Comparison of the stochastic fields method and DQMoM-IEM as turbulent reaction closures

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This paper compares two mean reaction rate closures for turbulent reacting flow: the Stochastic Fields (SF) method and the Direct Quadrature Method of Moments using the Interaction by Exchange with the Mean micromixing model (DQMoM-IEM). The methods have many common features and have received significant attention in recent literature, yet have not been systematically compared. We present both methods in the same mathematical framework and compare their numerical performance. In addition, we introduce antithetic sampling as a variance reduction technique to increase the efficiency of the SF algorithm. We extend the methodology to take advantage of this development and show details of the implementation of each method in a commercial computational fluid dynamics code. We present a systematic investigation and consider both axisymmetric and 3D formulations of a problem known from the literature. DQMoM-IEM showed excellent agreement with experimental and transported probability density function data. SF gave reasonable agreement, but retained a minor grid-dependence not seen with DQMoM-IEM and did not fully resolve the sub-grid segregation of the species. The antithetic sampling was demonstrated to significantly increase the efficiency of the axisymmetric SF cases.

Author Name:
Jethro Akroyd
Alastair J. Smith
Laurence R. McGlashan
Markus Kraft
Industries:
Products:

strength engineering simulation.
