Reviewer #1

In the revision, the authors only partially addressed the comments in my referee report. One of the main comments "Although the statistical convergence of the data seems limited and uncertainty analysis is limited. These aspects should be improved." Of my previous report was essentially not addressed and this should still be done.

--> While the authors acknowledge that the statistical convergence could have been better, no further data on this is required. Instead, the authors state that no additional statistical data could be obtained, as the simulations could not be extended as these are computationally expensive [give the simulations under consideration I can see it is not easy to run these much longer]. However, the authors would not have to perform additional simulations. Instead, they can provide a more thorough statistical simulation analysis of the already available data (I do not agree with the statement that "the statistical conference of the data could not be assessed", as standard statistical methods could be employed on the dataset available as is). In essence, the reader should get some feel for what the uncertainty in the presented data is.

Thank you for your feedback. We thus propose an analysis of the statistical convergence to answer both questions:

- Is the sampling frequency (1Hz) high enough?
- Is the segment length (respectively 80, 40 and 10 minutes for the neutral, unstable and stable cases) long enough?

To answer these questions, we respectively:

- Computed the 95% uncertainty interval for each term of the TKE breakdown equation as well as the MFOR turbulence.
- Separated each segment into two equal sub-segments and computed the corresponding values of each term. If the two sub-segment give similar results than the full segment, it means that increasing further the segment length is not expected to have any significant effect.

If this does not fit your expectations, could you please provide an example of what you mean by "standard statistical methods", if possible, on similar work. We added at the end of section 3:

The error induced by the choice of the 1 Hz sampling has been estimated with a 95 \% confidence interval and discussed in Appendix \ref{Appendix:A} for the MFOR turbulence and all the terms of Eq. \ref{eq:TKEFFOR2MFOR}. In short, the chosen sampling frequency of 1 Hz is sufficient for the neutral and unstable case. In the stable case, due to the higher share of small-scale turbulence, the 95 \% interval is large, indicating that a higher sampling frequency would improve the accuracy of the LES.

Due to numerical limitations, the segment lengths were constrained to 80, 40 and 10 (see Table \ref{table:NumParam}). To estimate the statistical convergence, each of these segments is divided in two and the difference between the two sub-segments and the full-simulation is assessed in Appendix \ref{Appendix:A}. It appears that the stable and the neutral simulations would barely benefit from an extension of their duration whereas the unstable simulation seems to change significantly between the two sub-segments of 20 minutes. This is particularly true for terms (V)

and (VI) of the turbulence breakdown equation (Eq. \ref{eq:TKEFFOR2MFOR}).The appendix can be found in the paper attached.

** In the conclusions a paragraph should be added that discusses the potential impact of the statistical convergence on the results.

The paragraph on statistical convergence has been replaced with-:

