Response to Reviewers 2' comments on
"Investigating wake reproduction of a model-scale wind turbine:
experimental measurements versus Large Eddy Simulation with actuator line"
Wind Energy Science, WES-2025-242

Emmanuel Gillyns, on behalf of all authors

August 18, 2026

Response to Reviewer 2 (R2)

General comments

The authors have made a genuine effort to address the comments raised during the first round of review. The revised manuscript is substantially improved: the numerical setup is now described in sufficient detail for reproducibility, the scope has been clarified (combined experimental–numerical investigation rather than strict validation), and additional context has been provided for the turbulence model, simulation parameters, airfoil polar generation, and surface finish of the 3D-printed blades. These additions are appreciated and resolve a number of the concerns I raised previously. That said, two important issues remain.

We thank the reviewer for their positive assessment of the revised manuscript and for acknowledging the improvements we have made to address their previous comments. We appreciate their recognition that the numerical setup, scope clarification, and additional technical details have substantially strengthened the paper.

Main point 1

Firstly, the airfoil polars used in the cALM and OpenFAST simulations are generated with XFoil at $Re = 5 \times 10^4$ and $Ncrit = 9$. While the authors' choice not to tune Ncrit is understandable for a general-purpose evaluation, it is problematic for a paper focused on experimental–numerical cross-validation. At this Reynolds number, aerodynamic coefficients are strongly affected by complex phenomena such as laminar separation bubbles, and the default $Ncrit = 9$ assumes a clean, low-turbulence environment. On the other hand, the model uses a 3D-printed blade surface and is tested in elevated freestream turbulence. Both things would suggest earlier transition, warranting a lower value of NCrit. Moreover, from what I can tell, experimental polar data for this exact airfoil at a nearby Reynolds number ($Re = 60,000$) is available from the UIUC Low-Speed Airfoil Tests [1, 2]; a comparison with XFoil-generated polars (at the same Reynlods number) is strongly recommended. I would alse recommend motivating why experimental polars were not used, are there any apparent issues with the experimental dataset? This concern also has a direct consequence in the manuscript: the OpenFAST-predicted Cp in Figure 7 substantially overpredicts the measurements (peak 0.40 vs 0.25), which the authors attribute entirely to mechanical losses, but possible overestimated lift and underestimated drag from XFoil would produce the same results. More broadly, the uncertainty in polar data and how it propagates to the wake comparison should be discussed explicitly.

Response:

We thank the reviewer for this valuable point. Our choice of XFoil-generated polars was driven by methodological generality: in many practical applications (e.g., full-scale wind turbine simulations), experimental data are unavailable at all required Reynolds numbers. We have now added a discussion on page 18 acknowledging available experimental datasets (such as UIUC) while explaining our rationale for using XFoil.

Regarding Ncrit, we acknowledge that a sensitivity study would be informative. However, a full parametric sweep would require re-running the complete set of XFoil, LES, and OpenFAST simulations, which is beyond the scope of this revision. We have added a paragraph on page 10 discussing the limitations of the Ncrit = 9 assumption and its potential influence on the predicted coefficients, and we identify this sensitivity analysis as a direction for future work.

Main point 2

Secondly, the continuous ALM (cALM) formulation presented in this paper, where forces are represented as polynomials on the spectral element mesh nodes rather than as discrete point sources, is to my knowledge a new contribution. I did not understand this clearly upon first review as too many detail were missing IMO. I would encourage the authors to more clearly articulate what distinguishes the cALM from prior ALM implementations in spectral element codes, and to explicitly state the novelty of the continuous formulation.

Response:

We thank the reviewer for recognizing the novel contribution of the continuous ALM formulation and for highlighting the need for clearer articulation. We have now explicitly stated the distinction between cALM and prior ALM implementations in spectral element codes in both the Introduction on page 2, in section 3.3 on page 19 and Conclusion sections. This clarification emphasizes that representing forces as polynomials on the spectral element mesh nodes, rather than as discrete point sources, constitutes a key innovation of this work.

Minor point

The authors should provide evidence that the LES is adequately resolved, for instance by reporting the ratio of resolved to total turbulent kinetic energy at representative locations. This is standard practice for scale-resolving simulations and would support the claim that grid resolution is adequate without requiring a full mesh convergence study.

