1. Motivation
- Numerical simulations of turbulent combustion still a challenging task
- Detailed kinetics increase CPU cost for large scale simulations
- Need to obtain low-dimensional representation

2. Numerical model
Combining manifold methods and dimensionality reduction: Manifold Generated from PCA (MG-PCA)
- Select and transport the principal variables (PV) amongst the total variables:
  \[ \frac{\partial \hat{Y}(q)}{\partial t} = -\nabla \cdot \hat{j}(q) + \hat{s}(q) \]
- Estimate the non-transported \((Q - q)\) variables using a PCA-based projection:
  \[ \hat{Y}(Q - q) = \hat{Y}(q) \hat{B}(Q - q) \]

3. MG-PCA approach
1. Training data generation
2. PCA for PV selection and clustering
3. Computation of local reconstruction matrices
4. Adaptive simulation

4. On-the-fly classification
Reconstruction error of the \((Q - q)\) variables can be minimized using local low-dimensional projections, to follow the manifold curvature

5. Results
Flame in a box configuration
- \( f = 1.2 \)
- \( T = 500 \) K
- \( P = 1 \) atm
1D and 3D model training
Assessment against CSP based reduction
In-house DNS code KARFS

- Transported (top) and non-transported (bottom) minor species
- Timescales analysis