Rapidly Rotating Convection: When Geometry Matters

- The problem:
  - Rotationally constrained: $E = \dfrac{\nu}{\Omega d^2} \ll 1, \; Ro = \dfrac{U}{\Omega d} \ll 1$
  - Highly turbulent: $Re = \dfrac{Ud}{\nu} \gg 1$
  - Unstably stratified

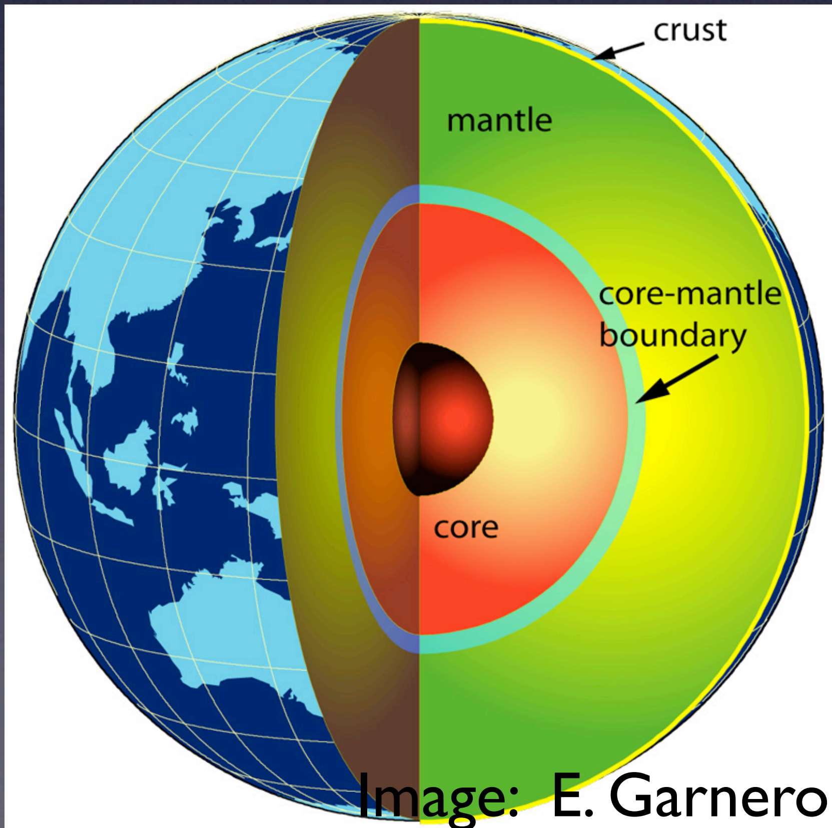

Image: E. Garnero

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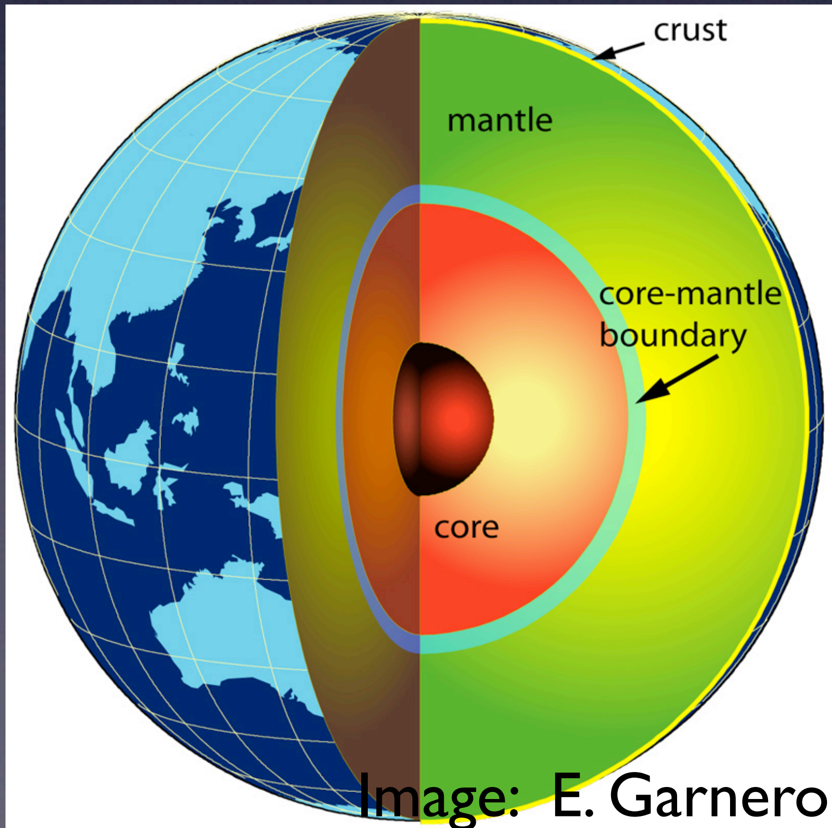
Earth's core:

