Response to Anonymous Referee #2 comments of Manuscript ID WES-2022-5 entitled "FarmConners Wind Farm Flow Control Benchmark: Blind Test Results Part I"

Thank you very much for taking the time to review our article and your comments. We're glad to hear you find the results also interesting. Following your suggestion, and other feedback we got from the community, we have indeed decided to divide the article into two, where Part I (the current form) consists of Blind Tests #1, #3 and #4 (field tests and LES comparisons); and Part II focuses on Blind Test #2 with the wind tunnel experiments.

Major Comments

1. Page 2, Introduction: It is recommended to highlight in more detail literature sources documenting previous validation work of the wake models used in this blind comparison.

   The most recent (and the most in-depth) discussion of the WFFC validation overall is presented in Meyers et al. 2022 - now added to the Introduction (at the end of the first paragraph).

2. Page 9: Equation 1 – the paper should elaborate in more detail the limitations of this model for the range of time-averaged CT considered in the blind tests. References to relevant past works dealing with yawed rotor aerodynamics should be included. Consideration has to be given to the following: (1) n does depend on the tip speed ratio (& hence CT) acting on the rotor; (2) rotor yaw causes CP (and CT) to become a function of time and (3) the time-averaged CP does decreases with yaw angle.

   There are indeed several studies in literature indicating the sensitivity of the yaw loss exponent (or equation 1 in general) to the wind turbine model/type and experimental settings. To clarify further, a few sentences are added before equation 1, including the majority of these studies (around line 170) that read as: "There are several values proposed for n depending on the experimental setup and the turbine type; where n = 3 is typically considered based on blade element momentum (BEM) theory as well as numerous wind tunnel experiments (Krogstad and Adaramola, 2012; Bartl et al., 2018b, a), n = 1.8 is proposed by other wind tunnel experiments (Schreiber et al., 2017) and LES (Draper et al.,175 2018), n = 1.88 was considered in (Gebraad et al., 2016), and n = 1.4 was used in (Fleming et al., 2014). Further discussion on varying n within the wind farm (based on upstream and downstream turbine configurations) can be found in (Liew et al., 2020b)."

3. Page 10, first paragraph: the statistics of the polynomial fits should be included (R squared, standard error).

   Now a new figure (Figure 5) is added, in which the statistics of the fit is also described.

4. Page 10: an important consideration where considering open field measurements is the influence of shear. Wind shear causes the wake to deflect upwards, thus also theoretically contributing to the wake losses reduction. Thus, apart from considering the impact of rotor yawing, the effects of shear should also be assessed. Have the effects of wind shear without rotor yawing been examined? This analysis is important in order to properly quantify the real contribution of rotor yawing alone.

   The authors agree to the importance of shear (as well as veer) in the wake behaviour change, with or without misalignment. In order to isolate the effects as much as possible, the normalised quantities of interests, namely the energy and power gain in equations 2 and 3, are discussed to evaluate the contribution of the rotor yawing alone. It should also be noted that the main objective of the article is to evaluate and discuss the participating model performances under flow control, rather than analysing the field test results which is presented in Simley et al. 2021 as cited in the article, studying the same wind farm as in Blind Test #1 in the FarmConners benchmark.

5. Page 13: Including data about the site topography is important for the reader to understand better the operating environment of the wind farm. Such data can be obtained through satellite data.

   The site description provided in the beginning of Section 2, as well as the references therein that studies the same wind farm, are indeed adequate to understand the operating environment of the SMV wind farm. On the other hand, the participants were not provided detailed terrain maps or satellite data within Blind test #1. On page 13, participant P6 instead used the provided time series under the calibration data set to infer local differences on the turbine productions within the wind farm, which is due to combination of factors (terrain + spatial variability of the flow / turbulent structures, etc.). Now the statement is slightly rephrased to avoid confusion.

6. Page 13, line 5: the term “waked directions” is inappropriate.

   Now rephrased.

7. Page 14, line 285: It is understood that, following the binning process, the average wind direction was computed - was a vector average used?

   The available yaw angles were simply split into 3 subsets with the simple goal of obtaining a more yaw-specific power curve and compromise with the limited number of data points available. Hence each of these 3 subsets were represented by the average of the yaw angles for each subset, intended as scalar average. This allowed to estimate an “average” power curve for each correspondent “average” yaw setting.

8. Page 15, first para: It is helpful to present the relation for estimating the wake skew angle here. How does the formula correct for the variation of the wake skew angle with CT? Past works have shown that this follows a quasi-linear relationship.

