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Combustion Modelling TME 280 2017-10-05

Assignment 3
Turbulent Non-Premixed Combustion

1. Averaging data with a β-PDF

A piloted methane jet flame has been simulated using CFD with a steady flamelet model. The gas that is leaving the main jet consists of 74 % N_2, 20 % O_2 and 16 % CH_4 with the diameter of the jet nozzle being $D_{\mathrm{Nozzle}} = 7.2$ mm. The gas mixture is ignited by a small pilot flame. The fuel stream is defined as the content that exits the gas jet ($\widetilde{Z} = 1$)). The mixture at the exit of the pilot jet is equal to $\widetilde{Z} = 0.271$

a) Load and visualize the CFD data. The data set consists of the velocity field, U_x, U_y, U_z, the mixture fraction field and its variance, $\widetilde{Z}$, $\widetilde{Z''}$, turbulent kinetic energy, k and dissipation of turbulence, ε.

b) Implement a python function that calculates the mean of temperature and major species using the provided flamelet library. The mean values of temperature and mass fractions should depend on $\widetilde{Z}$, $\widetilde{Z''}$ and the scalar dissipation rate:

$$\tilde{\chi}_{\mathrm{st}} = \frac{C_\chi \varepsilon \widetilde{Z''}}{k} \tag{1}$$

Where $C_\chi = 2$

c) Use the function implemented in b) to calculate the mean temperature field of the methane flame. Mark the stoichiometric mixture fraction line in your plot. Also, plot the mean temperature in mixture fraction space. How does the scalar dissipation rate affect the temperature?

Due date for assignment: October 23, 2017
Credit points: 1.5