Numerical Model of Far Turbulent Wake Behind Towed Body in a Linearly Stratified Media

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Abstract: A flow that arises in a turbulent wake behind a body that moves in a stratified fluid is rather peculiar. With a relatively weak stratification a turbulent wake first develops essentially in the same way as in a homogeneous fluid and extends symmetrically. However, buoyancy forces oppose vertical turbulent diffusion. Therefore a wake has flattened form at large distances from the body and, finally, ceases to extend in a vertical direction. Because of turbulent mixing the fluid density within the wake is distributed more uniformly than outside it. Buoyancy forces tend to restore the former unperturbed state of a stable stratification. As a result, convective flows, which give rise to internal waves in an ambient fluid, arise in the plane perpendicular to the wake axis.

The aim of our research is to add some certainty and cover some gaps in our knowledge for phenomenon of far turbulent wakes behind towed bodies. The numerical model of far turbulent wakes behind the bodies of revolution in linearly stratified fluid and propagation of passive scalar in wakes has been constructed. To describe the flow in a far turbulent wakes three-dimensional parabolized system of averaged equations for the motion, continuity and incompressibility in the Oberbeck-Boussineq approach is used. This system of equations is not closed. The modified model of turbulence is used for the system to be closed. In this model the unknown values of the Reynolds stresses and turbulent fluxes are determined by the algebraic approximations. In addition the differential equations for averaged concentration of passive scalar and dispersion of fluctuations transfer are used. The finite-difference algorithm of the problem solution is based on the methods of splitting into physical processes and space variables. The results of numerical modeling of parameters of momentumless and drag turbulent wakes are in a satisfactory agreement with experimental data of Lin and Pao. The results of numerical experiments which demonstrate the dynamics of drag far turbulent wake in passively and actively stratified fluid in comparison with dynamics of far momentumless wake are cited. The anisotropy decay of turbulent wakes in linearly stratified fluid is under consideration. Some results of numerical experiments are presented both in homogeneous and stratified fluids which demonstrated the propagation of passive scalar in turbulent wakes. It is demonstrated that at large distances from a bodies in a homogeneous fluid the behavior of characteristics of a passive scalar becomes self-similar. The results of numerical experiments in stratified fluids are illustrated the influence of gravity force.

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