Topology of Local Flame-Flame Interaction Events in Turbulent Flames

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Abstract: A large number of modern combustion devices have multiple closely-spaced turbulent flames that interact with each other, resulting in interacting flowfields as well as scalar fields. The local structure and dynamics of adjacent flames is dependent on both these interacting fields. Local flame-flame interaction occurs frequently in turbulent flames, occasionally resulting in formation of unburned gas pockets, and in some cases, burned gas pockets. Unburned gas pockets can be a source of harmful pollutants, as they may result in toxic fuel emissions. The topology of interaction events can vary significantly in the presence of adjacent flames and it becomes crucial to understand the sensitivity of these flames to these local interaction events for improving the design and operability of multi-flame devices. In this study, we investigate two interacting premixed flames in a dual burner configuration and apply high-speed OH-planar laser-induced fluorescence (OH-PLIF) to obtain instantaneous flame front locations of bluff-body stabilized and Bunsen flames. A non-rigid image registration technique is applied to flame images to track the topological changes occurring in small time steps. Flame-flame interaction events are identified using this technique and statistics conditioned on these events are compared between the two flame shapes. In particular, results are compared between the two branches of these flames to illustrate the differences that interacting flames have on flame topology. Probabilities of flame-flame interactions that result in flame pockets are also discussed.