Institut für Technische Verbrennung | RWTH AACHEN UNIVERSITY

Bachelor or Master thesis

Modeling of Turbulent, Reactive Flows Using a Self-Learning Approach

Topic is suitable for

- ✓ Bachelor thesis
- ✓ Master thesis

Field of activity

Turbulent reacting flows

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One major focus of combustion research is the reduction of pollutants. As pollutants are mainly formed through intermediate species on various timescales and are harmful in low concentrations, the simulation and prediction of pollutants is very complex. Numerical simulations are widely used to develop new combustion devices; however, accurate combustion models are needed for these simulations to be predictive. The goal of this thesis is the implementation and evaluation of a novel combustion model using a machine learning approach. Typically, reduced order models for turbulent combustion are created using flamelet-generated manifolds. A fully resolved, laminar reference flame (flamelet) is computed with detailed chemistry, tabulated, and accessed through one or more mapping variables. This is very efficient because the chemistry is decoupled from the flow field but requires prior knowledge and experience to correctly setup the chemistry table. Instead, in this project we want to use a data-driven model where the complex tabulation of flamelet data is handled by a self-learning algorithm. That way, we can create light-weight, reduced-order models that are tailored to the desired case, without lots of prior knowledge about the case. The self-learning algorithm has been developed and validated for hypersonic flows. Here, we want to extend the model to combustion cases.

Your task in this thesis is to extend the model for turbulent combustion cases and perform a-priori analyses using fully resolved simulations (Fig. 1). Secondly, you will investigate the extrapolation abilities of the model by using flamelet data as input. Finally, the full model should be implemented in our in-house code and evaluated a-posteriori.

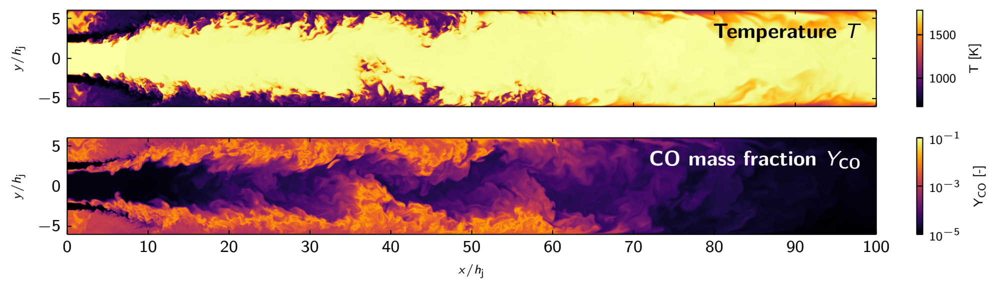

Figure 1. Temperature and CO mass fraction fields from a direct numerical simulation of two turbulent jet flames with flame-wall interaction. The flames are quenched at the cold walls, causing changes in the thermochemical states and non-equilibrium CO emissions.

Your tasks

- ◊ Setup the novel model and perform a-priori analyses with existing data
- ◊ Investigate the extrapolation capabilities of the model
- ◊ Implement the full model and run validation cases

About you

This thesis might be suitable for you, if you:

- ◊ Are interested in programming and numerical modeling
- ◊ Are familiar with HPC environments and programming, preferably Python

If you are interested, this thesis can be combined with a Hiwi position. Contact us for more details.

This thesis does not quite fit your ideas? Feel free to contact us to customize this topic or to find an alternative thesis.