Answer to reviewer comments

March 16, 2024

1 Summary of changes

Many thanks for your suggestions. We made the following adjustments:

- Updated citation of Sanchez Gomez et al. (2023).
- Refrasing the introduction of addressing the importance of wind veer.
- Comments on eyewall definition in the Method section.
- Quantification of sensitivity to eyewall definition in Discussion.
- Refracing labels for Figures 2, 8, and 9.
- Change of axis labels in Figure 2.

Detailed reasoning for the changes is given in Sect. 2.2.

2 Resoponse to comments

2.1 General Comments

1. Both reviewers agree that substantial revisions have greatly improved the manuscript.
   Thank you, we are glad that the revisions are well received.
2. Reviewer 2 has a few suggestions that should be easily handled, included below, including an important distinction regarding the definition of the eyewall.
   The comments from reviewer 2 are answered in Sect. 2.2.
3. The editor notes that references to "Gomez et al." (lines 40, 410-413, 577) should be references to "Sanchez Gomez et al." rather than "Gomez et al.".
   The reference is corrected.

2.2 Comments from Reviewer 2

I have two additional comments.

1. First, in the introduction, the authors stated that wind veer should be considered in wind turbine load assessment (line39), but it is not accounted for the IEC standards (line 35). So, one of the objectives of this paper, I think, should be the examination of how wind veer can be included in the IEC standards for wind turbine loading based on this research. But this issue has not been clearly addressed in the paper. Based on the research, a recommendation should be made in the conclusion or discussion whether wind veer should be included in the IEC standards and how.
   Thank you for this comment! Indeed we don't make a clear statement on the inclusion of veer in the IEC. We are cautious about making a strong recommendation on whether veer needs to be included in the IEC standard. Based on our study we can state, that the veer over the open ocean in mesoscale simulations is relatively small compared to veer in stably stratified low-wind regimes. Yet, 1.) we did not assess the impact of wind veer on wind turbine loads under tropical cyclone conditions, and 2.) we had to limit the scope of the study to a case study over the open ocean. Both shortcomings are stated and suggested for further work. Further work is needed to conclude if the contribution of wind veer to turbine loads in tropical cyclone conditions is sufficiently significant to be included in standards. We already address the inclusion of veer in the standards:

- In the discussion: *"Further, the simulated wind veer is relatively small in comparison with wind veer found in low-wind regimes and particularly during stable conditions. This supports the conclusion, that the current IEC standard may be sufficiently similar in terms of wind shear and veer during tropical cyclones over open water. However, there are clear limitations to this conclusion as discussed in the following ..."*
- In the conclusion: *"Based on these conclusions, further investigation is needed to address 1) how wind speed, shear, and veer in tropical cyclones evolve during landfall, 2) how much wind shear and wind veer vary between tropical cyclones with different intensities and radii, and 3) how much wind turbine load estimates based on the current IEC standard differ between load estimates based on the simulated wind speed, shear, and veer distributions."*

You are right, the introduction directly led to the question of whether veer should be included in the standards and provokes the expectation of a clear statement. For that reason, we decided on subtle changes in the introduction. Concretely, we refrain from starting the introduction of wind veer with: "Wind veer, the change in wind direction with height is not accounted for in the IEC standards."

2. Second, the eyewall is now defined as the region of 80th percentile of 10-m wind speed and the radius is smaller than 250 km. But 250 km is a large radius, which would include both eyewall and inner rainbands. It could also include a part of the outer rainbands. So, such defined "eyewall region" is not really the eyewall commonly referred to in tropical meteorology. This can cause confusion. Here are my two suggestions. If possible, I'd suggest defining the "eyewall region" as the area with 80th percentile of 10-m wind speed and within the vicinity of the maximum wind (RMW), i.e., [RMW-dR, RMW+dR]. This is closer to the traditionally defined eyewall. If this is a burden for the authors as they have to redo all the analyses, then, alternatively, the authors could specifically note in the paper that such defined "eyewall region" should not be interpreted as the true eyewall in tropical cyclones, rather, it refers to a rough region with high wind speeds that includes the eyewall and inner rainbands, or maybe a part of the outer rainbands.
This is a valid point, thank you for the concrete suggestion. We are aware of the effect of using different definitions and thus, we follow your suggestions and add:

