Review of the paper

"3D Shear layer simulation model for the mutual interaction of wind turbine wakes: Description and first assessment"

By Davide Trabucchi, Lukas Vollmer and Martin Kühn

General comments

The authors present an extension of the Ainslie wake model, which account for non-axisymmetric wake shapes and includes explicit (rather than assumed) wake-wake interactions. This is an important step towards an intermediary between existing engineering models and CFD. However, the paper has some shortcomings in presentation and in content.

I miss a description of the evolution of the wake shape in the new model. What does the wake cross section look like in the near wake? Figure 7 shows this in the far wake, but it would be useful with a line plot of the deficit profile in the cross stream or vertical direction at several downstream distances.

The comparison with FLaP in the case of an axisymmetric wake does not add anything significant to the manuscript. For a single, axisymmetric wake the equations reduce essentially to the Ainslie model, and section 3.1.1 is akin to a verification of the numerical scheme against another numerical implementation. It is nice to know that this has been done, but the details can be omitted from the paper.

In my view the paper is presents a novel idea, which has the potential to move engineering wake models forward. The weak part of the model in its present state is the near wake model, which is taken directly from FLaP/Ainslie. The authors ought to have critically addressed the near wake formulation, which is overly complicated with a great number of constants and parameters, yet seem responsible for much of the difference between the model and the reference field.

The paper is publishable in its present form, but can be improved with further work. At the very least the authors should adopt the turbulence mixing model introduced at the end, almost as an afterthought, from the beginning of the paper instead. I have made additional comments for the authors to consider below.

Specific comments

Add a description of the simulation time for a single wind speed and direction inflow case at least for the three-WTG example given. It is an important aspect in adopting a new model to understand how practical it is from an operational point of view and how much investment is needed in terms of coding.

P 4, line 18: can you be more specific on how the downstream step size is evaluated at each cross section? It would help a reader who desired to implement the model and work on refining it.

P 5, equation (8): $(x-4.5)^{1/3}$ becomes complex for $x > 4.5$. Are the limits $x ><5.5D$ meant to be at $4.5D$? If not, then specify in the text how you handle the complex values in $F(x)$, or better re-write the equation so it is clear mathematically. For example, if you end up just taking the real part.

P5, lines 21-24: are the characteristic turbulence length scales r_y and r_z updated at each vertical cross-section as the wakes are propagated forward? A drawing would help make the calculation of r_y and (r_z) easier to understand – illustrating the averaging of all deficits corresponding to the same y (z) and finding the width.

P6, line 11: the REWS concept has a specific meaning in the literature on power curves, where it signifies the cubic root of the average kinetic energy flux over the rotor. This is not the same as the average wind speed on the rotor plane. If you do mean the REWS in the power curve sense, then please include a reference to Wagner et al, Wind Energy 8, 993 (2011) at this point and rephrase the parenthesis at the end of line 11 (or replace it with a formal definition in an equation). If you meant instead the arithmetic mean of the wind speed on the rotor plane, then please use a different notation than REWS throughout the manuscript.

P 6, equation (13): please provide a reference for this equation.

P6, equation (16): include a reference to Figure 2, when discussing the stream tubes.

P7: add more reasoning for breaking the calculation into blocks. What is the purpose or what problem does this approach solve?

P7: in the description of how the simulation is divided into blocks, a drawing would help the reader and make the conceptual structure of the calculations clearer.

Technical corrections

P 1, lines 9-10: use present tense like the rest of the abstract (prove(d) and evaluate(d))

P 2, line 19: "new engineering model" is a more objective description than "innovative engineering model". Please consider changing the term to "new"

P 4, line 7: in the Ainslie model do you not mean to say that the radial velocity v_r is the same at each anugular coordinate \theta? You write that it is the same at each radius r.

P 4, line 8: do you mean the partial derivative of u_D with respect to x and not of u?

P 7, line 14: change "would have disregard" to "would have disregarded".

Section 3, first paragraph: consider using present tense throughout (instead of "were", "compared", "used").

P 8, line 8: neutral stratification is \Phi_m(z_H/L_MO)=1 not 0.

P 8, line 18: should the wake radius "r" not be "r^*" to correspond with equation (17)?

P 11, line 3: insert an "of" between "downstream" and "the second and third rotor".

P 11, line 7: I don't think "diversity" is the right word. Consider replacing with disagreement, difference or discrepancy.

P13, line 26: "an homogeneous" should be "a homogeneous".

P14, line 9: "slightly worsening" should be "slight worsening".

P14, line 21: change "add" to "adds".