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Optimal Disturbances and Receptivity of 3D Boundary Layers[1]
DAVID TEMPELMANN, KTH Mechanics, ARDESHIR HANIFI, FOI Sweden & KTH Mechanics, DAN HENNINGSON, KTH Mechanics — We will present spatial optimal disturbances in a Falkner-Skan-Cooke boundary layer and illuminate how these can be used to determine the receptivity of crossflow vortices to freestream disturbances. Optimal disturbances, which are obtained by solving a parabolized set of equations, initially take the form of vortices tilted against the direction of the mean crossflow shear. Further downstream they evolve into bended streaks and finally into crossflow disturbances. A large potential for initial non-modal growth becomes apparent where both the lift-up effect and the Orr-mechanism are identified as responsible physical mechanisms. We inquire if non-modal growth is related to a receptivity mechanism for modal instabilities in 3D boundary layers. We therefore use continuous modes from the Orr-Sommerfeld/Squire spectrum as a model for freestream turbulence and project them onto initial optimal disturbances in order to obtain receptivity coefficients. A parametric study concerning optimal growth and receptivity will be presented as well as a comparison to existing DNS and experimental data.

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