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Adequate mathematical and laboratory modeling of environmental systems

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Traditionally only large-scale phenomena caused by buoyancy, general rotation and local fluxes effects are taken into account in physical and mathematical (analytical and numerical) modelling of environmental systems. Really physical and chemical fields are characterized by so called fine structure, that impact on propagation of substances and energy. The goal of given paper is to analyze all set of microscale phenomena accompanying macro scale processes, that is waves (surface and internal ones), singular vortices, jets and wakes. Complete analytical analysis of governing equations taking into account real boundary conditions was performed and set of singular disturbed phenomena was recognized. Among these phenomena are set of boundary layers and corresponding internal boundary currents in a fluid interior. Basing o this analysis a number of initial value problems was solved analytically and tested in laboratory experiments. Firstly the transient diffusion induced currents in 2D and 3D environments were investigated. General compensating flow is supplemented by transient internal waves due to interruption of molecular fluxes. Generation of internal waves of compact sources and reflection of internal waves was calculated and compared with data of laboratory visualization. Propagation of admixtures in the wakes past obstacles was studied experimentally and concentration of substances on interfaces was identified. Transient and zero-frequency internal waves around localized double diffusive convection regions were calculated and observed. Methods of extrapolations of modelling results on natural conditions and demands to accuracy and completeness of environmental measurements are discussed.