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Low order oscillatory modeling of the inner layer of turbulent boundary layers[1] PROMODE R. BANDYOPADHYAY, AREN M. HELLUM[2], Naval Undersea Warfare Center, Newport, RI — The visualization of the viscous sublayer (VSL) by Einstein & Li (1956) and others indicates an oscillatory character with varying periods of growth followed by Strouhal-like liquidation of spanwise vorticity into arrays of lifting hairpins. In streak PIV at 20 wall units due to Li, Adrian & Hanratty (1996), we notice a preponderance of dislocations. Therefore, we assume the sublayer to be in a permanent state of near-bifurcation irrespective of Reynolds number. To the lowest order, we model this process by Stuart-Landau (SL) oscillator equation. It is assumed that within a VSL cell, the oscillator is diffusively coupled along the span, the surface-normal growth is also diffusive—slowing as it thickens—and the outer layer provides the disturbance vector. The sublayer growth is followed by breakdown, creating a new outer layer disturbance vector for the next cycle. The SL equation is modified accounting for the above processes. The initial value solution of spanwise vorticity shows the development of nonuniformity, numerous dislocations and meandering streak-like structures that persist over extraordinarily large number of oscillatory cycles. Variation of the oscillator time scale shows the effects of increasing Reynolds number.

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