Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Effect of Surface Curvature on Crossflow Instability in Swept-Wing Boundary Layers M. MALIK, W. LIAO, F. LI, M. CHOUDHARI, C. CHANG, NASA Langley Research Center — A three-dimensional boundary layer is subject to crossflow instability that manifests itself in the form of stationary or traveling disturbances. Stationary disturbances are induced by surface roughness while free stream turbulence induces traveling disturbances. It is known that convex surface curvature tends to stabilize crossflow instability while the mean flow non-parallel effect is generally destabilizing, with the net effect being mildly stabilizing when compared to the results obtained using quasi-parallel linear stability theory. Here, an analysis is performed for two swept airfoils using parabolized stability equations that account for both the surface curvature and the non-parallel effect. One airfoil has larger convex curvature than the other, where the convex surface curvature is scaled by defining a Gortler number. The net decrease in the stationary crossflow N factor is about 6 for the airfoil with stronger curvature. The analysis suggests that, if transition is induced by stationary crossflow disturbances, then surface curvature could be used as a control parameter for natural laminar flow design. The strong effect of surface curvature on stationary disturbances highlights the importance of investigating the receptivity of stationary and traveling disturbances since the latter are much less influenced by surface curvature resulting in much higher relative N factors for traveling disturbances.

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Date submitted: 05 Aug 2011 Electronic form version 1.4