# Level Set Methods in Large-Eddy Simulations of Premixed Turbulent Combustion

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**Abstract**

Premixed turbulent combustion in technical devices often occurs in thin flame fronts. The propagation of these fronts, and hence, for instance, the heat release, are governed by the interaction of transport processes and chemistry within the front. In flamelet models this strong coupling is expressed in treating the flame front as a thin interface propagating with a laminar burning velocity $s_L$. Flamelet models for premixed turbulent combustion have been extensively used in the past and different models have been formulated for Reynolds averaged and large-eddy simulations (LES).

We have recently developed a new consistent formulation of the G-equation approach for LES. A new filter kernel has been developed, which averages along surfaces. Using this filter, the G-equation for the filtered flame front location can be derived. This equation has two unclosed terms. Since the new filter kernel only considers states at the instantaneous flame front, the convection velocity appearing in this equation is an average conditioned on the location of the flame surface. To relate this conditional velocity to the unconditionally Favre-filtered velocity, which is known from the solution of the momentum equations, a model for this quantity has also been developed. The second unclosed term involves the turbulent burning velocity. A model for this term has also been developed. A length scale equation for the sub-grid flame brush thickness has been derived. An analytic expression for the turbulent burning velocity follows from the assumption that production equals dissipation in this equation. The model is validated by simulations of two turbulent premixed Bunsen flames at different Reynold numbers. The results of the present simulations are compared with experimental data for temperature, velocity field, and turbulent flame brush thickness.