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Direct Numerical Simulations of a Full Stationary Wind-Turbine Blade[1] ADNAN QAMAR, WEI ZHANG, WEI GAO, RAVI SAMTANEY, Division of Physical Sciences and Engineering, King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, KSA — Direct numerical simulation of flow past a full stationary wind-turbine blade is carried out at Reynolds number, Re=10,000 placed at 0 and 5 (degree) angle of attack. The study is targeted to create a DNS database for verification of solvers and turbulent models that are utilized in wind-turbine modeling applications. The full blade comprises of a circular cylinder base that is attached to a spanwise varying airfoil cross-section profile (without twist). An overlapping composite grid technique is utilized to perform these DNS computations, which permits block structure in the mapped computational space. Different flow shedding regimes are observed along the blade length. Von-Karman shedding is observed in the cylinder shaft region of the turbine blade. Along the airfoil cross-section of the blade, near body shear layer breakdown is observed. A long tip vortex originates from the blade tip region, which exits the computational plane without being perturbed. Laminar to turbulent flow transition is observed along the blade length. The turbulent fluctuations amplitude decreases along the blade length and the flow remains laminar regime in the vicinity of the blade tip. The Strouhal number is found to decrease monotonously along the blade length. Average lift and drag coefficients are also reported for the cases investigated.

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