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Structure and mechanism of turbulence under dynamical restriction in plane Poiseuille flow NAVID CONSTANTINOU, Univ of California - San Diego, BRIAN FARRELL, Harvard University, PETROS IOANNOU, National and Kapodistrian University of Athens, JAVIER JIMENEZ, Universidad Politecnica de Madrid, ADRIAN LOZANO-DURAN, Stanford University, MARIOS-ANDREAS NIKOLAIDIS, National and Kapodistrian University of Athens — The perspective of Statistical State Dynamics (SSD) is used to investigate plane Poiseuille turbulence at moderately high Reynolds numbers ($Re_\tau \approx 940$). Simulations of a quasi-linear restricted nonlinear dynamics (RNL), which is an approximation to the full SSD, provide insight into the mechanism and structure of turbulent flow. RNL dynamics spontaneously limits the support of its turbulence to a small set of streamwise Fourier components giving rise to a natural minimal representation of its turbulence dynamics. Although greatly simplified, this RNL turbulence exhibits natural-looking structures and turbulent statistics. RNL turbulence at the Reynolds numbers studied is dominated by the roll/streak structure in the buffer layer and similar very-large-scale structure (VLSM) in the outer layer. Diagnostics of the structure, spectrum and energetics of RNL and DNS turbulence are used to demonstrate that the roll/streak dynamics supporting the turbulence in the buffer and logarithmic layer is essentially similar in RNL and DNS. This mechanism, which has analytical expression in the SSD, comprises a cooperative interaction between the coherent streamwise mean flow and the incoherent turbulent perturbations.

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