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Interactive comment on "Ducted wind turbines in yawed flow: A numerical study" *by* Vinit Dighe et al.

Vinit Dighe et al.

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The authors appreciate the valuable comments from reviewers #3 and #4. The manuscript has been modified following the reviewers comments. Modifications are reported in blue in the revised manuscript. For the sake of completeness, modifications carried following the comments of reviewers #1 and #2 in the first round of peer-review are retained and highlighted in red.

1. Response to reviewer #3:

   - **Page 1, line 22: correct the sentence (there are ...)**
     The sentence is corrected.

- **Page 3, line 2: why not including rotating actuator disc? and why not 3D?**
  Through this study, the authors wished to characterize the performance of the DWT in yawed flow without accounting for 3D effects. A 2D AD approach allows us to decouple the effects discrete blades from the turbine, while also saving a singnificant amount of computational resources. Thus, the effects of distributed AD loading, wake rotation and divergence are totally ignored for this preliminary investigation. The study would lay a foundation for more detailed analysis of DWTs in yaw, where 3D and rotational effects can be included.

  Following your comments, the authors performed a further numerical validation of the numerical approach presented. Numerical results are compared with the experiments on a full 3D DWT model (see page 7, line 13). The computed results agree well with the experimental findings, with the relative difference, calculated lower than 10%, which is within the experimental uncertainty.
- **Page 4, 18: you mention "minimum" y+ of 1: do you mean "maximum" here? If your simulations are wall resolved, your yplus should be less than 1. Can you plot the y+ values across the ducts for the investigated cases? Same line: you mention standard wall function is used. Why do you use wall function at all? if your mesh is fine enough to resolve the boundary layer, wall functions should not be used.**
  Indeed, this has not stated transparently in the previous version of the paper. The maximum value of yplus along the duct walls is 1. Standard wall functions have not been used and this has been removed from the current version of the paper. The distribution of $y+$ on the duct wall surface is shown in Figure 4.
- **Page 4, line 21: Please explain what is a "fan" boundary condition. It is not a classic BC.**

Details about the fan boundary condition is added (see page 5, line 4).

- **Page 5, line 8: "multi-core" is a vague explanation. Explain how many cores is exactly used for the computations. Same page: line 10: add "camber" after cross-section. Can you explain what does D5 mean here?**
  The corrections are made (see page 6, line 5) and (page 9, line 3).
- **Page 6, fig 5: Please add both upper and lower sections of the duct (and/or write in the caption that this is the lower cross-section) and possibly with the use of colors make it more clear which lines correspond to which duct. It is a little unclear until you see figure 9.**
  Figure 7 has been modified.
- **Page 6, line 15: why can the blockage effect be ignored in this scenario?**
  Numerical results are validated against the experiment reported by Igra (1981). Following the explanation by Igra, the experimental test section nozzle is large (10 times that of the experimental model used), and therefore does not suffer from interference or blockage effects.
- **Page 7: provide more details on the 3D case, a snapshot of the mesh, lateral extent, etc.**
  Figure 3 is modified in order to include the lateral extent of the 3D computational domain
- **Page 7, line 5: Provide more details on time averaging (how many iterations used for it? are figure 9 the time-averaged velocities or the instantaneous ones?)**
  Further details are added (see page 6, line 2). The velocities are time-averaged.
- **Page 8, line 7: four times larger, but how many mesh points?**
  A more clear explanation is provided (see page 6, line 5).

- **Page 10, line 14: Ok for the explanation of the fact, but can we hear what is the physics behind?**
  Further details are added (Page 11, line 16).
- **Page 11, line 6: This sentence looks a little paradoxical to me: "... DonQi D5 duct configuration not only demonstrates an insensitivity to yaw but a gain in the overall performance" does it alter the performance or is it insensitive after all?**

  The sentence has been corrected.

2. Response to reviewer #4:

   - **The paper attempts to study the impact of yawed wind on ducted wind turbines. This study is fundamentally flawed because the real problem is three-dimensional (and not even axisymmetric). Therefore, 2D simulations have no relevance (2D axisymmetric assumptions may be OK for non-yawed conditions, but these are not even axisymmetric). The fact that 3D and "2D" simulations agree for the validation case is just coincidence. Unless detailed 3D studies are conducted, this paper must be rejected.**

     The study is an attempt to understand the aerodynamic performance of DWTs in yaw for different duct configurations. For the current investigation, the effects of distributed AD loading, wake rotation and divergence are totally ignored. The study would lay a foundation for more detailed analysis of DWTs in yaw, where 3D and rotational effects are included (for e.g. Dighe, V. V., Avallone, F., van Bussel, G. (2020). Effects of yawed inflow on the aerodynamic and aeroacoustic performance of ducted wind turbines. Journal of Wind Engineering and Industrial Aerodynamics, 201, 104174.). The

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Discussion paper

agreement between the 2D and 3D results suggests that the simplified duct-AD approach to model the flow around DWTs in yaw was satisfactory, and should be considered in the preliminary stages. Following your comments, changes have been made to the manuscript:

- Additional references using the AD approach to study yawed inflow for simple HAWTs have been added (see page 3, line 3).
- A further numerical validation of the numerical approach is presented. Numerical results are compared with the experiments on a full 3D DWT model (see page 7, line 13). The computed results agree well with the experimental findings, with the relative difference, calculated lower than 10%, which is within the experimental uncertainty.

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