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Effects of a three-dimensional hill on the wake characteristics of a model wind turbine[1] XIAOLEI YANG, KEVIN B. HOWARD, MICHELE GUALA, FOTIS SOTIROPOULOS, Univ of Minn - Minneapolis — The spatial evolution of a turbine wake downwind of a sinusoidal hill is studied using large-eddy simulations and wind tunnel measurements. The computed flow fields behind the hill show good agreement with Particle Image Velocimetry measurements. It is observed that the turbine wake downwind of the hill recovers faster than the wake of the same turbine in the turbulent boundary layer flow (OT case) because of the increased entrainment of ambient flow into the turbine wake, which is due to enhanced turbulence convection in both the spanwise and vertical directions. It is also observed that the recovery rates of the available mean kinetic energy in the turbine wakes are nearly the same for turbine positions of 4D, 6D and 8D downwind of the hill (HT cases). The turbulence kinetic energy (TKE) in the turbine wake for all the HT cases exhibit significant increases as compared to that from the OT case. However, the profiles of the turbine-added TKE nearly collapse for all OT and HT cases (except in the turbine near wake region) when normalized by a characteristic velocity defined by the turbine thrust. A simple model for the turbine-added TKE in complex terrain is also proposed based on the new physical insights from the simulated cases.

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