Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Conditional Reynolds stress modeling in turbulent premixed jet flames JINYOUNG LEE, MICHAEL MUELLER, Princeton University — Conventional turbulence modeling approaches based on traditional unconditional averaging implicitly assume that combustion heat release does not affect turbulence. However, in turbulent premixed flames at low Karlovitz number, combustion-induced dilatation and flame motion significantly modify turbulence. Instead of relying on unconditional averaging, simultaneously solving momentum and scalar transport equations conditionally averaged on a flame structure variable could provide a superior framework for modeling combustion-affected turbulence since the flame dynamics are embedded into the flame-conditioning. The primary challenge in this approach is developing closure models for conditional terms, which evolve in both physical and conditional spaces. In this work, a new model for conditional Reynolds stresses, which appear in the conditionally averaged momentum equations, has been developed. The new model consists of a conditional Boussinesq-like term and a new term representing turbulent momentum transport in conditional space. A theoretical scaling of the new model has been investigated, and the model performance has been evaluated in a priori analyses using DNS databases of turbulent premixed jet flames at low and high Karlovitz numbers.

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Date submitted: 24 Jul 2019

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