Influence of rotation on salt fingers

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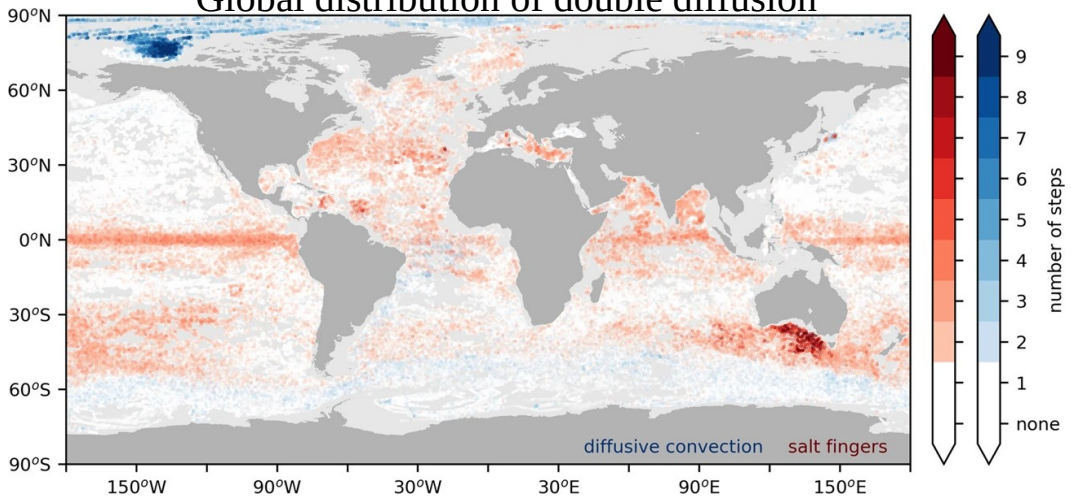
Geo/Astrophysical flows (GAFD): Planetary oceans/atmospheres, inter-stellar medium, gaseous giants, planetary & stellar cores.

Crucial ingredients: Buoyancy + Rotation
Classical models: Rotating Rayleigh-Bénard

Global distribution of double diffusion



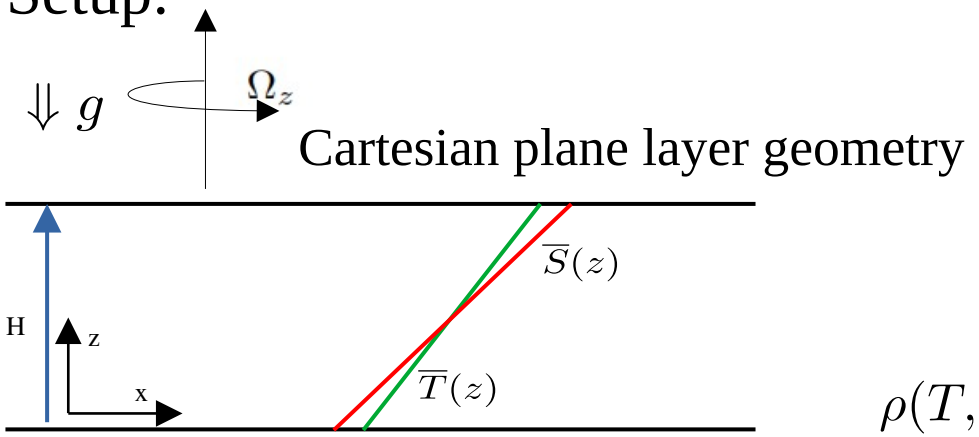
Van der Boog. et al. Communications Earth & Environment (2021)

$$\rho(T,S) = \rho_o[1 - \alpha_T(T - T_o) + \alpha_S(S - S_o)]$$

Double-diffusion:
Unequal diffusivities of components $(\kappa_T \neq \kappa_S)$

$\kappa_T/\kappa_S \sim 10^2 \Rightarrow$ Potential doubly-diffusive instabilities

Setup:



Governing equations:

- Incompressible Navier-Stokes
- Advection and diffusion of the 2 components

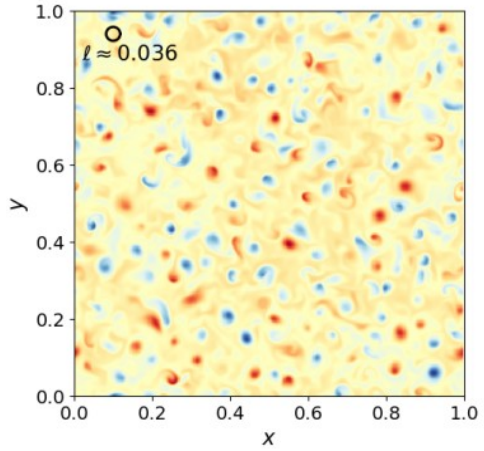
$$\rho(T,S) = \rho_o[1 - \alpha_T(T - T_o) + \alpha_S(S - S_o)]$$

Stable temperature $(\partial_z T < 0)$ stratification
Unstable compositional stratification

→ Stable overall stratification → $\kappa_T \neq \kappa_S$ → Salt fingers!

$$\ell \sim \left(\frac{\nu\kappa_T}{g\alpha_T\beta_T}\right)^{1/4}$$

Simulation (DNS):



Predictions from linear stability analysis are observed in simulations.

Scalings in the rapidly rotating regime $(E \ll 1)$

$$\mathcal{R}_c \sim \mathrm{E}^{-4/3}; k_\perp \sim \mathrm{E}^{-1/3}; \mu \sim \mathrm{E}^{-2/3}$$

→ Suggests reduced model?