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Accumulation and transport of scalar quantities in stratified and rotating flows

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Remote distance instruments have shown that contaminants in the environmental flows form extended narrow bands having irregular of even arch forms. The goal of paper is theoretical searching of mechanisms of such flow patterns formation and their laboratory modeling. The fundamental set of governing equations including equation of state, Navier-Stokes, Fourier's and/or Fick's equations describing flows of stratified or generally rotating fluids is selected for analysis. The set is treated as a high order singular disturbed system as the terms with the highest spatial derivatives contain small factors (that are kinetic coefficients). Solutions of such systems contain regular disturbed functions describing large scale flow components that are jets, wakes, vortices and waves as well as a rich family of singular disturbed functions describing extended and thin flow components. In contrast with conventional boundary layers the singular disturbed components can be disposed inside a fluid body and be stationary type (soaring interfaces inside attached waves past uniformly moving obstacles) or twinkled type. Their thickness is defined by kinetic coefficients, characteristic velocity and frequency of buoyancy or rotation. All components are dynamically active and interact between themselves directly. The minimal number of singular disturbed components is associated with viscosity effects and is equal two. In flows energy and momentum are transported by regular disturbed components. The energy dissipation and vorticity generation and transportation are associated with singular disturbed components. Passive admixtures are accumulated on singular disturbed components and transported along their surfaces or lines of their intersections. In domains of their convergence compact vortices are self-organized. In experiments with stratified flows accumulation of a dye was observed on interfaces formed inside the fluid past moving 2D (horizontal cylinder) and 3D flows (a uniformly moving sphere). On the surface of compound vortex in a cylindrical container the dye from surface spot was spinning into spiral arms gradually extended into thin filaments. Even oil on the surface of rotating fluid is restructured into spiral system where separate arms are separated by bands of clean water. Extrapolation of theoretical and laboratory data on the environment is discussed.