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A Three-Dimensional Extension of Minimal Quasi-Linear Approximation for Channel Flow JACOB HOLFORD, Imperial College London, MYOUNGKYU LEE, Sandia National Laboratories, YONGYUN HWANG, Imperial College London — This paper extends a minimal quasi-linear approximation proposed in Hwang and Eckhardt (2020, J. Fluid Mech., 894, A23) to account for turbulent channel flow. A data-driven approach is applied to determine the optimal stochastic forcing for a linearized, eddy-viscosity based model. The streamwise forcing distribution is determined through an optimization problem, matching the two-dimensional spectra from a DNS at $Re_\tau = 5200$ to the linearised response, with the forcing subject to sufficient smoothness. Results are determined for fixed spanwise lengthscales and the self-similarity of energy-containing motions throughout the near-wall and logarithmic regions is exploited to determine a universal distribution. The spanwise forcing distribution is then determined self-consistently by matching the spanwise forcing distribution such that the Reynolds stress produced from the fluctuations matches that from the eddy-viscosity based mean flow. The two-dimensional spectra and turbulence intensities and quasi-linear approximation are then compared, with improvement found over the anisotropic previous results, qualitatively consistent with energetics of the self-sustaining process.

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