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Turbulent boundary layers: Inflow effects and cross-validation of simulation and experiment RAMIS OERLUE, PHILIPP SCHLATTER, Linne FLOW Centre, KTH Mechanics, Royal Institute of Technology, Stockholm, SWEDEN — A recent assessment of available direct numerical simulation (DNS) data from turbulent boundary layer flows [Schlatter & Örlü, J. Fluid Mech. 659, 116 (2010)] showed surprisingly large differences not only in the skin friction coefficient or shape factor, but also in their predictions of mean and fluctuation profiles far into the sublayer. Several DNS of a zero pressure-gradient (ZPG) turbulent boundary layer (TBL) à la Schlatter et al. [Phys. Fluids 21, 051702 (2009)] with physically different inflow conditions and tripping effects were performed. Most of the differences observed when comparing available DNS could thereby be traced back to different initial conditions. It was also found, that if transition is initiated at a low enough Reynolds number (based on the momentum-loss thickness) $Re_\theta < 300$, all data agree well for both inner and outer layer for $Re_\theta > 2000$; a result that gives a lower limit for meaningful comparisons between numerical and/or wind tunnel experiments. Based on these results a detailed comparison between DNS and experiment of a ZPG TBL flow at $Re_\theta = 2500$ and 4000 is presented. Good agreement is obtained for integral quantities, mean and fluctuating streamwise velocity profiles, but also for the probability distribution and spectral map throughout the boundary layer.

Ramis Oerlue
Linne FLOW Centre, KTH Mechanics,
Royal Institute of Technology, Stockholm, SWEDEN

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