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Compressible Lattice Boltzmann Method for Turbulent Jet Flow Simulations

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Abstract : In Computational Fluid Dynamics (CFD), there are a variety of numerical methods, of which some depend on macroscopic model representatives. These models can be solved by finite-volume, finite-element or finite-difference methods on a microscopic description. However, the lattice Boltzmann method (LBM) is considered to be a mesoscopic particle method, with its scale lying between the macroscopic and microscopic scales. The LBM works well for solving incompressible flow problems, but certain limitations arise from solving compressible flows, particularly at high Mach numbers. An improved lattice Boltzmann model for compressible flow problems is presented in this research study. A higher-order Taylor series expansion of the Maxwell equilibrium distribution function is used to overcome limitations in LBM when solving high-Mach-number flows. Large eddy simulation (LES) is implemented in LBM to simulate turbulent jet flows. The results have been validated with available experimental data for turbulent compressible free jet flow at subsonic speeds.

Keywords : compressible lattice Boltzmann method, multiple relaxation times, large eddy simulation, turbulent jet flows
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