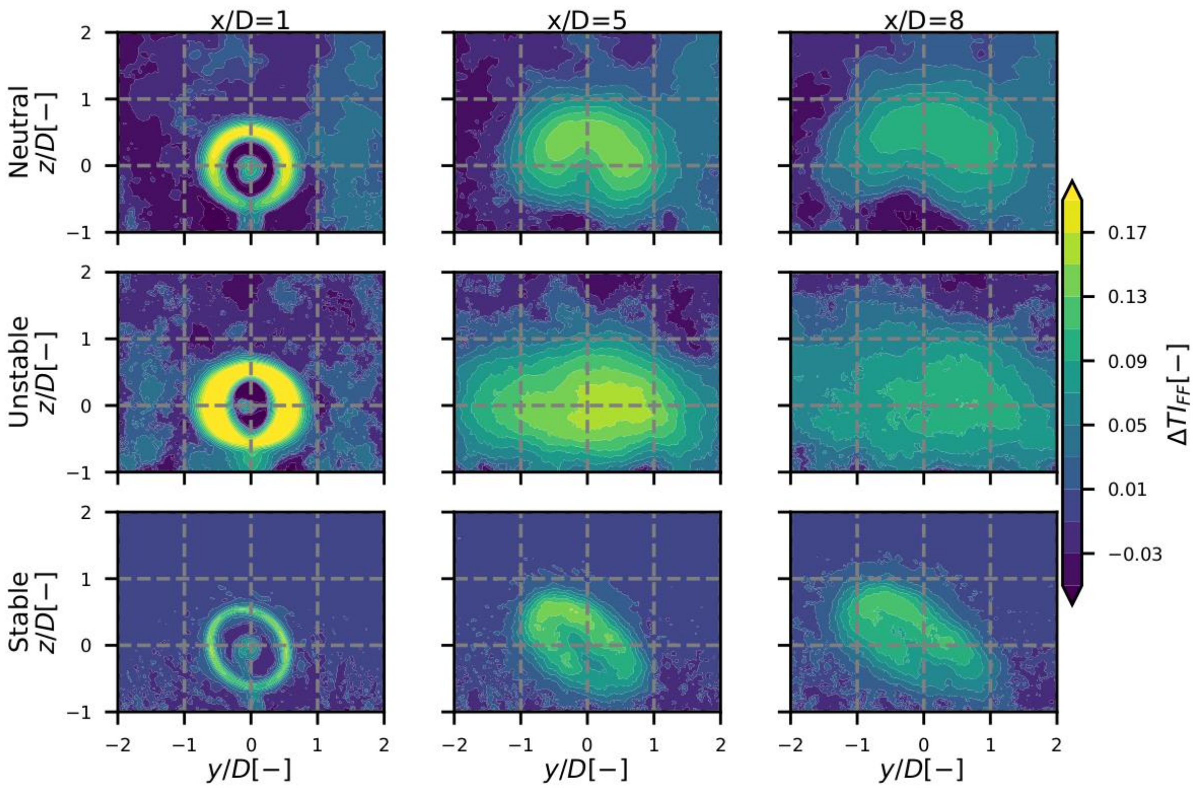
"The statistical convergence of the data has been assessed and showed that increasing the sampling frequency would most likely improve the reliability of the stable case but would have a low impact for the two other cases. On the other hand, increasing the simulation time would probably change the unstable results but have few effects for the other cases. The uncertainty is the highest on the cross-terms of the turbulence breakdown equation, but the pure-terms are subject to only small uncertainty. For a better interpretation of these terms, it may be important to perform ensemble simulations to get reliable fields."

** Line 400, a new comment has been added

"As shown in Jézéquel et al. (2022), the atmospheric stability mostly affects meandering and not the field in the MFOR."

--> I am not sure what this comment is precisely based what this comment is based on, but I disagree. For example, in figure 12, we can see that the wake shape is very different in the stable case than in the neutral and unstable case. In this context, it would be helpful to the Fixed frame of Reference results corresponding to figure 12, so the reader can compare.

Indeed, this statement is more understandable if one looks at the FFOR turbulence field:



However, since we already added 3 figures for your remark on figure 5 and some appendices for the statistical convergence, we did not want to add too many plots. Especially since this part is not the core of the work. We still modified the corresponding paragraph, and the reader can report to our conference paper for more information. Or even to the zenodo deposit if needed.

