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A similarity model solution for corner-roll in turbulent Rayleigh-Bénard convection[1] WEN-FENG ZHOU, JUN CHEN, ZHEN-SU SHE, State Key Lab. for Turb. & Complex Sys., College Engg., Peking Univ., Beijing 100871, China, YUN BAO, Dept. Appl. Mech. & Engg., Sun Yat-sen Univ., Guangzhou 510275, China — The corner-roll (CR) is the coherent structure in Rayleigh-Bénard convection (RBC), playing an important role in determining convection dynamics and heat transport. By inspecting the streamlines of the average flow field of direct numerical simulation (DNS) of RBC for Rayleigh number, $10^8 \leq Ra \leq 5 \times 10^9$, we propose a similarity model of statistically steady CR, based on an invariant geometrical form for the central role connected to a multi-layer description near the wall. It is shown that the model predicts the right characteristics of the mean velocity scaling $u_{cr}/U_f \sim Ra^{-0.165}$ and global Reynolds number's scaling $Re_{cr} \sim Ra^{0.25}$, compared to DNS. Furthermore, the model allows to extract, from DNS, a characteristic velocity scaling and a Reynolds number's scaling for the CR. More interestingly, we find that the CR possesses a Nusselt number scaling, $Nu_{cr} \sim Ra^{0.33}$, higher than the wind-shearing region $Nu_{sh} \sim Ra^{0.285}$. This is explained by a model considering the mechanical balance of plume emission in CR, respectively predicting $Nu_{cr\_mod} \sim Ra^{1/3}$, $Re_{cr\_mod} \sim Nu * \frac{r}{H} \sim Ra^{1/3-0.085}$, and $u_{cr\_mod}/U_f \sim Ra^{-1/6}$. In conclusion, a similarity model for CR is proposed and validated by DNS.

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