RC2 comments,

Introduction

- Could you also please comment on whether a control system with pre-monitoring would be sufficiently fast to react to EOGs?
- Ans: A LIDAR beam can measure the approaching flow field of the size of the rotor diameter at 100-150 m upstream. Based on the average wind velocities it gives about 8 to 15 seconds to wind turbine to react with collective pitch or individual pitch control. But still LIDAR technology has limitations and it needs more developments, but it is very promising [Bossanyi, E. A., Kumar, A. and Hugues-Salas, O.: Wind turbine control applications of turbine-mounted LIDAR, J. Phys. Conf. Ser., 555, 012011, doi:10.1088/1742-6596/555/1/012011, 2014.]

Gust length and time scaling

- please comment on why you are choosing 4 loops of a blade tip vortex?
- Ans: the gust time in the IEC is between 10.5 or 15 seconds. The rated rotor speed of the commercial turbines based on their size in nominal operational condition is between about 12 to 20 RPM. Considering 16 RPM rotor speed and 13 s gust time in average, the rotor does 3-4 complete rotation during the gust time. This is the simplified idea behind our scaling consistent with the dynamic processes involved related to the progression downstream of trailed vorticity in the wake.

- could you give a citation where this gust has been simplified? Also, it should be added that the important part is the amplitude by which the wind increases (here from 3.5 m/s to 9.5 m/s in 1.25 s (2.4 s IEC)) - the drop should therefore not simply be ignored.

- Ans: We acknowledge your comment, I have changed the words that have been used in this section, by mentioning that this is just the closest time duration that we can get with the current setup. The main goal was just to capture the amplitude from mean to the peak gust. The IEC standard gust includes an initial dip to match field experiments in which gusts are preceded by a lull; the present of the lull when the turbine is otherwise operating at mean conditions is likely benign, with the important gust impacts being realized from the extent of the wind speed excursion above the mean wind speed.

Results

- if I interpret the figures correctly, you have turbulence intensities of up to 50% (fig. 11 c, 1.5m height: V _ 5m/s, _ _ 2:5m/s. You argue that this is due to vortex forming. Could you please comment on possible consequences during your experiment?
- Ans: as you know velocity shear is the main element of turbulence production in the TKE transport equation. With this high shear strong vortexes form and increase the momentum mixing between different layers. This high amount of turbulence intensity definitely affects our results from the cobra probes. According to the manufacturer up to 30% of turbulence intensity the accuracy of measurements is about +-0.5 m/s in velocity range of 2- 40 m/s, however at higher turbulence the range of accuracy is unknown but certainly less accurate.

- Fig12, is this a phase average? Did you verify the reproducibility of the gust? it appears that one cobra probe does measure a significantly lower velocity (more than 0.5 m/s you give as probe accuracy) than the other sensors: There is a bump in fig. 12 d-g. Since both vertical and horizontal measurements have been performed, this appears to be a problem with the probe rather than an alteration in the flow field (probe F for hor. measurements/ D for vert. measurements – but since F and D are symmetrically ordered around the center, it might actually be the same probe with different labelling?). Did you make sure the cobra probes are calibrated the same way or test the measured velocity variation between the probes?

- Ans: Yes, all the velocity figures are phased averaged with 0.2 s window. And you are right it is the same probe D recording consistently lower velocities than others. All of the probes have been calibrated identically. We noted this in the text.

- "Based on Figure 13d for the EOG generated with changing fan powers, the velocity at the upper height in the test section is not achieving a totally uniform flow condition (time series from probe H)." Did you check how the raw data looks? Considering the rather broad moving average window of 0.2s / 400 data points, the "hole" at t = 35s might stem from some not collected data points which may for cobra probes occur if the flow leaves the measurement area (too high/low velocity/ too large flow angle).
- Ans: In other experiments we saw the same inconsistency of the flow from the top row of the fans when we create uniform gusts. The velocity ranges and directions are in the cone shape measurement area of the probes.

