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Direct numerical simulation of turbulent Rayleigh-Bénard convection in a vertical thin disk[1] WEI XU, YIN WANG, Department of Physics, Hong Kong Univeristy of Science and Technology, XIAO-ZHOU HE, Shenzhen Graduate School, Harbin Institute of Technology, HIU-FAI YIK, Department of Physics, Hong Kong Univeristy of Science and Technology, XIAO-PING WANG, Department of Mathematics, Hong Kong Univeristy of Science and Technology, JORG SCHUMACHER, Institut fr Thermo- und Fluiddynamik, Technische Universitt Ilmenau, PENGER TONG, Department of Physics, Hong Kong Univeristy of Science and Technology — We report a direct numerical simulation (DNS) of turbulent Rayleigh-Bénard convection in a thin vertical disk with a high-order spectral element method code NEK5000. An unstructured mesh is used to adapt the turbulent flow in the thin disk and to ensure that the mesh sizes satisfy the refined Groetzbach criterion and a new criterion for thin boundary layers proposed by Shishkina et al. The DNS results for the mean and variance temperature profiles in the thermal boundary layer region are found to be in good agreement with the predictions of the new boundary layer models proposed by Shishkina et al. [Phys. Rev. Lett. 114, 114302 (2015)] and Wang et al. [Phys. Rev. Fluids 1, 082301(R) (2016)]. Furthermore, we numerically calculate the five budget terms in the boundary layer equation, which are difficult to measure in experiment. The DNS results agree well with the theoretical predictions by Wang et al. Our numerical work thus provides a strong support for the development of a common framework for understanding the effect of boundary layer fluctuations.

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