High-performance large eddy simulation of incompressible turbulent flows

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Large Eddy Simulation (LES) of turbulent flows is based on the idea of directly computing the dynamics of the flow scales responsible for the energy transfer, while modeling the dynamics of the scales where dissipation takes place. Although LES has a reduced cost with respect to Direct Numerical Simulation, where all the scales are solved, it is a computationally expensive technique, and its application to realistic flows is a usual context for high-performance computing. In this talk, we focus on the design and development of a parallel LES code for wall-bounded incompressible turbulent flows. Starting from suitably filtered Navier-Stokes equations, a projection method is applied for decoupling the continuity and momentum equations. The discretization of the resulting equations leads to a numerical procedure that requires, at each time step, two main tasks: computation of convective and diffusive fluxes, and solution of large and sparse linear systems. Our software design methodology is based on a formulation of these tasks in terms of basic linear algebra operations involving sparse matrices, to use reliable and efficient open-source scientific software, such as PSBLAS [1] and MLD2P4 [2], for developing an effective simulation code.

References

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[2] P. D'Ambra, D. di Serafino, S. Filippone, *MLD2P4: A Package of Parallel Algebraic Multilevel Domain Decomposition Preconditioners in Fortran 95*, ACM Trans. Math. Software, 37, 3 (2010), pp. 30:1–30:23.

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