Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Variable density mixing in buoyancy driven turbulence DANIEL LIVESCU, RAY RISTORCELLI, Los Alamos National Laboratory — The homogenization of a heterogeneous mixture of two pure fluids with different densities by molecular diffusion and stirring induced by buoyancy generated motions, as occurs in the Rayleigh-Taylor instability, is studied using Direct Numerical Simulations. The Schmidt number, Sc, is varied by a factor of twenty, $0.1 \leq Sc \leq 2.0$, and the Atwood number, A, a factor of ten, $0.05 \leq A \leq 0.5$. Important differences between the mixing in a variable density (VD) fluid, as compared to a Boussinesq fluid, are observed. The pure heavy fluid mixes more slowly than the pure light fluid: an initially symmetric double delta density PDF is rapidly skewed and, only at long times and low density fluctuations, it relaxes to a Gaussian-like PDF. Diverse mix metrics and their dependence on A, Re, and Sc are used to examine the homogenization of the two fluids. In particular, it is shown that the specific volume density covariance is a better measure of the mixing state than the density variance for VD flows, as it directly appears in the dynamical equations. The usual mix parameter θ is mathematically related to the variance of the excess reactant of a hypothetically fast chemical reaction. Analytic expressions and bounds relating θ and the normalized product, Ξ, are derived. In general, no usual mix measure can predict the amount of pure or mixed fluid in the flow, however bounds on the fluid composition, using low order moments of the density PDF, can be derived.

Daniel Livescu
Los Alamos National Laboratory

Date submitted: 01 Aug 2007 Electronic form version 1.4