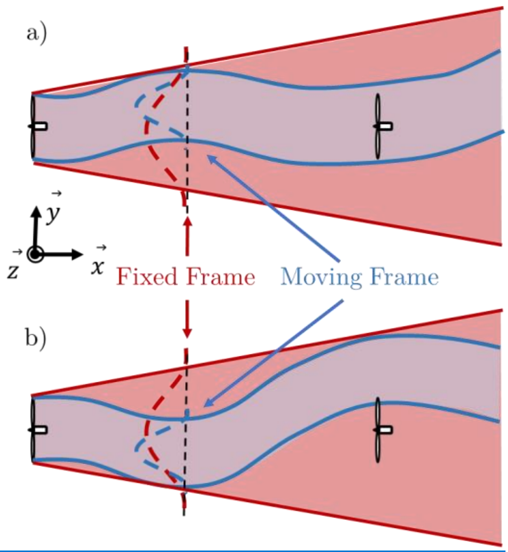
Despite strongly different values of Δ(IV) among the different cases, Fig. 12 show that the atmospheric stability mostly affects meandering and not the field in the MFOR. Indeed, the magnitude of the normalised added turbulence in the vicinity of the turbine (at x/D = 1) is about 19 % in the neutral and unstable case, and the slightly lower value in the stable case (about 15 %) is attributed to smaller integral length scales upstream the turbine. These small discrepancies must be compared to the values achieved in the FFOR: around 22%, 27 % and 16% for the neutral, unstable and stable case (Jézéquel et al., 2022). The skewed shape of the stable case is attributed to the veer that appears in such ABL, but is negligible in neutral and unstable ABL. As the wake travels downstream, the asymmetry increases, in particular for the neutral and stable cases, but the magnitudes of ΔT I are still similar among the different cases despite different values of atmospheric stability, shear and hub height velocity. The asymmetry is attributed to the ambient shear, which increases with atmospheric stability. Negative values of Δk_{MF} are observed in the near wake between the wake centre and the edge in the neutral and unstable cases and also in the bottom of the far wake in the neutral case. This indicates a transfer of energy from such regions to the high turbulence region, i.e. the edge and the top of the wake. Overall, this figure shows that the different values of Δ(IV) among the cases mainly come from the meandering operation and only slightly from the MFOR turbulence itself.

** Line 458: "to correct this error and drastically reduce the overall RMSE." --> Yes adding the cross terms improves the results. However, figure 6 shows that in the direct wake region also using just terms III and IV approximates the turbulent profile in the wake well. The wording "Drastically reduce" is too strong given that you state that the results for the cross terms are not statistically converged.

The word drastically has been removed.

** Figure 1 does not provide a sketch of the moving frame and mixed frame definitions suggested around line 40.

The picture has been changed to clarify the two frames. Moreover, the colors have been changed to improve the readability for colorblind persons.



** Figure 5 Indicated for which case.

** Figure 5 -- line 280 Some of the described results do not seem to be shown in the figure

The other cases of stability have been added to this figure, as well as for Figure 7. This was not done in the precedent submission in order not to overload the manuscript. Some additional details have been added in the text to help the reader interpret the results (see the new submission).

** Conclusions line 453 please use marks as mentioned in the manuscript text. Now percentages and locations are slightly different, which isn't very clear.

There has indeed been a typo that leads to this confusion: instead of *"3 % overestimation of the available power in the wake of the wind turbine for a turbine located further than 2 D behind the wake emitting rotor",* it is ***"2 % overestimation of the available power in the wake of the wind turbine for a turbine located further than 3 D behind the wake emitting rotor",*** as mentioned in the manuscript text. Thank you for your awareness, this has been corrected.

** In the caption of each figure, clearly state for which case it is and the location where it is measured.

Thank you for the remark, this has been corrected.

** Figure 8, 9, 10 Why are you normalizing the results with the Fixed frame results here? The lower row seems to give the moving frame of reference results, but this is not mentioned in the figure caption. It also does not seem to be discussed in the manuscript text.

All the terms from these figures are in the FFOR. If at one point the $\hat{\ }$ operator is used, it means that the variable is in the FFOR (which is the case for every line of these figures). We wanted a normalisation so the colormaps can be compared between the terms and the cases. But we wanted to keep the actual shape of every term, so we had to normalise with a single point value (and not a 2D field). That is why the maximum value of the total streamwise turbulence has been chosen.

** Figure 10 Why are the values in the bottom row so low? Or in other words, the lower panels of figure 8, 9, and 10 need more discussion.

The significance of the last line in particular is clarified in line 335, just below eq. 23. This has been moved to the end of the paragraph, and further explained: ***The reference turbulence in the FFOR $\overline{\widehat{k_{x,ref,MF}}}$ is also plotted in the last line of Figs. 8, 9 and 10 to quantify how the wake turbulence is going back to its unperturbed value: the closer $\overline{\widehat{k_{x,ref,MF}}}$ is to 1, the more dissipated is the wake. At x/D = 8 in the unstable case, the reference turbulence in the FFOR represents the main part of the total turbulence which means that the wake is almost dissipated. Conversely, in the stable case, the reference turbulence in the FFOR is negligible, compared to the other terms, showing that the wake is much less dissipated than in the other cases.***