PROGRESS IN THE MODELLING OF TURBULENCE-RADIATION INTERACTION IN LARGE-EDDY SIMULATION OF TURBULENT REACTIVE FLOWS

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ABSTRACT

Turbulent fluctuations are responsible for complex coupling phenomena in reactive flows, namely turbulence-combustion coupling, which must be taken into account in the numerical simulation of turbulent reactive flows. Although turbulence-radiation interaction (TRI) is widely acknowledged, it is often ignored, even though this simplification may lead to significant errors in predicting the radiative heat fluxes and the radiative heat source. At present, large-eddy simulation (LES) is the state-of-the-art model in the numerical simulation of turbulent flows, except in simple configurations and low to moderate Reynolds numbers, where direct numerical simulation is feasible. While TRI has been investigated in the framework of Reynolds-averaged Navier-Stokes models for more than two decades, the studies performed in the case of LES are more recent. In LES, the largest scales are resolved, and only the subfilter-scale (SFS) fluctuations need modelling. The present lecture summarizes the progress achieved in the simulation of TRI in LES of turbulent reactive flows. The instantaneous and the spatially filtered forms of the radiative transfer equation (RTE) are presented, and the unresolved correlations resulting from the filtering operation are discussed. Models for accounting for SFS-TRI are surveyed and relevant results on the importance and characteristics of SFS-TRI are presented, particularly for turbulent jet diffusion flames and pool fires. The main findings of these studies are summarized, and recommendations on future research directions are given.

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