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Large-Eddy Simulations of Plasma Control for Separated Supersonic Flow[1] NICHOLAS BISEK, JONATHAN POGGIE, Air Force Research Laboratory — The Navier-Stokes equations were solved using a high-fidelity time-implicit numerical scheme and an implicit large-eddy simulation approach to investigate plasma-based flow control for supersonic flow over a compression ramp. The configuration includes a flat-plate region to develop an equilibrium turbulent boundary-layer at Mach 2.25, which was validated against a set of experimental measurements. The fully turbulent boundary-layer flow traveled over a 24° ramp and produced an unsteady shock-induced separation. A control strategy to suppress the separation through a magnetically-driven gliding-arc actuator was explored. The size, strength, and placement of the actuator were developed based on recent experiments. Three control scenarios were examined: steady control, pulsing with a 50% duty cycle, and Joule heating. The results show the control mechanism reduced the time-mean separation length for all three situations. The case without pulsing and Joule heating was the most effective, with a reduction in the separation length by more than 75%. The controller was also found to significantly reduce the low-frequency content of the turbulent kinetic energy spectra within the separated region and reduce the total kinetic energy downstream of reattachment.

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