

Interactive comment on “A case study of wind farm effects using two wake parameterizations in WRF (V3.7) in the presence of low level jets” by Xiaoli G. Larsén and Jana Fischereit

Anonymous Referee #2

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Review of Larsén and Fischereit - gmd-2020-358

General

The study by Larsén and Fischereit investigates two different wind farm wake parameterisations that are in principle available for the mesoscale model WRF during a situation with low level jets. Thus, the study generally addresses two important topics of mesoscale meteorology: the simulation of low level jets as well as the topic of larger scale wake effects and could thus in principle be an important scientific contribution.

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However, there are several major points and a number of minor points that the authors should address before consideration the publication as research paper in GMD. As these points require from my point of view re-simulation and re-interpretation of parts of the results, I recommend publication after major revisions.

Major Points

- Bug in Fitch parametrization:** The authors mention the bug in the Fitch parametrization that was announced and corrected in June 2020 and discussed in the publication by Archer et al. 2020. However, large parts of the results that the author discuss are due to this bug in the parametrization. One prominent example is the high TKE above the farm, e.g. in Fig. 11c. The reason that other studies like the Siedersleben et al., 2020 are affected as well is not a reason for obviously using a parametrization that contains a bug! Thus, I see the need for correcting the bug in the WRF version used by the authors, re-running and re-discussing all results with this new version.
- Erroneous turbine data:** Table 2 contains several wrong information about the wind farm details. These should be corrected and the simulations re-run. The ones I could identify are: Alpha Ventus contains of 12 turbines of two different turbine types (Adwen M5000-116 (southern part) and Senvion 5M (northern part)), Bard Offshore contains of 80 turbines of the BARD 5.0 turbine with a rotor diameter of 122 m. Horns Rev 2 has a hub height of 68 meters. Please correct those and carefully check all others and re-run the model simulations.
- Reproducibility:** The authors are referring to the Volker et al, 2015 study for the availability of the EWP model. However that one refers to a zenodo record <https://zenodo.org/record/33435> that contains the parametrization for the WRF

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model version 3.4. The authors however have used WRF version 3.7. So, the actual EWP model code used in this study should be provided along with the study.

4. **Language:** In addition, the study would benefit from a thorough review of the language as it is hard to read in several parts. The authors for example make several times use of in-line enumerations which should either be indented or rewritten so that these sentences are easier to understand.

Minor Points

1. **P1-L15:** "For instance in the North Sea..." ⇒ I recommend introducing what a wind farm and a wind farm cluster is from your point of view. Also please set the reference to 4COffshore as a proper reference.
2. **P1-L21:** "most-used mesoscale model" ⇒ for the application of wind farm wakes
3. **P2-L24:** "the two most commonly applied explicit wind farm parametrizations" ⇒ I suggest to explain in one sentence what the difference between an implicit and an explicit wake scheme are.
4. **P2-L50:** "... occurred on about 65 % of the days during the campaign." ⇒ This is true but it should be mentioned here that this is not 65 % of the time but could also be a short period of the day.
5. **P3-L59:** "... open source flight data from Bundesnetzagentur ..." ⇒ The Bundesnetzagentur which is the federal grid agency does not provide flight data. This is confusing here as the turbine coordinates originate from them not the flight data.
6. **P3-L77:** "is the open access measurements" ⇒ Grammar and language issue - Maybe: The first are the publicly available airborne measurement data?

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7. **P3-L82:** "The flight data include (1) ..." ⇒ One of the enumerations mentioned in Major Point 4 that should be indented or reformulated.
8. **P3-L90:** "... corresponding to a horizontal resolution of 0.66 m ..." ⇒ How is this calculated? With the speed above ground of the aircraft?
9. **P4-L94:** "The choice of the window length ..." ⇒ I did not understand his sentence. Please revise.
10. **P4-L96:** "... order of a couple of minutes, which is a reasonable time scale" ⇒ Reasonable for what? Comparing to the models output/time step/horizontal averaging?
11. **P4-L101 and Fig. 3b:** Please use another color than the blue dots as the turbine positions are also blue.
12. **P4-L104:** "The second measurement type is from the ..." ⇒ Do you mean that the second dataset originates from the FINO1 met mast?
13. **P4-L105:** "FINO 1 is in the wake of the upstream wind farm Borkum Riffgrund..." ⇒ Again difficult to understand. Do you mean: In this situation, FINO1 is located in the wake of the wind farm Borkum Riffgrund that is operating XX km upstream?
14. **P4-L115:** "LLJs over the Southern North sea ... Tay et al., 2020)" ⇒ This whole paragraph should be shifted to the introduction.
15. **P4-L118:** "... WRF, where important elements include model domain configuration,..." ⇒ Important elements for what?
16. **P4-L122:** "This includes (1) ..." ⇒ see major comment 4.
17. **P5-L125:** "... others in Tay et al. (2020), while in Nunalee and Basu (2014), MYNN performed fine but best candidate was QNSE ..." ⇒ Are these the same

