4C10: DIRECT NUMERICAL SIMULATION ANALYSIS OF THE FLAME SURFACE DENSITY TRANSPORT EQUATION IN THE CONTEXT OF LARGE EDDY SIMULATION.

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Did you try to estimate the order of magnitude of the different terms appearing in your transport equation for the flame surface density and sort out the most important terms?

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We have explicitly filtered our DNS data for use in LES model development using a filter size ranging from 0.2 δ_L to 2.8 δ_L (where δ_L is the thermal flame thickness). It is important to note that the order of magnitude of different terms of the Flame Surface Density (FSD) transport equation depends on the filter size.

The magnitude of these terms, conditionally averaged on Favre filtered reaction progress variable, behaves as follows:

1. The resolved propagation term $P_{\{mean\}}$ decreases with increasing filter size.

2. The resolved curvature term $C_{\{mean\}}$ decreases with increasing filter size.

3. The sub-grid curvature term $C_{\{sg\}}$ increases with increasing filter size.

4. The sub-grid FSD flux term increases with increasing filter size.

5. The resolved strain rate $S_{\{mean\}}$ decreases with increasing filter size.

6. The sub-grid strain rate term $S_{\{sg\}}$ increases with increasing filter size.

Other points are:

7. For all filter sizes, the strain rate and curvature contributions remain leading order contributors to the FSD transport.

8. The sub-grid strain rate term $S_{\{sg\}}$* $\backslash\Sigma_{\{gen\}}$ scales as the efficiency function *sqrt (k)*$\backslash\Sigma_{\{gen\}}\backslash^{\Delta}$ where k is the sub-grid turbulent kinetic energy, Δ is the filter size and $\backslash\Sigma_{\{gen\}}$ is the generalised FSD.

9. The sub-grid curvature term scales as $-\backslash\alpha_n * S_L * (\backslash\Sigma_{\{gen\}}^2)/(1\text{-filtered c})$ where $\backslash\alpha_n$ is a resolution factor which becomes 0 in the limit of zero filter size (i.e. when the flow is fully resolved) and S_L is the laminar burning speed.

10. The curvature dependence of the LES surface averaged displacement speed due to the tangential diffusion component of displacement speed remains important for all filter sizes especially in the thin reaction zones regime.

In addition to these general trends it is worth emphasising that the modelling of all terms remains important in the context of LES because locally a term can become a major contributor even though its magnitude may show a small value on conditional averaging over a Favre filtered c iso-surface.