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Stability transitions and energy pathways in horizontal convection at large Rayleigh numbers[1] BISHAKHDATTA GAYEN, ROSS W. GRIFFITHS, GRAHAM O. HUGHES, Australian National University — We report three-dimensional convective circulation forced by a temperature gradient along the surface of a rectangular channel, using direct and large eddy simulations over a wide range of Rayleigh numbers, $Ra \sim 10^8 - 10^{15}$. The solutions are allowed to reach thermal equilibrium in which there is no net heat input. A sequence of several stability transitions lead to a change from laminar to fully-developed turbulent flow. At the smallest Ra convection is maintained by a balance of viscous and buoyancy forces inside the thermal boundary layer, whereas at the largest Ra inertia dominates over viscous stresses. This results in an enhancement of the overall heat transfer at $Ra \geq 10^{10}$, while both dynamical balances give $Nu \sim Ra^{1/5}$. Our main focus is to analyze the mechanical energy budget. Below the transition the small scales of motion are driven predominately by thermal convection, whereas at $Ra > 10^{13}$ shear plays a dominant role in sustaining the small-scale turbulence.

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