Abstract Submitted
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Shock-induced transition and heating in hypersonic boundary layers[1] LIN FU, MICHAEL KARP, Center for Turbulence Research, Stanford University, Stanford CA 94305, SANJEEB T. BOSE, Cascade Technologies Inc., Palo Alto, CA 94303, PARVIZ MOIN, JAVIER URZAY, Center for Turbulence Research, Stanford University, Stanford CA 94305 — The interaction of an incident shock wave with a Mach-6 undisturbed laminar boundary layer is addressed using DNS and equilibrium wall-modeled LES (WMLES). The wall temperature is cold compared to the free-stream stagnation temperature, such that the mean temperature profile develops a peak near the wall due to viscous heating. The consequences of the interaction are that the boundary layer transitions to turbulence downstream of the shock impingement point, and that transition causes a localized significant increase in the Stanton number and skin-friction coefficient. The peak thermomechanical load increases approximately linearly with the incidence angle. WMLES prompts transition and peak heating, delays separation, and shortens the separation bubble. WMLES provides predictions of DNS peak loads within 10% at 150 times lower computational cost. In the fully-turbulent boundary layer, WMLES agrees well with DNS for the Reynolds-analogy factor (Chi and Spalding, 1966), the mean velocity and temperature profiles, including the temperature peak, and the temperature/velocity correlations.

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