

Numerical modeling of turbulent convection in an asymmetric rough Rayleigh-Bénard cell

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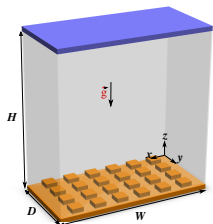


Asymmetry of temperature field due to roughness

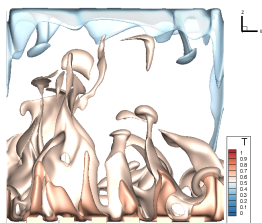
Rough Rayleigh-Bénard convection: a 5-parameter problem

- 2 physical parameters: $Ra = \frac{g\beta\Delta TH^3}{\kappa\nu}$, $Pr = \frac{\nu}{\kappa} = 4.38$ (with $\Delta T = T_{hot} - T_{cold}$)
- 3 geometrical parameters: $A_{plot} = H_{plot}/H = 0.03$; $A_W = W/H = 1$; $A_D = D/H = 0.5$

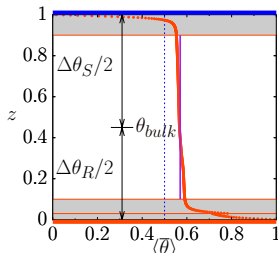
Geometry and temperature field



Computational domain:
a Rough/Smooth cavity (R/S)



Instantaneous temperature field



Mean vertical profile

Plate separation regarding bulk temperature (θ_{bulk}): two new $\Delta\theta$ (Tisserand et al. 2011)

- Smooth plate: $\Delta\theta_S = 2(\theta_{bulk} - \theta_{cold})$
- Rough plate: $\Delta\theta_R = 2(\theta_{hot} - \theta_{bulk})$

Intensification of heat transfer (Nu) due to roughness

Plate separation regarding bulk temperature (θ_{bulk}): two new Ra , Nu (Tisserand et al. 2011)

• Smooth plate:

$$\begin{cases} Ra_S &= Ra \times (\Delta\theta_S/\Delta\theta) \\ Nu_S &= Nu \times (\Delta\theta/\Delta\theta_S) \end{cases}$$

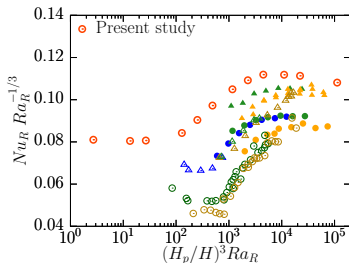
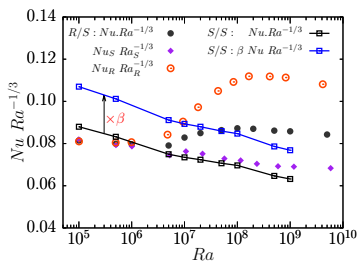
• Rough plate:

$$\begin{cases} Ra_R &= Ra \times (\Delta\theta_R/\Delta\theta) \\ Nu_R &= Nu \times (\Delta\theta/\Delta\theta_R) \end{cases}$$

Compensated Nusselt number (Nu) versus Rayleigh number (Ra)

► Influence of roughness

► Good agreement with experimental results



Exchange surface ratio β ($= \frac{S_R/S}{S_{smooth}}$, $S \equiv$ surface)

Experimental data from (Rusaouen et al., *JFM*, 2018)

$H_p = 2mm$: Small cell (\triangle , \triangle , \triangle), Tall cell (\circ , \circ);

$H_p = 4mm$: Small cell (\blacktriangle , \blacktriangle) and Tall cell (\bullet , \bullet)