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Direct Numerical Simulation of Turbulence and Mixing in Highly Compressible Flows YIFENG TIAN, FARHAD JABERI, Michigan State University, ZHAORUI LI, DANIEL LIVESCU, Los Alamos National Laboratory — The effects of normal shock waves on isotropic turbulence and scalar mixing are studied by direct numerical simulation (DNS) of fully compressible equations with high-order monotonicity-preserving and compact finite-difference numerical schemes for various flow and scalar conditions. Detailed examinations of the turbulence and scalar statistics such as the turbulent kinetic energy and scalar variance indicate that the numerical method is accurate and is able to correctly capture the shock-turbulence interactions and scalar mixing near and away from the shock even at very high Mach numbers. As expected, the shock wave increases the small-scale turbulence and the skewness and flatness of the turbulent velocity fluctuations, but the turbulent compressibility is actually decreased by the shock. The effect of shock on the turbulence was to found be strongly dependent on the pre-shock turbulence parameters such as the turbulence intensity. The enhancement of scalar mixing by the shock is also found to be dependent on the pre-shock scalar structure. The mechanisms responsible for the modification of turbulence and scalar mixing are identified by analyzing the flow structure and the transport equations for the Reynolds stress, vorticity and scalar variance inside and outside the shock zone.

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