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DNS of turbulence around a wing section at moderate Reynolds number PHILIPP SCHLATTER, SEYED M. HOSSEINI, RICARDO VINUESA, ARDESHIR HANIFI, DAN S. HENNINGSON, KTH Mechanics, Stockholm — We present the results of a large-scale simulation of the turbulent flow around a NACA-4412 wing section. The achieved Reynolds number is $Re_c = 400000$ based on the chord length ($Re_\theta = 3000$ based on momentum thickness), at angle of attack of 5 degrees. The fully resolved direct numerical simulation is performed using the spectral-element code Nek5000 with 3.2 billion grid points. After discussing details of the setup, e.g. boundary conditions and flow tripping at the leading edge, the focus is on the turbulent boundary layers under favorable and adverse pressure gradient developing along the wing surfaces. A first question to address is the definition of boundary-layer thickness in curved geometries. The adverse pressure gradients (APG) remain fairly constant $\beta < 4$ for the most part of the wing's upper side, only towards the trailing edge, incipient separation and much higher β are observed. The mean profiles show typical characteristics of APG boundary layers, to which we will compare in detail. A distinct outer peak in the fluctuations can be seen. These observations will be complemented with spectral views of the growing outer-layer influence. Furthermore, visualizations of the vortical structures will be shown, both on the wing, but also in the wake region.

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