This three-dimensional benchmark was first proposed by [?]. It has been subsequently presented in [?, ?, ?, ?, ?, ?, ?]. We here focus on Case 1 of [?]: an isoviscous bimodal convection experiment at $Ra = 3 \times 10^5$.

The domain is of size $a \times b \times h$ with $a = 1.0079h$, $b = 0.6283h$ with $h = 2700$km. It is filled with a Newtonian fluid characterised by $\rho_0 = 3300\text{kg.m}^{-3}$, $\alpha = 10^{-5}\text{K}^{-1}$, $\mu = 8.0198 \times 10^{23}\text{Pa.s}$, $k = 3.564\text{W.m}^{-1}\text{.K}^{-1}$, $c_p = 1080\text{J.K}^{-1}\text{.kg}^{-1}$. The gravity vector is set to $\boldsymbol{g} = (0, 0, -10)^T$. The temperature is imposed at the bottom ($T = 3700°\text{C}$) and at the top ($T = 0°\text{C}$).

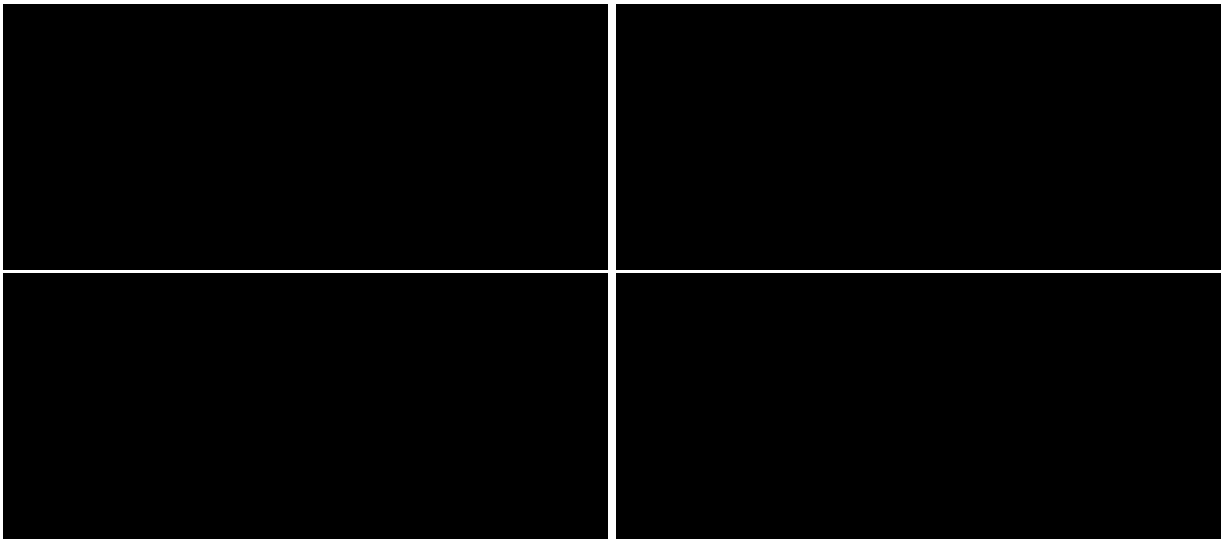
The various measurements presented in [?] are listed hereafter:

- The Nusselt number Nu computed at the top surface following Eq. (??):

$$Nu = L_z \frac{\int\int_{z=L_z} \frac{\partial T}{\partial y} dxdy}{\int\int_{z=0} T dxdy}$$

- the root mean square velocity v_{rms} and the temperature mean square velocity T_{rms}
- The vertical velocity w and temperature T at points $\boldsymbol{x}_1 = (0, 0, L_z/2)$, $\boldsymbol{x}_2 = (L_x, 0, L_z/2)$, $\boldsymbol{x}_3 = (0, L_y, L_z/2)$ and $\boldsymbol{x}_4 = (L_x, L_y, L_z/2)$;
- the vertical component of the heat flux Q at the top surface at all four corners.

The values plotted hereunder are adimensionalised by means of a reference temperature (3700K), a reference lengthscale 2700km, and a reference time L_z^2/κ.



features

- $Q_1 \times P_0$ element
- incompressible flow
- mixed formulation
- Dirichlet boundary conditions (free-slip)
- direct solver
- isothermal
- non-isoviscous
- 3D
- elemental b.c.
- buoyancy driven

ToDo: look at energy conservation. run to steady state and make sure the expected values are retrieved.