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Stochastic transport models for mixing in variable-density turbulence J. BAKOSI, J.R. RISTORCELLI, Los Alamos National Laboratory — In variable-density (VD) turbulent mixing, where very-different- density materials coexist, the density fluctuations can be an order of magnitude larger than their mean. Density fluctuations are non-negligible in the inertia terms of the Navier-Stokes equation which has both quadratic and cubic nonlinearities. Very different mixing rates of different materials give rise to large differential accelerations and some fundamentally new physics that is not seen in constant-density turbulence. In VD flows material mixing is active in a sense far stronger than that applied in the Boussinesq approximation of buoyantly-driven flows: the mass fraction fluctuations are coupled to each other and to the fluid momentum. Statistical modeling of VD mixing requires accounting for basic constraints that are not important in the small-density-fluctuation passive-scalar-mixing approximation: the unit-sum of mass fractions, bounded sample space, and the highly skewed nature of the probability densities become essential. We derive a transport equation for the joint probability of mass fractions, equivalent to a system of stochastic differential equations, that is consistent with VD mixing in multi-component turbulence and consistently reduces to passive scalar mixing in constant-density flows.

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