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Transport by deep convection in buoyancy-forced circulation in a rotating basin CATHERINE VREUGDENHIL, BISHAKHDATTA GAYEN, ROSS GRIFFITHS, Australian National University — We use direct numerical simulations of buoyancy-forced circulation in a rotating f-plane basin to examine transport by geostrophic flow and deep convection. The domain is a closed rectangular box with vertical and horizontal aspect ratios of $A = 0.16$ and $A_y = 0.24$ respectively. Half the base is cooled and half is heated to achieve Rayleigh numbers $Ra \approx 10^{12} - 10^{13}$, where Ra defined in terms of domain length L. Ekman number is varied as $E \approx 10^{-7} - 10^{-5}$ and Prandtl number is $Pr = 5$. The results show that circulation and heat throughput are governed by horizontal geostrophic flow in the thermal boundary layer and are functions of a convective Rossby number. Vertical heat transport is mostly by open-ocean chimney convection; mean vertical transport of water is both in chimneys and against side boundaries. We calculate energy budgets and, for the Ra available here, the energy sinks of dissipation and irreversible mixing are largely confined to the thermal boundary layer. For small Rossby numbers relevant to the ocean the results imply that heat throughput and mean circulation are controlled by geostrophic flow and boundary currents, while vertical heat transport from the surface layer into the deep interior occurs mostly in open-ocean chimney convection.

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