World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:14, No:03, 2020

Wind Turbine Wake Prediction and Validation under a Stably-Stratified Atmospheric Boundary Layer

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Abstract : Turbulence energetics and structures in the wake of large-scale wind turbines under the stably-stratified atmospheric boundary layer (SABL) can be complicated due to the presence of low-level jets (LLJs), a region of higher wind speeds than the geostrophic wind speed. With a modified one-k-equation, eddy viscosity model specified for atmospheric flows as the sub-grid scale (SGS) model, a realistic atmospheric state of the stable ABL is well reproduced by large-eddy simulation (LES) techniques. Corresponding to the precursor stably stratification, the detailed wake properties of a standard 5-MW wind turbine represented as an actuator line model are provided. An engineering model is proposed for wake prediction based on the simulation statistics and gets validated. Results confirm that the proposed wake model can provide good predictions for wind turbines under the SABL.

Keywords : large-eddy simulation, stably-stratified atmospheric boundary layer, wake model, wind turbine wake
Conference Title : ICCFD 2020 : International Conference on Computational Fluid Dynamics
Conference Location : Prague, Czechia
Conference Dates : March 19-20, 2020

Open Science Index, Computer and Systems Engineering Vol:14, No:03, 2020 publications.waset.org/abstracts/111209.pdf