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Title: "Compressibility Effects on Turbulent Mixing"

Abstract

Understanding of compressibility effects on turbulence has a crucial impact on the development of hypersonic flight, allowing the realization of its tremendous potential. The existence of compressibility with its attendant strong thermodynamic fluctuations and mean flow coupling produces significant topological and large-scale effects for turbulent mixing applications at high Mach number. While there is a significant body of knowledge at low compressibility conditions, knowledge gained from high compressibility mixing layers studies in laboratory conditions has significant implications for predicting behavior in very high speed boundary layers ($M > 10$) due to turbulent Mach number similarity. A review of past experimental and computational results motivates examination of highly compressible flow regimes (turbulent Mach number, $M_t > 1$).

Experimental results are focused on the two-stream mixing layer over a wide range of compressibility (convective Mach number, $0.8 < M_c < 3$, turbulent Mach number, $0.6 < M_t < 2$). Scalar mixing and aerodynamic heating information is gained through Planar Laser Induced Fluorescence (PLIF) imaging of the flowfield to extract both concentration and temperature fields. Visualizations of the mean and instantaneous scalar field over a range of Mach numbers imply that shear layers become more efficient mixers at high compressibility, also suggesting the use simple gradient transport mixing models over structure-based techniques. Spatially resolved imaging results uncover three-dimensional shock structures which are caused by slow scalar structures convecting in a supersonic flow, but *do not* confirm the existence of shocklets in highly compressible turbulence. The results assist to complete the picture of compressibility affects on mixing over realistic Mach numbers and contribute to the modeling of complex, hypersonic flows.