$$Ro \sim 10^{-7}, E \sim 10^{-15}, Re \sim 10^{8}$$



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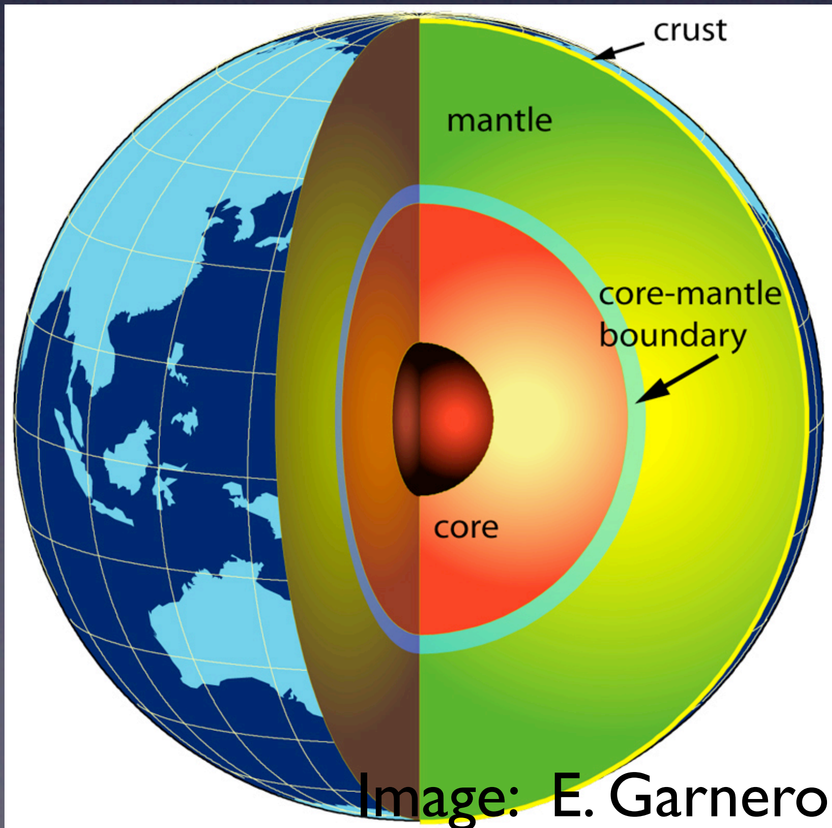
MHD environment, but don't understand convection yet



