# Self-Similar Solution of Horizontal Convection due to Local Cooling From Below

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Time evolution of a horizontal convection which is caused by cooling a half of the bottom boundary of a viscous stratified Boussinesq fluid is investigated.

In the most general situation, the evolution of the convection consists of three distinct stages: During the first stage, the horizontal diffusion of heat is dominant. During the second stage, the flow can be regarded as a gravity current. Finally, during the third stage, the stratification becomes important.

A self-similar solution of the time-dependent governing equations which describe the dynamics of each stage has been discovered. These solutions, for example, are useful for understanding the formation mechanism of an atmospheric heat island circulation.

Time evolution of a horizontal convection which is caused by cooling a half of the bottom boundary of a viscous stratified Boussinesq fluid is investigated both theoretically and numerically. Though the problem is very principal for the geophysical fluid dynamics, the discussions so far were concentrated on the steady state, and the physical mechanism of the formation has not been clarified.

In the most general situation, the evolution of the convection consists of three distinct stages: During the first stage, the horizontal diffusion of heat is dominant over the horizontal advection. During the second stage, the stratification is still less important. The flow is non-linear and can be regarded as a gravity current in which the vertical scale is determined by the diffusion length scale. Finally, during the third stage, the stratification becomes important and the flow is described by a linear dynamics. In case of strong stratification, the transition from the first stage to the third stage occurs directly.

A self-similar solution of the time-dependent governing equations which describe the dynamics of each stage has been discovered. The solution for each stage is found to be only a function of the Prandtl number, and is without no explicit time dependence, after relevant scalings of the variables are introduced. Numerical experiments with fully non-linear governing equations have confirmed the validity of the similarity solution at each stage. These solutions, for example, are useful for understanding the formation mechanism of an atmospheric heat island circulation in which convections first develop from the two edges of heated area and penetrate into the center to form a steady state convection eventually.