Review of *"Observations of wind farm wake recovery at an operating wind farm"* by Krishnamurthy, R., Newsom, R., Kaul, C., Letizia, S., Pekour, M., Hamilton, N., Chand, D., Flynn, D. M., Bodini, N., and Moriarty, P.

The revised manuscript analyses the vertical profiles of the vertical momentum flux and vertical wind speed within a wake induced by a large wind farm in the US Great Plains. In their paper, the authors distinguish between several meteorological parameters, including atmospheric stability, boundary layer height, presence of LLJ events and extreme veer and shear occurrences. Further, the authors provide an exemplary extreme case with a very high downward flux in the wake, possibly induced by the presence of a gravity wave. The results show a clear dependence of vertical momentum flux and wind speed deficit on the prevailing atmospheric stability regime, as well as on the presence of extreme events, such as LLJs and in one particular case a gravity wave. Further, observations suggest, that the wind farm's effects are present throughout the entire atmospheric boundary layer, even far above the rotor plane. Thus, the manuscript addresses internationally relevant questions of importance for the scientific community within the scope of the journal.

From my point of view, the language used in the presented manuscript is very nice and the writing style is easy to follow. The chosen title is concise and represents the content of the paper quite well. The authors provide a very thorough and informative literature overview and separate their work from previous research.

Within the introduction of the paper, the objective statement is formulated very vague. Instead, I would suggest that the analysis of the wake properties is directly included (cf. comment #7).

The structure of the revised manuscript is now easier to grasp and follows a clear storyline. Sections that do not directly add value to the main objective of the paper are now moved to the appendix and provide valuable additional information on the measurements and post-processing.

Considering this and the comments presented in the following, I would recommend the manuscript for a minor revision.

We thank the reviewer for their valuable comments and suggestions. We have addressed all the comments in the updated manuscript. Our responses to the reviewer comments in black are provided in blue below.

General comments:

1. The authors jump between abbreviations and the written version of LLJ and low-level jet.
(e.g. L. 10, 14, 16, 24, 278, etc.)

These have been made consistent in the updated manuscript.

2. Sometimes, adding a "the" would lead to increased readability, e.g. L.236: "[The] larger the vertical momentum flux, [the] faster the wake […]" or L. 241-242: "the impact of conventional updrafts or downdrafts on [the] propagation of wakes"

Thanks for the comment. We fixed the two instances mentioned by the reviewer but have also identified others in the manuscript. Please see the revised manuscript.

3. In Fig. 3 error bars are given for the median profiles, while they are missing in Fig. 5 and following. Is there any specific reasoning behind this?

Yes, we felt that by adding the error bars, although they provide valuable information, the median profiles without the error bars are cleaner to understand the trends shown in the paper. Especially when in Figure 5 and following, we have 4 vertical profiles shown in one panel. The error bars would significantly clutter the figure and make them less readable.

Specific comments:

4. L. 28: You only mention mesoscale simulations here, but e.g. in Schneemann et al. 2020 the authors observed them with scanning offshore lidars.

We agree, the authors have included "…and offshore observations…" in the updated manuscript.

5. L. 53: The formulation "ABL is lower than 300m" suggests that this is always the case. However, as per my knowledge, even in stable conditions boundary layer height can exceed 300m (e.g. Peng et al. 2023).

Thanks for this comment, we agree, and have made the below change to the text.

"…and in offshore or stable atmospheric conditions the ABL can be lower than 300 m."

6. L. 209: Here, the authors claim that "sufficient" data is available. It would be helpful to know, how much (e.g. in hours or No. of measurements) that is.

Thanks for pointing this out, we have mentioned the number of measurements available from the southerly wind direction chosen in this manuscript. The revised sentence is provided below.

"Since the wind directions are predominantly southerly, sufficient data is available (1490 10-min samples) to accurately estimate the mean trends of momentum flux during specific atmospheric conditions."

7. L. 229: The authors claim, that larger momentum flux deficits for near surface areas are observed for unstable and neutral conditions. However, I would argue that during stable conditions, based on the provided figures, the momentum flux deficit is larger than for neutral conditions and also compared to unstable conditions. At larger heights it then seems as if momentum flux deficits are larger during unstable conditions. Maybe a clearer picture containing directly the difference in fluxes or some other information supporting the presented claim could be provided. Also, the large error bars make it hard to really make such a distinguished claim.

