

The current paper contains an interesting investigation of fluid dynamics mechanisms and mean kinetic energy fluxes behind the increased wake recovery observed in the most popular wake flow control mechanisms. The paper provides sufficient reference to literature, outlines the methodology in detail, and discusses the mean kinetic energy budget for both "aligned" and "varying wind direction" cases. Specific attention is further given to the fluxes through the top surface which are highly relevant for large and wake-saturated wind turbine arrays.

I believe the paper presents very interesting results and conclusions, and the majority of my comments below are not criticisms to the methodology and analysis (which I believe is sound), but rather to the presentation and discussion, as I believe some modifications could be made to further increase paper quality and readability and make the most important findings more explicit.

- The paper is rather long and, while this is not per se a problem in itself and final formatting will reduce the amount of pages, I believe the length of the paper impacts the readability. Certain parts could be made less verbose, shortened or moved to Appendix to improve the overall storyline of the paper. I leave it up to the authors and editors to decide, but some examples where I believe improvements could be made are
 - Section 2.3 on inflow conditions spans over 2 full pages of text + 2 tables and a figure, I believe the main idea of having representative inflow conditions are worthwhile including in the main text, but the details of, e.g., lidar filtering, could be moved to Appendix.
 - Section 3.2.1 on verification of technique could be moved to appendix without impacting the storyline of the paper
 - Figure 9 is a copy of Figure 8 for the "varying wind direction" case, and is not explicitly discussed by itself. I feel this figure could easily move to appendix or even be omitted.
 - 5 control techniques are discussed: WS, WM Pulse, WM Helix, WM side-to-side, and WM top-down. However, they are not investigated to the same amount of detail, and the reasons for this are a bit lost in the manuscript text. Especially side-to-side and top-down are only discussed very sparsely in the text, but included in most figures which makes them quite a lot busier and more difficult to analyse. I am wondering whether they actually contribute much to the analysis in the current manuscript, or could be omitted / moved to appendix after their introductions in Tables 7 and 8.
- Figure 2 shows the domain for the control volume analysis. The caption and manuscript highlight that the turbine is not part of this domain, but from looking at the figure, it does appear to be inside since the turbine footprint is in the blue shadow of the CV domain. I'd suggest revising the figure slightly.

- Section 2.2 details the LES setup. Although the description of the setup is generally satisfactory, for (stable) ABL simulations, initialization details matter, as significant unsteadiness in mean flow profiles can remain in improperly initialized simulations. However, these details are not elaborated or insufficiently detailed for reproducibility (e.g. What are the initial profiles of temperature and velocity, is a wind angle controller used to achieve a desired wind direction at hub height, the spinup period is detailed as "tens of thousands of seconds"). I would suggest to include these details in Appendix.
- Line 225 and Figure 4 show that the LES cannot reproduce the strong veer observed in the NY Bight lidar measurements. This is an interesting observation, also in light of the statement in the last line of the conclusion. Out of interest, do the authors have a hypothesis why the veer in the observations is so much stronger?
- Section 3.1 and specifically Figure 7 show that, after 10 D, WS achieves the strongest wake recovery which gives the impression that this is the most suitable technique for power maximization. However this does not give the complete story as the power loss in T1 is not included in the analysis. Although I understand the scope of the current paper is on the wake behavior rather than the achieved power gains, I believe a small note on the power losses in T1 could help put the comparison between techniques in better perspective.
- The titles of section 3.2.2 (Aligned wind direction) and especially 3.2.3 (Varying wind direction) in my opinion came across as confusing since the analysis is all performed on a constant wind direction LES. Perhaps they could be titled "narrow control volume" and "wider control volume" and the link to aligned vs. uncertain wind directions could be made in the manuscript.
- (Optional) I am wondering whether some of the figures would benefit from plotting the difference with the baseline rather than the absolute value, e.g. Figure 11 / 12. Upon reading the discussion in the text it takes the reader quite some work to identify the related features in these figures.
- Reporting of units and variables is highly inconsistent throughout the manuscript to the point where it becomes confusing and different conventions are used even within the same figure, please homogenize. Some examples
 - Around line 214: K-hr, K-m/s, ...
 - Table 3: $m s^{-1}$
 - Figure 4: m / s
 - Figure 6: $u U_{hh}^{-1}$, x/D