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Steady Boundary Layer Disturbances Created By Two-Dimensional Surface Ripples[1] MATTHEW KUESTER, Virginia Tech — Multiple experiments have shown that surface roughness can enhance the growth of Tollmien–Schlichting (T–S) waves in a laminar boundary layer. One of the common observations from these studies is a "wall displacement" effect, where the boundary layer profile shape remains relatively unchanged, but the origin of the profile pushes away from the wall. The objective of this work is to calculate the steady velocity field (including this wall displacement) of a laminar boundary layer over a surface with small, 2D surface ripples. The velocity field is a combination of a Blasius boundary layer and multiple disturbance modes, calculated using the linearized Navier-Stokes equations. The method of multiple scales is used to include non-parallel boundary layer effects of $\mathcal{O}(R_\delta^{-1})$; the non-parallel terms are necessary, because a wall displacement is mathematically inconsistent with a parallel boundary layer assumption. This technique is used to calculate the steady velocity field over ripples of varying height and wavelength, including cases where a separation bubble forms on the leeward side of the ripple. In future work, the steady velocity field will be the input for stability calculations, which will quantify the growth of T–S waves over rough surfaces.

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