In this sentence we are only discussing about the large vertical momentum fluxes observed in neutral and unstable conditions compared to stable conditions, and not the momentum flux deficits. But to the reviewers point, the momentum flux deficits are larger during unstable conditions at higher altitudes but larger during stable conditions at lower heights (see Figure below just for the reviewer, and we feel is evident from the existing figures in the paper). We have added the below sentence to the manuscript at Line 240: "Overall, momentum flux deficits are greater during unstable conditions at higher altitudes, while they are larger during stable conditions at lower heights."

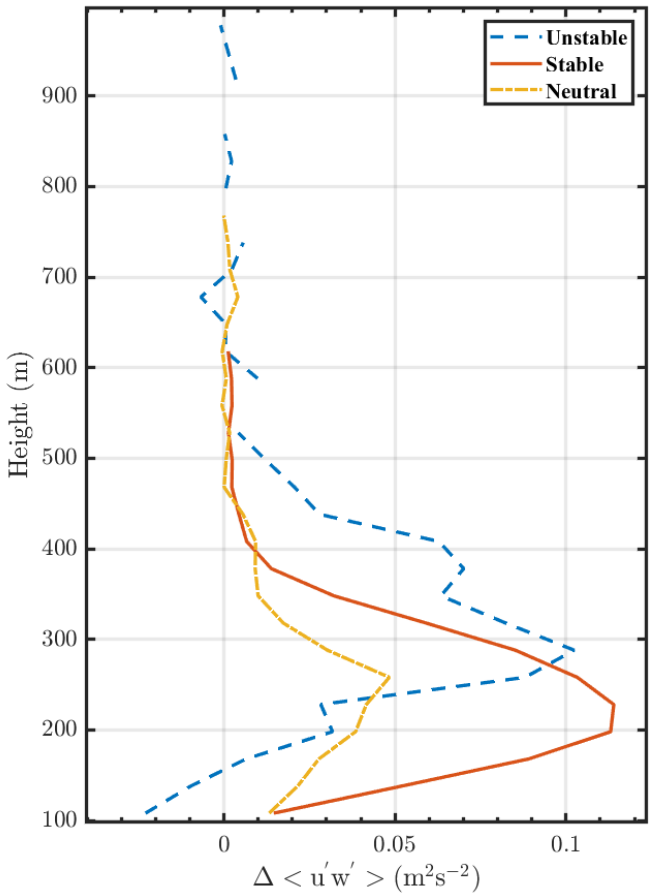

Figure: Median momentum flux difference between the upwind and downwind during unstable, stable, and neutral conditions. Not shown in the updated manuscript.

8. L. 271: The authors only mention a "set threshold". Could this be specified? This would then also make the next sentence, specifying three different thresholds, which were all combined in the end no longer necessary. Maybe just specify the "weakest" threshold.

The weakest drop off threshold of 5 ms^{-1} is mentioned in the updated manuscript. The updated sentence is provided below:

"The definition is based off two criteria, 1) wind speed maximum (*i.e.,* LLJ nose) is observed within the lowest 2-km and is greater than at least >10 ms^{-1}, and 2) wind speed drop-off above the jet-nose is observed and above a set threshold (at a minimum > 5 ms^{-1})."

9. L. 280: The authors claim that it is "evident that [the] higher the Z_{LLJ}, […][the] higher the hub height wind speed". However, Fig. 4c shows that a maximum LLJ height is observed for hub height wind speeds of 13 m/s with a slight drop-off thereafter.

The sentence has been rephrased to: “It is evident that, up to near rated wind speed (approximately 13 ms^{-1}), a higher Z_{LLJ} results in a higher jet nose wind speed and a higher hub-height wind speed.”

Technical Corrections:

10. L. 140: Here, the unit GWh is written out, which is not necessary and is also not done for other units, e.g., meters or Megawatts.

We agree and the acronym is not spelled out in the updated manuscript.

11. L. 142: Here, it sounds like with “the millions of U.S. homes” all homes in the entire state/country are meant. As this is not the case, I would leave out the “the”.

The word “the” is removed in the updated manuscript.

12. L. 156: It should be “correct” instead of “correcting”

Thank you and the typo is now corrected in the updated manuscript.

13. L. 503: I think here it should be “impact on wake recovery”, not “of”

The typo is corrected in the updated manuscript.

14. L. 511: “Gravity waves enhance” instead of “enhances”

The typo is corrected in the updated manuscript.

Literature

Peng, S., Yang, Q., Shupe, M. D., Xi, X., Han, B., Chen, D., Dahlke, S., and Liu, C.: The characteristics of atmospheric boundary layer height over the Arctic Ocean during MOSAiC, Atmos. Chem. Phys., 23, 8683–8703, https://doi.org/10.5194/acp-23-8683-2023, 2023.