Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2019-45-RC1, 2019

WIND ENERGY SCIENCE DISCUSSIONS

WESD

Interactive comment

Interactive comment on "Does the rotational direction of a wind turbine impact the wake in a stably stratified atmospheric boundary layer?" *by* Antonia Englberger et al.

Anonymous Referee #1

Received and published: 10 September 2019

The authors used numerical simulations to study the effect of the rotational direction of a wind turbine on the wake subjected to the veering inflow. They considered different cases with and without veer with the clockwise and counterclockwise rotating turbine. The idea is of interest and relevant to the wind energy community. However, there are several issues in the simulations, modeling, and interpretations of the results. The main comments are as follows:

A. Simulations:

A1. The inflow conditions need to be added to the text, specifically, profiles of stream-wise and lateral wind, temperature, turbulence intensities (in different directions) and

Printer-friendly version

Discussion paper

Reynolds shear stresses, as these parameters would affect the wake aerodynamics.

A2. It is mentioned that the turbulence intensity is the same in no-veer and veering cases. Is it turbulence intensity in the streamwise direction or the total turbulence level? As the other terms in the Reynolds stress tensor also contribute to the turbulent transport and the wake recovery, would it be enough to match the turbulence level in no-veer and veering cases?

A3. In veering inflow simulation, the wind direction changes with height, and it might also change with time. Is the wind direction fixed during the simulation? How the wind direction is kept constant during the simulation to avoid any yaw misalignment?

A4. What is the rotational speed of the turbine and how it is set during the simulations – with and without wind veer? The main characteristics of the turbine such as turbine RPM, turbine thrust and power coefficients should be added to the text for different cases.

A5. Based on the domain size, the blockage ratio is about 8% which is relatively large for simulations of a stand-alone wind turbine. It is recommended that the blockage ratio should be less than 2% to neglect its effect on wake development. Please clarify this point.

A6. The authors mentioned that the simulations are performed for 20 minutes and the results are averaged over the last 10 minute. Is 10min enough for the averaging? I believe a longer time should be considered for averaging especially for far wake region to make sure the statistics are well converged. I think the full recovery of the wake occurred at 16D might be related to limited simulation time.

B. Interpretation of the results:

B1. All the results are qualitative, and the paper suffers from the lack of quantitative comparisons. Velocity profiles at different distances from the turbine need to be plotted and added to the text to better quantified the effect of wake rotation.

B2. In the text, the analysis is only focused on the mean velocity (first-order statistics). Why only the mean velocity? How does the wake rotation affect the turbulence level or TKE behind the turbine in a stable regime?

B3. The authors use a fixed value for the wind veer (0.08 deg/m). What would be the effect of wind veer strength (or rotor size) on the results? As the effect of wind veer has been extensively studied before, it is expected that a more comprehensive investigation to be done.

B4. In page 9, line 3: the authors mentioned that: “this enhanced production of TKE due to the shear and wind veer . . ..” The authors did not show any results about the TKE or TKE production in the text. It is not clear how they concluded that TKE production increases due to the veer.

B5. Following the previous comments, it would be useful that the authors show how the wake rotation can affect the TKE production in the wake.

C. Analytical modeling:

There are several major issues in the low-order model presented in the text:

C1. Eq(9): Why 0.3? Could you provide a physical justification for using 0.3? This value can be related to the induction factor of the turbine, but, in the current form, it is not justified.

C2. Eqs (13) and (14): This assumption should be verified or assessed by comparing the model to the simulation results. It is known that the lateral and vertical components of the velocity in the wake are different from the incoming wind.

C3. I could not follow how Eqs. (18-20) are obtained from Eqs. (15-17). Eqs. (15-17) are only a function of r. However, Eqs. (18-20) are a function of r and x.

Also, it should be explained how the magnitude of \delta and \gamma are obtained.

C4. Does the proposed model satisfy basic physics like mass and momentum conservation? This point needs to be clarified in the text.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2019-45, 2019.