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Increase of heat transfer efficiency and plume coherence induced by geometrical confinement in turbulent thermal convection[1] KE-QING XIA, SHI-DI HUANG, MATTHIAS KACZOROWSKI, RUI NI, The Chinese University of Hong Kong — Using a classical convection model system, we show that a simple geometrical confinement can greatly increase the turbulent convective heat transfer efficiency, the Nusselt number Nu. It is found that when the aspect ratio (lateral dimension over height) of the system is decreased from 0.6 to 0.1, Nu is increased by 17% for the parameter range explored. Detailed experimental and numerical studies show that this enhancement is brought about by the changes in the dynamics and morphology of the thermal plumes in the boundary layers and in the large-scale flow structures in the bulk. It is found that the confined geometry produces more coherent and energetic hot and cold plume clusters that go up and down in random locations, resulting in more uniform and thinner thermal boundary layers. The study demonstrates how changes in turbulent bulk flow can influence the boundary layer dynamics and shows that the prevalent mode of heat transfer existing in larger aspect ratio convection cells, in which hot and cold thermal plumes are carried by the large-scale circulation along opposite sides of the sidewall, is not the most efficient way for heat transport.

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