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Time-Accurate Calibration of a Thermoacoustic Model on Experimental Images of a Forced Premixed Flame HANS YU, USHNISH SENGUPTA, MATTHEW JUNIPER, Department of Engineering, University of Cambridge, LUCA MAGRI, Department of Engineering, University of Cambridge; Institute for Advanced Study, Technical University of Munich — Thermoacoustic instabilities are a persistent challenge in the design of jet and rocket engines. The time-accurate calculation of thermoacoustic instabilities is challenging due to the presence of both aleatoric and epistemic uncertainties, as well as the extreme sensitivity to small changes in certain parameters. We extend our previous work (Yu et al., CTR summer program 2018; Yu et al., J. Eng. Gas Turbines Power 2019) by applying our recently published level-set data assimilation framework (Yu et al., J. Comput. Phys. 2019) to experimental images of a forced premixed flame. We force a Bunsen flame with a loudspeaker and record videos at different frequencies and amplitudes. Data assimilation provides an optimal estimate of the true state of a system, and improves the predicted shape and location of the flame. Parameter estimation uses the data to find a maximum-likelihood set of parameters for the model while simultaneously quantifying their uncertainty and identifying deficiencies in the model. We demonstrate our level-set data assimilation framework using both the ensemble Kalman filter and smoother. More generally, we take a physics-informed, reduced-order model and use statistical learning techniques to make it quantitatively accurate.

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