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# Assessment of a tabulated flamelet model with mixture averaged transport for turbulent hydrogen combustion

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This work explores the application of a tabulated chemistry (TC) model with mixture-averaged diffusive transport [1] in turbulent combustion regimes through Large-Eddy simulations (LES) modelling. The approach introduces new terms as diffusive fluxes into transport equations for controlling variables. The flux coefficients are derived from the manifold and stored in the flamelet database, which is constructed by solving premixed, unstretched, adiabatic, one-dimensional flames with mixture-averaged transport across a range of mixture fractions.
The model has been validated through simulations of laminar hydrogen flames in canonical configurations—including premixed, stratified, and triple flames with varying mixing lengths [1]—as well as lean mixtures exhibiting thermodiffusive instabilities [2]. Results demonstrate that the model accurately captures flame structure and propagation velocities at a reduced computational cost.
In this study, results for LES of several turbulent combustion setups are presented, including a planar turbulent hydrogen-air jet (Re = 11,000) employing the TC model and benchmarked against the Direct Numerical Simulations (DNS) of Berger et al. [3, 4], as well as three-dimensional planar flame fronts of premixed lean hydrogen flames [5] and transient state flames with strong turbulent-chemistry interaction effects based on setups from [6].

## References

[1] E. J. Pérez-Sánchez et al. Assessment of the flamelet generated manifold method with preferential diffusion modeling for partially premixed hydrogen flames. *Combustion and Flame*. 2025;277:114-141.

[2] E. M. Fortes et al. Analysis of thermodiffusive insta- bilities in hydrogen/air premixed flames using a tabulated flamelet model. *International Journal of Hydrogen Energy*. 2025;137:247-259.

[3] L. Berger et al. Synergistic interactions of thermodiffusive instabilities and turbulence in lean hydrogen flames, *Combustion and Flame* 2022;244:112-254.

[4] E. M. Fortes et al. Large-eddy simula- tions of a lean hydrogen premixed turbulent jet flame with tabulated chemistry. *13th Mediterranean Combustion Symposium MCS13*. 2025.

[5] A. J. Aspden et al. Three-dimensional phenomenology of freely-propagating thermodiffusively-unstable lean premixed hydrogen flames. *Proceedings of the Combustion Institute*. 2024;40(1-4):105634.

[6] E. R. Hawkes et al. A petascale direct numerical simulation study of the modelling of flame wrinkling for large-eddy simulations in intense turbulence *Combustion and Flame*. 2012;159(8):2690-2703.