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Experimental and Numerical Investigation of Vortical Structures in Lean Premixed Swirl-Stabilized Combustion SOUFIEN TAAMALLAH, NADIM CHAKROUN, SANTOSH SHANBHOGUE, GAURAV KEWLANI, AHMED GHONIEM, Massachusetts Institute of Technology — A combined experimental and LES investigation is performed to identify the origin of major flow dynamics and vortical structures in a model gas turbine's swirl-stabilized turbulent combustor. Swirling flows in combustion lead to the formation of complex flow dynamics and vortical structures that can interact with flames and influence its stabilization. Our experimental results for non-reacting flow show the existence of large scale precession motion. The precessing vortex core (PVC) dynamics disappears with combustion but only above a threshold of equivalence ratio. In addition, large scale vortices along the inner shear layer (ISL) are observed. These structures interact with the ISL stabilized flame and contribute to its wrinkling. Next, the LES setup is validated against the flow field's low-order statistics and point temperature measurement in relevant areas of the chamber. Finally, we show that LES is capable of predicting the precession motion as well as the ISL vortices in the reacting case: we find that ISL vortices originate from a vortex core that is formed right downstream of the swirler's centerbody. The vortex core has a conical spiral shape resembling a corkscrew that interacts - as it winds out - with the flame when it reaches the ISL.

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