Review WES

October 5, 2023

On behalf of all the authors, we would like to thank Reviewer 1 (Pietro Bortolloti) and the anonymous Reviewer 2 for reviewing our manuscript. Your suggestions significantly improved our manuscript, and we have attempted, to the best of our knowledge, to address all of them.

We have used different colors throughout the review process:

Green: The green color indicates one comment/question from a Reviewer

Black: The black color generally refers to content from the original submission of the manuscript (from the published preprint)

Blue: the blue color indicates either our answer or content added to the original text in the published preprint in WES

Reviewer 1

- Page 4 line 113: typo, reference is duplicated

Answer: Thank you for identifying the referred typo, we have fixed by excluding one of the occurrences of "Perez et al.".

- Page 7 line 191: how off are the AEP values?

Answer: The plots from Figure 1 (not included in the manuscript) show one of our earliest simulations. At that point, we hadn't done a fine-tuning to get a faster optimization workflow/setup. We considered 180 wind direction bins for comparisons at that time. The initial values of the AEP were around 1.5 to 3.5% different compared to the benchmark by Baker (2019). As a reference, the benchmark performed by Baker (2019) considered 16 wind directions. The final optimized AEP, however, was within around 7.5% and 8.5% different when comparing the 16 wind direction bins and the 180 wind direction bins.

In the end, we decided to be conservative and use 360 wind direction bins due to the occurrence of wriggles, as described in lines 406 to 412:

"Another possibility to speed up wind farm optimization is considering a subset of the flow cases. For wind farm AEP computations, Thomas et al. (2022b) demonstrated that at least 40 or 50 wind sectors are necessary to run WFLO. However, wriggles can occur when simulating too few wind directions. We define wriggles as direction-dependent variations in wind turbine wakes when averaging all the wind directions with their sector frequency weight. In simple cases, the occurrence of such wriggles has been found to drastically increase the number of local minima. Taking this into consideration, in this work, we took the conservative approach of considering wind direction bins of 1°. However, we acknowledge other possibilities and intend to explore them in future work."

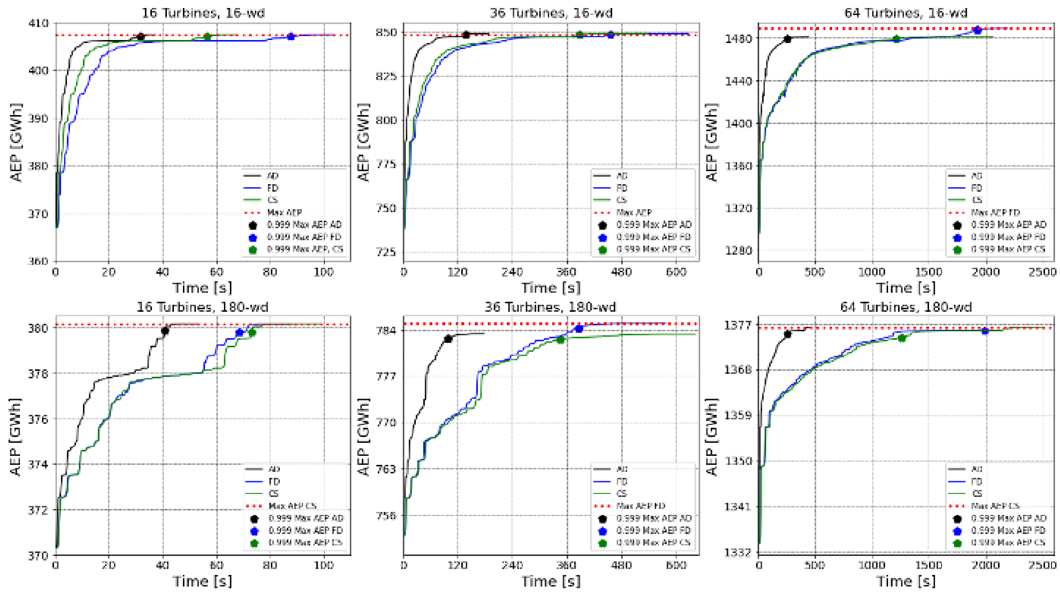

Figure 1: Comparisons showing final optimized AEP according to different numbers of wind directions.

