Abstract Submitted
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A restricted nonlinear-dynamics model for turbulent channel flows[1] ADRIÁN LOZANO-DURÁN, JAVIER JIMÉNEZ, Universidad Politécnica de Madrid, BRIAN F. FARRELL, Harvard University, PETROS J. IOANNOU, MARIOS A. NIKOLAIDIS, NAVID C. CONSTANTINOU, University of Athens — The dynamics of the formation of very-large scale structure in turbulent plane Poiseuille flow is studied by restricting the nonlinearity in the Navier–Stokes (NS) equations to interactions between the streamwise-averaged flow and perturbations. Using comparisons with DNS, we show that this restricted nonlinear dynamics (RNL) supports essentially realistic turbulence at $Re_\tau = 900$, despite the naturally occurring severe reduction in the set of streamwise wavenumbers supporting the turbulence. Using statistical diagnostics we verify that there are similar self-sustaining processes (SSP) underlying turbulence in the RNL and in the NS dynamics, separate manifestations of which operate in the buffer and outer layers. In the buffer layer, the SSP supports the familiar roll-streak mechanism of wall-bounded turbulence, while the outer-layer streaks in the RNL are probably the streamwise elongated structures referred to as VLSI. It is argued that the formation of the roll-streak structure is a universal mechanism that can be fruitfully studied in the minimal dynamics of RNL.

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