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Cellular Convection in a Chamber with a Warm Surface Raft
JOHN WHITEHEAD, Woods Hole Oceanographic Institution, ERIN SHEA, MIT, MARK BEHN, WHOI — We calculate velocity and temperature fields for Rayleigh-Benard convection in a chamber with a warm raft that can float along the top surface for Rayleigh number up to Ra=20,000. Two-dimensional, infinite Prandtl number, Boussinesq approximation equations are numerically advanced in time from a motionless state in a chamber of length L' and depth D'. We consider cases with an insulated raft and a raft of fixed temperature. Either oscillatory or stationary flow exists. The case of an insulated raft has three governing parameters: Ra, scaled chamber length L=L'/D', and scaled raft width W. For W=0 and L=1, the marginal state is at Ra=779.3. For smallest W (determined by numerical grid size) and Ra<790 the raft approaches the center monotonically in time. For 790<Ra<811 the raft has a decaying oscillation consisting of raft movement back and forth (and convection cell reversal). For 811>Ra>871 amplitude is steady, starting small and increasing with larger Ra and for Ra>871 raft movement ceases. For larger W, a range of W and Ra has raft oscillation up to Ra=20,000. Rafts in longer cavities (L=2 and 4) have almost no oscillatory behavior. With a raft of temperature Tr rather than insulating, Ra=20,000, and with internal heating, there are wider ranges of oscillating flow. Thus the presence or absence of motion is very sensitive to W, L, raft thermal properties and Ra. Reasons why are discussed.

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