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Interactive comment on "Wind-farm layout optimisation using a hybrid Jensen–LES approach" *by* V. S. Bokharaie et al.

Anonymous Referee #1

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General Comments

The paper "Wind-farm layout optimisation using a hybrid Jensen–LES approach" pursues an interesting hybrid approach to wind farm layout optimization that tunes the Jensen linear flow model to better agree with time averaged-LES results during optimization iterations. The layout optimization process uses the cross-entropy (CE) method that is fairly new to the wind farm community. The approach is novel, however I would like to see further discussion of the advantages/disadvantages of a sampling based approach like CE and a better characterization of the local/global nature of the solutions and convergence rates. The LES results also appear to need significantly more computation time as there is great variability in the turbine power production and unphysical structures are still visible in the LES time averaged velocity fields.

Specific Comments

Jensen model formulation:

1. The velocity deficit is introduced as \Delta U in equation 3 and then at the top of page 4 the turbine velocity is defined as U_{\infty} - \Delta U. I believe this should actually be U_{\infty} * (1 - \Delta U).

CE questions:

3. Is CE a global optimization method or local? Are there convergence rates or other ways to characterize its performance?

4. Does applying the site constraint by projecting the turbine onto the boundary change the underlying distribution you sample from? Does this affect convergence?

Jensen optimization:

5. Why use CE to fit k_w? With just a single parameter this seems like overkill.

6. There have been a number of recent developments in gradient based optimization of Jensen/FLORIS models (see papers by Gebraad, Ning, Fleming, etc). Can you comment on a sampling approach of CE vs gradient-based optimization methods?

7. Is the expansion coefficient optimization done to maximize agreement in power production on a per-turbine basis or simply total power output? Why not try to maximize agreement in the velocity field itself?

Results:

8. In Figure 3 the almost 15% range in relative power outputs for the first row of turbines is substantial and as noted by the authors requires a much longer averaging period. Tuning the Jensen model to match a 15% variability in turbine to turbine power could lead to incorrect values of k_w. While the authors argue that meteorological conditions would change before achieving a sufficient time window for the averages to

converge to 100%, this seems irrelevant for the purposes of fitting k_w since the goal is simply to produce the best time-averaged flow fields. If a longer LES time averaging period improves the power prediction, it should also change the optimal k_w values (presumably for the better).

9. In Figure 4 Jensen model results appear to have a velocity of almost 0 directly downwind of the first turbines. With C_T = 8/9 as reported on page 6, \Delta U can be at most 2/3. Using the corrected form for the velocity, this results in values of u/u_{\infty} that should not drop below 1/3. Have the authors implemented other modifications to the Jensen model? Or perhaps there is an error in the colormap?

10. In the lower left panel of Figure 4 there appear to be changes in the far wake that are noticeable in a number of turbines, for example in the wake of the two most upstream turbines. Are these numerical artifacts or is this a reflection of the wake off the ground? Further discussion would be helpful.

Optimization Results:

11. Are Figures 6, 7, 8, and 9 showing power results from the time averaged LES or Jensen model? The most upwind turbines are not producing 100% power, so perhaps it is LES?

12. Why are the optimization results for a single wind direction not symmetric about the midplane? Is this the global optima?

13. How sensitive are the optimization results to the choice of initial distributions or the samples chosen from a given distribution? Do you arrive at the same optima if you repeat the optimization process?

Technical Corrections

1. \Omega in Eq. 2 is not defined.

2. Don't capitalize atmospheric boundary layer on line 24 page 3

3. Line 11 page 5 'trust coefficient' should be 'thrust coefficient'

4. Kilometer should be abbreviated 'km' not 'Km'

5. Second line in Table 1 should possibly read '(without fringe region)' instead of repeating '(with fringe region)'?

6. Would be convenient to list hub height velocity in Table 1.

7. Are the reported LES resolutions before or after the dealiasing is applied?

8. Line 5 page 11 describes Figure 3 as showing staggered, gradually staggered and 2 random layouts, but appears that the figure actually shows aligned, staggered, and 2 random layouts.

9. Page 19 line 5 'a iterative' should be 'an iterative'.

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