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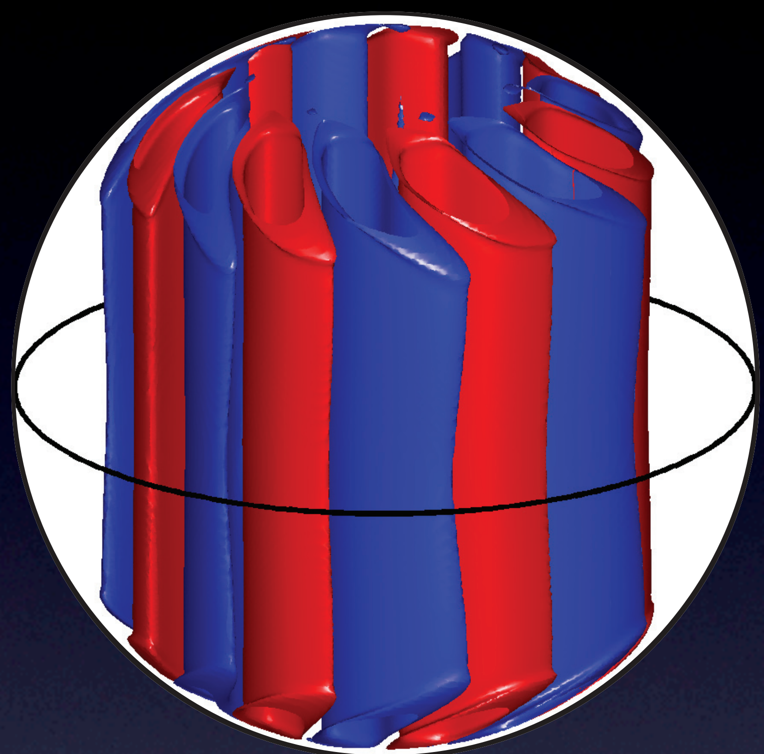
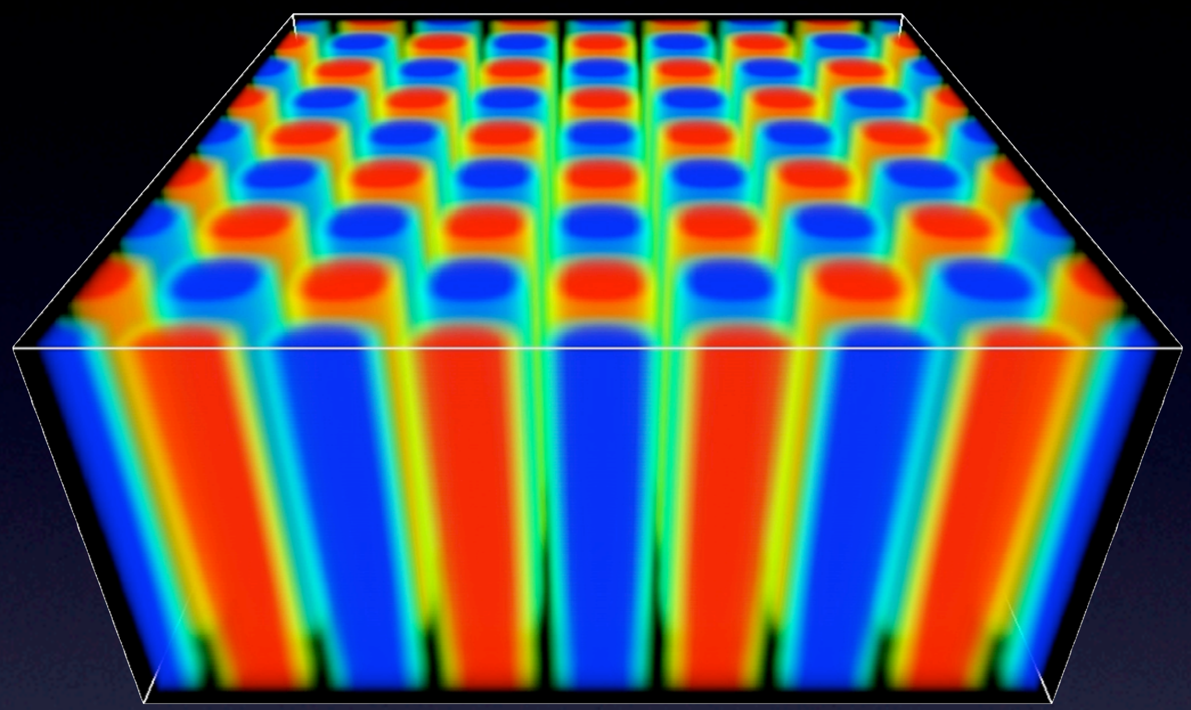
Spherical vs. Cartesian



E~1e-4 (Krista Soderlund)



E<<1 (Calkins et al., 2013)

- Traveling Rossby waves
- Scalings:

$$k_\phi \sim E^{-1/3} \;\; k_R \sim E^{-2/9} \;\; k_Z \sim \mathcal{O}(1)$$

- Stationary for Pr > 1
- Scalings:

