Logarithmic temperature profiles in DNS of turbulent convection

ROBERTO VERZICCO, Università di Roma “Tor Vergata”, RICHARD STEVENS, Dept. Mech. Eng. Johns Hopkins University, DETLEF LOHSE, Physics of Fluids, University of Twente, SIGFRIED GROSSMANN, Dept. of Phys. University of Marburg, UNIROMA2 TEAM, UTWENTE TEAM, MARBURG TEAM — We report numerical results for vertical profiles of mean and rms temperature fluctuations for confined turbulent thermal convection in a cylindrical sample of aspect ratio $\Gamma = 0.5$ and 1 (diameter over height ratio) over a Rayleigh number range $2 \times 10^{10} \leq Ra \leq 2 \times 10^{12}$ and for a Prandtl number $Pr = 0.7$. We found that both quantities vary linearly in $\ln(z)$ with $z$ the distance from the horizontal plates. This behaviour had been predicted for the ultimate regime but it was not expected for the classical state ($Ra \leq 10^{13}$). Similar findings have recently been obtained also experimentally\(^1\) and an excellent agreement with the numerical results has been observed for the mean temperature profiles. The rms fluctuations, in contrast, present relevant differences with respect to the experiments and several explanations are possible.