STATISTICAL MOMENT REPRODUCTION IN A TURBULENT REGION FORMING ABOVE A HILL LOCATED IN A STABLY STRATIFIED FLOW

S.N. Yakovenko

Khristianovich Institute of Theoretical and Applied Mechanics, Siberian Branch of RAS
Novosivirsk 630090, Russia

Abstract: To study second- and third-order statistical moments in a quasi-steady turbulent region arising in stably stratified flows over obstacles after the internal wave breaking, the direct numerical simulation (DNS) method developed for variable density fields is used. The DNS data of velocity and density fields at Reynolds number $\mathrm{Re} = 4000$ and Froude number $F_h = 0.6$ (based on obstacle height h and inflow velocity U) are taken to obtain time dependence and spatial distributions of Reynolds stress tensor components, turbulent kinetic energy, scalar variance, triple correlations, and terms of budgets of transport equations for the statistical moments. The analysis shows that (for both scalar variance and turbulent kinetic energy) the time rate is indeed relatively small, and the global balance is between mean-shear production, advection and viscous dissipation, whereas locally buoyant production and turbulent diffusion (triple correlation gradient) are significant. For Reynolds stresses, the pressure-strain term is important too, providing the redistribution of normal stress components. The studies allow us not only to explore the wave-breaking turbulent patch by means of statistical moments, but also to examine closure assumptions for separate items of transport equations and validate turbulence models, as well as to evaluate geophysically interesting quantities which can be derived from the averaged DNS data.

Keywords: direct numerical simulation, statistical moments, stably stratified flow, internal wave breaking, Reynolds stress tensor, turbulence models, closure assumptions.