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sites? Also, there are six years between these studies. Implementations might also change considerably over these years.

18. **P5-L128**: “We use WRF version 3.7 to simulate this case ... (Stark et al., 2007) was used.” ⇒ Please consider putting this model setup into a tabular overview rather than running text.
19. **P5-L153**: “This problem is solved by increasing the land area in the southern part.” ⇒ I guess you did not artificially increase the land but shifted ore increased the domain don't you?
20. **P5-L158**: “... and manually corrected to fit the wind farm shapes from emodnet” ⇒ Good that you mention that you have corrected the coordinates. The Bundesnetzagentur data are known to be erroneous. Sometimes turbines are also missing. Did you make sure that the correct number of turbines per farm are included?
21. **P5-L159**: “with the simulated date (Table 2).” ⇒ I guess you measurement time?
22. **P6-L175**: “jet nose, with the lowest ones beneath 200 m and the highest ones at 350-400 m, suggesting the presence of multiple internal boundary layers in associated with the flow from the land.” ⇒ Is that really true or did the jet core move with height as there is considerable time between the measurement of the profiles?
23. **P6-L182**: “... from upstream Borkum Riffgrund wind farm” ⇒ Do you mean “originating from the Borkum Riffgrund wind farm that is located upstream”?
24. **P6-L184**: “Six 10-min modeled data ...” ⇒ This sentence is very hard to understand. Please revise.
25. **P6-L186**: ⇒ One of the enumerations mentioned in Major Point 4 that should be indented or reformulated.

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26. **P6-L188**: “Thus the average values from the surface to the rotor top height are comparable between the two schemes.” ⇒ Please add “in this situation”.
27. **P7-L197**: “The above descriptions of the wind speed for FINO1 are also true for point A, as can be seen in Fig. 7a. Here the EWP scheme provides a better estimate of mean wind speed.” ⇒ You should also mention/discuss here which profile looks physically more sound. The EWP scheme just provides more shear and better values at measurement height but the Fitch one looks closer to measured and high-fidelity modeled wake profiles.
28. **P7-L200**: “TKE from the Fitch scheme increases significantly with height, and for the value at point A, it is overestimated in comparison with the flight data.” ⇒ Is that still true without the bug in the parametrization?
29. **P7-L207**: “Here the modeled values at FINO 1 are weighted between two closest grid points (one inside and one outside the farm) according to the distances between the grid points and the mast location.” ⇒ I am not convinced that it is physically meaningful at all to compare data from a model grid point where a parametrization is active to measurement data. Why didn't you just use the data from the first grid point upstream?
30. **P7-L218**: “Without taking wind farm wake into...” ⇒ Do you mean “the wind farm wakes”?
31. **P8-L233**: “This is a phenomenon that deserves further investigation (Djath et al., 2018) but is beyond the scope of this study.” ⇒ Do you mean the flow below the rotor, which is in particular strong during stable stratification?
32. **P8-L256**: “The abrupt increase in the TKE in the same aera is likely related to this flow acceleration and is also missing in the WRF results.” ⇒ Couldn't also the different jet core heights of simulations/measurements be a reason for this?

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33. **Discussion/Conclusion:** The introduction of the discussion section has the character of a conclusion. I recommend combining and restructuring sections 4 and 5.
34. **P10-L320:** Low level jets and wind farm wakes have been investigated in numerous studies. In particular LES. Long-distance / mesoscale wakes might be true.
35. **P11-L329:** The zenodo link is not working.
36. **P11-L335:** Are FINO1 station data really available from the PANGEA database?
37. **P12 - References:** Several References contain several URLs, some URLs are in italic font.
38. **P12 - L349:** "Bärfuss K. ..." ⇒ That reference looks strange.
39. **Figure 9,11,12,13:** Please add the quantity and unit shown to the color bars. They are provided in the captions only.