Abstract Submitted
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Linear mechanisms sustaining wall turbulence[1] ADRIAN LOZANO-DURAN, Stanford University, MARIOS-A. NIKOLAIDIS, National and Kapodistrian University of Athens, MICHAEL KARP, Stanford University, NAVID C. CONSTANTINOU, Australian National University — Turbulence is the primary example of a highly nonlinear phenomenon. Nevertheless, there is evidence that the energy-injection mechanisms sustaining wall turbulence can be ascribed to linear processes. The different scenarios stem from linear stability theory and comprise modal instabilities from mean-flow inflection points, transient growth from non-normal operators, and parametric instabilities from temporal mean-flow variations, among others. These mechanisms, each potentially capable of leading to the observed turbulence structure, are rooted in simplified theories. Whether the flow follows any or a combination of them remains unclear. In the present study, we devise a novel collection of numerical experiments in which the Navier-Stokes equations are sensibly modified to quantify the role of the different linear mechanisms. This is achieved by direct numerical simulation of turbulent channel flows with constrained energy extraction from the streamwise-averaged mean-flow. We demonstrate that (i) transient growth alone is not sufficient to sustain wall turbulence and (ii) the flow remains turbulent when the modal instabilities are suppressed. On the other hand, we show that the parametric instability due to the time-varying mean-flow is essential to maintain turbulence alive.

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