EMS Annual Meeting Abstracts
Vol. 16, EMS2019-816, 2019


# Direct numerical simulation of turbulent plane Couette flow: modification of large-scale structures by stable stratification

Evgeny Mortikov (1,2), Andrey Glazunov (2,1), Grigory Zasko (3), and Yuri Nechepurenko (2)

(1) Moscow State University, Research Computing Center, Moscow, Russian Federation (evgeny.mortikov@gmail.com), (2) Institute of Numerical Mathematics, Russian Academy of Science, Moscow, Russian Federation, (3) Institute of Applied Mathematics, Russian Academy of Science, Moscow, Russian Federation

Direct numerical simulation (DNS) approach was used to study turbulence dynamics in plane Couette flow under conditions ranging from neutral stability to the case of extreme stable stratification, where the flow becomes intermittent. It is shown that besides chaotic irregular turbulent motions the plane Couette flow exhibits large coherent structures in the whole range of stability. The well known counter-rotating rolls found in neutral case become unstable even with small increase in stratification. But for moderate stability skewed layered structures may be identified. It is argued that this layers act as barriers for turbulent mixing of heat without blocking momentum turbulent transfer, which results in increase in turbulent Prandtl number. We show that both types of structures have spatial scales and forms that coincide with the scales of the corresponding optimal disturbances of the simplified linear model of the Couette flow.

For very strong stratification the flow becomes intermittent but the turbulence persists for very high bulk Richardson numbers. Intermittency in the plane Couette flow corresponds to the formation of secondary large-scale structures elongated in the spanwise direction, which define spatially confined alternating regions of laminar and turbulent flow. The spanwise length of this structures increases with the increase in the bulk Richardson number and defines an additional constraint on the computation box size. DNS results of intermittent turbulence in Couette flow are presented in extended domains for a wide range of stability and Reynolds numbers.

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