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Numerical Investigation of Turbulent Inflow Strategy in Wind Energy Applications

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Abstract : Ongoing climate change demands the increasing use of renewable energies. Wind energy plays an important role in this context since it can be applied almost everywhere in the world. To reduce the costs of wind turbines and to make them more competitive, simulations are very important since experiments are often too costly if at all possible. The wind turbine on a vast open area experiences the turbulence generated due to the atmosphere, so it was of utmost interest from this research point of view to generate the turbulence through various Inlet Turbulence Generation methods like Precursor cyclic and Kaimal Spectrum Exponential Coherence (KSEC) in the computational simulation domain. To be able to validate computational fluid dynamic simulations of wind turbines with the experimental data, it is crucial to set up the conditions in the simulation as close to reality as possible. This present work, therefore, aims at investigating the turbulent inflow strategy and boundary conditions of KSEC and providing a comparative analysis alongside the Precursor cyclic method for Large Eddy Simulation within the context of wind energy applications. For the generation of the turbulent box through KSEC method, firstly, the constrained data were collected from an auxiliary channel flow, and later processing was performed with the open-source tool PyconTurb, whereas for the precursor cyclic, only the data from the auxiliary channel were sufficient. The functionality of these methods was studied through various statistical properties such as variance, turbulent intensity, etc with respect to different Bulk Reynolds numbers, and a conclusion was drawn on the feasibility of KSEC method. Furthermore, it was found necessary to verify the obtained data with DNS case setup for its applicability to use it as a real field CFD simulation.

Keywords : Inlet Turbulence Generation, CFD, precursor cyclic, KSEC, large Eddy simulation, PyconTurb
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