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Direct Simulation of Fluid-Structure Interaction in a Hypersonic Compression Ramp Flow[1] BRYSON SULLIVAN, University of Illinois at Urbana-Champaign, THOMAS WHALEN, STUART LAURENCE, University of Maryland, DANIEL BODONY, University of Illinois at Urbana-Champaign — Sustained hypersonic flight presents an enduring challenge to aircraft design and control. An extreme aerothermal environment acting on thin, multi-functional structures can yield significant fluid-thermal-structural interaction (FTSI) in control surfaces and/or a complete vehicle. While computationally efficient, the accuracy of reduced-order aerodynamic models can be compromised by local regions of subsonic/separated flow, highlighting the need for high-fidelity numerical simulations. The present talk outlines recent time-accurate FTSI simulations of a viscous flow at $M_\infty = 6.0$ over a 35° compression ramp with an embedded compliant panel. Reduced-order models are compared directly to FTSI simulation data, and a simple modification is proposed which can improve the accuracy of shock-expansion/local piston theory predictions. A reduction in surface heat flux is observed for most compliant cases, while traditional heat transfer analogies were found to be reliable only for the rigid case. Oscillation of the reattachment point was found to synchronize with the motion of the compliant panel for large-amplitude vibrations.

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