Response:

We thank the reviewer for this suggestion. In spectral element codes, we can diagnose resolution via the Gibbs phenomenon at cell interfaces. While this vanishes in mesh where the turbulence is fully resolved, its presence in LES qualitatively indicates local resolution. As shown in Fig.1, Gibbs oscillations are confined primarily to the walls. Within the turbine region (the region of interest), this effect remains limited. It increases slightly at location 2 but remains qualitatively acceptable, confirming adequate resolution in the region of interest.

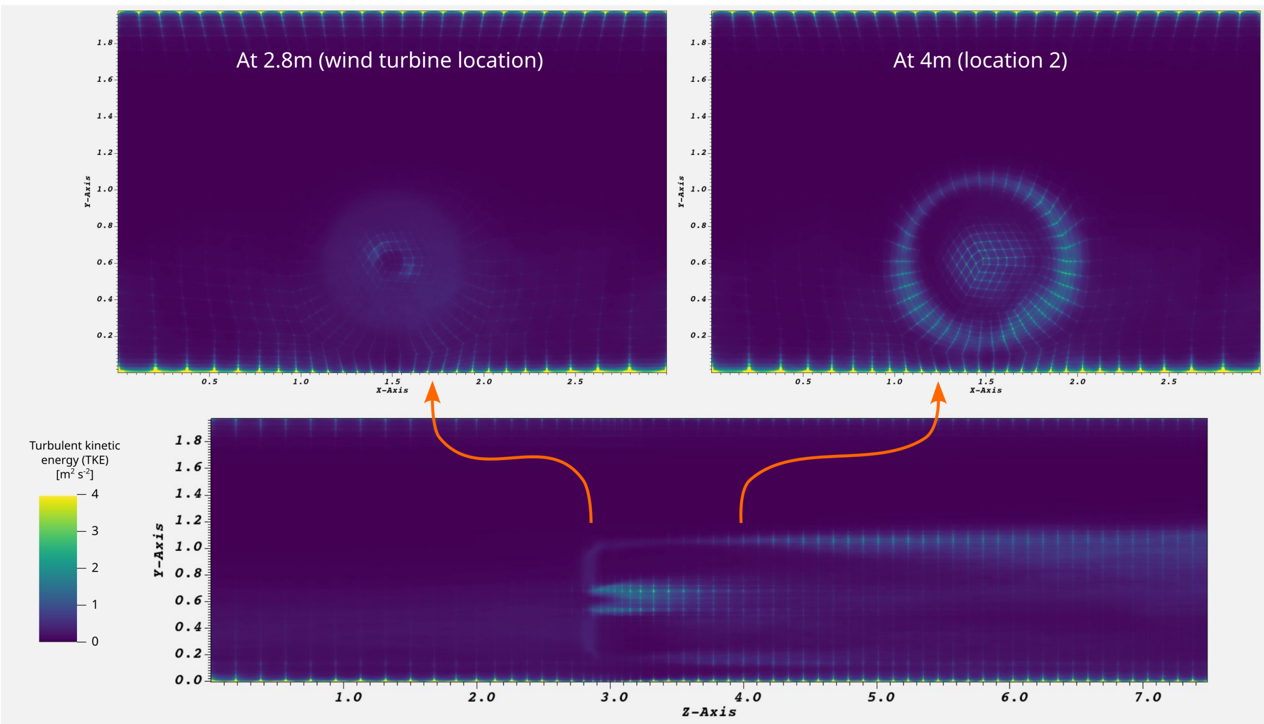

Figure 1: Turbulent kinetic energy, used as a qualitative evaluation of the mesh quality.

References

[1] P. Giguère and M. S. Selig. "Low Reynolds Number Airfoils for Small Horizontal Axis Wind Turbines". In: *Wind Engineering* 21.6 (1997). URL: https://m-selig.ae.illinois.edu/pubs/GiguereSelig-1997-WindEngineering-LRN-Airfoils.pdf.

[2] M. S. Selig et al. *Summary of Low-Speed Airfoil Data, Vol. 1*. SoarTech Publications, 1995. URL: https://m-selig.ae.illinois.edu/uiuc_lsat/Low-Speed-Airfoil-Data-V1.pdf.