

PLUMES AND LARGE SCALE CIRCULATION IN TURBULENT THERMAL CONVECTION WITH A ROUGH PLATE

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In a real thermal system, the underlying surfaces have specific topographies or small scale roughness that have a significant effect on heat transfer. In particular, in the case of turbulent convection, the addition of wall roughness leads to a global increase in heat transfer [1, 2]. Three successive heat transfer regimes can be obtained. It is generally accepted that the heat transfer enhancement results from an intensification of the thermal plume emission (e.g. [3]).

In the present study, we consider convection over a regularly roughened plate in a Rayleigh-Bénard cell. The aim of this work is to determine how the roughness alters the interactions between the plumes and the large-scale circulation, as a function of the heat transfer regime. Three-dimensional direct numerical simulations (DNS) have been performed for Rayleigh numbers covering five decades up to $Ra = 10^{10}$ and for two roughness sizes.

However, even though the development of massively parallel DNS solvers now makes it possible to tackle calculations in highly turbulent regimes, it remains difficult to statistically approach all flow scales, store them or easily replay their sequences. Therefore, a first attempt to build a reduced model for 3D flow reconstruction using physically informed neural networks is presented [4].

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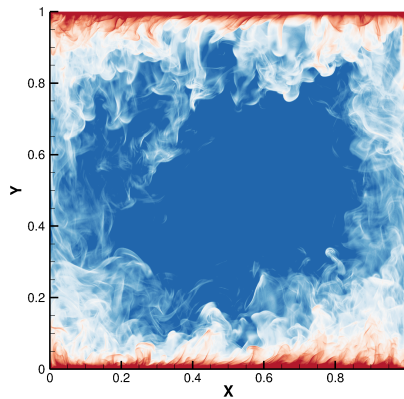


Figure 1: Thermal plumes in a water-filled cell at $Ra = 10^{10}$ with several hundred blocks roughened on the bottom plate.

References

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