Extended Variational Multiscale Methods for Turbulent Bubbly Channel Flow

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Motivation

In technical applications, two-phase flows are often encountered. Since the majority of technical flows are turbulent, the simulation of turbulent two-phase flows is particularly important. However, computational approaches to two-phase flows are considerably more challenging than to single-phase turbulent flows. The increase in computational power over recent years has enabled first steps towards the simulation of fully resolved two-phase flows. Nevertheless, such simulations are still very expensive and often infeasible for realistic applications. Here, a computational method for large-eddy simulation (LES) is proposed, with the particular feature, that the phase interface is captured as a sharp contour.

Example

Results from an LES of a fully developed turbulent channel flow, in which a gaseous bubble rises, are shown here. They are compared to results from a detached direct numerical simulation reported in \cite{2}. Statistics are collected over four independent ensembles, adding up to a total of 4000 sampled steps. The resulting mean velocity in the channel direction is illustrated in Fig. 2. The flow at Reynolds number $Re = 450$ is simulated on a grid of $122\times50\times41$ tri-linearly interpolated elements.

Conclusions and Outlook

It was shown that the XFEM technology in conjunction with a level-set based interface capturing can successfully be applied to LES of turbulent two-phase flows. On this basis we intend to improve the turbulence modeling in future works. A promising approach for multi-phase problems is the inclusion of a multifractal subgrid-scale model, which was recently developed and applied to turbulent incompressible single-phase flows in \cite{3}.

References