Supplementary material: On the CNN ability to learn from flame topology only

The Convolutional Neural Network (CNN) takes as input the field of progress variable and local equivalence ratio. The local variation of the equivalence ratio plays a role in the variation of the burning rate $\dot{\omega}$, which could therefore bias our conclusion that the CNN is able to model based on the filtered flame topology (e.g. the curvature of the progress variable). To demonstrate that this is actually the case, a new training has been performed for the case of global equivalence ratio $\phi_g = 0.35$ without information on the equivalence ratio. Burning rate inference is found to be very accurate (Figs S19 and S20). The Normalized Mean Absolute Error (NMAE) is about 0.09, which is slightly higher than the NMAE at $\phi_g = 0.35$ when the CNN is aware of the equivalence ratio variations, reported in the main manuscript at $\mathrm{NMAE} \approx 0.06$. Thus, although the CNN is well able to model burning rates based on the progress variable alone, the information on the spatial variation of equivalence ratio provides additional information that improves the prediction slightly.

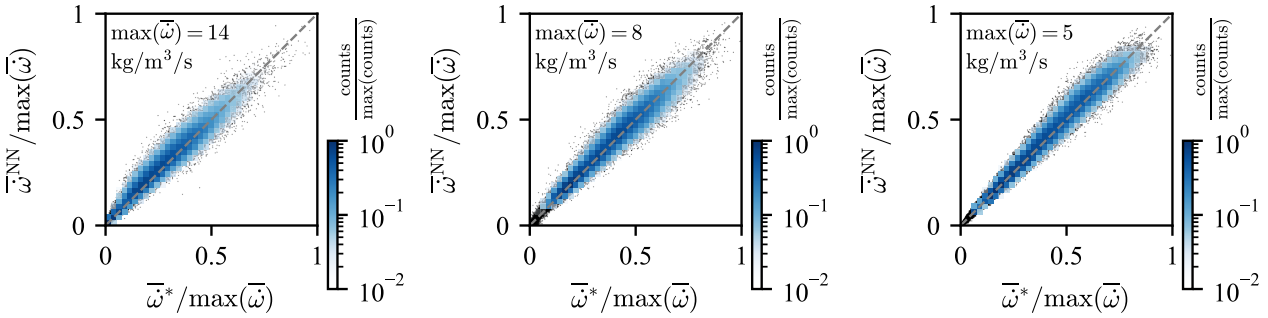

Figure S19: Scatter plots with 2D histograms: CNN-modeled burning rate $\overline{\dot{\omega}}^{\mathrm{NN}}$ versus ground-truth filtered burning rate $\overline{\dot{\omega}}^{*}$. Individual values are normalized by the maximum burning rate in the datasets. The points used for the histograms have a progress variable c: $0.05 \leq c \leq 0.95$. Histogram values below the colour scale are transparent. Gray dashed line indicates $x = y$ (i.e. zero error). From left to right: $(\sigma = 4, \mathrm{DSF} = 2)$, $(\sigma = 8, \mathrm{DSF} = 4)$ and $(\sigma = 16, \mathrm{DSF} = 8)$. Data are collected from the testing solutions. The global equivalence ratio is $\phi_g = 0.35$. The CNN has been trained without the information on the local equivalence ratio ϕ.

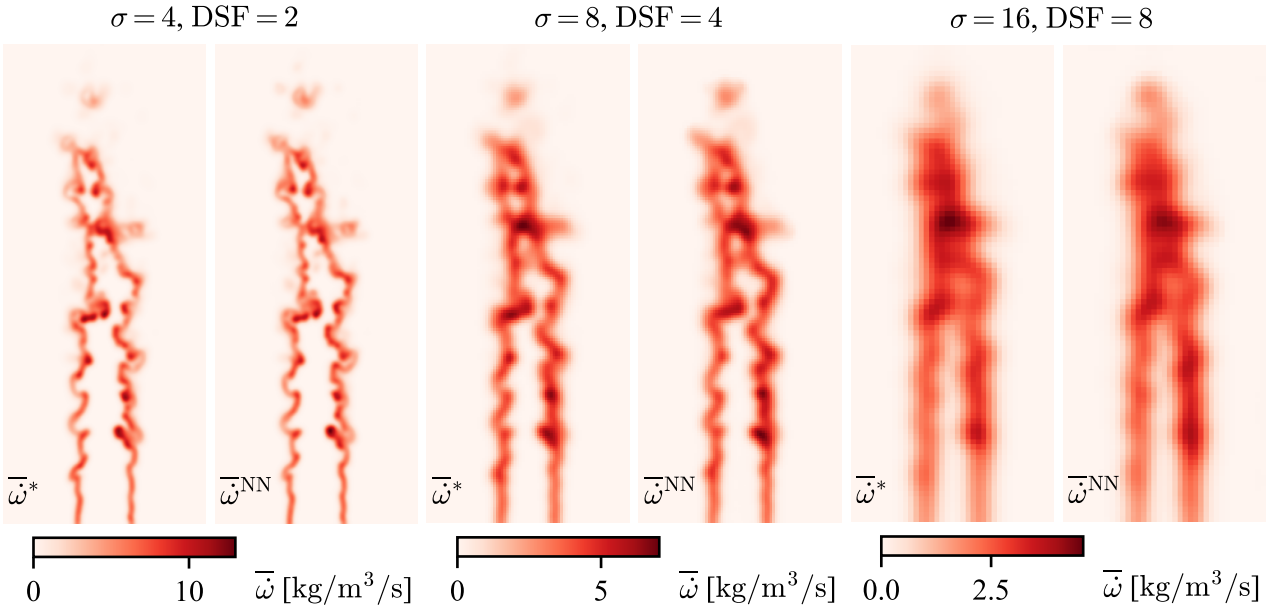

Figure S20: Planar cut normal to the z-axis, in the middle of the domain, colored by the ground-truth filtered burning rate $\overline{\dot{\omega}}^{*}$ and the CNN-modeled burning rate $\overline{\dot{\omega}}^{\mathrm{NN}}$ for three sets of LES parameters. The global equivalence ratio is $\phi_g = 0.35$. The CNN has been trained without the information on the local equivalence ratio ϕ. The complex turbulent flame topology of the burning rates is remarkably well reproduced by the CNN.