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Superstructures in Rayleigh-Benard convection[1] RICHARD STEVENS, University of Twente, ROBERTO VERZICCO, University of Rome 'Tor Vergata', DETLEF LOHSE, University of Twente — We study the heat transfer and the flow structures in Rayleigh-Bénard convection as function of the Rayleigh number Ra and the aspect ratio. We consider three-dimensional direct numerical simulations (DNS) in a laterally periodic geometry with aspect ratios up to $\Gamma = L_x/L_z = L_y/L_z = 64$ at $Ra = 10^8$, where L_x and L_y indicate the horizontal domain sizes and L_z the height. We find that the heat transport convergences relatively quickly with increasing aspect ratio. In contrast, we find that the large scale flow structures change significantly with increasing aspect ratio due to the formation of superstructures. For example, at $Ra = 10^8$ we find the formation of basically only one large scale circulation roll in boxes with an aspect ratio up to 8. For larger boxes we find the formation of multiple of these extremely large convection rolls. We illustrate this by movies of horizontal cross-section of the bulk and the boundary layer and analyze them by using spectra in the boundary layer and the bulk. In addition, we study the effect of the large scale flow structures on the mean and higher order temperature and velocity statistics in the boundary layer and the bulk by comparing the simulation results obtained in different aspect ratio boxes.

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