Numerical study of sub-grid models for Large eddy simulation (LES) which preserve the symmetries of the Navier-Stokes equations

Can Selçuk (can.selcuk@univ-eiffel.fr)[1], Nadjma Akhal (nadjma.akhal2@univ-eiffel.fr)[1], Oscar Cosserat (Oscar.Cosserat@mathematik.uni-geottingen.de)[2], and Dina razafindralandy (Dina.razafindralandy@univ-lr.fr)[3]
[1] *Laboratoire Modélisation et Simulation Multi Echelle (MSME), University Gustave Eiffel, Marne-la-Vallée*
[3]*Göttingen Mathematisches Institut, Georg-August-Universität Göttingen*
[2]*Laboratoire des Sciences de l'Ingénieur pour l'Environnement (LaSIE), Université La Rochelle, La Rochelle*

Playing a critical role in numerous natural and engineering processes, such as atmospheric flows, aerodynamics, combustion in engines or biomedical applications, turbulence is one of the most complex phenomena in fluid dynamics. Despite this widespread presence, understanding and accurately predicting turbulent flows remain a significant challenge due to the inherently chaotic, multi-scale nature of turbulence. Among the methods available to numerically simulate such turbulent flows, we focus on the LES technique and more specifically on subgrid-scale (SGS) models which preserve the symmetry of the Navier-Stokes equations.

Symmetry-preserving SGS models have been proposed in [1] for isothermal fluid flows and in [2] in the anisothermal case. In [3], a direct extension of these models is proposed with a family of SGS tensors that do not depend only on the strain-rate tensor but also on the vorticity tensor.

During this internship, we propose to test this new family of sub-grid models in LES computations (*a posteriori* configuration). We would like to assess their accuracy on a simple and synthetic turbulent field configuration, such as the homogeneous isotropic turbulence (HIT [4]) (fig. 1-a and 1-b) and compare them to more classical closure models such as Wale, Smagorinski, Bardina. The candidate should have a strong motivation to work on a fundamental subject and should be willing to develop in an existing in-house code ("Fugu") in Fortran90 .

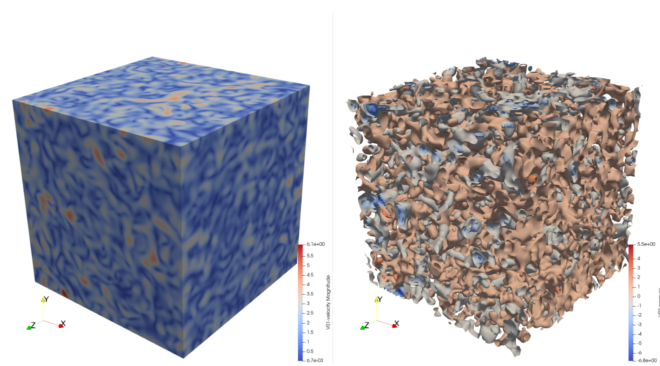

Figure 1: Illustration of the HIT flow: (a) Velocity norm of an instantaneous velocity field (b) Iso-countours of the pressure field

References

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