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Airfoil Drag Reduction using Controlled Trapped Vorticity Concentrations MICHAEL DESALVO, ARI GLEZER, Georgia Inst of Technology — The aerodynamic performance of a lifting surface at low angles of attack (when the base flow is fully attached) is improved through fluidic modification of its "apparent" shape by superposition of near-surface trapped vorticity concentrations. In the present wind tunnel investigations, a controlled trapped vorticity concentration is formed on the pressure surface of an airfoil (NACA 4415) using a hybrid actuator comprising a passive obstruction of scale O(0.01c) and an integral synthetic jet actuator. The jet actuation frequency [$St_{\mathrm{act}} \sim$ O(10)] is selected to be at least an order of magnitude higher than the characteristic unstable frequency of the airfoil wake, thereby decoupling the actuation from the global instabilities of the base flow. Regulation of vorticity accumulation in the vicinity of the actuator by the jet effects changes in the local pressure, leading in turn to changes in the airfoil's drag and lift. Trapped vorticity can lead to a significant reduction in drag and reduced lift (owing to the sense of the vorticity), e.g. at $\alpha = 4^{\mathrm{o}}$ and $Re = 6.7{\cdot}10^5$ the drag and lift reductions are 14% and 2%, respectively. PIV measurements show the spatial variation in the distribution of vorticity concentrations and yield estimates of the corresponding changes in circulation.

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