Implementation of scalar filtered density function for large eddy simulation of turbulent reacting flow using a high-order discontinuous Galerkin method

Aidyn AITZHAN [1], Medet INKARBEKOV [1], Asetzhan KOLDAS [1], Aidarkhan KALTAYEV [1]

[1] *Department of Mechanics, Al-Farabi Kazakh National University, Almaty, Kazakhstan*
E-mail: aitzhan.aidyn.b@gmail.com

Abstract: Turbulence is interesting and useful flow phenomena of nature. In case of reacting flows, turbulence promotes effective mixing of reactants. Due to fine mixing a chemical reaction is going to be highly productive. Hence, turbulent reactive flows are especially needed in industry. Nowadays engineering problems require highly accurate simulation of turbulent reacting flow. Therefore mathematical models and numerical methods must be sufficiently accurate.

In present work, a Filtered Density Function methodology (FDF) coupled with high-order Discontinuous Galerkin (DG) method is applied for Large Eddy Simulation (LES) of turbulent reacting flow. The FDF method has proven to be very effective for LES of turbulent reactive flows [1, 2] from the other side DG method is highly accurate and useful method, and at the same time is compact and relative easy [3]. In order to compare results there are provided results of computations of discontinuous Galerkin LES/FDF and finite difference direct numerical and large eddy simulations. In addition a DG-LES/FDF numerical code is parallelized with CUDA technology, which accelerated computations more that 10 times.

Keywords: filtered density function, high-order method

2010 Mathematics Subject Classification: 76F25, 76F65

References

[1] Colucci, P. J., Jaberi, F. A., Givi, P., Pope, S. B., "Filtered density function for large eddy simulation of turbulent reacting flows", *Phys. Fluids*, Vol. 10, No. 2, pp. 499–515, 1998.

[2] Jaberi, F. A., Colucci, P. J., James, S., Givi P., Pope S. B., "Filtered mass density function for large-eddy simulation of turbulent reacting flows", *J. Fluid Mech.*, Vol. 401, pp. 85–121, 1999.

[3] Schaal, K., Bauer, A., Chandrashekar, P., Pakmor, R., Klingenberg, C., Springel, V., "Astrophysical hydrodynamics with a high-order discontinuous Galerkin scheme and adaptive mesh refinement", *MNRAS*, Vol. 453, No.4, pp.4278–4300, 2015.