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Extending the restricted nonlinear model for wall-turbulence to high Reynolds numbers[1] JOEL BRETHEIM, CHARLES MENEVEAU, DENNICE GAYME, Johns Hopkins University — The restricted nonlinear (RNL) model for wall-turbulence is motivated by the long-observed streamwise-coherent structures that play an important role in these flows. The RNL equations, derived by restricting the convective term in the Navier-Stokes equations, provide a computationally efficient approach due to fewer degrees of freedom in the underlying dynamics. Recent simulations of the RNL system have been conducted for turbulent channel flows at low Reynolds numbers (Re), yielding insights into the dynamical mechanisms and statistics of wall-turbulence. Despite the computational advantages of the RNL system, simulations at high Re remain out-of-reach. We present a new Large Eddy Simulation (LES) framework for the RNL system, enabling its use in engineering applications at high Re such as turbulent flows through wind farms. Initial results demonstrate that, as observed at moderate Re, restricting the range of streamwise varying structures present in the simulation (i.e., limiting the band of x Fourier components or k_x modes) significantly affects the accuracy of the statistics. Our results show that only a few well-chosen k_x modes lead to RNL turbulence with accurate statistics, including the mean profile and the well-known inner and outer peaks in energy spectra.

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