Author's response

Dear Referee #1,

Thank you for your feedback that helped us further improve and strengthen our manuscript. An overview of the changes in the manuscript related to your comments are presented below.

1. Why not combining both definitions for LLJ identification, as for example done in the Debnath et al. 2021 WES paper? (Anyways, I would also suggest adding that paper as a reference).

Thank you for this comment and excellent suggestion of work to be referenced. We are aware of the Wind Energy Science guideline of a maximum of 20 references in a Brief communication, but we hope that the editor is okay with us adding this extra reference.

The reason we are not combining the two definitions is to be able to clearly differentiate the effect on the results on the selection of the definition being employed. However, although we are not presenting results explicitly for the combination of the two definitions, Fig. 2 indicates what would be the effect of such a combined definition. This is shown both in terms of which individual profiles that would be excluded (see e.g., the red dots outside of the blue line in panel b, showing that the shear definition identifies some profiles as LLJs although the relative falloff below the core is not reaching the threshold applied by the falloff definition) and the overlap between definitions (indicated by the Venn diagrams (panel d) in the old version of the manuscript, and on lines 87–90 in the revised version).

We agree that it is an interesting idea to combine the definitions, and in the revised draft we have added this as a suggestion for future work in the Discussion section. Lines 144–145 now read:

To build on this study, the effect of using a combination of the falloff and shear definitions could be investigated (similar to what was used by Debnath et al. 2021)

2. Also, can you analyze the sensitivity of the single definitions to the thresholds you select for each? I expect some of the differences to increase/decrease if you use more/less strict thresholds.

This could easily be done, and results for different combinations of absolute and relative falloff criteria applied both on model data and lidar observations of the wind speed profile are presented in earlier work by us (Aird et al. 2021; Hallgren et al. 2022). However, as the aim of our Brief communication is to compare the two qualitatively different definitions – rather than comparing the results for different thresholds employed by a single type of definition – we relinquish from this task. As is also mentioned in the manuscript, we suggest that statistical methods could be used to find the optimal shear threshold for LLJ identification for a specific site if multi-decade data is available, refraining from using arbitrary thresholds (such as e.g., 0.01 s^{-1}), see lines 148–151 in the revised manuscript.

3. L.19: should be "LLJs" (the same applies in several other places in the draft)

We have changed accordingly.

4. Mention somewhere that the jet core is also sometimes referred to as jet nose.

This is added on lines 18–19.

5. L.50: specify, for both definitions, if "above/below" means "between above and below" or "between above and the core, AND below and the core" or "between above and the core, OR below and the core".

This is an important clarification. Thank you for this suggestion. In the revised manuscript, the definitions on lines 51–54 now reads:

- ***Falloff:*** *an increase in horizontal wind speed of at least 1 m s^{-1} and 10% of the core speed below the core and simultaneously a decrease of 1 m s^{-1} and 10% above the core*

- ***Shear:*** *a local wind shear (i.e., between two vertical levels, see Fig. 1a) of at least 0.01 s^{-1} below the core and simultaneously at least -0.01 s^{-1} above the core*

6. L.80: comma after "i.e." (the same applies elsewhere too)

This has been corrected.

7. Figure 2: I find this figure rather challenging to understand given the small size of the plots and overlap in the points. How about not including the points on the horizontal planes at all, and just show the histograms and Venn diagrams? With this scenario, I would also suggest having the yellow, blue, and red histograms all share the same y-axis, so that the reader can get a sense of the frequency of LLJs compared to all profiles with a local maximum. Also, the percentages in panel (d) are not clear. Does it mean, for example, that 67% of the yellow cases are classified as LLJs in the Baltic Sea, when using the falloff definition? It wouldn't seem like that's the case from the histograms as they are shown now.

We agree that Fig. 2 is challenging and it takes some time to get used to the plots. There is a lot of information we want to convey in a compressed format, and reconsidering the plot and alternative ways of plotting we still conclude that this is probably the clearest way of presenting all the information. However, we enlarged panels (a)–(c) so that the points are easier to distinguish.

Keeping the data points on the horizontal plane is important because it provides information about the relationship between the two distributions shown in the vertical planes. While it is true that – if the variables were independent – the point clouds could be omitted, this is not the case here since there is a strong correlation between e.g., the wind speed below and above the local maximum. Further, the scale on the ordinate is not written out as it is dependent on the bin size used to create the histograms. However, the bin size is of course the same for all histograms within a panel, and thus the histograms in each panel are comparable.

You are absolutely right that the percentages given in the Venn diagrams are not clear. What we meant to say is that, e.g., for the Baltic Sea 67% of the LLJs identified by the falloff definition were unique to that definition and that 25% of the LLJs identified by the shear definition were unique to that definition. In other words, 33% of the LLJs found by the falloff definition were also found by the shear definition, and 75% of the LLJs found by the shear definition were also found by falloff definition. This has been clarified in the revised manuscript. Based on your comment, we also decided to remove the Venn diagrams from Fig. 2, as these results easily could be described in text.

8. Can you include the (revised) plots for all sites in a supplement?

We have added a supplement where the revised plots for all sites can be found

9. L.110: specify AM or PM.

We have rephrased and clarified this sentence, which now reads (lines 112–113):

For the onshore sites, there is evidence of a diurnal cycle (Fig. 3f), which is most pronounced for the Great Plains, with a peak in LLJ frequency during the night.

10. L.150: the shear-based definition is not really novel.

We have removed the words "traditional" and "novel" describing the two definitions.

11. L.165: I believe you need to add a reference entry for the data used, according to Copernicus' policies.

Thank you for this comment. The data availability now reads (lines 175–179):

For the ERA5 data (hourly values on model levels for wind components, temperature, and specific humidity, hourly data on a single level for surface pressure) we refer to Hersbach et al. (2017). Data were downloaded

from the Copernicus Climate Change Service (C3S) (2023). The results contain modified Copernicus Climate Change Service information. Neither the European Commission nor ECMWF is responsible for any use that may be made of the Copernicus information or data it contains.

Once again, thank you for your comments.

Sincerely,
C. Hallgren, J.A. Aird and co-authors

References

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