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Control of Small- and Large- Scales in a Shear layer[1] ZVI RUSAK, INNESS EISELE, RPI — The response of a backward facing step flow to upstream flow perturbations at both low and high actuation frequency is investigated. This investigation entails the use of local linear temporal and spatial stability analyses, a second-order model equation, a global stability study, and direct numerical simulations. The model problems attempt to mathematically mimic the setup and flow conditions in the experiments of Vukasinovic et al. (2005). The computed results shed light on the perturbed flow structure and the measured flow characteristics along the shear layer of both free and directly manipulated states. The flow evolution may be described by a linear combination of the shear layer instability modes and the global mode of the base flow. It is shown that at low forcing frequencies, the periodic vortical perturbations grow over a distance in the near field of the step. This distance is directly related to position where the imposed perturbations' frequency matches twice the local natural frequency of the flow. Beyond this distance, the flow perturbations in the mid field decay exponentially, yet feeding energy to the far-field global mode which dominates the flow at large distances from the step. At high forcing frequencies, above twice the maximum local natural frequency in the domain, the near-field behavior is suppressed and flow perturbations decay with distance from the step (the mid field), thereby feeding much less energy to the far-field global mode.

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