Numerical continuation of spatially localized patterns in doubly diffusive convection

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ABSTRACT

Doubly diffusive convection, that is, convection driven by a combination of concentration and temperature gradients, is known to display a wealth of dynamical behavior whose properties depend both on the direction and the magnitude of the initial or imposed gradients. The present work focuses on situations in which the gradients are either parallel or perpendicular to the buoyancy force. In the latter situation, numerical continuation in large two-dimensional periodic domains of the so-called opposing case has demonstrated the presence of homoclinic snaking leading to the formation of steady spatially localized states interpreted in terms of a pinning region in parameter space [1]. Similar behavior has been identified in a horizontal binary fluid layer heated from below [2,3] and in a layer of porous material [4].

In the present communication, we discuss the use of numerical continuation to study the formation of localized states in various two- and three-dimensional large scale doubly diffusive systems. We first investigate stationary spatially localized states in two-dimensional thermosolutal convection in a plane horizontal layer with no-slip boundary conditions at top and bottom and demonstrate the formation of convectons in the form of 1-pulse and 2-pulse states of both odd and even parity [5]. We next turn to large scale three-dimensional configurations focusing on two situations: a vertical fluid layer placed in horizontal thermal and solutal gradients and a horizontal porous material heated from below and saturated with a binary fluid mixture [6]. Steady convection patterns, spatially localized in one or two dimensions, are computed for negative separation ratios in the latter case, and numerical continuation is used to examine the growth, stability and proliferation of each pattern as parameters are varied.

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