Author Response to Review Comment #3

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 3.1 When comparing the Mann model to the Kaimal model, a more statistical approach would be preferred. For instance, on page 13 line 15, it is stated that ". . . the measured data agrees very well with the Mann turbulence model coherence. The Kaimal model on the other hand seems to give a slight underestimation of coherence". Can you quantify this agreement/underestimation numerically? Perhaps as a function of frequency?

AC We have added the root-mean-squared-error (RMSE) between measured and modeled coherence to quantify the performance of the model compared to the measured data. A table presenting the RMSE values has been added and a paragraph describing the results.

RC 3.2 Could you provide concisely the benefits of the Mann model over the Kaimal model, and potential drawbacks of the Mann model if applicable? Computation time is mentioned on page 2, lines 13-14, but not elaborated on; and Mann model fitting is mentioned in Appendix C, but it is unclear to me how much more complex the Mann model (3D) is than the Kaimal model (1D) (page 15, line 9).

AC Just before section 2.1 we have described the pros and cons of the Mann and Kaimal models in some detail and added several additional references.

RC 3.3 In the conclusion, it is stated that blade passage effects were not included. In the experimental data, how was the effect of blade passage removed?

AC The lidar removes blade interference by default based on the returned spectra, which show a very distinct shape when the laser light is reflected by the blades.

RC 3.4 A fuller description of lidar operation would be preferred, for readers who are not highly familiar with lidar operation. There are terms used that may not be very meaningful to readers, such as Rayleigh length, Doppler spectrum, probe volume, focus distance, and perhaps even wave number.

AC We have added a small description of the lidar principle at the beginning of sec. 2.3 and extended the description of Rayleigh length, focus distance, Doppler spectrum, probe volume and wave number.

RC 3.5 Is (3) an alternative definition of the spectral tensor? The definition from Mann (1994) does not appear in the manuscript.

AC (3) is a general definition of any spectral tensor. The definitions in Mann (1994) follow a more strict mathematical description. Here we follow the definitions in Mirzaei and Mann (2016), which are equivalent to Mann (1994).

RC 3.6 I don't understand the i,j indices in (16). Further, the meaning of ". . . summation of repeated indices is implied" (page 6, line 14) is unclear to me. It appears also that in (18) and (19), the i,j indices are replaced with k,l. Could you be explicit about what each of these indices represent (especially since k has been assigned to the wavenumber previously)?

AC We have expanded the explanation of the indices after (16). We have also added after (19) that the index k should not be confused with the wave number k.

RC 3.7 Labeling on plots needs some improvement. Font sizes are small and labels are unclear. For instance, Figure 6 has "WSP" on the x-axis, but this is not defined.

AC We have improved the labeling of the figures. "WSP" has been changed to wind speed in figure 6.

RC 3.8 There is inconsistent notation, particularly with Greek lettering. β is used for both pitch angle and azimuth angle, e.g., page 5, line 20 and table 1. β and θ are both used for blade pitch angle, e.g., page 1, line 20 and page 5, line 20. φ is used for both the lidar weighting function (eq. (15)) and the average turbine misalignment (page 7 line 11). alpha is used for both the half-cone opening angle (page 6, line 21) and the Kolmogorov constant (page 11 line 1).

AC The Greek letter β has been removed from table 1. The Kolmogorov constant is now \alpha_K. The pitch angle is now β in all instances. \varphi is used for the weighting function and \phi for the yaw misalignment.

RC 3.9 It would be nice if some of the key parameters are labeled in the left panel of Fig. 4. For instance, the half-cone angle and the focus distance. The distance d_{Nac} could be labeled in the right panel of Fig. 4, especially that this is not really defined until page 15 (long after table 1 where it first appears). Delta x, which also appears in Table 1, was not completely clear to me until page 15 when it is finally defined.

AC The illustration has been added to figure 4 and the distance between lidar system and rotor is mentioned in the text.

RC 3.10 Figures 9 and 10 could be labeled more clearly. Perhaps the "Data" line should be labeled "turbine estimates" (or something similar)? Then it may be clearer that each curve represents the coherence between the lidar data and each of the labeled items.

AC The legend in figures 9 and 10 aims to indicate that here experimental data is compared to two models. The data is not only gathered from the turbine but also the lidar. Thus, we believe that the label "data" is a sufficient distinction from the two models.

RC 3.11 There is inconsistent notation for lidar focus distance (d_f vs L_f). See page 6, line 8 and page 7, line 7.

AC The notation has been changed to d_f.

RC 3.12 What is the difference between the induction factor and the axial induction factor on page 7? What is the relationship between them?

AC They are the same. “Axial” has been removed on page 7.

RC 3.13 The term ‘filter’ appears to be used to refer to both a digital filter (in referring to a Butterworth Filter, page 16) and something far more general on page 12. This use (particularly the more general use, on page 12) is confusing in a scientific journal.

AC On page 12, l. 1, it was mentioned that a data filter is applied. The text has been clarified to indicate that this is a filtering of data where measurements are rejected based on certain criteria.

RC 3.14 Readers may find the use of ‘region 1, region 2’ (page 13 lines 11-12) confusing if coming from a wind energy background, where modes of turbine operation (below cut-in, below rated operation) are also referred to as ‘regions’.

AC We have added a note indicating that these regions should not be confused with the operational regions of the wind turbine controller.

RC 3.15 There are some typos and grammatical errors throughout which should be corrected.’

AC We went through the manuscript and corrected the typos and grammatical errors.