   - In the methods: *"This definition of the eyewall region includes high wind speed areas of the inner rainbands and potentially outer rainbands. Therefore the eyewall region should not be interpreted as the narrow eyewall in tropical cyclones, but rather as an extended high wind speed area."*
   - In the discussion: *"When restricting the definition of the eyewall region to a narrower band with a width of 0.4 × RMW, the median wind speed in the eyewall increases on the order of 12 %, the shear exponent 4 %, and veer 10 %."*

   For the second statement, we tested an alternative definition of the eyewall region. Here we provide some further information, which is not included in the paper. We added two criteria for the alternative definition of the eyewall region: 1) the mean eyewall width is 0.4 × the RMW (as used for distributions of shear and veer in Figure 8 of Sanchez Gomez et al. (2023)), and 2) the eyewall extends maximal to 1.5 × RMW. The resulting distributions are summarized in Table 1 (not included in the manuscript).

		Wind speed [$\mathrm{m\,s^{-1}}$]		Shear exponent			Wind veer [$^\circ\,\mathrm{m^{-1}}$]	
Region	Scheme	median	IQR	median	IQR	$\% > 0.11$	median	IQR
Eyewall	YSU	42.9	5.1	8.8×10^{-2}	1.0×10^{-2}	1.5	1.6×10^{-2}	8.1×10^{-3}
	MYNN	37.5	3.7	9.8×10^{-2}	1.0×10^{-2}	7.8	1.8×10^{-2}	7.0×10^{-3}
	MYJ	45.3	6.2	1.1×10^{-1}	1.2×10^{-2}	60.1	1.8×10^{-2}	7.7×10^{-3}
Outer cyclone	YSU	27.6	7.2	7.1×10^{-2}	1.6×10^{-2}	3.3	9.5×10^{-3}	7.9×10^{-3}
	MYNN	25.4	6.4	9.0×10^{-2}	1.8×10^{-2}	9.7	1.2×10^{-2}	7.6×10^{-3}
	MYJ	27.1	7.8	10.0×10^{-2}	1.9×10^{-2}	23.4	1.2×10^{-2}	8.6×10^{-3}

Table 1: As table 2 in the article but for a eyewall with an average radius of 0.4 RMW: Median and interquartile range (IQR) of wind speed at 139 m, wind shear exponent, and wind veer, as well as the percentage of shear exponent values larger than 0.11. The values are listed for the eyewall region and outer cyclone region for the YSU, MYJ, and MYNN simulation.

2.3 Other comments

1. Although Figure 2 is an illustration figure. It is not appropriate to use longitude and latitude as x- and y-axis without any marker. I'd suggest using radius so that readers can have a rough idea of the size of the storm and ranges of defined eyewall region and outer cyclone.
   Good point, we changed the axis of Figure 2 to show the distance from the cyclone center.

2. Caption of Figures 8, it reads "Profiles of a,b) wind speed, and shear exponent c,d) for the a,c) eyewall region, and b,d) outer cyclone region". This is an awkward sentence with so many a,b), c,d), a,c), and b,d). Please simplify the sentence. You can just say: "a, c) and b, d) are the vertical profiles of wind speed and shear exponent for the eyewall region and outer cyclone, respectively.
   Thank you we followed your suggestion.

3. The same problem is for Figure 9 caption.
   The caption to Figure is changed similarly to Figure 8.

References

Sanchez Gomez, M., Lundquist, J. K., Deskons, G., Arwade, S. R., Myers, A. T., and Hajjar, J. F.: Wind conditions in category 1-3 tropical cyclones can exceed wind turbine design standards, ESS Open Archive, https://doi.org/10.22541/essoar.168394766.67483870/v1, 2023.