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DNS of turbulent boundary layer over a flat plate at $\mathbf{Re}_\theta = 5200$[1]

ANTONINO FERRANTE, KEEGAN WEBSTER, University of Washington, Seattle — We performed direct numerical simulations (DNS) of a spatially developing turbulent boundary layer over a flat plate at $\mathrm{Re}_\theta = 5200$. At this Reynolds number, our DNS results show that the overlap region of inner and outer layers extends for about 150 wall units. The turbulent inflow conditions were generated using the method of Ferrante & Elghobashi [J. Comput. Phys. 198 (2004)]. The computational domain of the main simulation is a parallelepiped with $2048 \times 1024 \times 512$ grid points in the streamwise, spanwise and wall-normal direction, respectively. The closest grid point to the wall is at $z^+ = 0.4$. The turbulence statistics were collected over a period of about 80 large-eddy turnover times. These simulations were made possible thanks to our development of an optimized and scalable 3D Poisson solver, which reduced the time to integrate the incompressible Navier-Stokes equations by 40%. Our DNS results are in excellent agreement with the experimental data of DeGraaff and Eaton [J. Fluid Mech. 422 (2000)] at the same Re_θ.

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