**Review: Tropical cyclone low-level wind speed, shear, and veer: sensitivity to the boundary layer parameterization in WRF**

**Summary**

The authors perform a study evaluating how different boundary layer parameterizations in WRF modify mean wind characteristics relevant for offshore wind energy. The authors simulate typhoon Megi using the YSU, MYJ, and MYNN boundary layer schemes. The simulation results are validated using best-track estimates, surface wind speed observations, and synthetic aperture radar data. After validation, wind speed, wind speed shear, and wind veer are estimated over the turbine rotor layer of a hypothetical 14MW wind turbine in the eyewall vicinity and in the rainband region. The authors contrast current wind turbine design standards against mean wind characteristics in the boundary layer for each boundary layer scheme. Wind speed in the rotor layer varies with boundary layer parameterization, especially near the eyewall. Wind shear and veer also vary, but to a lesser extent. In general, the authors report low wind veer in the turbine rotor layer and shear that agrees with turbine design standards.

The manuscript provides a coherent story and is an important addition to the growing literature on tropical cyclones. However, there are major concerns with the manuscript that should be addressed before publication.

**Major comments:**

1. Velocity fields are averaged azimuthally: The velocity fields in cyclones have distinct characteristics depending on the azimuthal location (Ren et al., 2019). For instance, the height of the tangential wind speed maxima and the height of the inflow varies azimuthally. Therefore, it is possible that by performing this azimuthal averaging, these characteristics are being lost, and shear and veer are being underestimated.
2. Radial locations in analysis: The radial distance that defines the eyewall regions is very large (60 km), thus the most extreme wind conditions that occur in the vicinity of the radius of maximum winds might be eclipsed by slower winds inside the eyewall. How is the 60 km to 120 km range chosen to define this as the eyewall region? Furthermore, given that the different PBL schemes result in different storm sizes, the radial distances might not be entirely equivalent for the different storms.
3. Context: The authors do not acknowledge the role of large-scale turbulence structures that form in tropical cyclones and the limitation of their simulations in resolving these structures. Please clarify that your simulations do not accurately resolve structures smaller than 15 km in wavelength due to the employed grid resolution. As a result, small- and large-scale variability in the boundary layer relevant for wind turbine design (such as large-scale vortices) are not captured.
4. A brief description of wind turbine design standards should be provided. The authors should include a brief explanation of the extreme wind speed models used for design load cases 6.1-6.4 in the IEC 61400-3 standard.

**Minor comments:**

Please review English writing throughout the manuscript. Some examples include:

- Line 48: Hyphen in large-eddy simulations.
- Line 70: Capitalize Weather Research and Forecasting model.

Line 22: Please include the role of large-eddy simulations, which can resolve large- and small-scale turbulence structures (e.g., mesovortices) relevant for loads in wind turbines.

Line 48: depending on the grid resolution (e.g., 2 km), mesoscale simulations might not resolve scales smaller than 10 km either.

Line 117: Is the timestep the same for all domains? A 45 second timestep for the 2 km domain seems too long, especially for such intense storm.

Section 2: Please mention vertical grid resolution in the lowest levels.

Line 74: Please clarify the spinup time for each domain. Is it 12 h for domain 1, or are all domains initialized at the same time?

Line 125: Please clarify that veer is the shortest rotational path of the wind vector and, as such, is restricted to $|\mathrm{Veer}| \leq 180°$.

Line 139: Note that the averaging period is very different between Kapoor et al. (2020) and your simulations. Therefore, wind veer is expected to differ.

Section 2.2: Is there a reason for restricting the shear analysis to two heights only? Did the authors consider fitting wind speed at all model heights within the rotor layer to the power-law wind profile to estimate $\alpha$?

Section 3.2: Please report the mean radius of maximum winds for each boundary layer scheme.

Line 206: Minimum SLP and maximum wind speed are shown in Figure 4.

Caption Figure 4: The 0.93 factor converts from 1-min to 10-min averaged winds and not the other way around.

Figure 5: Consider moving panels d,e,f to a new figure farther down in the manuscript. The authors only comment on these panels in line 255, after referring to Figure 6, 7, and 8.

Figures 1, 2, 3, 4, 5, 8: Please include axes and color bar labels where needed.

Lines 221-225: Please comment on the limitations of comparing instantaneous velocities from the mesoscale domains with 1-min and 10-min observational averages. These are not entirely comparable and the instantaneous velocity fields are grid dependent.

Line 231: Please clarify what you mean with symmetric wind component. Is this the tangential wind speed?

Line 235: Units for 12 m $s^{-1}$.

Line 253: Consider relocating numbers in sentence for clarity.

Line 257: Please rephrase for clarity. Perhaps break down into two sentences.

Line 269: Please clarify that the simulations only resolve large-scale variability of atmospheric variables.

Section 4: Please comment on the limitations of estimating veer from these simulations given that the depth and intensity of the radial inflow varies with grid resolution (Xu et al., 2021; Ren et al., 2022).

Line 312: Please soften the language in this sentence. Shear in the tropical cyclone boundary layer has been shown to be different in LES and mesoscale simulations (Ren et al., 2022; Xu et al., 2021; Li et al., 2021).

Line 312: This conclusion is drawn based on median wind characteristics. What about wind characteristics that are near the tail of the distribution (e.g., 0.75 percentile)?

Figure 7, Figure 8, and Table 2: The wind profiles representing the 0.75 percentile in Figure 7 display much larger shear than the median wind profiles. This is also evident in the inter quartile range for $\alpha$ reported in Table 2 and in the distribution of $\alpha$ in Figure 8. Please comment on the percentage of wind profiles with shear exponent larger than 0.11. Based on Table 2, it seems about 25% of wind profiles may display shear larger than 0.11.

Figure 8: Why are the y-axis tick labels for shear and veer larger than 1 if this is a plot of probability density?

**References**

Kapoor, A., Ouakka, S., Arwade, S. R., Lundquist, J. K., Lackner, M. A., Myers, A. T., Worsnop, R. P., and Bryan, G. H.: Hurricane eyewall winds and structural response of wind turbines, Wind Energ. Sci., 5, 89–104, https://doi.org/10.5194/wes-5-89-2020, 2020.

Li, X., Pu, Z., and Gao, Z.: Effects of Roll Vortices on the Evolution of Hurricane Harvey During Landfall, Journal of the Atmospheric Sciences, https://doi.org/10.1175/JAS-D-20-0270.1, 2021.

Ren, H., Dudhia, J., Ke, S., and Li, H.: The basic wind characteristics of idealized hurricanes of different intensity levels, Journal of Wind Engineering and Industrial Aerodynamics, 225, 104980, https://doi.org/10.1016/j.jweia.2022.104980, 2022.

Ren, Y., Zhang, J. A., Guimond, S. R., and Wang, X.: Hurricane Boundary Layer Height Relative to Storm Motion from GPS Dropsonde Composites, Atmosphere, 10, 339, https://doi.org/10.3390/atmos10060339, 2019.

Xu, H., Wang, H., and Duan, Y.: An Investigation of the Impact of Different Turbulence Schemes on the Tropical Cyclone Boundary Layer at Turbulent Gray-Zone Resolution, JGR Atmospheres, 126, https://doi.org/10.1029/2021JD035327, 2021.