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Numerical Investigation of Synthetic-jet based Flow Control on Vertical-axis Wind Turbine Blades ASHWIN MENON, STEVEN TRAN, ONKAR SAHNI, MANE, RPI — Vertical-axis wind turbines encounter large unsteady aerodynamic loads in a sustained fashion due to the continuously varying angle of attack that is experienced by turbine blades during each revolution. Moreover, the detachment of the leading edge vortex at high angles of attack leads to sudden change in aerodynamic loads that result in structural vibrations and fatigue, and possibly failure. This numerical study focuses on using synthetic-jet based fluidic actuation to reduce the unsteady loading on VAWT blades. In the simulations, the jets are placed at the dominant separation location that is observed in the baseline case. We consider different tip-speed ratios, O(2-5), and we also study the effect of blowing ratio (to be in O(0.5-1.5)) and reduced frequency, i.e., ratio of jet frequency to flow frequency (to be in O(5-15)). For all cases, unsteady Reynolds-averaged Navier-Stokes simulations are carried out by using the Spallart-Allamaras turbulence model, where stabilized finite element method is employed for spatial discretization along with an implicit time-integration scheme.

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