Simulation of incompressible flows with artificial compressibility using fully adaptive multiscale schemes

Youssef Stiriba [1]

[1] University Rovira i Virgili, ETSEQ-DEM, Av. Paisos Catalans 26,
43007 Tarragona, Spain
e-mail: youssef.stiriba@urv.cat

Abstract

Fully adaptive multiresolution methods for the solution of hyperbolic conservation laws concentrates computational effort only where there are most required. Such methods represent cell averages associated to any given finite volume method into a different format that give insight on the local smoothness of the solution [3]. By locally adapting the computational mesh where needed, we reduce computational effort in terms of both CPU time and memory requirement. The accuracy of the reference solution on the reference single mesh is maintained [3, 1].

In this work, we study the fully adaptive multiscale finite volume methods [3, 1] for incompressible Navier-Stokes systems. The schemes uses a multiscale analysis based on biorthogonal wavelets to adapt the grid in space only when they are most needed. Refinement is also performed in time by using a locally varying time stepping strategy [2, 4]. In order to couple the pressure and velocity fields at the same level the artificial compressibility method is employed. By introducing a pseudo-time derivative of the pressure into the continuity equation, the incompressible Navier-Stokes equations are changed from elliptic-parabolic to hyperbolic-parabolic equations. We present some benchmark two-dimensional steady incompressible flow solutions obtained from the fully adaptive finite volume schemes.

References

[1] Bramkamp F., Lamby Ph., Müller S., *An adaptive multiscale finite volume solver for unsteady and steady flow computations*, Journal of Computational Physics, 197, 460-490 (2004).

[2] Lamby Ph., Müller S., Stiriba Y., *Solution of the shallow water equations using fully adaptive multiscale schemes*, International Journal for Numerical Methods in Fluids, 49, 417-437 (2005).

[3] Müller S., *Adaptive multiscale schemes for conservation laws*, in: Lecture Notes on Computational Science and Engineering, Vol. 27, Springer, Berlin Heidelberg New York (2002).

[4] Müller S., Stiriba Y., *Fully adaptive multiscale schemes for conservation laws employing locally varying time stepping*, Journal of Scientific Computing, 30, No. 3, 493-531 (2007).