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Statistical inverse analysis of supersonic boundary-layer transition GENNARO SERINO, OLAF MARXEN, FABIO PINNA, von Karman Institute for Fluid Dynamics, PAUL CONSTANTINE, CATHERINE GORLE, GIANLUCA IACCARINO, Stanford University — In environments with low boundary-layer disturbance levels representative of free flight in the atmosphere, the laminar-turbulent transition process for vehicles moving at supersonic speeds is typically governed by the convective amplification of high-frequency disturbances. A valid statistical characterization of the disturbance spectrum upstream of the transition location is a pre-requisite for an accurate prediction of transition. Statistical inverse analysis offers the possibility to provide such a characterization of relevant disturbance spectra. Using measured streamwise distributions of heat-transfer coefficients in the transitional zone, an intermittency factor can be defined. The intermittency factor is fed into an inference algorithm based on the Markov chain Monte Carlo method. This approach is applied to infer two characteristic variables, amplitude and frequency, of the disturbance spectrum upstream of the transition location. It relies on the repeated solution of the forward problem, i.e., the computation of intermittency curve given a certain probability density function of the disturbances. The solution of the forward problem employs linear-stability theory in conjunction with a critical threshold amplitude for transition.

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