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Transition prediction for oblique breakdown in supersonic boundary layers with uncertain disturbance spectrum GENNARO SERINO, OLAF MARXEN, PATRICK RAMBAUD, THIERRY MAGIN, von Karman Institute for Fluid Dynamics — Prediction of laminar-turbulent transition is important for the design of heat shields for planetary (re)-entry vehicles. The heat load may increase significantly if a previously laminar boundary layer on the vehicle surface becomes turbulent. Transition-prediction methods based on linear stability theory, such as the e^N-method, offer an attractive compromise between simplicity and accuracy. However, non-linear stages of disturbance evolution as well as the receptivity stage are neglected, hampering the general use of these methods. Here we perform an investigation of the oblique breakdown scenario. In this scenario, a pair of oblique waves is convectively amplified and quickly leads to turbulence once these waves reach an amplitude of approximately two percent. This knowledge allows us to define a simple breakdown criterion as a model for the non-linear stage. The receptivity process, whose outcome provides the initial disturbance amplitudes, may not be as easily modeled. Flow physics of the receptivity process are neglected here. Instead, we assume an uncertain disturbance spectrum, which depends on the disturbance frequency and spanwise wave number. Using stochastic collocation, linear stability theory is then employed to yield a probabilistic transition prediction.

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