Geophysical Research Abstracts,
Vol. 10, EGU2008-A-12360, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-12360
EGU General Assembly 2008

Multiscale modeling of Rayleigh-Taylor Instability

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A LES model for compressible and incompressible flows is used to model the advance of 2D and 3D turbulent Rayleigh-Taylor and Richtmyer-Meshkov driven flows where arrays of bubbles and spikes prodoce local mixing. For several Rayleigh-Taylor configurations, it is shown that the characteristic lengths scale as t2 while the kinetic energies and spectral transfers behave as t2 and t. The evolutions of the front and of its fractal and multifractal dimensions are computed using the box counting algorithm for several regions of the flow. phenomenological coefficients of Youngs' scaling law are compared with experimental data. Comparisons with Linden, Redondo and Youngs three-dimensional numerical simulation are also performed. For shock tube experiments, where the Richtmyer- Meshkov instability initiates the mixing. The mixing thickness evolution is well reproduced while the turbulence levels seem to be overestimated. The multi-fractal analysis allows to distinguish the regions where most of the local mixing takes place, thus helping turbulence models, both driven by Rayleigh-Taylor instability, and Richtmyer-Meshkov instability.