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Convective pattern selection in evaporating liquid blown up by wind.

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Selection of the convective structures in a thin layer of evaporating liquid blown up by an air flow is investigated. The problem considered pertains, in particular, to the formation of the near surface thermal boundary layers in the ocean and atmosphere. Besides, this problem is interesting in connection with the quests in the general theory of convective structures.

A low-mode model of the convective flow with a current, which describes a hexagon-to-roll transition observed in the laboratory experiment and in the subsurface thermal boundary layer of the sea in the presence of wind, has been constructed. The model is based on the spectral representation of the equations of three-dimensional mixed (gravity-capillary) convection and includes a system of equations for the complex amplitude profiles of spatial harmonics of four unknown quantities (vertical components of velocity and vorticity, Laplacian of the vertical velocity, and temperature perturbations) which is solved simultaneously with the equations for the profiles of mean temperature and two horizontal velocity components. With allowance for the results of laboratory modeling, the basic system of modes forming the structure of the convective flow at the cell-to-roll transition, which includes (in the simplest variant) five spatial harmonics and permits the existence of the main patterns observed experimentally, was identified. Numerical simulation of cell-to-roll transition with increasing velocity of the flow induced by the wind was performed within the framework of the proposed model. At low Reynolds numbers, chaotic variations of the cell form in time, which can be considered as an analog of the sophisticated spatial behavior of cell patterns observed in the experiments, were obtained. With increasing Reynolds number, the interchange of elongated (in the wind direction) cells and longitudinal rolls with growing life time of the rolls was revealed. Generation of the elongated cells is shown to be possible for effective Marangoni numbers several times less than the "molecular" value, and, in the purely gravitational convection, the cell-to-roll transition occurs in a jump-like manner and at lower Reynolds numbers.