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The effect of turbulent fluctuations on the relaxation of thermal non-equilibrium SUALEH KHURSHID, DIEGO DONZIS, Texas A&M University — In many engineering and natural systems, the microscopic behavior of constituent molecules can affect the macroscopic behavior of the flow. This interaction is significant when the two phenomena have commensurate time scales. We study the effect of turbulence on the relaxation of thermal non-equilibrium (TNE), in particular vibrational energy relaxation, using direct numerical simulation (DNS). First order effects are observed in the evolution of both vibrational energy and turbulence. For example, the rate of decay of kinetic energy is accelerated and temperature fluctuations are amplified. Analytic expressions for equilibrium vibrational energy, E_v^*, and characteristic relaxation time scale, τ_v, are compared against DNS data and used to understand features of the decay. This decay can be divided into two regimes, one dominated by TNE exchanges in time scales of the order of τ_v followed by a turbulence decay. Between the two regimes, some vibrationally hot flows become cold before reaching equilibrium. This reflects an aspect of the strong coupling between turbulence and TNE in both regimes. Compressiblity effects, quantified by turbulent Mach number (M_t), are also discussed.

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