L'évaluation des erreurs statistiques associées à DNS de l'écoulement dans un canal plan avec fluide viscoélastique

et

Evaluating statistical errors associated with DNS of plane channel flow of viscoelastic fluids

J. R. Andrade[1,3], R. S. Martins[1] , R. L. Thompson[2], L. Thais[1], G. Mompean[1], A. da Silveira Neto[3]

[1] *Laboratoire de Mécanique de Lille (LML), CNRS/FRE 3723, Polytech'Lille, Université des Sciences et Technologies de Lille, Cité Scientifique, Villeneuve d'Ascq, 59655, France*

[2] *Dep. of Mechanical Engineering, COPPE, Federal University of Rio de Janeiro, Centro de Tecnologia, Ilha do Fundão, Rio de Janeiro, RJ 21945-970, Brazil*

[3] *Dep. of Mechanical Engineering, FEMEC, Federal University of Uberlândia, Fluid Mechanics Laboratory, Campus Santa Mônica, Bloc 5P, Uberlândia, Minas Gerais, Brazil*

Email : joao.andrade@etudiant.univ-lille1.fr

Souhait : Communication Orale

Mots-clé : DNS, turbulence, statistic error, channel flow, viscoelastic fluid

Résumé :

Direct numerical simulations (DNS) provide useful information for the understanding and the modeling of turbulent phenomena. Particularly, in the context of viscoelastic fluid flows, DNS has been largely used to supply contributions to the understanding of the polymer induced drag reduction phenomenon. However, quantifying the errors associated with DNS is an important challenge to the scientific community. Recently, Thompson et al. (Computers & Fluids, 2016) presented a methodology to evaluate the statistical errors of the second-moment DNS data of Newtonian fluid flows, where the steady-state momentum balance equation was used to calculate the mean velocity profile by considering the Reynolds stress provided by DNS data. The authors applied the methodology to several channel flow databases available in the literature. In the present work, we follow the main idea of Thompson et al. (Computers & Fluids, 2016) to evaluate the statistical errors of viscoelastic fluid channel flows by considering the viscoelastic extra-stress tensor in the momentum balance equation. The present analysis was made by using data generated with the quasi-spectral code by Thais et al. (Computers & Fluids, 2011) for a friction Reynolds number equal to 180. The FENE-P model is used to represent the polymer solutions. Four different elasticity levels are tested by varying both the maximum chain extensibility and the relaxation time of the polymer. The simulation time necessary to reach the statistically converged fields is characterized as a function of these rheological parameters. The present methodology can be used as a convergence criteria to future DNS of viscoelastic fluids and to provide more accurate benchmark results for turbulence modeling.