

Review of “Validation of the dynamic wake meandering model with respect to loads and power production” by Inga Reinwardt et al., manuscript number: wes-2020-126

1. General comments

In this article, several versions of the DWM model are compared in terms of power and loads prediction for an onshore wind farm composed of closely spaced machines. Special focus is given to a calibrated version of the DWM model. This article shows the limitations of the Frandsen model compared to the DWM models for reduced spacing between machines. Finally, a lidar assisted version of the DWM model, which includes the wind speed deficit as well as the wake meandering obtained through lidar measurements, is proposed to decrease the uncertainties on the power and loads prediction.

- The article is well written and is pretty clear (see specific and minor comments).
- Try to complete hazy wording (immediate vicinity, considerably more, ...) with more precise data (see specific comments).
- The lidar assisted version of the DWM model presented in this article provides results that are in better agreement with the measurements than those obtained with the “classical” DWM models. It shows therefore that there is still room to improve the physics behind the DWM models and underlines the interest of additional studies focusing on the wake meandering physics. It seems interesting to me to add such a consideration somewhere in the text.

This article shows the influence of the version of the DWM model on power and loads prediction. Through the lidar assisted version of the DWM model, it also highlights the importance of the quality of the wake meandering modeling for power and loads estimation. It has certainly a value for the wind energy research community and I suggest the manuscript for publication after addressing the following comments.

2. Specific comments

Wind farm and measurement equipment

L 67: “*immediate vicinity*” Please precise by giving the distance of the closest wind farm.

L 79: “*recuperator*” Do you mean heat exchanger?

L 96: “*Considerably more ...*” Please precise by giving an order of magnitude.

L 97: “*The measured lidar data are filtered by the power intensity, ...*”. This phrasing is confusing considering the sentence at L 92: “*Only measurement results with normal power production are included in the analysis*”. Are you actually talking about the “return strength of the laser pulse”? I suggest specifying which power intensity.

L 108-109: “*The one-dimensional scan consists of only 11 scan points scanned in a horizontal line...*” Please give information about the streamwise positions.

L 109: "... around 16 s depending on the visibility conditions during the scan." What is the order of magnitude of the variation in duration: +- 0.1 s or +- 10 s?

Load simulation

L 123-124: "Furthermore, the multibody model is connected to a controller, which uses the generator speed and the pitch angle from the multibody simulation to calculate the generator torque and the pitch velocity and returns them to the multibody model." What do you mean by pitch velocity?

L 133-134: "Auxiliary sensors are added to the turbine model in alaska/Wind to compare the measured loads at the precise position of the strain gauges, the locations of which are given in Section 2." Please rephrase.

Dynamic wake meandering model

Figure 3: I do not understand the arrow going from BEM to small-scale turbulence based on the text at L 162-163: "This small-scale turbulence is calculated with a scaled homogeneous turbulent wind field, which is also generated by a Kaimal spectrum". Could you comment on this, please?

Lidar assisted load simulation

L 170-174: "To clarify that ..., the phrasing Horizontal Meandering Frame of Reference (HMFR) is introduced in Figure 4." I do not understand the part "and that the transformed wind speed deficit in the meandering frame of reference still includes the vertical meandering". Please comment on this and rephrase.

L 191: "... σ_y is the standard deviations of the horizontal displacement μ_y ." In Trujillo et al. (2011) and other articles, σ is the parameter representing the width of the wake. Are you sure that it corresponds to the standard deviation of the horizontal displacement?

L 212-213: "... and the turbine loads are not increased by an immediate change of the position of the wind speed deficit." Not clear to me. Could you comment on this, please?

L 214-215: "The comparison of simulations and measurements shows that the amplitude of the measured time series is more pronounced." From Fig. 5, it seems to me that it is the amplitude of the simulations (DWM-meas) that is more pronounced than the amplitude of the measured time series. Please clarify.

L 227-228: "... hence the mean wind speed deficit in the HMFR in the DWM model definition should be replaced by the lidar measurements." Not clear to me. You write that "the measured wind speed deficit shows a coarse distribution at the boundaries of the deficit", that "using this coarse curve leads to increased loads in the simulation, which are not feasible", and then "hence the mean wind speed deficit in the HMFR in the DWM model definition should be replaced by the lidar measurements". Please clarify.

Results

L 250-255: *"In summary, the simulated power agrees ... different inflow wind speed at the turbine than the one measured at the met mast and used in the simulations."* How do you justify the discrepancy for 8.25 m/s for which the std (errorbar) is similar to the std (errorbar) of the other wind speeds?

L 260-261: *"Only some slight discrepancies occur between 6m/s and 9m/s, where the simulation overestimates the loads slightly."* Can you give an explanation?

L 262: *"... local maximum around the rated wind speed"* I would say "just below".

L 266-268: *"... the illustration of the measured nacelle wind speed and the met mast prove the fact that the turbine experiences a local momentarily different inflow wind speed and explains the discrepancies."* It seems to me that it is the small number of points in the bin that results in a biased wind speed rather than a local momentarily different inflow wind speed. Could you comment on this?

L 297-298: *"Because of the tilt, the blade faces slightly away from the wind direction during the upward movement ... whereas during the downward movement, the blade faces slightly more towards the wind direction"* Not clear to me. Could you clarify, please?

L 311-314: *"The load is defined in the rotating frame of reference, so that the weight force switches its sign with each rotation, whereas the influence of the aerodynamic force on the edgewise moment does not change the sign. Thus, at one side of the rotor the forces level each other out, while on the other side of the rotor they accumulate."* The understanding would be eased if you could add a schematic.

L 371: *"... no wind speed deficit is considered in Frandsen's model"*. Not clear to me. Could you comment on this?

L 404: *"Another explanation ..."* Which is the first explanation?

L 405-407: *"For the comparison measurements at the closest available lidar range gate that is still outside the rotor area of the downstream turbine is used, thus it happens that the downstream distance used in the simulations is slightly to low."* Not clear to me. Please clarify.

L 408: *"However, the influence should be small, due to the small gradient of the wind speed in downstream direction."* So, it does not justify the differences you observed. Please clarify with L 405-407.

3. Minor comments

Table 1: not referenced in the text.

L 182: What is epsilon?

L 241: *"In order to validate the aerodynamic load simulations the following section ..."* →
"In order to validate the aerodynamic load simulations, the following section ..."

Figure 14 (a): Please split the legend of the measurements in 2: line for all measurements and circle symbol for 10-min time series for which lidar measurements are available. Remove also gray lines below other symbols.

Figure 14 (b): Add normalized before power for the axis labels and in the legend.

Figures 15 (a), 16 (a) and 17 (a): Idem Fig. 14 (a)

Figure 16 (b): Do not repeat the legend as you didn't for the other figures.

L 395: *"The simulated power over the measured power"* → *"The normalized simulated power over the normalized measured power"*

L 405: *"For the comparison measurements ..."* → *"For the comparison, measurements ..."*

L 406: *"... is used,"* → *"... are used,"*

L 407: *"... to low."* → *"... too low."*