Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Inhomogeneous Nusselt Number Distribution in Turbulent Rayleigh-Bénard Convection[1] WEN-FENG ZHOU, JUN CHEN, ZHEN-SU SHE, State Key Lab. for Turb. & Complex Sys. — The Nusselt number (Nu) scaling with Rayleigh number (Ra) has been the focus in the study of Rayleigh-Bénard (RB) convection, inspiring the Grossman-Lohse proposal. However, different apparatus seem to display different scalings. We investigate this issue by considering inhomogenous Nu distribution along horizontal plate, with four flow regimes, i.e. corner-roll, jet-impingement, wind-shearing and plume-ejecting. In corner-roll, Nu scaling follows a modified mixing zone model, with a scale correction $r \sim Ra^{-0.085}$. In jet-impingement region, a streamwise momentum similarity yields an Nu distribution: $Nu_{ji} = 0.2Ra^{0.3}\exp(-1.2(x - x_{rea})/L_{ji})$. In wind-shearing region, side wall does not affect the similarity of the momentum and thermal boundary layer. In plume-ejecting region, after choosing the proper scale of plume scale as the buffer layer thickness and the ejecting velocity as large scale circulation velocity, the balance of inertia and buoyancy yields $Nu_{pe} \sim Ra^{0.369}$. In summary, four local Nu-scalings are obtained: 1/3, 0.30, 0.262, and 0.369, and the global Nu scaling is then obtained by adding all four with multiplying them with their spatial domain sizes. This model provides an alternative interpretation for Nu-scaling transition.

[1]Supported by National Nature Science Fund 11221062, 11452002 and by MOST 973 project 2009CB724100.

Jun Chen
State Key Lab. for Turb. & Complex Sys.

Date submitted: 02 Aug 2019 Electronic form version 1.4