# Boundary layer dynamics at high Rayleigh numbers using DNS and experiments

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Rayleigh-Bénard cavity flows are particularly well suited to studying the physics of turbulent thermal convection, as they consist of boundary layers sheared by a turbulent wind, which itself is generated by buoyant convection, creating a turbulent bulk. Recently, it has been shown that by considering the Reynolds number of the wind, the apparent contradiction between the large number of experimental results in the literature based on different operating conditions can be resolved[1]. A universal critical Reynolds number has also been identified. This number distinguishes two turbulent regimes.

In this work we focus on the second regime. The kinetics of this regime is fully turbulent, but it is not yet the so-called ultimate regime. It corresponds to Reynolds numbers higher than $10^4$, for which we report results from experimental and direct numerical simulations (DNS). These results are summarized in the figure 1 together with some data from the literature. The instantaneous temperature field, displayed in figure 1, is a typical example of flow in this regime. Based on numerical simulations of water flows and experiments[2] with water or fluorocarbon as working fluid, for Rayleigh numbers up to $10^{12}$, we will examine the nature and the structure of the kinetic and thermal boundary layers in terms of normal mean profiles to the wall, or local heat-fluxes.

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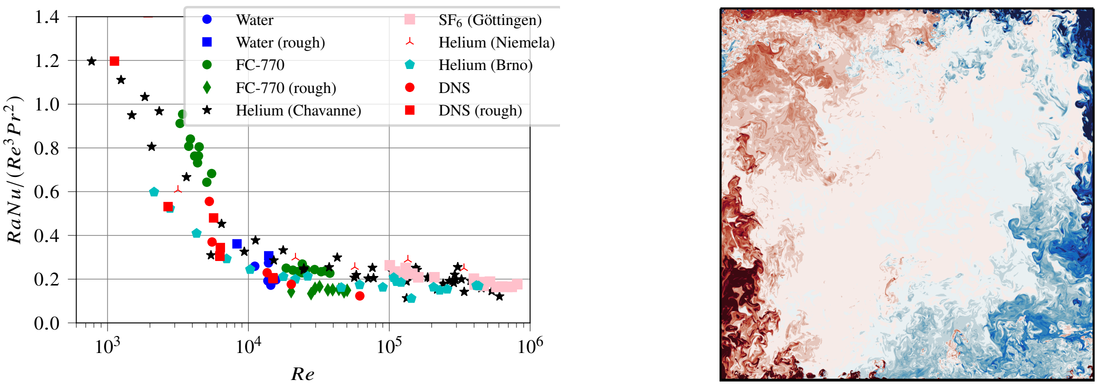


Figure 1: Left: Friction coefficient from Lyon's experiments and Orsay's DNS data combined with literature data (see legend). From (1). Right: A particular instantaneous temperature field in the median vertical plane with the Rayleigh number ($Ra = 10^{12}$ and $Pr = 4.4$) obtained by DNS.

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[1]Brichet et al., *In revision* (2025)
[2]Méthivier et al., *EPL* **136**, 10003 (2021)