On non-Oberbeck-Boussinesq effects in Rayleigh-Bénard convection in air ZHENHUA WAN, BEN WANG, QI WANG, SHU-NING XIA, QUAN ZHOU, DE-JUN SUN, University of Science and Technology of China — Direct numerical simulations (DNS) of non-Oberbeck-Boussinesq (NOB) Rayleigh-Bénard (RB) convection are performed in two-dimensional (2-D) and three-dimensional (3-D) cells. Perfect air is chosen as the operating fluid and the Prandtl number ($Pr$) is fixed to 0.71 for the reference state. Strong NOB effects are induced by large temperature differences at moderate Rayleigh numbers ($Ra$). Due to top-down symmetry breaking under NOB conditions, an increase of the centre temperature $T_c$ is found compared to the arithmetic mean temperature $T_m$, and the shifts of $T_c$ are strongly dependent on Rayleigh number $Ra$ and temperature differential $\epsilon$. The NOB effects on the Nusselt number ($Nu$) are quite small ($<2\%$). The power-law scalings of $Nu$ versus $Ra$ are robust against NOB effects, even though the temperature difference reaches up to 240 K. The Reynolds numbers $Re$, as well as the scalings of $Re$ versus $Ra$, are also insensitive to NOB effects. It is noteworthy that the influence of NOB effects on $Nu$ and $Re$ in 3-D RB flow is weaker than its 2-D counterpart.

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