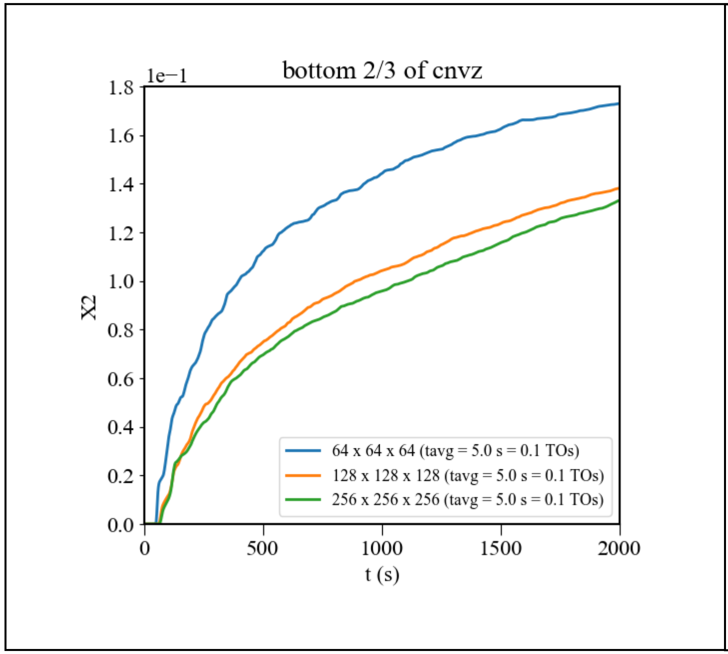
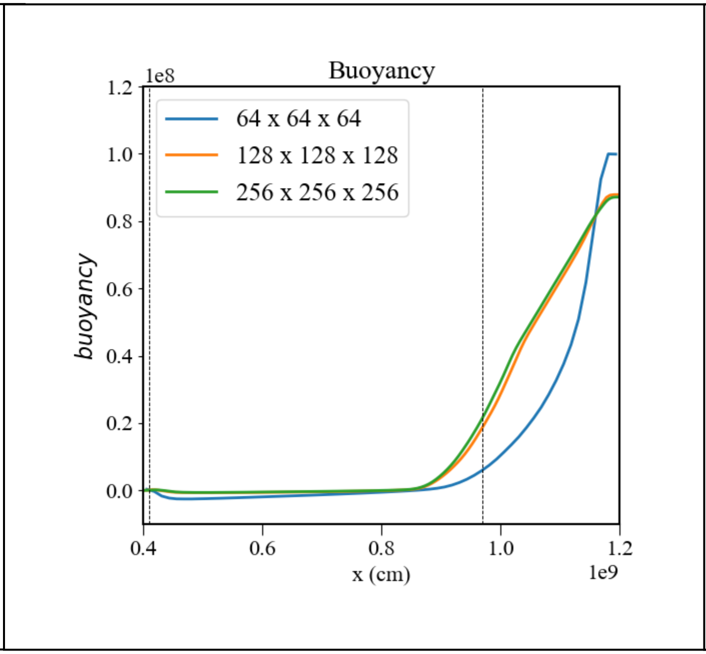
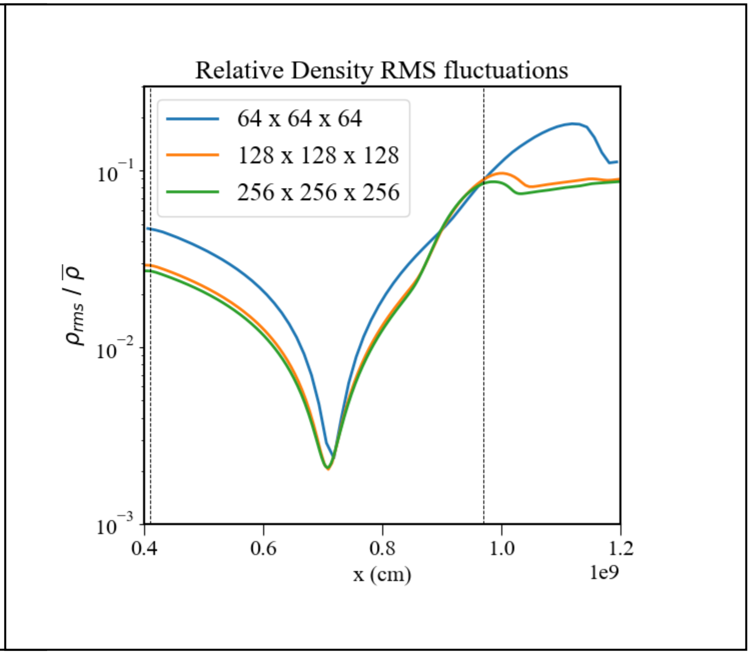
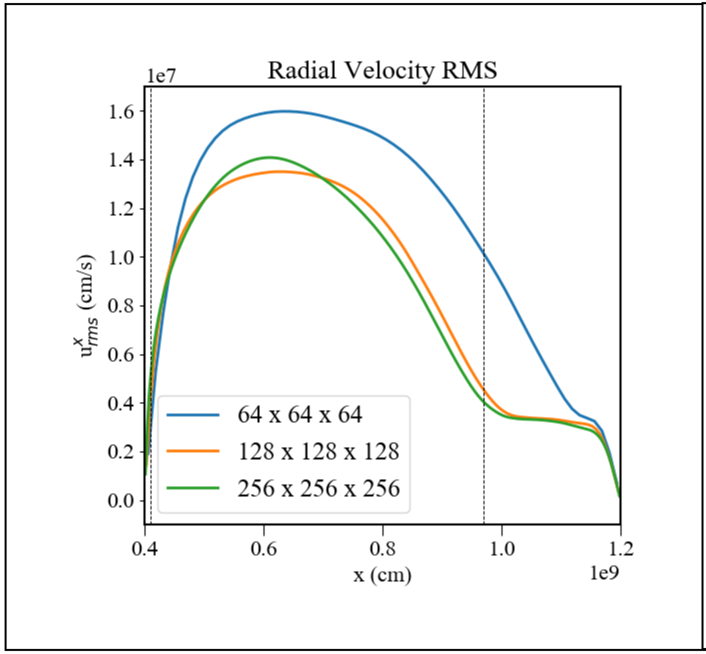
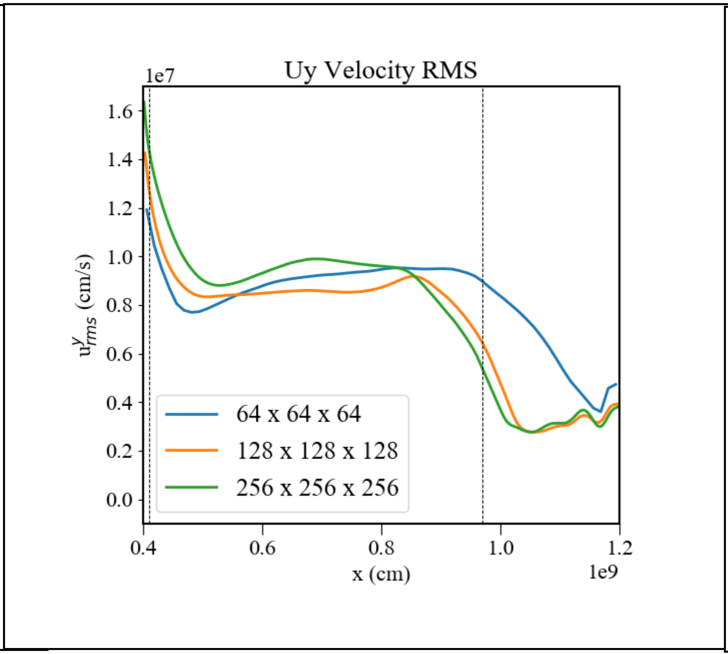
Code Comparison Project – two-layer setup 3D simulation (RANS analysis hightlights)

