ALGORITHMS FOR THE SIMULATION OF INCOMPRESSIBLE TURBULENT MIXING

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We address a series of related topics, which in combination allow a new approach to the simulation of incompressible turbulence and mixing. Algorithmically, we start with the sharp interface code FronTier, suitable to control numerical mass diffusion. Finite levels of species or thermal diffusion through an interface are allowed, so that the tracking serves to maintain steep gradients but allows diffusion according to laws of physics. To this we add the subgrid scale (SGS) dynamic turbulence closure models to define a large eddy simulation (LES) with all parameters specified by the ongoing simulation. On this basis, we study solution convergence; in the inertial regime, we reformulate convergence as w* convergence of measures to a Young measure limit. In this way, we preserve fluctuations, which are inherent in the simulation of turbulence and turbulent mixing, and we achieve convergence of probability distributions (P DFs). Connections to Kolmogorov's1941 theory of turbulence allows a theoretical analysis of convergence. Because of the fluctuations and PDF convergence, nonlinear functions of the solution are also convergent, a fact which facilitates simulation of nonlinear processes built on top of the fluids and their mixing.

Verification and validation of various aspects of these ideas will be presented. Additionally, we have under development an application programming interface (API) to facilitate use of our algorithms in other codes. Asymptotic properties of the approach to the high Reynolds number limit will be described.

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