Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

HPC of Loading Transients on a 5-MW Wind Turbine Rotor by Atmospheric Turbulence Eddies[1] ADAM LAVELY, GANESH VIJAYAKUMAR, BRENT CRAVEN, BALAJI JAYARAMAN, The Pennsylvania State University, TARAK NANDI, Pennsylvania State University, ERIC PATERSON, Virginia Polytechnic Institute and State University, JAMES BRASSEUR, The Pennsylvania State University — As atmospheric boundary layer (ABL) turbulence eddies sweep through a commercial wind turbine rotor disk, they generate unsteady loadings and bending moments on the blades and shafts. We use blade resolved hybrid-URANS-LES to compute unsteady loadings of a typical daytime moderately convective ABL (MCBL) on the NREL 5 MW wind turbine. The MCBL is generated with LES of exceptional resolution (147M cells) and a low-dissipation spectral algorithm. The ABL LES is used as an initial condition and as inflow boundary conditions for the NREL 5 MW computational domain. This domain is an ABL simulation with 130M cells in an OpenFOAM framework. The atmospheric eddies interact with the blades through a novel hybrid blending of the k-ω-SST-SAS URANS stress model near the blade and a 1-equation SFS LES stress model in the far-field. The time variations in integrated loads, power and bending moments are being correlated with ABL eddy passage. The integrated loads will then be compared to local surface stress transients to determine the source(s) that underlie integrated load, power and moment transients. In this way, we aim to determine the role of atmospheric turbulence on deleterious blade loadings and potential relationships between loadings and local blade boundary layer dynamics.

[1]Support: DOE, NSF

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Date submitted: 02 Aug 2013 Electronic form version 1.4