Vertically bounded double diffusive convection in the fingering regime

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Double diffusive convection (DDC) is the buoyancy-driven flow with the fluid density being affected by two scalar components. The two scalars usually have very different molecular diffusivities. DDC is ubiquitous in various natural and engineering environments. One of the most relevant cases is the oceanic flow, where the two scalars are the temperature and salinity. DDC plays a crucial role in the vertical mixing of ocean. In this talk we focus on the fingering regime of DDC, saying the fluid layer experiences an unstable salinity gradient and a stable temperature gradient. This corresponds to the situation in most subtropic oceans. We conducted systematic direct numerical simulations of fingering DDC flow bounded by two parallel plates which are perpendicular to the gravity. We first investigated the scaling laws for the scalar fluxes and flow velocity versus the control parameters. It is shown that the Grossmann-Lohse theory of Rayleigh-Benard (RB) convection can be extended to the current DDC flow and accurately account for the behaviours of the global responses. We further studied the effects of the stabilising temperature gradient. As the strength of the temperature gradient increases from zero, the flow transits from a RB type to a DDC type. Counterintuitively, the stabilising temperature gradient with mediate strength can enhance the salinity transfer even though the flow motion is weaker. This is due to the fact that the DDC finger structures are more organised than the convection rolls in RB flow, therefore transfer salinity at higher efficiency.