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THREE-DIMENSIONAL WIND SIMULATION

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ABSTRACT

A method for numerically simulating a three-dimensional field of turbulent wind-speed (the "Sandia method") for use in the aerodynamic and structural analyses of wind turbines is presented. The required inputs are single point power spectral densities (PSDs) and the coherence function. Suggestions for appropriate inputs and an example calculation are included. The simulation method is used to obtain "rotationally sampled" PSDs, which are compared with measurements obtained by Pacific Northwest Laboratories. The results show that the Sandia method is capable of producing simulations that agree with the measurements, especially when the coherence function is augmented from the usual form to include the ratio of spatial separation over height raised to the 0.25 power. The method is specialized for horizontal axis wind turbine analysis by phase lagging the simulations at each point in space so that wind speeds are simulated only when the turbine blade passes the point, reducing storage requirements and computation time by about an order of magnitude. For vertical axis applications, where interpolation will be required, the error induced by the interpolation is estimated and eliminated by the addition of white noise.

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