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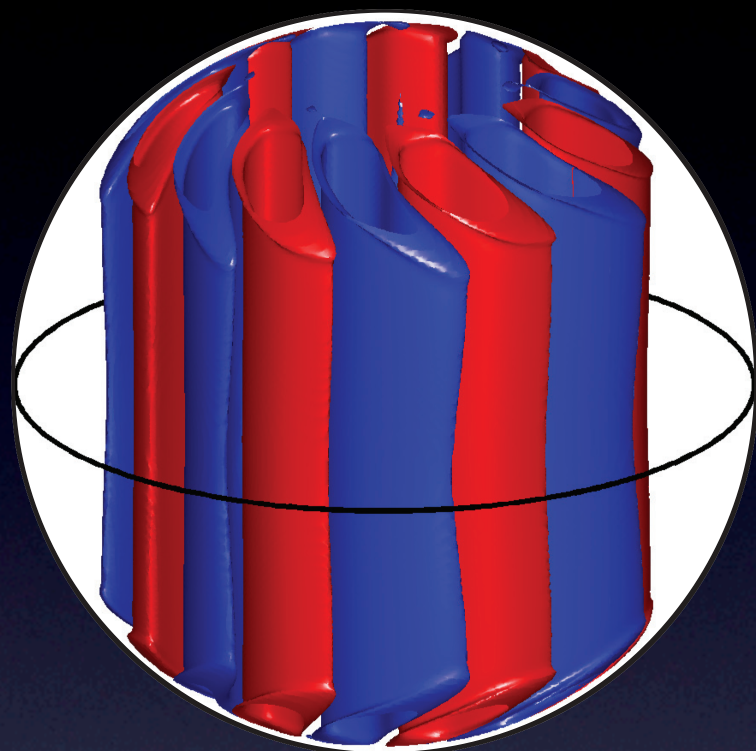
Spherical vs. Cartesian



E~1e-4 (Krista Soderlund)

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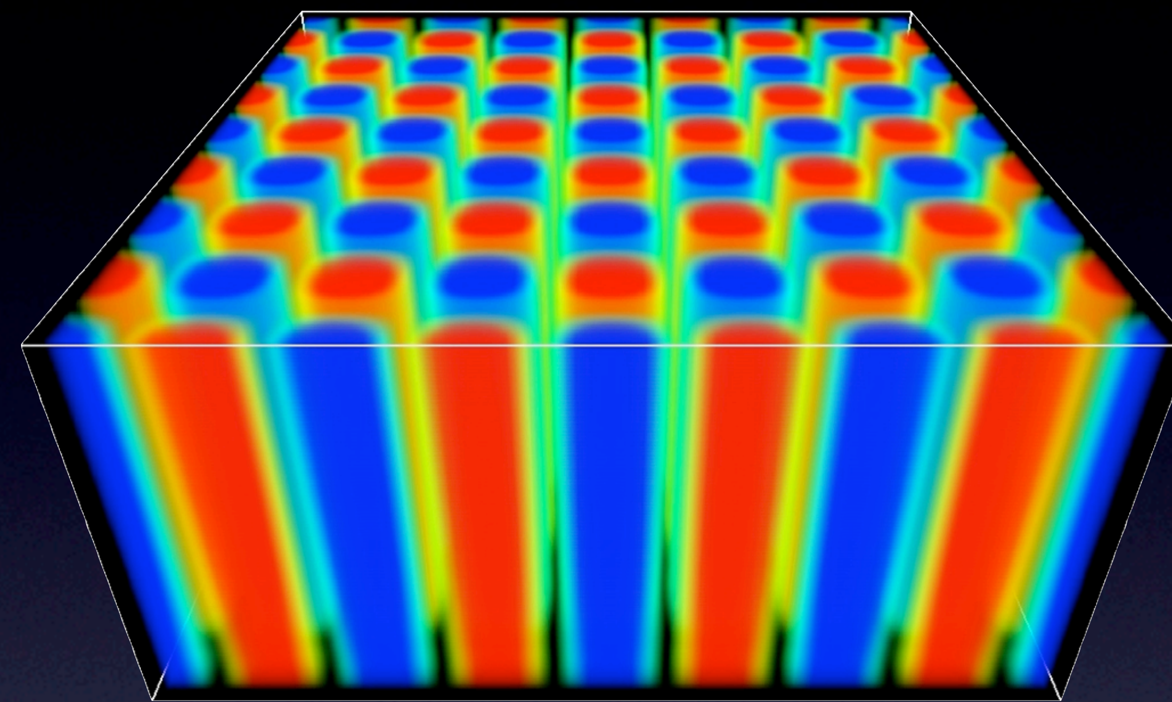