Aiming to improve the manuscript following the Reviewer 1 question, we have included the estimates mentioned here in line 191:

"Note that, in the current study, we simulate 360 wind directions (as shown in Table 1) while only 16 wind directions were considered in the original IEA Wind Task 37 case study. Our results are, therefore, not directly comparable to the AEP results of the benchmark in Baker's work (Baker et al., 2019). The final optimized AEP values from Baker's benchmark were around 7.5% to 8.5% higher than our preliminary results."

- Page 7 line 180: please add "wind farm" to the Horns Rev I

Answer: Thank you for your comment. We have added "wind farm" to line 180. Now, it reads:

"The simulations to investigate the time per iteration were performed with a realistic setup, the Horns Rev I wind farm. "

- Figure 1b reports a Ct for the IEA 3.4 that is clearly wrong. Not sure where the value comes from, but this file might be a better source for Ct

Answer: The IEA 37 wind turbine we used in this work is slightly different from the IEA 3.4MW reported in:

Bortolotti, P., Tarres, H. C., Dykes, K. L., Merz, K., Sethuraman, L., Verelst, D., and Zahle, F. (2019). IEA Wind TCP Task 37: Systems engineering in wind energy-WP2. 1 Reference wind turbines (No. NREL/TP-5000-73492). National Renewable Energy Lab.(NREL), Golden, CO (United States).

The wind turbine we used in this study is reported in:

International Energy Agency. 2019. IEA WIND TASK 37 on Systems Engineering in Wind Energy (2019): Wake Model Description for Optimization Only Case Study. Tech. rep., International Energy Agency, Available in: https://github. com/byuflowlab/iea37-wflo-casestudies/blob/master/cs1-2/iea37-wakemodel. pdf (last access: 03 October 2023).

The same turbine was later used in the benchmark study below:

Baker, N. F., Stanley, A. P., Thomas, J. J., Ning, A., and Dykes, K. (2019). Best practices for wake model and optimization algorithm selection in wind farm layout optimization. In AIAA Scitech 2019 forum (p. 0540).

This is a 3.35MW idealized wind turbine, and as reported in the references above, a constant C_T=8/9. Initially, the reasoning behind this choice was the possibility of verification of our model in PyWake with the benchmark provided in the study. Given the same conditions, e.g., the number of wind speeds (only 9.8m/s) and wind directions (16 sectors), the PyWake results for the AEP match exactly with the results from the benchmark study. We have named this simplified and, therefore, faster wake model as "Simple Bastankhah Gaussian" as it is based on the idealization described here.

In order to clarify readers and Reviewer 1, we have changed lines 178-185 as below:

"The results for the number of iterations and number of multi-starts are based on more than 55,000 GBWFLOs, and these were performed with a faster setup, which uses ~~the wind turbine~~ idealized 3.35MW wind turbines with constant C_T, site, and wake model definitions from the IEA Wind Task 37 case study 1 (IEA Wind Task 37, 2018; Baker et al., 2019). These wind turbines are slightly different than the reference IEA 3.4MW wind turbines defined by Bortolotti et al., 2019 . Extra cases were designed to scale the analysis (Figure 3). In this simplified setup, only the rated wind speed (9.8m/s) is simulated, and all wind turbines operate with constant ~~$C_T \approx 0.964$~~ $C_T \approx 8/9$."

- Figure 2: I don't understand why 80 turbines are marked in black and others in white

Answer: The 80 turbines marked in black are the original turbines from the Horns Rev I layout, whereas the turbines marked in white represent the rows and columns added to the original layout.

In order to clarify the reviewer and readers, we have changed the caption of Figure 2 including:

"**Figure 2**. Considered variations of the scaled Horns Rev I site. The 80 turbines marked in black are the original turbines from the Horns Rev I layout, whereas the turbines marked in white represent the rows and columns added to the original layout."

- Page 8 line 203: the sentence seems a little clunky

Answer: We have updated the sentence in line 203 to:

"This work implemented parallelization in a computational cluster. Single node operation was utilized with each node being composed of 2x AMD EPYC 7351 16 core CPUs, @2.9GHz, with 128GB of RAM."

- Page 10 line 218: what does AEP best mean?

Answer: As also pointed out by Reviewer 2, there was a typo in that symbol. The typo happened because of a mistake in the LATEX file. The arrow symbol was supposed to be the symbol $\mathcal{L}$ and should read as below:

"Next, SMAST randomly selects a point p among the points associated with the highest AEP, $\mathcal{L}_{best}$, and places the next turbine at p."

$\mathcal{L}_{best}$ is the an array with potential positions with turbines, $\mathcal{L}_{best}$ is the same type of array but with the positions with the highest AEP.