NUMERICAL MODELLING OF INHOMOGENEOUS TURBULENT FLOWS BY LES

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Abstract In the work the solution of three-dimensional unsteady Navier - Stokes equations for simulation of inhomogeneous turbulent flows by LES is considered

Turbulence remains one of the most complex objects of study of fluid mechanics and gas. In the almost century-long history of study offered dozens of different approaches that reflect the most actively developed by promising areas of mathematics and physics. The theory of turbulence is far from complete. An increasing number of models proposed for a better understanding of some of its properties [1].

The method of large-eddy simulation is an effective option between direct numerical simulation and solution of the averaged Navier-Stokes equations. It is based on two assumptions. The first is the ability to separate the velocity field to the motion of large and small eddies. Second - the possibility of approximation of the nonlinear interactions between large and small eddies by large eddies only with the use of subgrid models.

We consider the inhomogeneous turbulence in open channel. Constant heat flux is imposed from the top of the wall and is controlled by the pressure gradient along the x axis, the frequency applied to the horizontal directions. The surface of the bottom and the top wall is flat, with no slip condition and without pressure. The size of the x and y correspond 2πh and πh, where h- height of channel. The heterogeneity of the medium is taken into account with the change of density fluctuations at a constant temperature changes with height. The basic equations of the problem are based on the unsteady filtered Navier-Stokes equations in dimensionless form of the density. The initial condition is given in the phase space for the velocity field, it is translated into the physical space using a Fourier transform [2].

To solve the momentum equations splitting scheme by physical parameters is used, which consists of three stages. At the first stage momentum equations solved without pressure. Convective and diffusive terms in the momentum equations approximated by high order compact scheme. The intermediate velocity field with fractional steps is computed by TDMA algorithm. In the second step the Poisson equation is solved for the solution of which the parallel algorithm - spectral transform in combination with a matrix factorization developed.

As a result of the solution of Navier - Stokes equation the large-scale and small-scale velocity field is calculated at each moment of time. The calculated velocity field allows to define longitudinal and transverse correlation functions, integrated and differential scales, kinetic turbulent energy and density fluctuations. Obtained turbulence characteristics are compared with [3].

References

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