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Large-eddy simulation of Rayleigh-Taylor turbulence with compressible miscible fluids

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Large-eddy simulation (LES) of the *three-dimensional* Rayleigh-Taylor problem using the *compressible* equations for the case of two *miscible* fluids with a density ratio of 3 is presented. The motivation is twofold. First, to study the behavior of the dynamic mixed subgrid model in this type of flow. In addition, numerical simulations allow the study of the Reynolds stresses and their transport equations in detail. Second, to analyze the effect of the intrinsic compressibility, that is, the Mach number of the fluctuations, M_t.

Results

LES predictions of the growth of the mixing depth and the evolution of mixing parameters compare well with the available literature (Cook *et al.*, 2001). Anisotropy of the Reynolds stresses also agree with reported values (Linden *et al.*, 1994). Simulations confirm the result predicted theoretically *a priori* by us that the turbulent Mach number cannot become large enough ($M_t < 0.3$, figure below). In other words, intrinsic compressibility effects cannot become important in a pure Rayleigh-Taylor problem. This is due to the link between the initial thermodynamic state of the flow and the level of turbulent fluctuations achievable from it. This link can be broken in the Richtmyer-Meshkov problem, so that, in contrast, M_t can increase substantially.

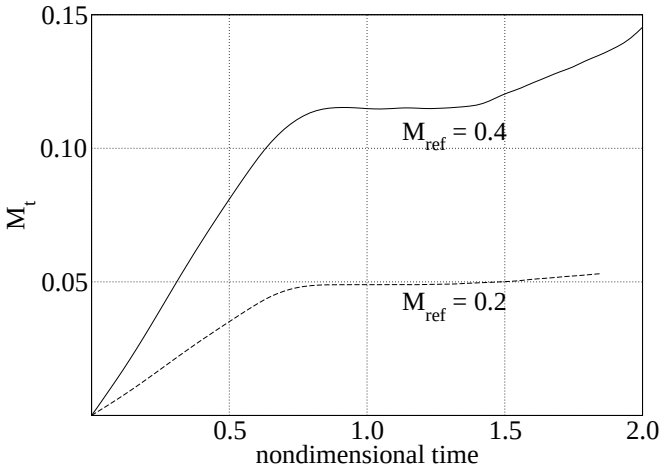

Figure 1: Temporal evolution at the center plane of the turbulent Mach number, $M_t = u_{rms}/\bar{c}$.

References

Cook, A. W. & Dimotakis, P. E. 2001 Transition stages of Rayleigh-Taylor instability between miscible fluids, *J. Fluid Mech.* **443**, 69-99.

Linden, P. F. & Redondo, J. M. and Youngs, D. L. 1994 Molecular mixing in Rayleigh-Taylor instability, *J. Fluid Mech.* **265**, 97-124.