Reviews corresponding to the article: ”A case study of wind farm effects using two wake parameterizations in WRF (V3.7) in the presence of low level jets”

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General comment:

In general, this work makes an important contribution to the wind energy resource assessment. The two most prominent wind farm parametrizations are evaluated by the use of airborne measurements and are compared against each other. This is important as the wind farm parameterization of Volker et al. (2015) has been used in a recently published report, indicating that wakes in the German Bight could have a massive impact on the energy harvesting in the future, although this parameterization was so far only poorly evaluated for offshore wind farms. However, three major points have to revised in this manuscript:

First of all, the description of the TKE coefficient (C_{TKE}) that determines the amount of TKE added by the wind farm parameterization is highly confusing. In this manuscript they authors describe C_{TKE} as a constant value. This is irritating as in existing literature this coefficient is described as the difference of thrust and power coefficient i.e. C_T - C_P. In contrast, I assume they mean a factor in front of difference C_T - C_P, resulting in C_{TKE} = anyFactor * (C_T - C_P), as it was pointed out in a recently published study (Archer et al. 2020). In case they really used a constant C_{TKE} for the comparison with the work of Siedersleben et al. (2020), the comparison is wrong.

Secondly, although they have shown that the bug corrected version of the wind farm parameterization of Fitch et al. (2012) has an large influence on the TKE within the rotor and wake area, the impact of the enhanced TKE on the wind speed is not discussed although this is the most crucial point of this study. I would assume that increased TKE would cause a weakening of the wakes due to enhanced mixing. This point should be added! A figure similar to Fig. 13 should be added for the horizontal wind field or Fig. 9a) should be replaced with the bug corrected Fitch parameterization.

Thirdly, a table with the conducted simulations would help the reader to have an overview about the different model setups.

Specific comments:

P1 L9: “However, their skill is limited… the farm edge.” This is not related to the parameterizations, this is a purely numerical issue. Considered omitting this sentence.

P2 L18: The turbulence is modified by wind farms within the wake but not necessarily increased. For example, see Platis et al. (2018).

P3 L59: The Bundesnetzagentur does not host any open source flight data! The Bundesnetzagentur does host wind turbine location data!

P5 L128: Could you please comment why you used WRF 3.7 and not a newer version of WRF by now WRF-4.2.2 is already released? Is the EWP scheme only compatible with WRF 3.7?

P5 L136: The spin-up time is really short, especially with regards to your domain with an 18 km horizontal grid? Have you worse results using a longer one?

P5 L148: The C_{TKE} coefficient wasn't set to 1 in S2020! They used the default WFP in which $C_{TKE} = C_T - C_P$! Please comment if you have modified the code within the Fitch scheme. If you have done so a comparison with the results of S2020 is difficult! Could it be that you mean: $C_{TKE} =$ factor* $(C_T - C_P)$?

P5 L154: See comment before, in case you used the power coefficients and thrust coefficients and you haven't modified the code in WRF 3.7 in module_fitch.F, your C_{TKE} is not constant i.e. unity. Please comment on that!

P6 L164: How have you determined the initial length scale for the EWP? Have you conducted a set of sensitivity studies to get a best fit? Was the same initial length scale used in Agora Energiewende et al. (2020)

P7 L192-204 Is this comparison really necessary, you are comparing a point measurement to a vertical profile?

Technical comments:

P2 L54: … the increased wind resource → increased wind resources?

P3 L79 … here as Fig. 2 -> in Fig. 2?

P3 L87 Horizontal flight data → horizontal flight data

P4 L124 ERA5: Be more precisely here, where did you get the data from? In case you have downloaded it from the Copernicus Climate Center you should definitely cite the source according to their terms of usage!

Fig. 2 The green and red colors are not color-blind safe, i.e. the flight track 1 and 3 are hardly to distinguish. Please consider redoing this figure!

Fig. 3 An indication of the location of the close-up shown in Fig. 3b) in the Fig 3a) would help the reader.

Fig. 5 These colors aren't the state of the art any more. Please consider redoing this figure as they are not colorblind safe. Is the TKE scale of 5e) similar to 5f). I am wondering as the last tick label in 5f) is missing.

Fig. 6 Could you please indicate the rotor-area, that would make it easier to follow the corresponding text.

Fig. 11 Rainbow is dead. Please consider redoing this figure using color-blind colorbars as pointed out in several publications (Stauffer et al. 2015; Thyng et al. 2016…).

Fig. 11 - 12: First of all: Please add a clear caption describing what is actually show in Fig. 12. It is possible to guess that (a-b) is showing wind speed due to the order of magnitude compared to (c-d). However, someone who is not that familiar with the units of TKE might have difficulties to draw the correct conclusions. Please use up to date colorbars as it is mentioned in the technical section (rainbow is dead).
Secondly, describe where this cross-section is located within the caption and make clear how this cross-section is orientated i.e. south-north or north-south!

Code and data availability

On 29 January 2021 the reviewer could not access the following address: https://zenodo.org/record/4133350.X5aZOO3cBaR

The authors should provide a corrected module_pbl_driver.F file, to account for the bug in wind farm parameterization of Fitch et al. (2020). In the official WRF repository they provide, the WRF bug is not fixed for version 3.7.

Literature

Agora Energiewende, Technical University of Denmark, Max-Planck-Institute for Biogeochemistry, and Agora Verkehrswende, 2020: *Making the Most of Offshore Wind: Re-Evaluating the Potential of Offshore Wind in the German North Sea*.

Archer, C. L., S. Wu, Y. Ma, and P. A. Jiménez, 2020: Two Corrections for Turbulent Kinetic Energy Generated by Wind Farms in the WRF Model. *Mon. Weather Rev.*, **148**, 4823–4835, https://doi.org/10.1175/MWR-D-20-0097.1.

Fitch, A. C., J. B. Olson, J. K. Lundquist, J. Dudhia, A. K. Gupta, J. Michalakes, and I. Barstad, 2012: Local and Mesoscale Impacts of Wind Farms as Parameterized in a Mesoscale NWP Model. *Mon. Weather Rev.*, **140**, 3017–3038, https://doi.org/10.1175/MWR-D-11-00352.1.

Platis, A., and Coauthors, 2018: First in situ evidence of wakes in the far field behind offshore wind farms. *Sci. Rep.*, **8**, 2163, https://doi.org/10.1038/s41598-018-20389-y.

Siedersleben, S. K., and Coauthors, 2020: Turbulent kinetic energy over large offshore wind farms observed and simulated by the mesoscale model WRF (3.8.1). *Geosci. Model Dev.*, **13**, 249–268, https://doi.org/10.5194/gmd-13-249-2020.

Stauffer, R., G. J. Mayr, M. Dabernig, and A. Zeileis, 2015: Somewhere Over the Rainbow: How to Make Effective Use of Colors in Meteorological Visualizations. *Bull. Am. Meteorol. Soc.*, **96**, 203–216, https://doi.org/10.1175/BAMS-D-13-00155.1.

Thyng, K., C. Greene, R. Hetland, H. Zimmerle, and S. DiMarco, 2016: True Colors of Oceanography: Guidelines for Effective and Accurate Colormap Selection. *Oceanography*, **29**, 9–13, https://doi.org/10.5670/oceanog.2016.66.

Volker, P. J. H., J. Badger, A. N. Hahmann, and S. Ott, 2015: The Explicit Wake Parametrisation V1.0: a wind farm parametrisation in the mesoscale model WRF. *Geosci. Model Dev.*, **8**, 3715–3731, https://doi.org/10.5194/gmd-8-3715-2015.