Second International Conference Math 2 Product (M2P 2025)
Emerging Technologies in Computational Science
for Industry, Sustainability and Innovation
June 4th-6th, 2025, Valencia, Spain

NUMERICAL METHODS FOR WIND ENERGY AERODYNAMICS

SERGIO G. HORCAS[*], ESTEBAN FERRER[†] AND JOSE I. ROJAS[‡]

[*] Dept. of Physics – Division of Aerospace Eng., Universitat Politècnica de Catalunya (UPC)
c/ Sant Nebridi, 22, 08222, Terrassa, Spain
sergio.gonzalez-horcas@upc.edu and https://orcid.org/0000-0002-4034-3118

[†] Dept. of Applied Mathematics, Universidad Politécnica de Madrid (UPM)
Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain
esteban.ferrer@upm.es and https://orcid.org/0000-0003-1519-0444

[‡] Dept. of Physics – Division of Aerospace Eng., Universitat Politècnica de Catalunya (UPC)
c/ Esteve Terradas 7, 08860, Castelldefels, Spain
josep.ignasi.rojas@upc.edu and https://orcid.org/0000-0002-7025-4378

ABSTRACT

The deployment of wind energy, as a crucial actor for achieving 100% renewable electricity, faces several technological, social, and economic challenges worldwide. In the technological domain, these challenges include proper aerodynamic characterization at wind farm, turbine, or blade scales [1]. This requires tailored models and developments, which are critical at stages like design, installation, and production. Recent progress, driven by ongoing research and availability of reference wind turbine models (such as those developed by the International Energy Agency or the National Renewable Energy Laboratory) has been key to addressing issues like the modelling of large rotors and the installation of turbines in highly dynamic floating environments.

This session covers recent research in applying numerical methods to aerodynamics modelling for wind energy. Contributions focusing on tailored and efficient numerical methods, such as high-order approaches or reduced-order modelling, are encouraged. Special attention is given to open-source codes like OpenFOAM, Saturne, or Horses3D [2], while research using in-house or commercial software is also welcome. The session will also explore the integration of these modelling approaches into numerical optimization or artificial intelligence frameworks, to enhance their design and prediction capabilities. Applications across all scales are welcome, from innovative airfoil geometries and the introduction of flow control devices (e.g. vortex generators or synthetic jets) to the study of wakes for wind farm design.

Given the multiphysics nature of the problem, this mini-symposium will also cover coupled problem modelling, such as recent advances in predicting vibratory phenomena related to aeroelastic instabilities or noise emissions through aeroacoustic simulations.

REFERENCES

[1] Veers, P., Bottasso, C.L., Manuel, L., Naughton, J., Pao, L., Paquette, J., Robertson, A., Robinson, M., Ananthan, S., Barlas, T., Bianchini, A., Bredmose, H., Horcas, S.G., Keller, J., Madsen, H.A., Manwell, J., Moriarty, P., Nolet, S., and Rinker, J., *Grand challenges in the design, manufacture, and operation of future wind turbine systems*, Wind Energy Science, Vol. 8 (7), pp. 1071–1131, 2023, doi: https://doi.org/10.5194/wes-8-1071-2023.

[2] Ferrer, E., Rubio, G., Ntoukas, G., Laskowski, W., Mariño, O., Colombo, S., Mateo-Gabín, A., Narbona, H., Manrique de Lara, F., Huergo, D., Manzanero, J., Rueda-Ramírez, A.M., Kopriva, D.A., Valero, E., *HORSES3D: a high order discontinuous Galerkin solver for flow simulations and multi-physic applications*, Computer Physics Communications, Vol. 287, 108700, 2023, doi: https://doi.org/10.1016/j.cpc.2023.108700.