Open Data

Training convolutional neural networks to estimate turbulent sub-grid scale reaction rates

In the combustion community, the determination of the sub-grid scale contribution to the filtered reaction rate in reacting flows Large Eddy Simulation (LES) is an example of closure problem that has been daunting for a long time. CERFACS proposes a new approach for premixed turbulent combustion modeling based on convolutional neural networks by reformulating the problem of subgrid flame surface density estimation as a machine learning task. In order to train a neural network for this task, a Direct Numerical Simulation (DNS) and the equivalent LES obtained by a spatial filtering of this DNS is needed.

- In a first step, two DNS of a methane-air slot burner are run and then filtered to create the training dataset. Models are trained on this data in a supervised manner. In a second step, a new, unseen and more difficult case was used to ensure network capabilities.
- This third DNS is a short-term transient started from the last field of the second DNS, where inlet velocity is doubled, going from 10 to 20 m/s for 1 ms, and then set back to its original value for 2 more ms.

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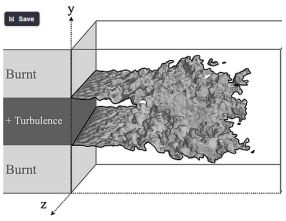

Figure 1: Physical domain used for the DNS. At the inlet, a double hyperbolic tangent profile is used to inject fresh gases in a sheet ≈ 8 mm high, surrounded by a slower coflow of burnt gases. Top-bottom (along y) and left-right (along z) boundaries are periodic. The isosurface is a typical view of T = 1600 K for DNS2.

Description of the dataset

Each of the dataset files corresponds to a time step of a simulation and contains 3 fields:

- Filt_8 is the filtered progress variable
- Filt_grad_8 is the DNS field
- Grad_filt_8 is the LES field

Works using this datset need to cite this manuscript:

Lapeyre, C. J., Misdariis, A., Cazard, N., Veynante, D., & Poinsot, T. (2019). Training convolutional neural networks to estimate turbulent sub-grid scale reaction rates. Combustion and Flame, 203, 255–264.
https://doi.org/10.1016/j.combustflame.2019.02.019

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