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On very-large-scale motions (VLSMs) and long-wavelength patterns in turbine wakes[1] ASIM ONDER, National University of Singapore, JOHAN MEYERS, KU Leuven — It is now widely accepted that very-large-scale motions (VLSMs) are a prominent feature of thermally-neutral atmospheric boundary layers (ABL). Up to date, the influence of these very long active motions on wind-energy harvesting is not sufficiently explored. This work is an effort in this direction. We perform large-eddy simulation of a turbine row operating under neutral conditions. The ABL data is produced separately in a very long domain of 240δ. VLSMs are isolated from smaller-scale ABL and wake motions using a spectral cutoff at streamwise wavelength $\lambda_x = 3.125\delta$. Reynolds-averaging of low-pass filtered fields shows that the interaction of VLSMs and turbines produce very-long-wavelength motions in the wake region, which contain about 20% of the Reynolds-shear stress, and 30% of the streamwise kinetic energy. A conditional analysis of filtered fields further reveals that these long-wavelength wakes are produced by modification of very long velocity streaks in ABL. In particular, the turbine row acts as a sharp boundary between low and high velocity streaks, and accompanying roller structures remain relatively unaffected. This reorganization creates a two-way flux towards the wake region, which elucidates the side-way domination in turbulent transport.

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Johan Meyers
KU Leuven

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