Development of a Curled Wake of a Yawed Wind Turbine under Turbulent and Sheared Inflow

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We thank the reviewer for the valuable comments, questions and suggestions. They helped to significantly improve the manuscript. Below are our responses to each comment.

The author's response is shown in red and the rephrased sentences in blue.

Author response to reviewer 1

General comments

In this research article a comprehensive measurement campaign of the wake behind a yawed wind turbine under different turbulent and sheared inflow conditions is presented. A short-range scanning Lidar system is used to map the wake flow at number of downstream locations, results showing good agreement with reference hot-wire measurements on the same setup. The high quality of Lidar measurements on these small scales is impressive to see, while pre-programmed scanning patterns show great future potential for acquiring full-field wake scans in a wind tunnel in a relative short time.

The paper is well-organized and has a very high quality of language and presentation of data. The results of the time-averaged wake flow for three inflow conditions and yaw angles are supplemented by an analysis of the dissipation rate, which is considered valuable for comparison with previous hot-wire measurements and future CFD simulations of the setup. The main findings on the inflow's influence on wake of yawed turbine confirm findings from previous experiments and simulations, which are cited at the right locations. Given the large amount of research on yawed turbine wakes during the last years, the main findings in this article are not completely novel. The very detailed analysis, well-organized presentation and good discussion of the results contribute to the high quality of this research.

Regarding the content of the article, I only have very few minor comments and technical corrections, which are listed below. Overall, this is an impressive piece of experimental research, and I am looking forward to seeing more following.

Specific comments:

P3.L25. Please provide more information on the operational point(s) of the model turbine for the different yaw angles, i.e., thrust and power, if possible. So far, the only info given here is the tip speed ration of 5.4. These would be valuable data for potential CFD simulations or repetitions of the setup.

While the performance (c_P, c_T) of the specific turbine used has been documented in previous work (e.g., Petrovic et al. 2018), during the measurement campaign reported here only power measurements but no thrust measurements were carried out. The following lines have been added regarding the operational points of the turbine:

The wind turbine controller is based on the torque of the generator (Petrovic et al. (2018)) leading to a tip speed ratio (TSR) of 5.7 and a power coefficient of c_P=0.41 at its operating point for zero-yaw without a grid. For yaw misalignment of +- 30°, the tip speed ratio (TSR) was reduced to 5.3 and the *power coefficient was reduced to c_P=0.29. The power was measured at the generator, which includes mechanical and electrical losses. During the campaign reported turbine thrust was not measured. However, Neunaber (2019) measured the thrust for this turbine using a force balance and obtained a combined value of the thrust coefficient of the rotor and the drag coefficient of the tower, related to the swept area, equal to $c_{T_{Rotor}} + c^*_{D_{Tower}} = 1.0$. This value was also measured without a grid and for zero-yaw.*

P10.L21. lateral displacement of the tower wake in yawed conditions. "This is a result of conservation of mass…". How much is the streamwise distance of from the rotor center to the tower center? Could this contribute to a lateral displacement of the tower wake when the turbine is yawed?

The distance between the rotor plane and the tower is 110mm for the MoWiTO 0.6. During a yaw-misalignment of 30 the rotor centre is shifted by 55mm. In Figure 5, the tower wake is displaced to the opposite than the deflection of the wake. The figures are all centred at the tower centre, meaning that the streamwise distance of the rotor centre to the tower centre does not result into a lateral displacement. The description in the methodology section has been modified to clarify how the scans were performed.

P3 The distance between the rotor centre and the tower centre is 110mm (0.19D).

P5 Furthermore, the dimension of the vertical plane is shown in Figure 1c with an area equalling to approximately 3D x 3D (1.74m x 1.74m) with y = 0[m] indicating the wake centre at non-misaligned cases and the tower centre

P14.L13. "The high dissipation rate at the wake centre can be related to the root vortices within the near wake." I do not really see any significant signature of root vortices in the plots describing the near wake at 2D. There seems to be one "yellow dot" in the central wake in Fig.7(e), but is this really a root vortex signature? Why isn't it visible in Fig. 7(b)?

The increase in the dissipation rate at the wake centre is visible in 7(b) and 7(e) in the blue color shading. At the centre the blue shading is lighter than at a larger radius (darker blue shading). The increase of the energy dissipation is not as profound as at the wake centre. The sentenced has been changed to indicate that a slight increase in the energy dissipation is visible.

The slightly higher dissipation rate at the wake centre visible in Figure 7b and Figure 7e in the different colour shading at the centre can be related to the root vortices within the near wake.

P28.L1. "An online database is currently being prepared." That is a very good idea to make this extensive dataset available for validation purposes. I hope the authors can provide a link to the dataset in the final version of this paper.

An online database has been prepared. At the moment we are working on finding a platform to share the data.

Technical corrections:

P4.L8. "Equations 2 approximates…" -> Equation

Has been changed

P9.L11. "… the turbulence is higher initially and the rapidly decays moving downstream …" -> it

Has been changed

P20.L17. “… which can casue spatial averaging …” -> cause

Has been changed

P21.L4. “At 1D in Figure 12…” -> Figure 13?

Has been changed