Abstract Submitted
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Small wavy roughness effect on T-S wave and three-dimensional transition by Direct Numerical Simulation[1] SHINGO HAMADA, AIKO YAKENO, SHIGERU OBAYASHI, Institute of Fluid Science, Tohoku University, BAGUS NUGROHO, The University of Melbourne — Tani (1988) refered that the very small roughness with the height of lower than $6\nu/U_\tau$ could reduce skin friction drag, that scale was smaller than riblets (Walsh, 1982). In this study, we employ 2D and 3D DNS resolving each small roughness to analyze the effect of it on the turbulent transition of a flat plate boundary layer at $\mathrm{Re}_{\delta_s} = 3535$, where δ_s is the inlet boundary layer thickness. Artificial-disturbance of T-S wave instability is applied in an upstream. The roughness height is fixed at $\mathrm{h}/\delta_s = 0.141$, and the wavelength is varied from $\lambda/\delta_s = 0.89$, 1.06, 1.35, 1.56, 2.91 and 5.80 (here we call it Case 1 to 6). Note that the Case 5 roughness frequency is set to correspond to T-S unstable frequency. Firstly our 2D simulation showed that the T-S wave growth was significantly restrained under a certain wavelength, a similar behavior was also observed by Tameike et al. (2020). Our 3D DNS showed that the T-S wave growth was almost identical to our 2D DNS. In Cases 3 and 4, the flow became three-dimensional more rapidly than in Cases 1, 2 and 5, and the phenomenon was considerably affected by the roughness shape. However, the entire transition-delay performance seemed to depend on the primary mode growth for the present cases.

[1]Simulations were performed on the Supercomputer system at the Institute of Fluid Science (IFS) in Tohoku University. We acknowledge NEDO and the Collaborative Research Project Fund of IFS.

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