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Shifted periodic boundary conditions for large-eddy simulation of wind farms[1] WIM MUNTERS, KU Leuven, CHARLES MENEVEAU, Johns Hopkins University, JOHAN MEYERS, KU Leuven — In wall-bounded turbulent flow simulations, periodic boundary conditions combined with insufficiently long domains lead to persistent spanwise locking of large-scale turbulent structures. In the context of wind-farm large-eddy simulations, this effect induces artificial spanwise inhomogeneities in the time-averaged local wind conditions as seen by the wind turbines, leading to spurious differences in power prediction between otherwise equivalent columns of wind turbines in a wind farm (a column is defined here as a set of turbines parallel to the mean flow direction). We propose a shifted periodic boundary condition that eliminates this effect without the need for excessive streamwise domain lengths. Instead of straightforwardly reintroducing the velocity from the outlet plane back at the inlet, as in classic periodic boundary conditions, this plane is first shifted in the spanwise direction by a predefined and constant distance. The method is tested based on a set of direct numerical simulations of a turbulent channel flow, and large-eddy simulations of a high Reynolds number rough-wall half-channel flow. Finally, we apply the method in a precursor simulation, generating inlet conditions for a spatially developing wind-farm boundary layer.

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