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Turbulent boundary layers in long computational domains
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KTH Mechanics — A new series of numerical simulations of spatially evolving turbulent boundary layers is discussed. The very long computational domain starts at a low $Re_\theta = 180$, where laminar-turbulent transition is initiated, reaching up to the (computationally very) high $Re_\theta = 8500$. In the domain, the boundary layer develops naturally from the tripping location to the higher Reynolds numbers without any re-injection or recycling procedures. In consequence, this computational setup allows us to study, e.g., the mean flow development and the scaling behavior of the fluctuating energy free from pseudo-periodic effects. However, such domains require a large number of grid points; in the present case up to 10 billion for running well-resolved large-eddy simulation. The present results show excellent agreement with wind-tunnel experiments at similar Re and previous (lower- Re) simulations (both direct and large-eddy simulations). The mean velocity profiles closely follow the correlation proposed by Monkewitz et al. (2007), just about reaching the plateau in the log-law diagnostic function. In a second part, three-dimensional visualizations of the evolving turbulent boundary layer are discussed with special focus on the persistence of transitional flow structures towards higher Reynolds numbers, having a highly unordered appearance.

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