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Vorticity, Strain Rate, and Scalar Gradient Dynamics in Premixed Reacting Flows[1] PETER HAMLINGTON, ALEXEI POLUDNENKO, ELAINE ORAN, Naval Research Laboratory — The interactions between turbulence and flames in premixed, stoichiometric hydrogen-air combustion are studied as a function of turbulence intensity by analyzing the coupled dynamics of the vorticity, strain rate, and scalar (reactant mass fraction) gradient. The analysis is based on fully compressible numerical simulations of statistically planar flames at a range of intensities, where the intensity is characterized by the turbulent *rms* velocity in the unburned mixture with respect to the laminar flame speed. The simulations have been carried out using the reactive-flow code Athena-RFX, and high numerical resolution allows the dynamics within the flame to be studied using conditional diagnostics based on the local, instantaneous value of the scalar. Particular emphasis is placed on the magnitudes and relative alignments of the vorticity, strain rate, and scalar gradient, which give insights into the interactions between these quantities in the presence of heat release effects. The analysis shows that there are substantial variations in the dynamics with both the turbulence intensity and position in the flame. The implications of these results for understanding the structure and evolution of premixed flames, particularly when the turbulence intensity is large, are discussed.

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