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Streak amplification and self-sustenance of turbulence in pipe flow BAOFANG SONG, Institute of Science and Technology Austria, MARC AVILA, Friedrich-Alexander-Universität Erlangen-Nürnberg, ASHLEY WILLIS, University of Sheffield, BJÖRN HOF, Institute of Science and Technology Austria — We propose that a minimum transient growth, i.e. a measure of the linear amplification of disturbances to the base velocity profile, is needed for pipe flow turbulence to be self-sustained. Transient growth in shear flows accounts for the generation of strong velocity streaks via streamwise vortices and increases linearly as the Reynolds number increases. The instability of sufficiently amplified streaks causes streak breakdown and further regeneration of streamwise vortices. Here we show that if the transient growth can be greatly reduced by forcing the velocity profile (i.e. streaks amplification suppressed), the turbulence self-sustaining cycle is intercepted and turbulence relaminarises. For this modified flow profile, after further increase in Reynolds number turbulence only becomes sustained once the same level of transient growth has been regained. We show that for a variety of different flow profiles and Reynolds numbers turbulence always first arises at the same level of transient growth (approx. 15). Besides, this value of transient growth is also demonstrated to be the minimum for turbulent puffs to be self-sustained in normal (unforced) flow at low Reynolds numbers. Finally, we show how this mechanism can be exploited on turbulence control.

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