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A deterministic analysis of the impact of slip surfaces on laminar-to-turbulent transition and turbulence[1] JAE SUNG PARK, ETHAN DAVIS, University of Nebraska-Lincoln — The effect of slip surfaces on nonlinear invariant solutions to the Navier-Stokes equations is studied by direct numerical simulation in channel geometry. These solutions are also known as exact coherent states and arise via a saddle-node bifurcation. In general, lower-branch solutions are insightful in the study of transition as they lie along the laminar-turbulent boundary in state-space, while upper-branch solutions provide insight into the mean behavior of a turbulent flow. A deterministic analysis of the effect of slip surfaces on transition and turbulence is made by applying it to both lower- and upper-branch solutions. Two solution families are considered, a core mode and a critical-layer mode. Slip surfaces are found to have distinct effects on the dynamics of the system as it leaves each of these solution states. Slip surfaces cause the system to leave a core mode lower-branch solution earlier with a negligible effect on the instability. However, slip surfaces delay the system in leaving a critical-layer mode lower-branch solution, and the flow eventually laminarizes above a critical slip length. Upper-branch solutions are also observed to behave in distinct manners with the inclusion of slip surfaces. Flow dynamics and structures are further discussed.

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