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Tow-tank investigation of the developing zero-pressure-gradient turbulent boundary layer JUNG HOON LEE, YONG SEOK KWON, JASON MONTY, NICHOLAS HUTCHINS, The University of Melbourne — Experiments are conducted using image-based measurement techniques to analyse the development of a zero-pressure-gradient turbulent boundary layer from trip to a high Reynolds number state. The unique experimental facility consists of a 5m long plate towed through a 60 x 1.8 x 1.8 m tow tank at speeds of up to 3 m/s. Windows in the side of the tank permit high-speed image acquisition and particle image velocimetry as the plate passes by the static measurement system. The evolution of the boundary layer can then be analysed from inception to Reynolds numbers up to $Re_\tau = 6000$ (near the end of the plate). Here $Re_\tau = \delta U_\tau/\nu$ is the Kármán number where δ is boundary layer thickness, U_τ is wall-shear velocity, and ν is kinematic viscosity. The unique frame-of-reference for this experiment enables us to track coherent motions as they evolve in the developing boundary layer. An analysis of vortical motion associated with the spatially and temporally evolving boundary layer reveals the development of large-scale vortices that originate from the inner region and extend to the edge of the outer region. Furthermore, the lifetimes of such large-scale vortical events can be estimated.

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