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A DNS study of a shear-driven three-dimensional turbulent boundary layer with emphasis on momentum transport HIROYUKI ABE, Japan Aerospace Exploration Agency — DNS is used to examine a non-equilibrium three-dimensional turbulent boundary layer (3DTBL) over a flat plate owing to sudden imposition of surface spanwise velocity W_s. Particular attention is given to the effects of crossflow and Reynolds number on momentum transport. In the simulations, three values of inlet momentum thickness Reynolds number (=300, 600 and 900) are used with several values of W_s. The present largest W_s is twice the freestream velocity U_0, comparable to the maximum value in the spinning cylinder experiment by Lohmann (1976). After imposing W_s, the secondary Reynolds shear stress $\overline{vw}$ builds up and the mean spanwise velocity (crossflow) increasingly propagates towards the outer region where there is a mean streamwise velocity deficit due to the skewing. Near-wall Reynolds stresses (normalized by U_0^2) increase with crossflow due to the increased straining. As Re increases, the inner region of a near equilibrium 3DTBL becomes increasingly enlarged where the structure parameter is smaller than 0.15. The mean velocity magnitude also exhibits a departure from the classical log law (i.e. a larger κ than in a 2DTBL). After turning off W_s, the recovery to a 2DTBL is slow in the outer region since the 3D effect persists there.

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