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Including APE in the energy budget of turbulent Rayleigh-Bénard convection ROSS GRIFFITHS, BISHAKHDATTA GAYEN, GRAHAM HUGHES, Australian National University — An expanded view of the mechanical energy budget for Rayleigh-Bénard convection is developed, recognising that the available part of potential energy (APE) is the energy source for convection. Energy conversion rates and the partitioning of energy pathways between large and small scales of motion are examined using three-dimensional numerical simulations. The relative magnitudes of different pathways change significantly over the range $Ra \sim 10^7 - 10^{13}$. At $Ra < 10^7$ small-scale turbulent motions are energized directly from APE while kinetic energy is dissipated by both the large- and small-scale motions at comparable rates. In contrast, at $Ra \geq 10^{10}$ most of the APE goes into kinetic energy of the large-scale flow, which then undergoes shear instabilities sustaining small-scale turbulence. At large Ra one half of the total APE supply goes to viscous dissipation, the other half to mixing, giving a mixing efficiency of 50% as predicted theoretically. While the viscous dissipation is largely in the interior, the irreversible mixing is largely confined to the unstable boundary layers. Thus inclusion of 'the other half' of the energy in the budget provides new information on the mechanics of the interior and boundary layers, and the roles of different length scales.

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