A comparative study of interface capturing methods with AMR for incompressible two-phase flows

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ABSTRACT

This paper presents a comparative study of interface capturing methods with adaptive mesh refinement for Direct Numerical Simulation (DNS) of incompressible two-phase flows. With this purpose, the buoyancy-driven motion of a single bubble is simulated under different physical conditions. The numerical algorithms for fluid motion and interface capturing methods have been previously introduced in the context of the finite-volume approach for both mass conservative level-set methodology [1] and coupled volume-of-fluid/level-set method [2] in the context of unstructured/structured fixed meshes. The AMR method introduced in [3] consist on a cell-based refinement technique to minimize the number of computational cells and provide the spatial resolution required for the interface capturing methods. With this operation, the amount of data, computational time and memory usage are reduced compared to fixed mesh simulations. The present AMR framework adapts the mesh according to a physics-based refinement criteria defined by the movement of the interface between the fluid-phases. Moreover, our AMR method is combined with parallel algorithms for partitioning and balancing of the computational mesh [3]. Numerical experiments are presented in order to evaluate the methods described in this work. This includes an extensive study of the hydrodynamics of single bubbles rising in a quiescent viscous liquid, including its shape, terminal velocity and wake patterns. These results are validated against experimental and numerical data well established in the scientific literature, as well as a critical comparison of the different approaches used. Furthermore, on going work using a novel adaptive mesh refinement on unstructured meshes with different interface capturing methods will be presented.

REFERENCES

[1] Balcázar, N., Jofre, L., Lehmkhul, O., Castro, J., Rigola, J., A finite-volume/level-set method for simulating two-phase flows on unstructured grids. *International Journal of Multiphase Flow*(2014) **64**:55–72.

[2] Balcázar, N., Lehmkhul, O., Jofre, L., Rigola, J., Oliva, A., A coupled volume-of-fluid/level-set method for simulation of two-phase flows on unstructured meshes. *Computers and Fluids*(2016) **124**:12–29.

[3] Antepara, O., Lehmkhul, O., Borrell, R., Chiva, J., Oliva, A., Parallel adaptive mesh refinement for large-eddy simulations of turbulent flows. *Computers and Fluids*(2015) **110**:48–61.