Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Regime transitions in high-Rayleigh number vertical convection QI WANG, University of Twente University of Science and Technology of China, HORAN LIU, University of Twente, ROBERTO VERZICCO, University of Twente University of Rome, SHISHKINA OLGA, Max Planck Institute for Dynamics and Self-Organization, LOHSE DETLEF, University of Twente — Vertical convection (VC) is investigated using direct numerical simulations over wide range of Rayleigh numbers $10^5 \leq Ra \leq 10^{14}$, in a two-dimensionl convection cell with unit aspect ratio. The Prandtl numbers Pr vary from 0.71 to 30. The dependence of the mean vertical center temperature gradient $[S = \langle \partial T/\partial z \rangle_{c,t}]$ on Ra shows three different regimes. In Regime I where $Ra \leq 5 \times 10^{10}$, S hardly depends on Ra. In the newly-identified Regime II ($5 \times 10^{10} \leq Ra \leq 5 \times 10^{12}$), S first increases with increasing Ra and then reaches its maximum as function of Ra, before decreasing again. In Regime III where $Ra \geq 5 \times 10^{12}$, S again becomes weakly dependent on Ra, with a smaller value than that of Regime I. It is further found that the change of S is closely related to the change of global flow organization: The flow in Regime III is characterized by well-mixed bulk region due to continuous ejection of plumes over large fraction of the plate, thus S is smaller than that of the first regime. The scaling exponent β in the effective scaling $Nu \sim Ra^{\beta}$ reaches a value very close to 1/3 in Regime II and III, which is larger than the value around 1/4 in Regime I.

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Date submitted: 03 Aug 2020 Electronic form version 1.4