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Special Issue on Recent Advances in Turbulent Premixed Combustion Modeling

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PREFACE

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Special Issue on Recent Advances in Turbulent Premixed Combustion Modeling

The importance of fuel-lean combustion in premixed mode for modern gas turbine and automotive engines has been well recognized. This combustion mode is prone to combustion-induced oscillation, which is usually addressed by introducing some partial premixing. The turbulent combustion of these mixtures is influenced strongly by the interplay among fluid dynamics, heat release, and both molecular and turbulent transport of momentum, mass, and heat. Some of these processes can be scale-dependent in the view of the large eddy simulation paradigm. Recently, good progress has been made in our understanding and modeling of turbulent premixed combustion. A one-day workshop was held at Robinson College, Cambridge, UK, on June 25, 2015, with a broad aim to survey and give an overview of these advancements and to identify important outstanding questions in this field. The discussion covered numerical, analytical, and experimental topics.

Professor Ken Bray opened the discussion with a brief review of premixed flamelets, which was followed by papers on DNS data analysis, experimental studies, and LES and RANS modeling. The influence of heat release on scalar spectrum was also discussed. The dissipation rate of the progress variable fluctuations, in both RANS and LES paradigms, plays an important role in the flamelet approach, and recent advances in modeling this quantity, including its near-wall modeling, were discussed along with subgrid scale velocity required in some of combustion modeling. It was quite clear that much of the existing SGS velocity scale model is inadequate to capture fluctuating velocity statistics resulting from flame intermittency effects observed experimentally in the corrugated-flamelets regime, where preferential-diffusion effects may also have to be included in the SGS combustion modeling. It was noted that the SGS velocity scale might not be required for fractal dynamic of the SGS combustion model. Further improvements of LEM required for its application to LES were discussed. A revised perspective to view the turbulent premixed flame brush as a three-layered structure to help its modeling in the RANS context was explored. The modeling of micro-mixing, a close ally to the scalar dissipation rate in modeling, in the scalar transported PDF approach was discussed.

All of these are presented in detail in the papers contained in this special issue. We must note that most of these papers have gone through at least two stages of reviews by three independent reviewers, and some of the reviewers were not participants of the workshop. This workshop was supported by Engineering and Physical Sciences Research Council (EPSRC), UK, and was run under the auspices of Institute of Physics, Combustion Physics Group and The British Section of Combustion Institute.

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