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Simulating inland waters thermodynamics in stably stratified shear flows: possible parametrizations of the coefficient of turbulent thermal conductivity

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The role of inland water bodies in the processes of general circulation of the atmosphere, ocean and land, their thermohydrodynamic and biological properties in weather forecasts have been established by now. The physico-mathematical simulation of the thermodynamics and hydrodynamics of inland waters is based on the Reynolds-averaged Navier-Stokes equations (RANS). Since this system contains unknown quantities (turbulent flows), it is necessary to involve additional hypotheses for its closure. Of practical significance is the so-called E-ε (k-ε) model based on the equations for the kinetic energy of turbulence E and its dissipation rate ε. The turbulent Prandtl number (PrT) is assumed to be constant in this model. This limits the description of the known effect associated with the existence of turbulence for large gradient Richardson numbers Ri. In this connection, special attention in the simulation of the thermohydrodynamic regime of inland water bodies is paid to stratification and, in particular, to its role in the processes of turbulent mixing. In this presentation we discuss one of possible parametrizations of the E-ε model for correct description of mixing processes in stably stratified shear flows. We employ the EFB-model by S. S. Zilitinkevich and the RANS-type model of turbulent transfer by Yu. I. Troitskaya and L.Ostrovsky. These models take into consideration the reciprocal conversion of the kinetic and potential energies of turbulent pulsations and the dependence of the turbulent Prandtl number on the gradient Richardson number. The obtained dependence was used in the E-ε model for parameterization of the coefficient of heat transfer eddy diffusivity in order to take into account stable stratification of inland waters. The results of verification of the modified E-ε model based on experimental data are presented.
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