Geophysical Research Abstracts
Vol. 21, EGU2019-14817, 2019
EGU General Assembly 2019

On the modelling of the dissipation rate of turbulent kinetic energy in stably stratified boundary layers

Evgeny Mortikov (1,2), Andrey Glazunov (2,1), Andrey Debolskiy (1,3), Evgeny Kadantsev (4,5), Sergej Zilitinkevich (4,5)

(1) Research Computing Center, Lomonosov Moscow State University, Moscow, Russia (evgeny.mortikov@gmail.com), (2) Institute of Numerical Mathematics, Russian Academy of Science, Moscow, Russia, (3) A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Science, Moscow, Russia, (4) University of Helsinki, Helsinki, Finland, (5) Finnish Meteorological Institute, Helsinki, Finland

The equation for dissipation rate of turbulent kinetic energy is discussed. It is shown that the well known empirical form of this equation used in turbulence closures for stably stratified flows may be seen as a simplified equation of a more general relaxation equation for turbulence wave number (defined as the inverse of turbulence length scale $l_t = k^{3/2}/\varepsilon$) to some "equilibrium" state. The "equilibrium" itself for horizontally homogeneous stably stratified flows is expressed using steady state turbulent kinetic energy budget equation and Monin-Obukhov Similarity Theory formulation of the velocity-gradient (see, (Zilitinkevich et al., 2018)). Moreover in this case the controversial constant defining the action of buoyancy on the dissipation rate in ε equation may be related to the ratio of von Karman constant and the critical Richardson flux number. In a more general form the new approach in deriving the ε equation leads to an additional relaxation term, which controls the adjustment of dissipation rate in non-stationary flows, and to our knowledge this adjustment mechanism may be missing in two-equation single column closures as used in large-scale models. We use large-eddy simulation data of stratified atmospheric boundary layer flows and direct numerical simulation of stably stratified plane Couette flow to verify steady state "equilibrium" solutions and discuss the behavior of dissipation rate of turbulent kinetic energy in non-stationary problems.

The research was partly supported by RFBR projects No. 16-05-01094, 16-55-52022, 17-05-00703, 18-05-60126, 18-05-60184. DNS and LES simulations were supported by Russian Science Foundation project No. 17-17-01210.

References

[1] S. Zilitinkevich, O. Druzhinin, A. Glazunov, E. Kadantsev, E. Mortikov, I. Repina, Y. Troitskaya. Dissipation rate of turbulent kinetic energy in stably stratified sheared flows, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-978, in review, 2018.