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Interactive comment on "Unlocking the Full Potential of Wake Steering: Implementation and Assessment of a Controls-Oriented Model" *by* Christopher J. Bay et al.

Anonymous Referee #2

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The manuscript presents a modified version of the recently-developed curled wake model. Predictions of this model and those obtained by the Gaussian wake model are compared with SOWFA simulations performed for two and three rows of wind turbines. By highlighting the importance of so-called secondary steering in wind farm yaw angle control, the presented results show the advantage of the curled model over the Gaussian one. Wake steering is an important stream of research since it is arguably deemed as the most promising wake mitigation strategy in the wind energy community. Therefore, I greatly appreciate recent efforts of the authors to develop computationally inexpensive models that can predict wake flows of yawed turbine more realistically.

The curled wake model has been already presented in the previous work of the authors (Martínez-Tossas et al. (2019). Therefore, I can summarize the contribution of the present manuscript as follows:

- Improve the theoretical framework of the curled wake model. This was achieved by adding (i) an additional term that accounts for vortex decay in the wake, and (ii) the effect of added turbulence by the turbine using the relationship developed by Crespo et al. (1996).

- Detailed comparison of curled wake model predictions with those of the Gaussian model to clearly show the higher accuracy of the former model and the importance of secondary steering in wind farm control strategies.

I think the authors did a great job addressing the second point mentioned above. However, I am afraid that I found the first part (theoretical model improvement) relatively sketchy and shallow. Eq. 6 is used to decay the vortex strength as the wake moves downstream. However, no explanation is provided on why this relationship was used. The validity of this relationship can be first verified using SOWFA simulations. Likewise, the turbulence added by the turbine is simply added by multiplying the effective viscosity by I+ and a constant coefficient. Indeed, it can be useful to provide physical insights on the validity of this approach. To sum up, I think this work is important and useful for the wind energy community, but in my opinion the theoretical part needs to to be improved first. Some more specific comments can be found below:

- Page 1, Line 23: Please check again Park et al. (2016). I think it should be "four" instead of "six".

- Page 2, line 3: I could not find Howland et al. (2019).

- Page 2, lines 21-22: Please rephrase this part. It seems that the last sentence is missing some parts.

- Page 4, line 16: If I am not mistaken, the last mentioned reference (Dilip and Porte-

Agel 2017) is not about the Gaussian wake model. Please also reorder the references according to the publication date.

- Eq. 1: M0 is defined but it is not used in the main equation. Please check this.

- Eq. 2 and 3: I cannot fully understand these equations too. It seems that there is another typo as simga_y and sigma_z are both defined two times. Please let me emphasize that as the paper discusses theoretical models, it is extremely important to ensure that all of the equations are written correctly. Otherwise, this may undermine the usefulness of this work for other researchers.

- Eqs. 2 and 3: u_R, u_0 and u_inf are not defined.

- Eq. 4: It is not clear how v_eff is calculated.

- Table 1: Are k_a and k_b the same as k_y and k_z? Why do they have so different values?

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