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Nonlinear optimal control of bypass transition in a boundary layer flow DANDAN XIAO, GEORGE PAPADAKIS, Imperial College London — Bypass transition is observed in a flat-plate boundary-layer flow when high levels of free stream turbulence are present. This scenario is characterized by the formation of streamwise elongated streaks inside the boundary layer, their break down into turbulent spots and eventually fully turbulent flow. In the current work, we perform DNS simulations of control of bypass transition in a zero-pressure-gradient boundary layer. A non-linear optimal control algorithm is developed that employs the direct-adjoint approach to minimise a quadratic cost function based on the deviation from the Blasius velocity profile. Using the Lagrange variational approach, the distribution of the blowing/suction control velocity is found by solving iteratively the non-linear Navier-Stokes and its adjoint equations in a forward/backward loop. The optimisation is performed over a finite time horizon during which the Lagrange functional is to be minimised. Large values of optimisation horizon result in instability of the adjoint equations. The results show that the controller is able to reduce the turbulent kinetic energy of the flow in the region where the objective function is defined and the velocity profile is seen to approach the Blasius solution. Significant drag reduction is also achieved.

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