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Interactive comment on "On the self-similarity of wind turbine wakes in complex terrain using large-eddy simulation" *by* Arslan Salim Dar et al.

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This paper performs large-eddy simulations over the complex terrain at Perdigao and investigates the impact of terrain on the wakes of wind turbines. Overall, the authors did a good job in selecting relevant cases to analyse the impact of increasingly complex terrain on turbine wakes, and appropriate normalizations are performed to be able to compare self-similar behavior under very different flow conditions. I believe the results are of interest to the wind energy community and important for future development of wake models in complex terrain. I do have some scientific questions and minor comments as listed below.

Scientific questions/issues

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Discussion paper

1. Page 1 line 13-15. You seem to suggest that wind turbine wakes in complex terrain are getting more attention because wind farm development is shifting toward complex terrain as a result of the depletion of flat terrain sites. Can you provide a reference for this statement?

2. Section 2. I appreciate that the main aspects of the LES framework are summarized in the paper and that the reader is referred to Sullivan et al. (2014) for more details. However, upon reading Sullivan's paper I noticed some differences in the formulation, for example in Eq. 3-5 compared to Sullivan's Eq. 2. I would try to use the exact same notation to avoid confusing the reader. Moreover, Sullivan says that U_i is normal to surfaces of constant ξ_i, while you say this velocity is normal to x_i surfaces (page 4 line 1). I assume this is a typo?

3. Section 2.1. First, actuator disk models have been used in many LES studies, so some references to pioneering work should be provided. Second, using the disk velocity instead of the free stream velocity when the latter is not well defined was first introduced by Calaf et al. (2010) so I would refer to that paper instead of Hansen (2015). Third, you seem to suggest that the velocity used to compute the thrust force is ensemble averaged, but I don't see how that could be implemented in a time-dependent LES framework. Rather, I believe the averaging denotes averaging over the rotor disk at every time step, like in Calaf et al. (2010). Please clarify. Finally, on line 24 of page 4, you seem to suggest that the induction and thrust coefficient are chosen to be 1/4 and 3/4, but in fact these two quantities are related by one-dimensional momentum theory, so an induction of 1/4 implies a thrust coefficient of 3/4.

4. Page 5 line 13-14. A turbine is mentioned in the case setup but it is not mentioned where the turbine is located. Likewise, table 1 shows some simulations have two turbines, but the placement of the turbines is not documented. Although the location can be deduced later in the paper, it would be best to give this information

in the setup section.

5. Section 3.2. I don't understand how averaging 40 (or any other number of) thirty-minute-averaged LES fields is different from just averaging over the total 20 hours. It feels to me that section 3.2 can simply be replaced by stating that the LES results are averaged over a number of hours to reach statistical convergence. Further, I wonder how the odd number of 30-minute windows in table 1 have been chosen per simulation. Did you estimate how long you needed to average to reduce the statistical convergence error below a certain limit?

6. Section 5.1 In a periodic domain there is not really an inflow velocity or a "first grid point" (page 9 line 11). It makes more sense to specify what distance upstream of the first ridge you take as the inflow velocity.

7. Page 10 line 4. What do you mean with the relative positioning of the rotor in the two cases? How are they different? Wouldn't it make more sense to have the rotors be at the exact same horizontal and vertical location independent of the grid resolution?

Other minor editorial changes

- The term stationarity is throughout the paper when discussing ensemble averaging, but I think the authors mean statistical convergence.
- Page 4 L24: A reference is missing and replaced with (?)
- Page 7 L3-4: Is the domain height H the same as Z_L in Eq. 9?
- Figures 5,6,10,11: is h the same as h_L in Eq. 9?
- Page 10 L26: "behind the three turbines" should I guess be "behind the two turbines".

- Figure 8: use z instead of h to indicate height to be consistent with other figures. Also, consider reordering figure 8b to have the smooth case on top so as to match the order of 8a
- Page 15 line 6: a “more” asymmetric behavior than the lateral profiles.
- Caption of figure 15: There is no inset in this figure.

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