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Preponderance of hairpin vortices and their life cycles in the outer region of the canonical flat-plate boundary layer JAMES WALLACE, University of Maryland, XIAOHUA WU, Royal Military College of Canada — While the dominance of hairpin vortices in the transitional and early turbulent regions of the zero-pressure-gradient, flat-plate boundary layer has been widely accepted, recent literature is divided on this issue at higher Reynolds numbers. Here we investigate the representative vortex structures in the outer region of the canonical boundary layer over the momentum thickness Reynolds number range of 1000 to 3000, using the DNS database of Wu, Moin and Hickey (Phys. Fluids 26, 091104). In the outer region of the boundary layer we observe that hairpin vortices comprise nearly fifty percent of all the vortical structures visualized with the swirling strength λ_{ci}. Furthermore, these hairpins remain identifiable while they are advected downstream over distances corresponding to increases of about 300 - 400 in momentum thickness Reynolds numbers. Therefore, over the Reynolds number range studied, approximately three generations of hairpins go through their life cycles. This demonstrates that many of these outer region hairpin vortices are generated in the fully-turbulent region, and thus are not the debris of the upstream transition to turbulence. Coherent structures in the near-wall region will also be discussed.

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