Evolution and Growth Competition of Salt Fingers in Saline Lake with Slight Wind Shear

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Since the discover of double-diffusive convection by Stommel, Arons & Blanchard (1956), "evidence has accumulated for the widespread presence of double-diffusion throughout the ocean" and for its "significant effects on global water-mass structure and the thermohaline convection" (Schmitt, 1998). The salt-fingering form of double-diffusion has particularly attracted interest because of salt-finger convection being now widely recognized as an important mechanism for mixing heat and salt both vertically and laterally in the ocean and saline lake.

In oceanographic situations or saline lake where salt fingers may be an important mechanism for the transport of heat and salt in the vertical, velocity shears may also be present. Salt finger convection is analogous to Bénard convection in that the kinetic energy of the motions is obtained from the potential energy stored in the unstable distribution of a stratifying component. On the basis of the thermal analogy it is of interest to discover whether salt fingers are converted into two-dimensional sheets by the wind shear, and how the vertical fluxes of heat and salt are changed by the wind shear. Salt finger convection under the effect of steady wind shear is theoretically examined in this paper. The evolution of developing in the presence of a vertical density gradient disturbance and the horizontal Couette flow is considered near the onset of salt fingers in the saline lake under a moderate rate of wind shear. We use velocity as the basic variable and solve the pressure Poisson equation in terms of the associated Green function. Growth competition between the longitudinal rolls (LR) and the transverse rolls (TR), whose axes are respectively in the direction parallel to and perpendicular to the Couette flow, is investigated by the weakly nonlinear analysis of coupled-mode equations. The results show that the TR mode is characterized in some range of the effective Rayleigh number, and that the stability is dominated by the LR mode in the system.

KEY WORDS: evolution, saline lake, salt finger convection, wind shear, growth competition, longitudinal rolls, transverse rolls, coupled-mode equations.