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Mean temperature profiles in turbulent Rayleigh-Benard convection O. SHISHKINA, M. KACZOROWSKI, DLR Goettingen, A. THESS, TU Ilmenau, C. WAGNER, DLR Goettingen, Germany — We report a study of mean vertical temperature profiles (TPs) in turbulent Rayleigh-Benard convection of water, $Pr = 4.38$, in unit-aspect-ratio cylindrical and cubic cells for Ra up to 10^9, based on DNS. The Nusselt numbers Nu computed for cylindrical cells are found to be in excellent agreement with the experimental data by Funfschilling et al. [J. Fluid Mech., vol. 536 (2005), pp. 145-154]. Based on this validation, the DNS data are used to extract TPs. In the DNS for the cylindrical geometry, reported in Shishkina & Thess [J. Fluid Mech. (2009), in press], we find that near the heating and cooling plates the TP $\Theta(y)$ obey neither a logarithmic nor a power law. We show that the Prandtl–Blasius BL theory predicts the TP-shapes with an error 7.9% within the thermal BLs alone. We further show that the profiles can be approximated by a stretched exponential approximation (SEA) of the form $\Theta(y) \approx 1 - \exp(-y - 0.5y^2)$ with an absolute error $< 1.1\%$ within the thermal BLs and $< 5.5\%$ in the whole cell. We provide also more accurate analytical approximations of the profiles involving higher-order polynomials in the SEA. Further, based on the DNS in a cube we extract TPs and estimate the accuracy of the above SEAs. Finally, we construct and analyze the quality of SEAs, which are based on local Nu.

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