A wall-model LES methodology for complex geometries and particulate transport

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Large Eddy Simulation (LES) is a powerful numerical tool that has become popular for the study of a large variety of multiphase flows of scientific and engineering interest. A typical example is the numerical simulation of the transport of pollutants in large cities[1], or the simulation of the wind blowing over the ocean surface[2]. In this variety of applications, complex geometries are omnipresent and thus the development of numerical algorithms capable to deal with them is mandatory. In this context, we aim to develop a new approach for the wall-modelled LES of multiphase flows involving complex geometries based on a multi-direct forcing Immersed Boundary Method (IBM). The basic idea is that of imposing, near the solid boundaries, an augmented viscosity to correct the wall shear stress in a wall-modelled, multi-direct IBM framework. The incompressible formulation of the Navier-Stokes equations is adopted. Implicit filtering is used together with a Wall-Adapting Local Eddy (WALE) viscosity model for the sub-grid scale fluctuations. In correspondence with the walls, an augmented viscosity is imposed to correct the wall stresses. The computation of this viscosity is based on the modelling of the velocity profile near the walls, via an ad-hoc wall function. The most innovative concept behind the present work is to impose the augmented viscosity in the correspondence of the interface using a multi-direct forcing scheme similar to the one employed for the velocity. The reader is referred to the reference for the numerical detail of the scheme used to impose velocity at the interfaces, which is identical to that employed here for the viscosity[3]. Point-particle equations can be solved in this frame to represent solid or liquid particulate transported by the turbulent carrier. Wall modelling for the point-particles is currently under development and additional details will be provided in the presentation. Fig. 1 provides preliminary results of the proposed method concerning a turbulent channel flow whose walls are modelled in the proposed IBM frame.

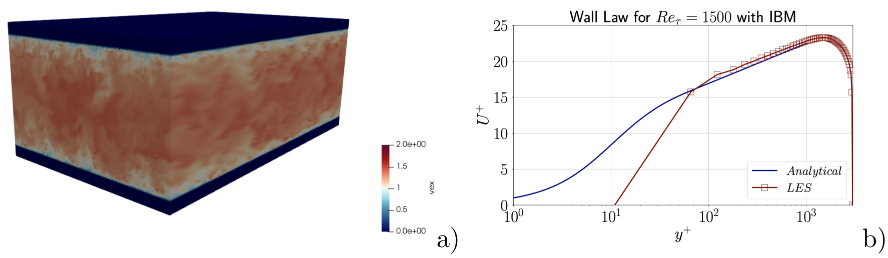

Figure 1: (a) Instantaneous snapshot of the turbulent channel. (b) Wall-normal velocity profile.

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