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Uncertainty quantification of the instability in a supersonic boundary layer with roughness OLAF MARXEN, GIANLUCA IACCARINO, ERIC SHAQFEH, Stanford University — Knowledge of the location of laminar-turbulent transition on the surface of vehicles (re-)entering a planetary atmosphere is important for heat-shield design. However, due to the heat-shield material itself or as a result of ablation during flight, the surface of a heat shield is often not smooth. Instead, surface roughness occurs, but the height of this roughness may not be known beforehand. A numerical investigation of disturbance amplification in a laminar compressible flat-plate boundary layer with a localized 2-D roughness is carried out. Both linear and weakly non-linear disturbance evolution are considered. The non-linear case exhibits a secondary subharmonic resonance. In addition to deterministic simulations, a stochastic approach is applied to quantify uncertainties. The random parameter is chosen to be the height of the roughness in the linear case, while in the non-linear case the amplitude of the primary disturbance is considered a random parameter. Deterministic simulations show that the 2-D roughness acts as an amplifier for convective disturbances, and the resulting increased disturbance amplitude can enhance a secondary instability. The stochastic approach allows to quantify the probability for an increased or decreased amplification.

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