Differential Fluid Mechanics: calculations of stratified flows for comparison with laboratory experiments and some observations of atmospheric phenomena

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Among varieties of atmospheric phenomena pictures ones of the most impressive are images of spiral arms above cyclones, tornadoes, internal waves and wind jets. Besides the well outlined external forms they are characterized by pronounced internal structure. The goal of the talk is to present adequate mathematical model and compatible laboratory experiment for the most gentle phenomena that are for diffusion induced flows as model of mountain and valley winds, periodic and lee internal waves. The theory is based on the fundamental equation set including continuity, balance of momentum, energy and concentration of admixtures equations supplemented by empirical equation of state and standard boundary conditions. The set is analyzed taking into account compatibility condition defining the rank of non-linear, order for linear and degree of characteristic algebraic equations by methods of singular perturbations theory. Regular perturbed solutions are applied for comparisons with observed wavy components, a rich family of singular perturbed solutions represents fine flow components in initially smooth exponential stratification. Calculated patterns of periodic and lee internal waves correspond to laboratory data with accuracy of measurements. Presented DNS solutions of the complete set demonstrate details of diffusion induced flows dynamic and structure. Calculation and lab data are supported by own observations of valley winds and lenticularis type clouds in different regions. Some speculations about general theory of fluid flows and environmental phenomena are presented at the conclusion.