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Enhancing kinetic energy entrainment in LES of large wind farms by unconventional forcing at the turbine rotors[1] CLAIRE VERHULST, United States Military Academy, CHARLES MENEVEAU, Johns Hopkins University — Vertical entrainment of mean kinetic energy is believed to be a limiting factor for power generation in very large wind farms, which operate in the turbulent atmospheric boundary layer and experience detrimental wake effects. A new approach, meant to increase vertical entrainment and aid wake recovery, is proposed and evaluated with a preliminary "proof of concept" test using Large Eddy Simulation (LES) with periodic boundary conditions to obtain realistic fully developed flow. In addition to the traditional actuator thrust force, a synthetic vertical force is applied at the turbine rotors to force high-speed flow downward and low-speed flow upward. The ratio of the vertical force and the thrust force, held constant within each case, ranges from 0 to 1 across six cases and is applied independently at each turbine. The proposed approach is found to increase the power extraction and mean kinetic energy entrainment significantly, by up to 95% when the vertical force is similar in magnitude to the thrust force. The effect of the forcing scheme on the mean velocity field is considered in detail. In addition, a quadrant analysis is performed to determine how the synthetic forcing changes the statistical characteristics of the mean kinetic energy entrainment within the wind farm.

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