

Supplementary material for ‘Modelling of the turbulent burning velocity based on Lagrangian statistics of propagating surfaces’

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1. Convergence study for Lagrangian statistics of propagating surfaces in non-reacting HIT

We present a convergence study to demonstrate that our non-reacting DNS is sufficiently well-resolved for calculating Lagrangian statistics of propagating surfaces. For case D, we run DNS of non-reacting HIT with three grid resolutions N^3 and $N = 64, 128$ and 256 , and calculate the Lagrangian statistics along with the DNS. Figure 1 compares surviving ratios and area growth rates with the three resolutions. We observe that the profiles of R_s and ξ_A are almost identical, so both quantities converge for $N = 128$ and 256 .

2. Convergence study for combustion DNS

We present a convergence study to demonstrate that our combustion DNS is sufficiently well-resolved. For case D, we first run a low-resolution simulation on the grid of $768 \times 128 \times 128$ to the stationary state, then the resolution is doubled to $1536 \times 256 \times 256$ and run over $20T_e$. The instantaneous turbulent burning velocities in the two combustion DNS cases are presented in figure 2, where the time scale has been normalized by the eddy turnover time T_e . We observe that S_T in the lower-resolution case generally agree with that in the higher-resolution case for over $10T_e$. The turbulent nature of the flow makes the flame inherently unstable, and S_T in the two cases gradually has some discrepancy, but the averaged S_T over $20T_e$ is only varied within 3.3%. In addition, figure 3 shows instantaneous slices at the two resolutions at the time indicated by the vertical dashed line in figure 2. Even after several eddy turnover times, flame structures in the two cases are still very similar.

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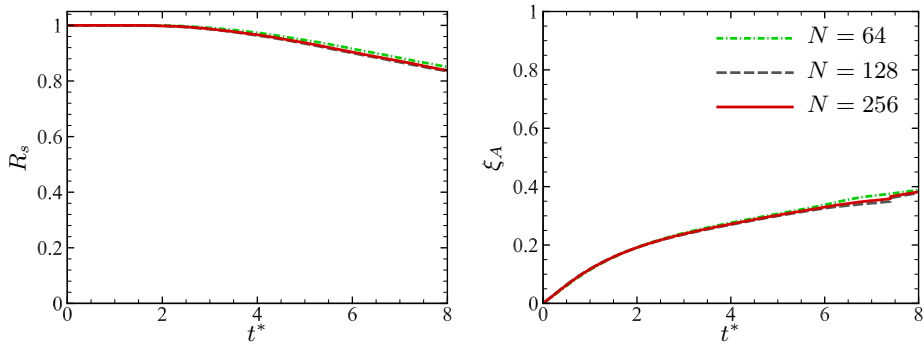


FIGURE 1. (Colour online) Surviving ratios (left) and area growth rates (right) of propagating surfaces in non-reacting HIT of case D with three mesh resolutions of the flow field.

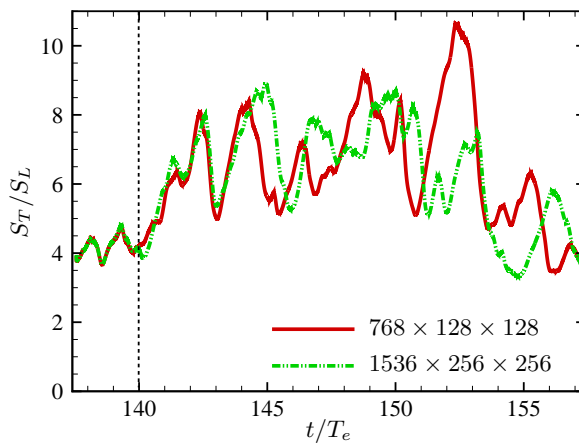


FIGURE 2. Turbulent burning velocities at two different resolutions for case D of combustion DNS.

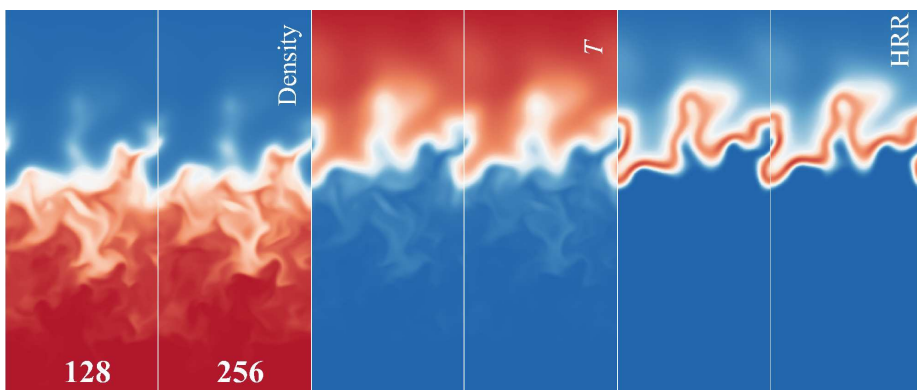


FIGURE 3. Slices at $x = 1.5L \sim 4L$ of density, temperature and heat release rate (HRR) for case D of combustion DNS at two different resolutions.