On the dynamics of polydisperse spray flames and auto-ignition in turbulent flows using the 3D parallel Euler-Euler approach

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The use of robust and accurate Eulerian/Eulerian formulations in the modeling of reactive two-phase flow would be a major step forward in the framework of turbulent combustion modeling with massively parallel supercomputers. As a matter of fact, Lagrangian methods combine an efficient modeling of the polydisperse phase, a high numerical efficiency, and an easiness of implementation. Nevertheless, in the framework of domain decomposition for parallel computations, it requires the use of complex and costly dynamic partitioning methods, to ensure a good load balancing between the different parallel processes. Hence, Eulerian methods provide an interesting alternative to Lagrangian methods, since they can easily take advantage of massively parallel computations [1], but require special attention in terms of mathematical structure and numerical diffusion [2, 3]. Therefore, the ability of the Eulerian multi-fluid model to capture all stages of turbulent spray combustion has been tested and compared with a usual Lagrangian formulation [4]. The multi-fluid model and related dedicated schemes and algorithms are implemented in Muses3d Code [1]. It allows to characterize properly the spray dispersion and segregation as well as the vaporization dynamics leading to the fuel mass fraction topology. Eventually, flame propagation and structure in a 3D forced isotropic homogeneous turbulence is characterized showing the capacity of the multi-fluid model to simulate such reactive flows with results with the same level of accuracy as a baseline solution obtained with Lagrangian droplet tracking.

Références

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