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Quantifying Rayleigh-Benard convection via a symmetry approach HONG-YUE ZOU, Peking University, XI CHEN, Texas Tech University, YUN BAO, Sun Yat-sen University, FAZLE HUSSAIN, Texas Tech University, ZHEN-SU SHE, Peking University — We apply our recent symmetry-based theory of wall bounded turbulent flow - WBT - (i.e. channel, pipe and TBL) to study turbulent Rayleigh-Benard convection (RBC), which yields a multi-layer description of both mean velocity and temperature profile in the vertical direction. Close analogy to the WBT is developed in terms of two order functions, i.e. a momentum stress length function and a thermal diffusion function. Using the multi-layer formulas, the predictions are in quantitative agreement with DNS and experimental data for the Rayleigh-number (Ra) covering seven decades. In particular, a thermal buffer layer is predicted in accordance with previously postulated mixing zone which follows a $Ra^{1/7}$ scaling. Recently observed logarithmic profile of the mean temperature is reproduced, and the Ra-dependence of the log profile is explained. The non-homogenous effects in the horizontal direction of the RBC cell are also characterized by slight variations of the multi-layer parameters (i.e. layer thicknesses), influenced by the plumes and corner vortex in the flow. Thus, the turbulent RBC shares a similar multi-layer structure with the canonical wall-bounded flows whose mean profiles are quantified here for the first time.

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