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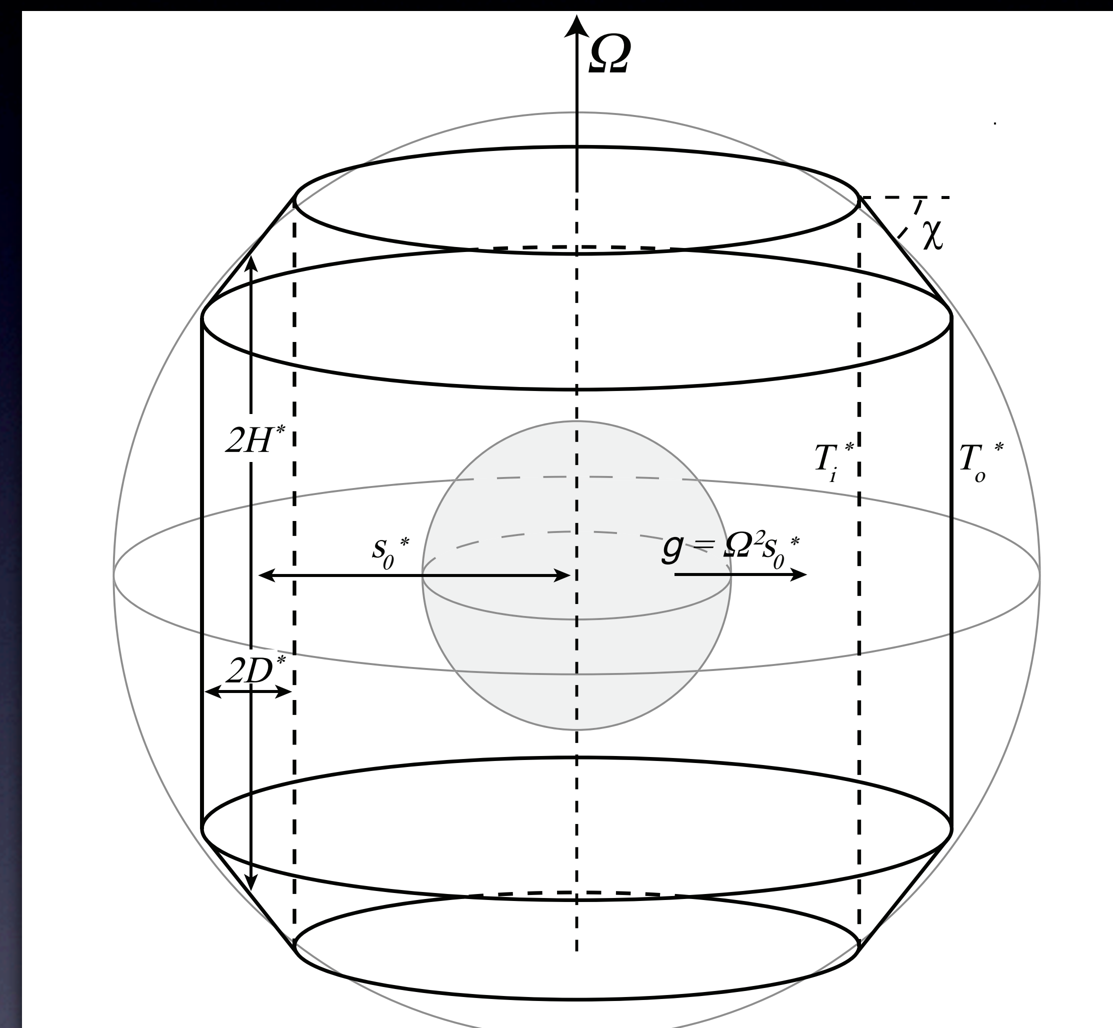
Small scales directly influenced by geometry!
Parameterization?

