Abstract Submitted
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Multi-fidelity numerical simulations of shock/turbulent-boundary layer interaction with uncertainty quantification[1] IVAN BERMEJO-MORENO, LAURA CAMPO, Stanford University, JOHAN LARSSON, University of Maryland, College Park, MIKE EMORY, JULIEN BODART, FRANCISCO PALACIOS, GIANLUCA IACCARINO, JOHN EATON, Stanford University — We study the interaction between an oblique shock wave and the turbulent boundary layers inside a nearly-square duct by combining wall-modeled LES, 2D and 3D RANS simulations, targeting the experiment of Campo, Helmer & Eaton, 2012 (nominal conditions: $M = 2.05$, $Re_\theta = 6,500$). A primary objective is to quantify the effect of aleatory and epistemic uncertainties on the STBLI. Aleatory uncertainties considered include the inflow conditions (Mach number of the incoming air stream and thickness of the boundary layers) and perturbations of the duct geometry upstream of the interaction. The epistemic uncertainty under consideration focuses on the RANS turbulence model form by injecting perturbations in the Reynolds stress anisotropy in regions of the flow where the model assumptions (in particular, the Boussinesq eddy-viscosity hypothesis) may be invalid. These perturbations are then propagated through the flow solver into the solution. The uncertainty quantification (UQ) analysis is done through 2D and 3D RANS simulations, assessing the importance of the three-dimensional effects imposed by the nearly-square duct geometry. Wall-modeled LES are used to verify elements of the UQ methodology and to explore the flow features and physics of the STBLI for multiple shock strengths.

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Ivan Bermejo-Moreno
Center for Turbulence Research, Stanford University

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