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Effect of initial conditions on self-similar turbulent mixing

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Three dimensional simulations of Rayleigh-Taylor (RT) mixing starting with short wavelength random perturbations (growth by mode coupling) give values of the quadratic growth rate coefficient, α , much less than observed, Dimonte et al (2004). However, if a low level of long wavelength perturbations with a $1/k^3$ power spectrum (amplitude $\propto$ wavelength) is added, higher values of α may be obtained which correspond to the experimental values, Youngs (2002).

For the free shear layer (Kelvin-Helmholtz (KH) mixing), Pantano and Sarkar (2002), use broadband initial perturbations to match the observed results. This suggests a similarity with the RT case. Simulations of the time-evolving shear layer are performed with the same perturbations as used in the RT simulations and this confirms that the behaviour is similar. It is suggested here that in both cases low-level long wavelength perturbations are present in typical experiments and have an effect on the growth rate.

For both the RT and KH cases the internal structure of the mixing zone (velocity and concentration fluctuations) for simulations which match the observed growth rates, is compared with the available data measurements and found to be in satisfactory agreement.

For turbulent Richtmyer-Meshkov (RM) mixing, the mix width is usually assumed to have a t^p time variation, where p is a fractional power. Three dimensional simulations are performed with initial perturbation spectra of the form k^{-m} . It is shown that p is not a constant but depends on the exponent m.

Finally the implications of these results for RANS models, in which coefficients are adjusted to match a range of self-similar experiments, are discussed.

References

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