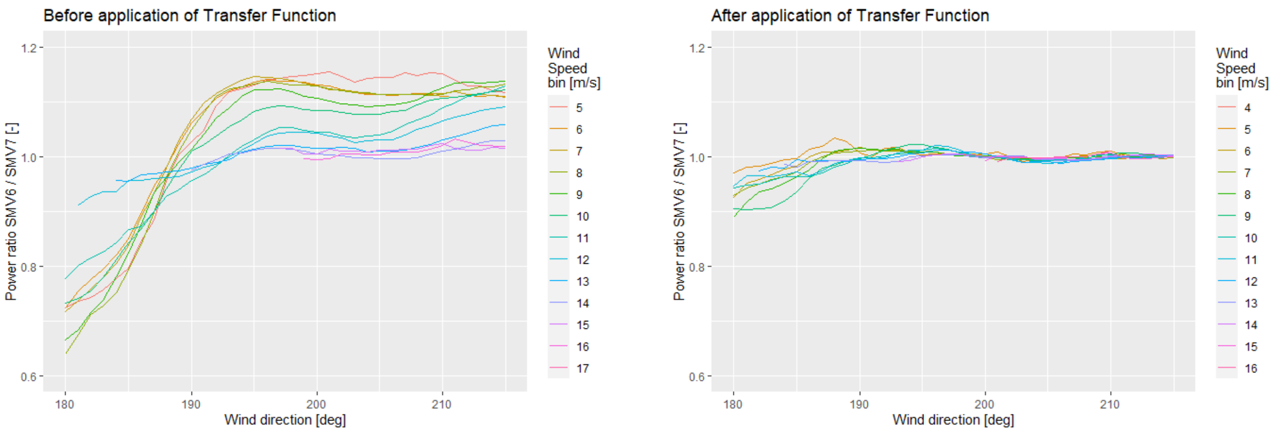
   The formulation follows Eq. 6.12 in Bastankhah 2016 and a direct reference has been added to the text. The function expressed in this formula is non-linear, however a simple test can show this can be approximated to a linear function where “skew= a*CT+c”, at least for a certain range of CT values. However, what is described in this paragraph is that previous calibration exercises carried out by NREL have suggested that a skew angle function multiplied by a factor of 2 better fits field experiments, and such an option was available in FLORIS platform.

9. Page 15, line 326: Explain what these parameters stand for.

   Now added “Those are principally the same model-parameters as described for the other participants in Table 6, described in detail in (Bastankhah and Porté-Agel, 2016), but implemented in a different framework than FLORIS.”

10. Page 17, line 373: To what extent has this transfer function been validated?

    The transfer function calculated was fitted and compared with normal operation data. Below, a comparison with and without the transfer function is added for evaluation.



(a) Without the transfer function

(b) With the transfer function

11. Page 17, line 380: The numerical technique applied for filtering has to be stated.

    It is the filtered data according to the procedure described in Section 2.1 (checking if the turbines are operational at the same time, no curtailment and the wind direction sector indicated in Table 2) - now rephrased for further clarity as “The final data set within that sector for wake steering consists of 216 data points ...”

12. Page 22, Section 3.1: Details about the operating conditions of the rotor are lacking (e.g. tip speed ratio)

13. Page 22, Section 3.1: the Reynolds number matching is difficult to achieve in the wind tunnel tests given that the scale ratio is far too small. The paper should elaborate about this limitation.

14. Page 26, line 578: in yawed rotors, the disk-averaged induction at the rotor becomes a function of time. This violates the assumption for the simplistic wake losses models that are based on the linear momentum equation applied for stead flow conditions. A remark on this matter should be included.

    As stated earlier, Section 3 Blind Test #2: CL-Windcon wind tunnel is now excluded from this article (Part I of the benchmark results), and transferred to the subsequent paper (Part II of the benchmark results). Your input is to be kept in mind for that submission.

15. Page 37: The paper should explain briefly the numerical verification work undertaken to ensure that numerical errors are negligible. It should be ensured that the uncertainty arising from numerical spatial and temporal discretization does not mask the differences in power estimated with and without WFFC.

    The verification tests performed within C-Windcon project are presented in Section 3.5 in Doekemeijer et al. 2018 (http://www.clwindcon.eu/wp-content/uploads/2017/03/CL-Windcon-D1.2-Wind-farm-models.pdf) – now cited also under Blind Test #3 of the article.

Minor Comments

All the minor comments are addressed.