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Experimental Study of Transient Growth of Instabilities in a Laminar Boundary Layer PHILIPPE LAVOIE, Institute for Aerospace Studies, University of Toronto, Canada, AHMED NAGUIB, Dept of Mechanical Engineering, Michigan State University, USA, JONATHAN MORRISON, Dept of Aeronautics, Imperial College, UK — Transient growth of instabilities in laminar boundary layers has attracted significant attention in recent years, both theoretically and experimentally. The present work stems from an interest in model reduction for flow control, using the transient growth mechanism as a linear physical model representation of a turbulent boundary layer. As a stepping stone towards this goal, the aim of this study is to investigate the receptivity of laminar boundary layers to transient-growth modes in order to develop a wall-based estimator. Inspired by the work of White (2002) and Fransson et al. (2004), an extensive parametric study was undertaken to study the transient growth of instabilities introduced by a spanwise periodic array of roughness elements in a wind tunnel. A distinctive aspect of the present experiment is that the effects of Reynolds number, and the roughness heigh, diameter and spacing relative to the boundary layer thickness are investigated independently of each other. Physiological-based scaling of the disturbance energy growth and decay is demonstrated over a wide range of perturbation input and flow parameters. Dynamical implications of this scaling are discussed from the point of view of developing a reduced order model for flow control.

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