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3D Entropic Lattice Boltzmann Simulations of 3D Navier-Stokes Turbulence GEORGE VAHALA, William & Mary, JEFFREY YEPEZ, Air Force Research Lab., Hanscom, LINDA VAHALA, Old Dominion University, MIN SOE, Rogers State University, JONATHAN CARTER, NERSC, LBL — Turbulence yields highly complex trajectories in x-space whose evolution is very difficult to accurately follow computationally. However, by appropriately projecting into a higher dimensional phase space the trajectory is simple and its evolution readily evaluated. Lattice Boltzmann (LB) representations play such a role for fluid turbulence. Moreover, in complex geometries and high Reynolds number flows, the smallest scales cannot be resolved but the usual closure schemes of eddy viscosity cannot be justified because of lack of separation of scales. At the kinetic level closure schemes can be better justified. After coarse-graining, we recover better macroscopic turbulent closure models. An Achilles' heel of LB simulations is nonlinear numerical instabilities, typically triggered as the transport coefficients tend to zero. However, by imposing a discrete H-theorem constraint on the evolution of the distribution function one achieves an entropic LB algorithm that is unconditionally stable for any level of transport coefficients. 3D turbulence simulations will be presented for the highly symmetric Kida profile as well as the Taylor-Green vortex.

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