Effects of employing liquid-liquid emulsions on heat transfer within a turbulent Rayleigh-Benard convection

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Figure 1: *20% Droplets*

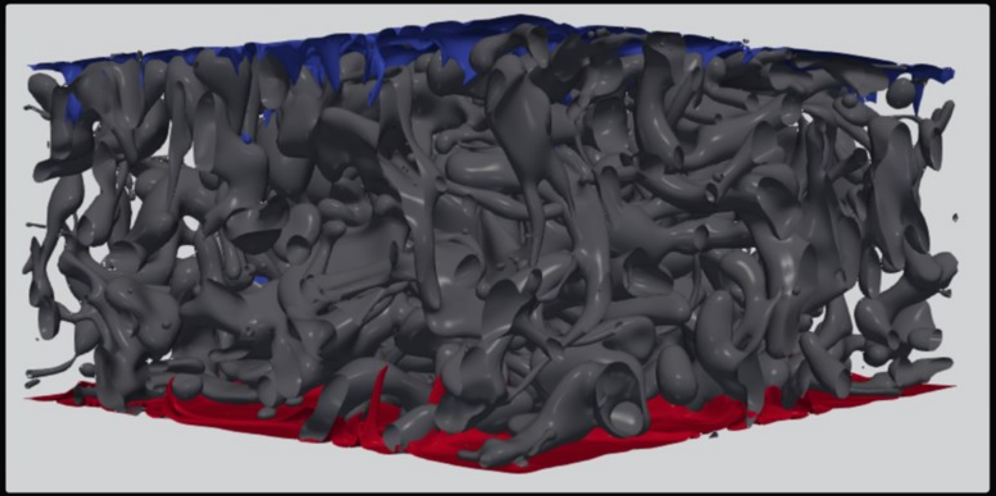
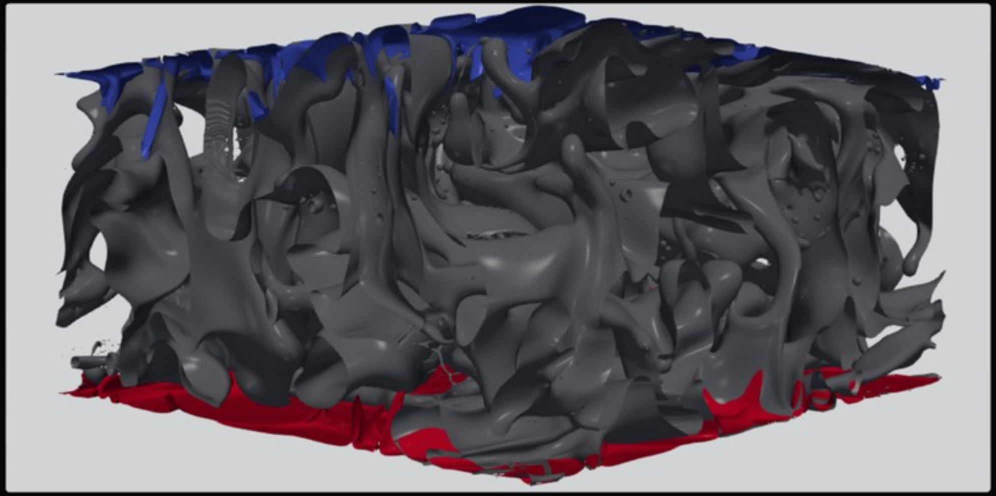


Figure 2: *50% Droplets*

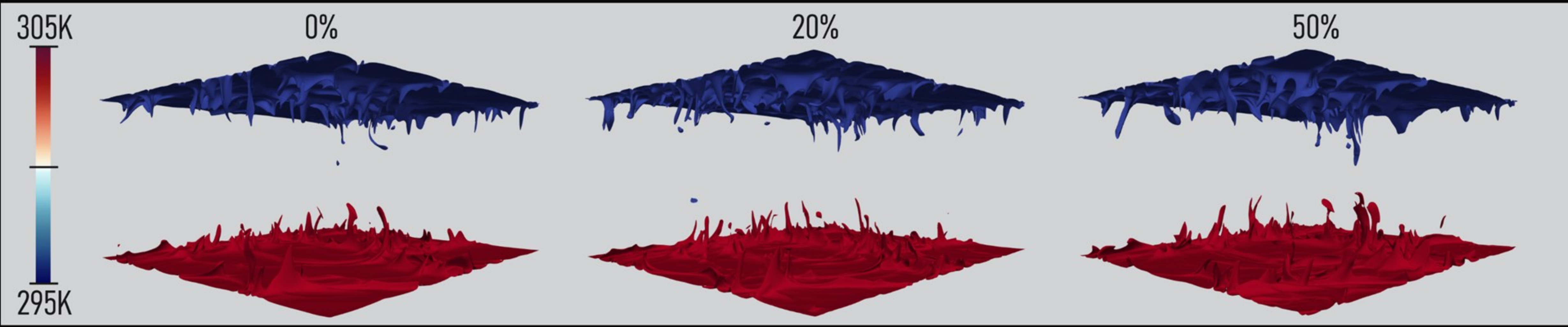


Boundary between fluids is shown as dark surface

Rayleigh-Bénard (RB) convection occurs in a fluid layer when there is a temperature difference between the top and bottom boundaries, resulting in the spontaneous formation of convective motion. In this study, a direct numerical simulation has been performed aimed at elucidating the impact of introducing dispersed droplets into a single-phase flow on the heat transfer dynamics within this flow. The dimensionless parameters considered in this study encompass a Prandtl number of 4, a Weber number of 6000, and a Rayleigh number of 10^8. Dispersed droplets were incorporated over a range spanning from 0 to 50%. Figures 1 and 2 present visualizations in the form of instantaneous three-dimensional iso-surfaces depicting the dispersed droplets, as well as the cold and hot thermal plumes. These visual representations pertain to two specific cases involving 20% and 50% droplet concentrations.

As figure 3 depicts, our findings reveal that the introduction of droplets into the single-phase flow induces notable alterations in the dispersed droplet size distributions, characterized by heightened coalescence dynamics and variations in the localized droplet distributions within the RB cavity. Consequently, both the diffusion flux in close proximity to the wall and the convection heat flux experience significant enhancements. These enhancements collectively contribute to an increase in total heat transfer, with the most significant enhancement observed in the case involving 50% dispersed droplets, where a maximum of 10% improvement in heat transfer was recorded.

Figure 3



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