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Velocity gradient dynamics in compressible and incompressible flows using Homogenized Euler Equation SAWAN SUMAN, SHARATH GIRIMAJI, Aerospace Engineering Department, Texas A&M University — Velocity gradient dynamics in compressible flows is expected to be influenced by variations in temperature and density. Along the lines of the restricted Euler equation meant for incompressible flows, we propose Homogenized Euler Equation (HEE) to study the evolution of compressible velocity gradient dynamics. The HEE is solved in the Lagrangian reference frame for a calorically perfect gas. Unlike the restricted Euler equation, the HEE allows for the inclusion of both the isotropic and the anisotropic parts of the pressure Hessian. Computations are performed for a large number of initial conditions. Conditional statistics of principal strain rates, vorticity vector alignment and the second and third invariants of the normalized velocity gradient tensor are presented with particle dilatation as a parameter. Also, the orientation tendencies of vorticity with the eigenvectors of the pressure Hessian tensor are investigated. The HEE results conditioned at appropriate dilatation values agree well with (1) two stable fixed points of Burgers dynamics and, (2) direct numerical simulation data for decaying isotropic, incompressible turbulence.

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