- while the ration $V=V_{max}$ may be similar to the IEC EOG, you do not achieve the amplitude. Also, a comment on the rise and fall time as compared to the IEC EOG would be interesting.

- Ans: You are right, but we tried to develop the closest possible gust to the IEC. With the complex system of the fans, the velocity drops is not possible to replicate. But we tried to at least reproduce the same time duration for all EOG and EWSs events (they all have 5 seconds for rising and falling periods). We tried to change the words that we used in the text as well to reflect this.

Conclusion

- "By ignoring the sudden velocity drops in the theoretical gust profile, the generated gusts would become identical to the standard." I disagree because your amplitude is lower while the rise and fall times are higher.

- Ans: You are correct; as per last comment, we changed our language in the conclusion.

RC1 Comments,

Abstract

- suggesting restructuring the abstract
- Ans: We did, thank you.

introduction

- ("rather than trying to replicate the much more complex current standard".) This is not really a justification - can the authors please comment?
- Ans: the current standard specifies a statistical approach to gusts; this project was a first step in wind tunnel experimentation to create a simplified gust/ shear based on a previously established industry standard. So, we chose IEC 3rd edition to do so, which has deterministic formula for these events. We have revised the text to clarify the context of the study, using a deterministic gust, relative to a stochastic handling of gust/extreme wind events which is more suitable for numerical simulations purposes but would be extremely difficult to achieve experimentally.

Numerical analysis

- (other parameter was left as default values) were these appropriate? Can the authors please comment?
- Ans: other parameters for automated mesh function in StarCCM are surface curvature, surface growth rate and mesh density. Usually the default for surface curvature is 6 degree which means it put a node on the surface at each 6 change of degree. The growth rate is 20% so then we do not have a big jump in size in proximity elements. The mesh density is usually being used for bluff bodies when you need to refine the wake of an object.

Experimental setup

- Not Enough details are included in the setup on the probes, justification of sampling frequency and time, a/d conversion, the measurement stations, etc.
- Ans: The sampling frequency was set to the highest (2k Hz) so we could have flexibility for our moving average filtering later. All of signals from the cobra probes were connected to a specific deck/ interface box and then a regular a/d conversion card then a windows laptop. The process is straight forward and accessible on their website. The text has been clarified in this respect https://www.turbulentflow.com.au/Downloads/Cat_CobraProbe.pdf.

- (fig 7) How were these value chosen? Can the authors please comment?
- Ans: the values are based on a 2.2 m wind turbine with 1.9 m hub height that also is visible in this figure. The goal was to just have acceptable resolution of the flow field in the rotor swept area with lowest number of the cobra probes.

scaling

- I suggest considering collating figures 9 and 1.
- Ans: At first, we thought the same but then we determined it improves the readability of the paper by displaying two separate figures. Because our scaling method needs rather long explanation, we didn't want to confuse readers as they progress through the paper.

Results

- (largest error exist in horizontal shear) Can the authors speculate on why this is the case? Have any attempt been made to match the level of agreement seen in the vertical shear case?
- Ans: the CFD model is tuned based on previously tested ABL flows. Also, in CFD all the fans were considered identical with the same amount of efficiency by ignoring the flow recirculation. The values in these steady shears as well as unsteady cases in physical experiments were taken directly from CFD predictions so we have nonconformity with what we expected/ IEC. As we mentioned in the conclusion because of the complex nature of the fans and the geometry of WindEEE the developed CFD just should be used in preliminary stage but then field adjustment will be needed.

- (fig 13) this figure contains too many subfigures, which are not discussed in detail. I suggest condensing this information and perhaps report one plot as an example. The rest of the plots could be added as supplementary material (or similar).

- Ans: Thank you for your suggestion, we have added more discussion to the figures. Putting figures right along each other maybe at first glance looks confusing but it going to improve their readability once the reader understands the integrated and relative structure of the layout between subplots.