Geophysical Research Abstracts, Vol. 8, 01273, 2006
SRef-ID: 1607-7962/gra/EGU06-A-01273

Study of the fine structure of flows produced by the Marangoni convection

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The Marangoni convection in a thin surface layer caused by a point source of energy is studied. The point source of energy gives rise to strong localized temperature gradients that produce sharp horizontal and vertical stratification of density and viscosity. In real fluids these gradients initiate the Marangoni convection at the free surface and, as a result, in underlying layers. The most complicated structure of the flow is formed in those fluids which properties (density, viscosity) are strongly dependent on temperature. A variety of methods including analytical and numerical solutions of hydrodynamic equations as well as series of laboratory experiments are used for the description of the complexity of the system. An asymptotic solution obtained for the "point source convection" reveals a good agreement with the results of numerical runs performed in the framework of the full system of the Navier-Stokes equations. Control laboratory experiments were performed in a small-scale tank filled with paraffin which was used as a viscous fluid. Being melted, paraffin becomes limpid, so it was possible to apply direct shadow methods for the flow visualization. Series of experiments with different sources of heat were carried out. The flow dynamics was investigated under different conditions of power input and temperature of the heater. All theoretical results (numerical and analytical) are in good agreement with the experimental data except of the only case, in which thin high-gradient envelopes of subsurface eddy were registered.

Acknowledgements: I thank Prof. Ylii Chashechkin for graciously providing access to the laboratory equipment of IPM(Moscow) as well as his valuable advices.