Interactive comment on "Controls-Oriented Model for Secondary Effects of Wake Steering" by Jennifer King et al.

Bart Doekemeijer (Referee)

b.m.doekemeijer@tudelft.nl

Dear authors,

I read your article with great interest. You present a very important contribution to the literature, being a surrogate wind farm model that incorporates the effects of secondary steering. I find the translation of secondary steering to an "effective" yaw angle a very interesting, eloquent and novel solution. This work will surely improve wind farm control algorithms and AEP predictions with such models. I envision that the proposed GCH model will replace the standard Bastankhah (Gaussian) wind farm model as the literature standard in the near future. My comments remain largely minor. That being said, I have a number of suggestions that may improve the clarity and the correctness

of the article.

1. Generally, the manuscript needs to be proofread. Some sentences can be rephrased in a clearer manner and there are still a handful of spelling errors in the manuscript. Similarly, in figures, axis labels legends, captions, and subfigure titles need to be reconsidered and may be made more clear. Note units and the size of text in figures compared to the regular manuscript font. Further, to simplify descriptions of simulation setups such as in the first paragraph of Section 5, the authors could consider putting such information in a table instead.

2. Section 2 would greatly benefit from adding a figure that demonstrates the definition of various variables. Generally, I found it difficult to follow the derivations shown in this section. A figure or perhaps some restructuring of the text may benefit clarity. Also, please have a look at the consistency in definitions when moving from a single-wake model (Eq 1) to the wind farm model. In Eq (1), y is defined as zero at the turbine, while this is not necessarily the case in Eq (11), for example. Moreover, is it not true that $M_0 = C_T$?

3. Figure 1 shows the time-averaged flow fields from transient, turbulent SOWFA simulations. From what I am seeing here, and based on my own experience, I observe the following. The precursor simulation in SOWFA has a constant west inflow, I am assuming (270 degrees). This may cause certain faster regions of flow to "stack up" in the precursor simulation due to the cyclic boundary conditions. This explains why you have a higher inflow wind speed to the left and right side of your turbines (based on what I see in the plots of Figure 1). Now, since you are specifically looking at secondary steering effects, this may actually have an impact on your work. The ambient wind speeds are already higher to the left and right of the turbine due to the non-homogeneous mean inflow wind speeds in the precursor, and therefore also to the left and right of the downstream wake. This may induce more or less wake deflection than in a precursor without such "stack-up" effects. I am not sure if you can address this in the current work, but you should consider this for future work.

4. The GCH model is compared to the Gaussian model in Figure 4. It may be nice to (instead) show the wake outlines (centerline + sigma_y, centerline - sigma_y) of the two models in a single plot to more clearly show the additional deflection achieved with the GCH model. This would also show that the wake behind turbine 1 is identical between the two models.

5. Figure 8 shows the power values measured from SOWFA. The default SOWFA implementation on Github has a bug where the generatorPower file in the turbineOutput folder is erroneously multiplied with a factor fluidDensity. This causes the power measurements to be a factor 1.225 too high in our own simulations, for which we have to correct manually. Have you considered this in your own work? It makes no difference in the other figures in which relative power productions are shown, but it does in Figure 8 where absolute values are shown.

6. Sections 3-6 show a thorough analysis of the GCH and Gaussian model, their differences, and how this reflects in simulation. This is very valuable. Though, due to the sheer amount of results, it can be a bit overwhelming. I wonder if the observations made in the 2- and 3-turbine analysis can also be made by only looking at the 5-turbine analysis.

7. What is the difference in computational cost between the GCH and Gaussian model?

You can find a highlighted manuscript with more detailed comments in the attachment.

Please also note the supplement to this comment:
https://www.wind-energ-sci-discuss.net/wes-2020-3/wes-2020-3-RC1-supplement.pdf