The influence of rotation on salt-fingers

Smiron Varghese, Wouter Bos, Benjamin Miquel

CNRS, Ecole Centrale de Lyon, INSA Lyon, Universite Claude Bernard Lyon 1, Laboratoire de Mécanique des Fluides et d'Acoustique, UMR5509, 69130, Ecully, France
smiron.varghese@ec-lyon.fr, benjamin.miquel@cnrs.fr

Salt-fingering convection is one example among the broad class of doubly–diffusive instabilities: when a stable stratification ($\partial_z \rho < 0$) results from a stable temperature stratification and an antagonistic unstable chemical composition stratification, the diffusivity ratio may drive the growth of slender structures, coined salt-fingers in the oceanographic context. This instability is also expected to occur in other geo- and astro-physical systems such as planetary and stellar cores [1] where rotation plays a crucial role [2].

In order to model the polar region of a planet or star, we study salt-fingering convection in a horizontal layer of fluid rotating about a vertical axis, as a step of intermediate complexity towards the spherical problem [3,4]. In this simplified geometry, we present the scalings obtained by linear stability analysis for both the threshold of the instability and the wavelength at onset. Different regimes exist, including one regime reminiscent of rapidly rotating Rayleigh–Bénard convection [2]. In addition, these predictions from linear theory are illustrated by 3D direct numerical simulations in the statistically-stationary regime [5].

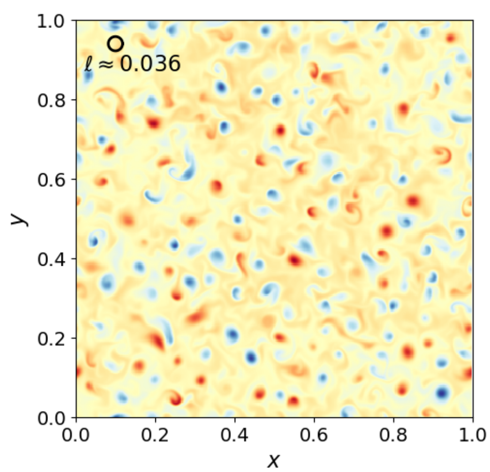

Figure 1. Salinity in the horizontal plane at mid-depth of a rapidly rotating layer in the stationary regime. Compared to the bottom surface, the top surface is kept at larger temperature (a stabilizing effect) and salinity (destabilizing). The black circle has a diameter representing the characteristic scale $\ell \approx 0.036$ of the fastest growing mode predicted by linear theory.

References

1. P. Garaud, *Ann. Rev. Fluid Mech.*, **50** 275-298 (2018).
2. S. Chandrasekhar, *Hydrodynamic and hydromagnetic stability* (1961).
3. R. Monville, J. Vidal, D. Cébron, N. Schaeffer, *Geophys. J. Int.*, **219**, S195-S218 (2019).
4. C. Guervilly, *J. Geophys. Res. Planets*, **127** (2022).
5. B. Miquel, *J. Open Source Soft.* (2021).