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Impact of a wind turbine on turbulence: Un-freezing turbulence by means of a simple vortex particle approach - DTU Orbit (09/11/2017)

Impact of a wind turbine on turbulence: Un-freezing turbulence by means of a simple vortex particle approach

A vortex particle representation of turbulent fields is devised in order to address the following questions: Does a wind turbine affect the statistics of the incoming turbulence? Should this imply a change in the way turbulence boxes are used in wind turbine aero-elastic simulations? Is it acceptable to neglect the influence of the wake and the wind turbine on the turbulent inflow? Is there evidence to justify the extra cost of a method capable of including these effects correctly? To this end, a unified vorticity representation of the flow is used: the wind turbine model is represented by a bound vorticity lifting line while the turbine wake vorticity and the turbulence vorticity are projected onto vortex particles. In the present work the rotor blades are stiff leaving aero-elastic interactions for future work. Inflow turbulence is generated with the model of Mann and converted to vortex particles that are inserted at the inlet of the computational domain. First the quality of the reconstructed turbulent flow field is evaluated and then the wind turbine is added in the simulations. The lack of a driving-force to sustain turbulence is found to give a progressive decay of turbulence away from the insertion point. The presence of the wind turbine and its wake is found to have insignificant effect on upstream turbulence. Finally, the mean velocity profiles in the wake are found to be in good agreement with both lidar measurements and CFD simulations. (C) 2016 Elsevier Ltd. All rights reserved.

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