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Comment on wes-2021-106

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Referee comment on "Comparing and validating intra-farm and farm-to-farm wakes across different mesoscale and high-resolution wake models" by Jana Fischereit et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-106-RC3, 2021

The paper uses SCADA data from an offshore wind farm as well as measurements from a co-located met mast to validate different wake models in the situation where the wind farm is affected by wakes from an upstream neighbour wind farm. Both the intra-farm and farm-to-farm wakes are modelled using three different types of models. (1) A mesoscale model that includes details of the regional flow with two different parameterizations of the wind farms. (2) A RANS model that describes the turbine interactions in greater detail that the mesoscale model, but in contrast relies on more idealised inflow conditions. (3) Three engineering wake models. The models are compared to data and to each other. The authors conclude that one of the mesoscale wind farm parameterizations (Fitch) and the RANS simulations agree reasonably well with the data, while the other mesoscale parameterization (EWP) and the three engineering models underestimate the farm-to-farm wake loss.

The topic is of great interest considering the plans for an extensive buildout of offshore wind capacity around the world. The paper is easy to follow, and the conclusions are sound given the available data. The analysis does only cover a limited period of one month. I assume that limited computational resources for the mesoscale simulations were the driving factor for this limitation, but the authors should make this clear, since the analysis would be much stronger if a longer period had been analysed. The criteria for selecting the specific month were high data availability for both met mast and SCADA data. Unfortunately, this specific month saw only a limited number of flow cases consistent with the farm-to-farm interactions that form the core of the study. In my view, the met mast data are not as interesting as the SCADA data, so it is possible that a better month could have been chosen based on high SCADA data availability combined with a higher frequency of useable flow cases. It may even have been better to not run the models on a specific calendar month but rather for specific days or weeks to maximize the number of useable flow cases. Nonetheless, the paper is still a solid and important contribution and I enjoyed reading it.

Minor comments:

Figure 1- consider making this figure larger for better readability

Line 41 – consider including a reference to https://zenodo.org/record/3637944/files/1.7_Poulsen%20Validation%20of%20wind%20farm%20parametrisation%20in%20WRF%20using%20wind%20farm%20data%20%28Thesis%29.pdf

Line 43: split "with a"

Line 75: I don't understand the remark about the effect of wake rotation on the velocity deficit. Consider if it is necessary or if additional explanation can be added.

Line 117 – Please discuss why a hub height TI of 7% was chosen. Is this based on on-site measurements from the met mast. Does the TI depend a lot on wind direction for this site given the proximity to land in some directions?

Line 145 – why was the wake decay constant in the Jensen model chosen as k=0.1? This is a very large value given the typical recommended range of 0.03-0.05 for offshore wind farms. Please add a discussion in the text

Line 149 – the BAS wake expansion constant is given as k=0.0324555. This may be following the original paper, but it seems like more digits than can be justified. How many decimal places can be seen in the results?

Line 158 – please comment on the grids used in the PyWake engineering model calculations. Are they only used for visualization purposes, or are they an integral part of the calculations of wake effects?

Page 10 – please indicate the order of magnitude of computation time for all the simulations. This is relevant for a reader interested in performing similar calculations.

Line 191 – why is the width of the Gaussian wind direction average 5 degrees? Where does this number come from? A reference to Gaumond et al, Wind Energy would be good to add as well.

Figure 7 – The Rødsand II wind farm is abbreviated RS2 in this figure, while in table 5 it is referred to as RØ. It would be better to use a consistent abbreviation.

Figure 8 – I can only really make out the black, orange and blue lines (sonic, NWT_in and FIT_e). Consider reducing the number of lines. I cannot know which of the other lines the curves I cannot see are hiding behind.

Figure 8 – The text states that the WRF simulations generally agree with the sonic measurements, with one exception being the storm on 28 October. I would say that there are a few examples where the deviation between WRF and measurements is even larger. I think in general the agreement is good, but you should maybe rephrase this so it doesn't sound like the storm is the only instance of disagreement between simulations and measurements.

Line 239 – Referring to Figure 9 the text states that Fitch clearly performs best for simulating the wind speed deficit. But Figure 9 does not show the wind speed deficit, only the wind speed. In addition, only a few points in Figure 9 are affected by wakes from Nysted. To support the statement, it would be more relevant with a scatter plot of wind speeds showing only the directions where Rødsand II is in the wake from Nysted.

Line 243 – The estimation of the wind farm wake effect for October 2013 by subtracting the NWF wind speed bias from the FIT or EWP wind speed bias neglects the global blockage effect on the met mast. The mast is quite close to the wind farm, so for wind directions where it is upstream of the wind farm it likely experiences a wind speed

reduction which will be included in the estimated farm wake loss.

Line 246 – I think Figure 7 is a better reference than Figure 8.

Line 249 – "based on 127 10-minute values". Table 6 says there are 19 periods with wind direction between 80 and 100 degrees and wind speeds between 9 and 12 m/s. Are the 127 m/s 10-minute values including wind speeds outside the 9-12 m/s range?

Figures 10-12 – These are hard to read, the features are quite small. Consider making them larger for example by re-arranging the subplots into a 3x2 array instead of the 2x3 used, and by making the full page width.

Figure 10 – Consider making the SCADA (f1) and SCADA (f2) dots different colours to better tell them apart.

Line 267 – I find it difficult to see from Figure 10 that SCADA (f2) agrees better with RANS-ABL than SCADA (f1). Consider making a separate plot showing only the RANS predictions at the turbine positions together with the SCADA data to show this or quantify the deviation.

Line 269 – "indicate" is there twice.

Line 270 – Lolland is not identified on the map.

Figure 14 – what data are used for the histograms? Do they include all wind directions and wind speeds?

Figure 15 – Include a description of the vertical dashed lines in the figure caption. Also, the bottom x-axis gives distances relative to some unknown point. Either specify in the caption what zero corresponds to or make the axis relative to the same origin as the top x-axis.

Line 363 – Are you trying to say that even far west of Rødsand II the NYRØ and RØ scenarios differ in wind speed, meaning the effect of Nysted on the flow can be still be seen at the western edge of the plot? Consider rephrasing the sentence.

Line 375 – Are you trying to say that wind resources are affected by wind farms more than 25 km away according to the RANS and WRF simulations? Consider rephrasing the sentence.

Line 378 – Instead of point measurements I suggest snapshots.

Line 436 – constraint -> constrained.

Line 453 – consider adding a reference to van der Laan, P., Peña, A., Volker, P., Hansen, K. S., Sørensen, N. N., Ott, S., & Hasager, C. B. (2017). Challenges in simulating coastal effects on an offshore wind farm: Paper. Journal of Physics: Conference Series, 854, [012046].