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Axial Evolution of Helical Modes in Reacting Swirl Flow MIKE AGUILAR, BENJAMIN EMERSON, DAVID NOBLE, TIM LIEUWEN, Georgia Institute of Technology — The swirling jet is a common method of flame stabilization for ground power and aviation combustors. The hydrodynamic stability characteristics of high Reynolds number, reacting, swirling jets are not well understood, but have important influences on the flame stability and combustion dynamics of these combustors. These systems exhibit a variety of unsteady motions associated with the globally unstable vortex breakdown region, as well as the convectively unstable shear layers. Depending upon whether the system is executing natural oscillations or is externally forced at some other frequency (such as during a combustion instability), the dominant shear layer modes can vary between symmetric, m=0 structures, to various helical m = +1 or +2 structures. In addition, these modes evolve axially in different ways. This study presents 10 kHz PIV measurements of such a reacting swirl flow, with and without harmonic forcing. Modal decomposition is used on the measured velocity fields to extract the dominant mode shape and its frequency and spatial growth. Next, hydrodynamic stability theory is used on the measured time averaged flow field to predict the dominant vortex shedding mode and its axial growthrate. The predictions are compared to the experimental results for various flow conditions and forcing arrangements. Finally, we comment on the utility of linear stability methods for predicting the dominant mode and its spatial growth in reacting, swirling jets.

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