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Cost-accuracy analysis for symmetry-preserving methods

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In recent years, Computational Fluid Dynamics (CFD) is used more and more as a design tool for industrial applications, such as the medical, automotive and renewable energy industries. The main constraint of the use of CFD in industrial applications nowadays lies in the computational cost and the wall-clock simulation time. This constraint inevitably leads to a cost-versus-accuracy trade-off when simulations are performed. This work is part of a larger project [1] in which the viability of conducting overnight LES simulations on GPU-accelerated supercomputers is evaluated, aiming to combine a highly-portable algebraic framework with a symmetry-preserving discretisation for unstructured collocated grids. The former part aims to cut down on the cost side, whereas a carefully chosen discretisation can greatly impact accuracy of the solution.

The symmetry-preserving discretisation aims to conserve energy, momentum and mass of the simulation by mimicking properties of the continuous operators of the Navier-Stokes equations in their discrete counterparts. This property is deemed essential in accurately depicting the motion of fluids at any scale, which has to be carried out properly in turbulent flow simulations. The effect on the accuracy of applying this scheme will be compared to the use of non-symmetry-preserving schemes using the open-source code OpenFOAM, for which the method was previously implemented by [2]. Using several benchmark cases and monitoring higher order turbulent statistics, while also monitoring computational costs, an extensive cost-versus-accuracy analysis is performed for this method. Analysing and improving the resulting accuracy, while simultaneously decreasing computational cost, these combined efforts will form a step towards feasible high-fidelity overnight simulations.

REFERENCES

[1] Alsalti-Baldellou, À., Colomer, G., Hopman, J.A., Álvarez-Farré, X., Gorobets, A., Trias, F.X., Pérez-Segarra, C.D. and Oliva, A. *Reliable overnight industrial LES: challenges and limitations. Application to CSP technologies.* In ETMM14 Barcelona, Spain 6-8 September, 2023: conference proceedings.

[2] Komen, E. M., Hopman, J. A., Frederix, E. M. A., Trias, F. X. and Verstappen, R. W. *A symmetry-preserving second-order time-accurate PISO-based method.* Computers & Fluids 225 (2021): 104979.