Small Scale Model for Sphere: The Annulus

- Annulus inscribed within sphere
- Captures "local" convective structures
- Theory/asymptotics allows for identification of small-scales



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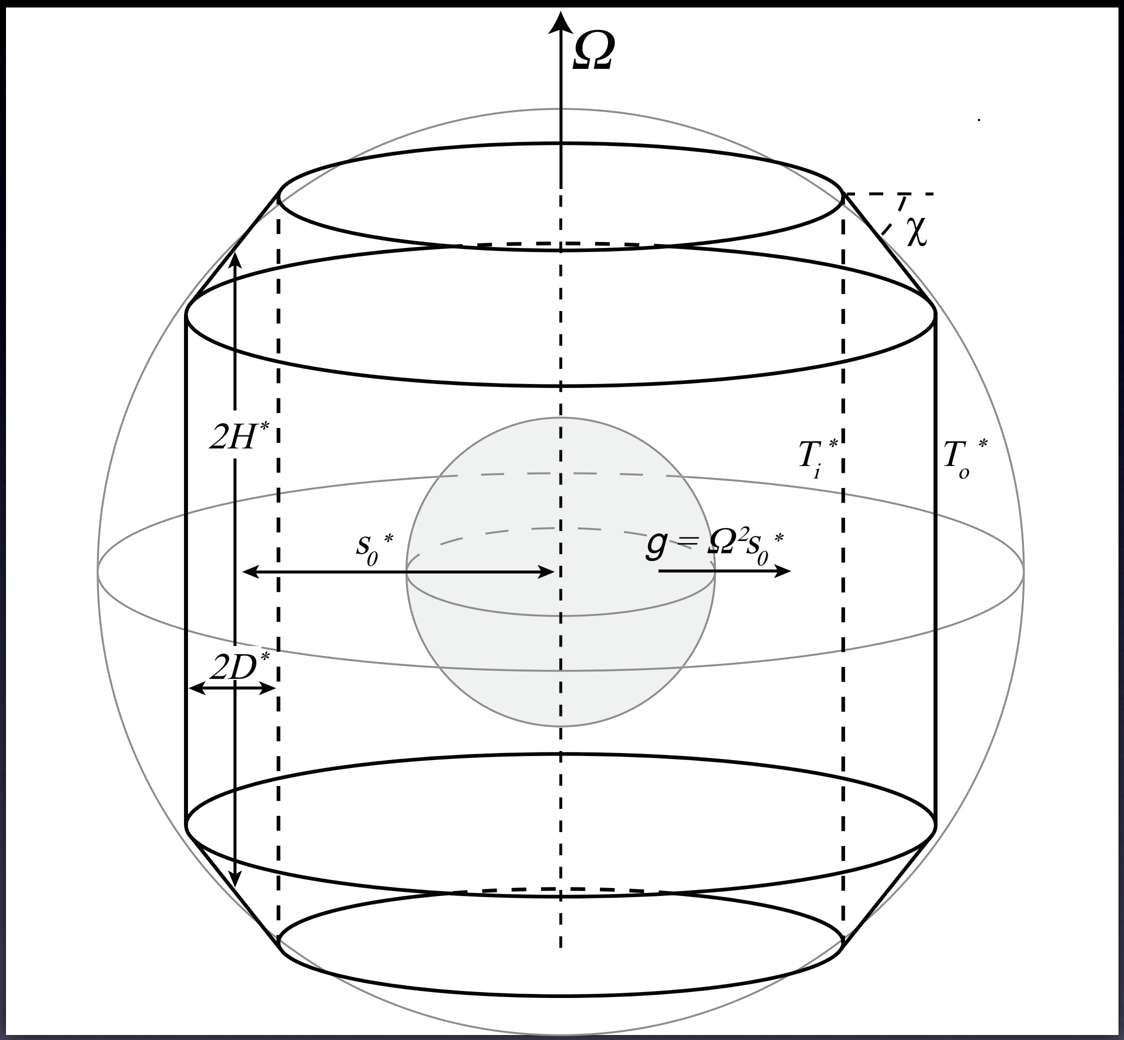

- What to do next?
  - Couple to large-scale models
  - Prandtl number effects