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Re-Innovating Recycling for Turbulent Boundary Layer Simulations JOSEPH RUAN, GUILLAUME BLANQUART, Caltech — Historically, turbulent boundary layers along a flat plate have been expensive to simulate numerically, in part due to the difficulty of initializing the inflow with "realistic" turbulence, but also due to boundary layer growth. The former has been resolved in several ways, primarily dedicating a region of at least 10 boundary layer thicknesses in width to rescale and recycle flow or by extending the region far enough downstream to allow a laminar flow to develop into turbulence. Both of these methods are relatively costly. We propose a new method to remove the need for an inflow region, thus reducing computational costs significantly. Leveraging the scale similarity of the mean flow profiles, we introduce a coordinate transformation so that the boundary layer problem can be solved as a parallel flow problem with additional source terms. The solutions in the new coordinate system are statistically homogeneous in the downstream direction and so the problem can be solved with periodic boundary conditions. The present study shows the stability of this method, its implementation and its validation for a few laminar and turbulent boundary layer cases.

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