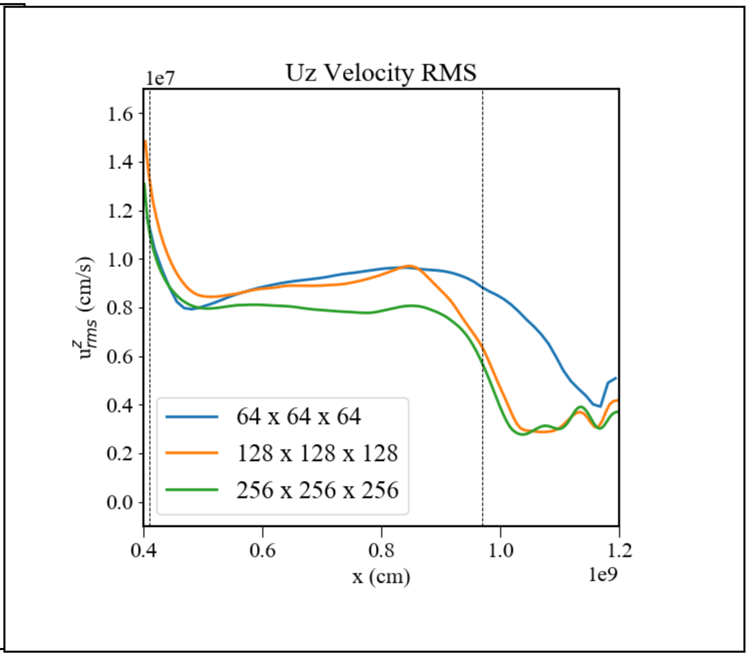












With increasing resolution, the strength of turbulence at convection boundary decreases (the radial and horizontal rms velocity goes down, perhaps due to decreasing density fluctuations, less buoyancy, weaker turbulence flow). Does the boundary become stiffer too? Can you infer from buoyancy jump? What effect has tavg? Profiles above averaged over 1500 secs.

One of the primary conclusions of these studies is that the entrainment rate depends on a Richardson number, which is a dimensionless measure of the "stiffness" of the boundary relative to the strength of the turbulence. In shear-free turbulent entrainment the bulk Richardson number,

$$\mathrm{Ri}_B = \frac{\Delta b L}{\sigma^2}, \tag{2}$$

is most commonly studied. Here Δb is the buoyancy jump across the interface, σ is the rms turbulence velocity adjacent to the interface, and L is a length scale for the turbulent motions, which is often taken to be the horizontal integral scale of the turbulence near the interface. The relative buoyancy is defined by the integral

$$b(r) = \int_{r_i}^{r} N^2 \, dr, \tag{3}$$

where N is the buoyancy frequency defined by

$$N^2 = -g\left(\frac{\partial \ln \rho}{\partial r} - \frac{\partial \ln \rho}{\partial r}\bigg|_s\right). \tag{4}$$

The entrainment coefficient E is the interface migration speed u_e normalized by the rms turbulent velocity at the interface $E = u_E/\sigma$ and is generally found to obey a power-law dependence on Ri_B,

$$E = A\mathrm{Ri}_B^{-n}. \tag{5}$$

The exponent is usually found to lie in the range $1 \lesssim n \lesssim 1.75$

Casey A. Meakin[1,2] and David Arnett[1]
Received 2006 October 27; accepted 2007 May 21

Turbulent kinetic energy dissipation appear to play a significant role at controling internal energy, temperature or enthalpy evolution.