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Restricted nonlinear large-eddy simulations of wall-turbulence[1]
DENNICE F. GAYME, JOEL U. BRETHEIM, CHARLES MENEVEAU, Johns Hopkins University — The prominence of streamwise elongated structures motivates the use of a restricted nonlinear (RNL) model for studying the dynamics of wall-turbulence. This model is formed by partitioning the Navier Stokes equations into a streamwise constant mean flow interacting with a streamwise varying perturbation field in which the nonlinear perturbation-perturbation interactions are neglected. RNL simulations have been shown to support self-sustaining turbulence with a mean profile and structural features consistent with DNS in a number of canonical flows. Recent results have shown that the accuracy of the statistical properties predicted by the RNL model at higher Reynolds numbers can be significantly improved by limiting the streamwise varying Fourier components in the perturbation dynamics; this "band-limiting" procedure also opens the door for lower-cost simulations. Here, we extend the RNL model to high Reynolds number boundary layer flows through the creation of a RNL large-eddy simulation (LES) framework. The results indicate that a band-limited RNL-LES approach captures key flow statistics with a drastically reduced number of degrees of freedom versus a standard LES.

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