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Modelling error analysis and estimation for unsteady flamelets

Flamelet models are asymptotic solutions of the nonlinear PDEs used to simulate turbulent flames. They capitalize on the scale separation between the flame thickness (assumed to be thin) and the other flow scales by replacing the distorted, unsteady flame front by a one-dimensional, steady object. This simplifies the computations tremendously. An idealized set-up is used to systematically investigate this type of strategy, using a combination of asymptotic analysis and numerical simulations.

The class of unsteady flows under consideration consists of a shear with a time-modulated cross-flow. It is known to lead to very interesting intermittent mixing regimes for non-reactive problems. In the present reactive case, it has the property that, to leading order, the flame indeed matches a flamelet structure, but with a highly non-trivial (local and unsteady) dissipation, which is the key fitting parameter of the model. Different strategies to predict this parameter are examined and their regimes of validity are identified. One goal is to design an automatic procedure that would select the appropriate model as the computation proceeds. This requires an efficient modelling error estimation procedure. Preliminary efforts in that direction will also be discussed.

Joint work with Oleg Volkov.