Application of Conditional Source-term Estimation (CSE) to A Turbulent Non-premixed Methanol Bluff-body Flame

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Methanol is an alternative fuel currently used in many applications including electric power generation and space heating. Due to its high octane rating and oxygen content, blending methanol into gasoline reduces vehicle emission significantly. In order to predict relevant turbulent flame characteristics, such as species concentrations and temperature, a numerical model capable of capturing the interactions between turbulence and chemistry is required. Conditional Source-term Estimation (CSE) is a turbulent combustion model that uses conditional averages to close the chemical source term and has been applied to simulate a range of flames such as premixed, partially premixed, and non-premixed flames. Previous CSE studies have shown that the model is able to predict the flame characteristics successfully. However, these studies have only focused on simple hydrocarbon fuels mostly composed of methane. The objective of the present study is to evaluate the capabilities of CSE applied to a turbulent non-premixed methanol flame, which has never been done previously. The turbulent non-premixed bluff-body flame, which has been both experimentally and numerically investigated, is reproduced using CSE. The turbulent flow field is solved using the SST k-omega model. Detailed chemistry is included in tabulated form using the Trajectory Generated Low-Dimensional Manifold (TGLDM) method. The predictions including both the conditional and Favre averaged mass fraction of reactive species and temperature are compared with available experimental data and previous numerical results. Overall, the predictions by CSE on both conditional and unconditional quantities are in a good agreement with the experimental data and the previously simulated results.