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Convective and global stability analysis of a Mach 5.8 boundary layer grazing a compliant surface[1] FABIAN DETTENRIEDER, DANIEL BODONY, University of Illinois at Urbana-Champaign — Boundary layer transition on high-speed vehicles is expected to be affected by unsteady surface compliance. The stability properties of a Mach 5.8 zero-pressure-gradient laminar boundary layer grazing a nominally-flat thermo-mechanically compliant panel is considered. The linearized compressible Navier-Stokes equations describe small amplitude disturbances in the fluid while the panel deformations are described by the Kirchhoff-Love plate equation and its thermal state by the transient heat equation. Compatibility conditions that couple disturbances in the fluid to those in the solid yield simple algebraic and robin boundary conditions for the velocity and thermal states, respectively. A local convective stability analysis shows that the panel can modify both the first and second Mack modes when, for metallic-like panels, the panel thickness exceeds the lengthscale $\delta_{99} Re_x^{-0.5}$. A global stability analysis, which permits finite panel lengths with clamped-clamped boundary conditions, shows a rich eigenvalue spectrum with several branches. Unstable modes are found with streamwise-growing panel deformations leading to Mach wave-type radiation. Stable global modes are also found and have distinctly different panel modes but similar radiation patterns.

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