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Hairpin vortices in the outer and near wall regions of the canonical turbulent boundary layer JAMES WALLACE, University of Maryland, XIAOHUA WU, Royal Military College of Canada, PARVIZ MOIN, Stanford University — While the dominance of hairpin vortices and their significance for transport processes in the transitional and early turbulent regions of the canonical turbulent boundary layer has been widely accepted, opinion is divided about the developed flow downstream. Here we investigate the representative vortical structures in the outer and near wall regions for the momentum thickness Reynolds number, Re_θ, of up to 3000 using the DNS database described in Phys. Fl. 26, 091104. This boundary layer grows spatially from a laminar state at $Re_\theta = 80$ beneath a freestream of continuous and nearly isotropic turbulence decaying from an intensity of 3 to 0.8%. The vortical structures are visualized with the swirling strength, λ_{ci}. In the outer region hairpin vortices appear and are advected over distances corresponding to about 300 - 400 in Re_θ within the fully turbulent region, demonstrating that they are not remnants of transitional structures. The near wall vortical structures are more difficult to visualize and require careful tuning of the swirling strength and making invisible the flow above the near wall region of the flow. The hairpins in this region occur in intermittent clusters that have features remarkably similar to transitional turbulent spots.

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