but the slope seems to vary.

RC 2.12 Pg. 6, In. 28: "From both properties mentioned above" Which properties are being referenced here?

AC This refers to the numbered list at the beginning of the subsection. A more clear formulation has been used.

RC 2.13 Pg. 7, In. 17: "Further, data from a meteorological mast at a distance of 120 m..." Incomplete sentence

AC This sentence has been completed.

RC 2.14 Pg. 8, In. 16: "In situations where the right half of the rotor ..." Check grammar in this sentence.

AC This sentence has been completed.

RC 2.15 Pg. 10, In. 11: "TI\_LOS2" -> "TI\_LOS1"?

AC Yes, this has been corrected.