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Roll/streak Structure Instability Induced by Free-stream Turbulence in Couette Flow BRIAN FARRELL, Harvard University, PETROS IOANNOU, MARIOS NIKOLAIDIS, National and Kapodistrian University of Athens — Statistical state dynamics (SSD) provides a new perspective for studying mechanisms underlying turbulence in shear flow including instabilities which arise intrinsically from interaction between coherent and incoherent components of the turbulence. Implementations of SSD in the form of a closure at second order is used in this work to analyze the instability emergent from the statistical interaction between coherent perturbations of roll/streak form and the incoherent free-stream turbulence in a minimal channel configuration of Couette flow. By perturbing the nonlinear SSD dynamics a new manifold of stable modes with roll/streak structure is shown to exist in the presence of small amplitude free-stream turbulence. With increase in a parameter controlling the free-stream turbulence energy, a member of this set of stable roll/streak structures is destabilized at a bifurcation and the associated roll/streak eigenmode is found to equilibrate at finite amplitude. The bifurcation structure predicted by the SSD roll/streak instability is reflected in both a closely related quasi-linear dynamical system, referred to as the restricted non-linear (RNL) system, and in DNS. This correspondence is further verified using ensemble implementations of the RNL and DNS systems.

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