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Coupled computational fluid-thermal investigation of hypersonic flow over a quilted dome surface[1] CHRISTOPHER OSTOICH, DANIEL BODONY, PHILIPPE GEUBELLE, University of Illinois at Urbana-Champaign — The hypersonic environment is characterized by the high temperatures that are generated in the fluid at a vehicle surface. In the effort to enable the operation of lightweight, reusable hypersonic vehicles, flexible, thin thermal protection panels have been considered to mitigate thermal loads. High surface temperatures create through-the-thickness thermal gradients which cause the panels to bow, resulting in changes to the external flow field and leading to a fully coupled fluid-thermal-structural problem. Certain aspects of the fluid-thermal (no structural) coupling were examined in a 1980s NASA Langley experiment of a Mach 5.74 laminar boundary past an array of spherical domes. We reexamine this case computationally using a high-fidelity Navier-Stokes solver coupled with a thermal solver to investigate the effects on the flow and resulting heat load on the structure due to the bowed panels. Specifically the surface temperature, surface heat flux, and downstream boundary developments are reported, and compared with experiment.

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