Response to Referee #2

We thank the referee for their review and their thoughtful comments. Point-to-point responses can be found below, and the relevant changes will be made to the manuscript during the revised submission stage (https://www.wind-energy-science.net/peer_review/interactive_review_process.html), colored in blue.

General comments:

Comment #1

One overall comment I had was I wasn't quite positive of the main, conclusion of the paper. Is that the proposed method is at least successful in the provided tests, or that it is necessary to use a method like this? The paper is a little bit long, I wondered if parts might be condensed also to make more clear what are the bigger, more important, findings? The authors however can freely disregard this suggestion, but I hope this impression is useful.

Response

Thank you for this helpful comment, we will streamline the discussion in the paper to highlight the main contributions.
The main technical contribution of this paper is the development of a closed-loop wake steering methodology for application in transient ABL flows which does not rely on an open-loop offline yaw misalignment lookup table calculation.
The two main conclusions are: 1) that the wake model, when combined with a state estimation approach, is able to predict the power production for the wind farm in yaw misalignment with significantly less error than the standard approach of an empirically pre-calibrated wake model and 2) model parameter uncertainties, such as the uncertainty in Pp, can inhibit the success of a wake steering application and these uncertainties must be carefully accounted for.

Comment #2

What is the model of yaw control within the turbine used? Is the turbine free to yaw at any moment? Most turbines have a built-in yaw control strategy which includes some dead-band about vane angle, and an intentionally delayed response to changes in wind direction. If this was not used, how would it change results if it were?

Response

The referee is correct that most utility-scale turbines have a native yaw control system which acts outside a deadband of 5-10 degrees based on low-pass filtered wind vane angle measurements. The yaw control strategy used in the present study low-pass filters the wind direction measured at the rotor based on a predefined time constant, leverages the computed turbine-specific wind direction to implement the desired yaw misalignment, and holds the imposed nacelle position for one period of the predefined time constant. This was described on Page 11 Line 315 and will be further expanded on in the revision to improve clarity.
Depending on the dynamics of the ABL, the method we have employed may lead to different results than the method the referee has mentioned. However, in the present conventionally neutral ABL large eddy simulations, the variations in the turbine-specific wind directions as a

function of time due to turbulence and inertial oscillations are relatively small (a few degrees) and therefore the yaw control method we have used and the deadband method will perform very similarly.
For Part 2 of this work, where the closed-loop controller is tested in the transient diurnal cycle, this native yaw control system will likely have a larger impact and we will test various native yaw control strategies.

Comment #3
One general comment I had on the sections related to the cos pP parameter, is that the discussions and conclusions are proposed in absolute terms, where relative would be more appropriate. As i understand, pP=3 is "correct" in this LES simulation, and so 2 is 2/3 of correct, and 4 is 4/3 of correct. Most of the numbers are baselined to a correct value of 3, but should be scaled in other simulations or on physical turbines. My main point is to avoid stating that 2,3 or 4 is better/worse and more under-predicting pP by x% leads to, while over-predicting pP by x% leads to ... In a similar way this would change the statement "a conservative estimate of pP=4" should be used in cases where it’s not yet known could be the more reasonable 125% of the value of the most similar published value (in terms of rated power or rotor size).

Response
Thank you for this comment. The referee is correct that the reference to conservative values of Pp are relative since they depend on the turbine-specific correct, or maximum likelihood estimate, value of Pp. The authors suggest that given a confidence interval on Pp for a given wind turbine, a conservative estimate should be selected for Pp for the calculation of the yaw misalignment strategy since the underestimate of Pp leads to power production loss during wake steering. We will modify the manuscript to consider your comment and discuss the Pp sensitivity in relative terms.

Specific comments:

Comment #1
The last sentences of the abstract are somewhat confusing before you read the paper
Response
We will modify the last sentence of the abstract for improved clarity.

Comment #2
p 13 "likely enhanced in yaw misalignment" see yaw-added recovery inhttps://www.wind-energ-sci-discuss.net/wes-2020-3/

Response
Thank you for highlighting this paper, we will add the reference to the yaw-added recovery.

Comment #3
P23 "wind speed and direction bins of arbitary size" this seems pretty possible using interpolating functions

Response
Thank you for this interesting comment, interpolating functions would be an excellent candidate to use in open-loop lookup table computation.

Comment #4
P23: "using a neural network for example" these ideas are theoretically possible but practical observation suggests that any method who’s parameters are not human intelligible will have obstacles because it will be difficult to make in-field adjustments

Response
The authors agree that methods which are based on first principles or physical phenomena are likely to perform better in a complicated field environment and we leave machine learning questions for future experimentation and improvement.