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Stability and sensitivity analysis of hypersonic flow past a blunt cone[1] JOSEPH W. NICHOLS, DAVID COOK, JOSEPH M. BROCK, GRAHAM V. CANDLER, University of Minnesota — We investigate the effects of nosetip bluntness and low-level distributed roughness on instabilities leading to transition on a 7 degree half-angle blunt cone at Mach 10. To study the sensitivity of boundary layer instabilities to bluntness and roughness, we numerically extract Jacobian matrices directly from the unstructured hypersonic flow solver US3D. These matrices govern the dynamics of small perturbations about otherwise laminar base flows. We consider the frequency response of the resulting linearized dynamical system between different input and output locations along the cone, including close to the nosetip. Using adjoints, our method faithfully captures effects of complex geometry such as strong curvature and roughness that lead to flow acceleration and localized heating in this region. These effects violate the assumption of a slowly-varying base flow that underpins traditional linear stability analyses. We compare our results, which do not rely upon this assumption, to experimental measurements of a Mach 10 blunt cone taken at the AEDC Hypervelocity Ballistic Range G facility. In particular, we assess whether effects of complex geometry can explain discrepancies previously noted between traditional stability analysis and observations.

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