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Study of transition mechanisms induced by an array of roughness elements[1] PRAKASH SHRESTHA, GRAHAM V. CANDLER, Univ of Minn - Minneapolis, COMPUTATIONAL HYPERSONICS RESEARCH LAB TEAM — We study transition mechanisms of a Mach 5.92 laminar boundary layer due to an array of prismatic roughness elements using large-scale direct numerical simulations (DNS). We simulate a boundary layer tripped by arrays of different numbers of roughness elements, corresponding to experiments conducted at the Texas A & M University Actively Controlled Experimental (ACE) facility. We obtain solutions using a high-order, low-dissipation scheme for the convection terms in the Navier-Stokes equations. We perform separate 2D and 3D simulations. Flow parallel inflow acoustic disturbances are implemented in the 2D domain. We then interpolate spectral content obtained at 30 mm from the leading edge of the 2D domain to the inflow of the 3D domain. In the 3D domain, we compute optimal modes of pressure using dynamic mode decomposition (DMD). Using sparsity-promoting dynamic mode decomposition (SPDMD), we select the dominant modes to study the transition mechanisms. Recirculating vortices upstream and separated shear layers downstream of the roughness elements are observed to be the most dominant modes of transition. We compare streamwise mean mass flux and energy spectral densities at different streamwise locations to validate our simulations.

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