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Two regimes of forced turbulent convection

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We study experimentally a forced turbulent convection in the Rayleigh-B\'{e}nard apparatus with an additional source of turbulence produced by the two oscillating grids located nearby the side walls of the chamber. Two different regimes have been observed in the forced turbulent convection. When the frequency of the grid oscillations f>2 Hz, the large-scale circulation (LSC) is totally destroyed, and the destruction of the LSC is accompanied by a strong change of the mean temperature distribution. For the very low frequency the thermal structure inside the LSC is inhomogeneous and anisotropic. The hot thermal plumes accumulate at one side of LSC, and cold plumes concentrate at the opposite side of LSC. The mean temperature gradient in the horizontal direction inside the LSC is significantly larger than in the vertical direction. For the high frequency (f > 10 Hz), LSC has not been observed and the mean temperature gradient in the central flow region in the vertical direction, \nabla_z T, is essentially larger than in the horizontal direction. In this regime of the forced convection the ratio $\ell_z |\nabla_z T| / \sqrt{< \theta^2 >} = $ const, in agreement with the theoretical predictions. Here ℓ_z is the vertical correlation turbulent length scale that is nearly independent of the frequency, and θ are the temperature fluctuations generated by the tangling of the mean temperature gradient by the velocity fluctuations.

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