In this paper, the authors have described a new analytical method to determine the eddy viscosity from LES and wind tunnel experiments. The authors incorporated the eddy viscosity model with with an engineering wake model and compared the results with that from LES. Overall, this paper is well-written, proposes a novel idea to determine eddy viscosity and have great potential to improve the accuracy of evaluations of wind farm wake. I really enjoyed reading it. Overall, I recommend publication in Wind Energy Science, but I think some very minor adjustments and comments might further improve this paper.

**Response:** The authors appreciate this review and the constructive comments. The text has been edited to reflect the reviewers comments and for clarity. The reviewers comments are addressed below and further revisions are highlighted in **bold** in the text.

**Comment 1:** Starting Line 12 and multiple instances: Please provide reference and/or define "hybrid wake model".

**Response:** Thank you for this suggestion, we have updated the introduction to contextualize hybrid wake models:
"Accurate wake modeling is essential for optimizing wind plant layouts and creating effective control strategies [7, 4]. Hybrid wake models balance the accuracy of high fidelity simulations with the computational efficiency of analytic models to facilitate wind plant design studies. Unlike superposition based approaches, hybrid wake models adopt a combined RANS-analytic framework to solve a linearized or parabolic representation of the mass and momentum equations [2, 3, 1]. This allows hybrid wake models to include additional physics beyond the scope of typical engineering wake models without incurring substantial computational costs."

**Comment 2:** Line 46 $--$ 48: LES simulations $->$ LES

**Response:** Fixed, thank you!

**Comment 3:** Equation 2: Please add when $i \neq j$. When $i = j$, the full form of Boussinesq approximation has a term of $2/3k$.

**Response:** Thank you, we have updated the theory related to Equation (2) and relocated Section 4.1. The updated text now reads:
"The eddy viscosity hypothesis relates turbulent stresses to turbulent kinetic energy and the rate of strain tensor. This relationship is introduced as:

$$\overline{u_i'u_j'} = \frac{2}{3}k\delta_{ij} - 2\nu_T S_{ij},$$

where $\overline{u_i'u_j'}$ is the turbulent stress tensor, $k$ is the turbulent kinetic energy, and $S_{ij}$ is the rate of strain tensor. Eddy viscosity is written as $\nu_T$ and acts as a constant of proportionality. In a wind plant, the streamwise-vertical components of the Reynolds stress are responsible for the majority of energy flux into the plant [5, 6] allowing Eq. () to be described in terms of mean flow components:

$$\overline{u_1'u_3'} = -2\nu_T S_{13},$$

Note, in presence of high veer, Coriolis forces, or nacelle yaw the streamwise-lateral stresses are of similar order. In these instances, we expect comparable eddy viscosity magnitudes could be obtained from the streamwise-lateral components."

**Comment 4:** Line 147: How did you normalize eddy viscosity? Please add it in the main text.

**Response:** Thank you for pointing this out. In Figure 5, $\nu^{\star}_{T,\mathrm{w}}$ is relative to the maximum for that case while in the remainder of the manuscript $\nu^{\star}_{T,\mathrm{w}}$ is given by:

$$\nu^{\star}_{T,\mathrm{w}} = \nu_{T,\mathrm{w}}(x)/A\left[0.01 + \frac{x}{\sigma^2}e^{-x^2/2\sigma^2}\right]$$

where $A = RU_\mathrm{B}\sqrt{1-C_T}/2$ and $\sigma = 5.5$. We have added the following near line 147 for clarity: "Here, $\nu^{\star}_{T,\mathrm{w}}$ is normalized relative to the maximum value for each case to facilitate consistent comparisons across cases."

**Comment 5:** Overall comment for Section 3.2, 4.1 and 4.2: It may be helpful if more runs for LES are performed with different thrust coefficients for the wind turbine the coefficient $\sigma$ in Eq 14 is obtained in a statistical way.

**Response:** Thank you, we agree parameterizing the model response to various inflow conditions and turbine operations is a valuable next step. We have addressed this suggestion alongside Comment 6.

**Comment 6:** Overall comment for Section 5: The proposed eddy viscosity model comes from the neutral ABL. Just curious whether the authors are planning to verify whether the proposed model still works under different atmospheric stability conditions.

**Response:** Thank you for this and the prior suggestion. While such studies are outside the scope of the present work we have suggested both a future work:
"Further parameterizion to include multiple turbulence intensities, turbine thrust coefficients, and atmospheric stabilities would ensure the proposed model performs across settings. Additionally, future work can resolve the discrepancies reported for nacelle misalignment. Describing surface interactions in terms of turbine operating parameters and roughness height is one promising avenue for further refinement. Detailing the streamwise-lateral rate of strain and shear stress response to yaw, veer, and Coriolis forces is another potential avenue for improving upon the proposed model. We anticipate future developments in this area will lead to improved predictions of wind plant performance and enable the design of more efficient wind plants."

## References

[1] Majid Bastankhah et al. "Analytical solution for the cumulative wake of wind turbines in wind farms". In: *Journal of Fluid Mechanics* 911 (2021).

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[6] Ryan Scott, Juliaan Bossuyt, and Raúl Bayoán Cal. "Characterizing tilt effects on wind plants". In: *Journal of Renewable and Sustainable Energy* 12.4 (2020), p. 043302.

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