Iran First International Combustion School (ICS2019)
Tehran, 24-26 August 2019

Combustion Modeling

Presentation of short course on Combustion Modeling

Alberto Cuoci

About me…

Alberto Cuoci

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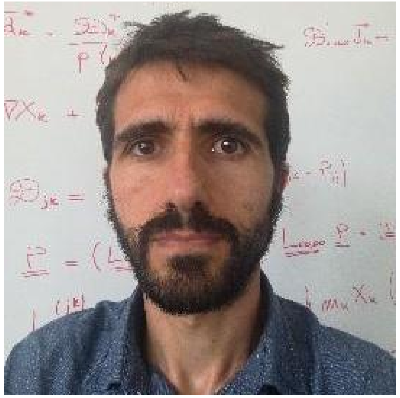

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About this course…

Objectives

i. to introduce the **main methodologies and techniques** that constitute the basis of combustion modeling
ii. to make the students more familiar with the **numerical implementation** of those techniques
iii. to cover a range of **modern/advanced techniques for numerical modeling of combustion**, aiming to provide students with a general knowledge and understanding of the subject, including recommendations for further studies.

Organization

6 modules (1.5 or 2 hours) on Combustion Modeling
Material for training sessions is provided (see next slides)

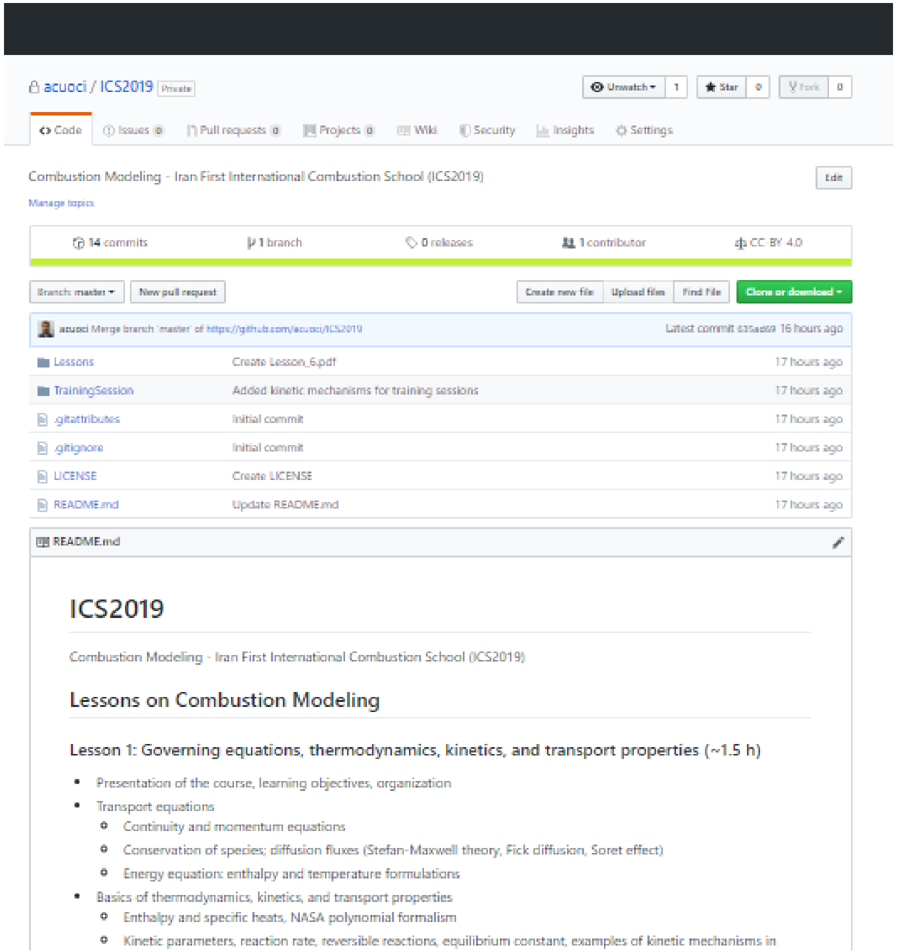
Topics

governing equations of reacting flows, numerical methods for solving 1D and multidimensional reacting flows, advanced techniques for combustion modeling with emphasis on detailed chemistry, turbulent combustion modeling

About this course…

Slides and material about the training sessions are available at the following GitHub page:

https://github.com/acuoci/ICS2019



I will keep the repository online and active during the next months.

If you find errors in the published material, please send me an email, so I can fix them:

alberto.cuoci@polimi.it

Syllabus

- **Lesson 1:** Governing equations, thermodynamics, kinetics, and transport properties (~1.5 h)
- **Lesson 2:** Numerical algorithms for reactive flows (~2 h)
- **Lesson 3:** Numerical methods for 1D and multi-dimensional flames (~2 h)
- **Lesson 4:** Advanced techniques for reacting flows with detailed kinetics (~1.5 h)
- **Lesson 5:** Introduction to numerical modeling of turbulent reacting flows (~1.5 h)
- **Lesson 6:** Turbulent combustion modeling (~2 h)

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Numerical methods for combustion

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Combustion and detailed chemistry

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Turbulent Combustion

Training sessions (I)

No training sessions are scheduled during the short course on Combustion Modeling. However, material (detailed instructions, software, input files, short comments on results) for self-assessed training sessions is provided in the same GitHub repository.

Feel free to contact me during the course or later for additional explanations, comments, etc.

The training sessions are based on numerical tools developed in my research group and freely available on the web:

- OpenSMOKE++ Suite: https://www.opensmokepp.polimi.it/ (registration is required)
- laminarSMOKE: https://github.com/acuoci/laminarSMOKE (it requires OpenFOAM)
- flameletsSMOKE: https://github.com/acuoci/flameletSMOKE (it requires OpenFOAM)

Training sessions (II)

Training Session 1 (OpenSMOKE++ Suite)
Pre-processing of kinetic mechanisms, thermodynamic equilibrium and adiabatic flame temperature

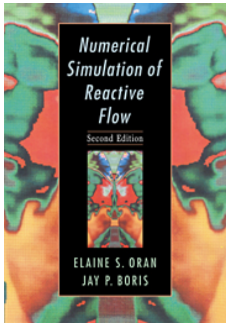
Training Session 2 (OpenSMOKE++ Suite)
Numerical simulation of 0D reacting systems: batch reactor (ignition delay times) and perfectly stirred reactor (speciation)

Training Session 3 (OpenSMOKE++ Suite)
Numerical modeling of 1D flames: laminar premixed flames and laminar flame speed

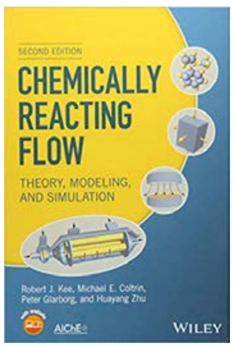
Training Session 4 (laminarSMOKE)
Simulation of a laminar coflow flame fed with a mixture of H2/N2 and air. Tutorial available at https://github.com/acuoci/laminarSMOKE/tree/master/run/validation/ToroFlames/F3

Training Session 5 (flameletSMOKE)
Simulation of Sandia CO/H2/N2 turbulent jet flame via Steady Laminar Flamelet model. Tutorial available at https://github.com/acuoci/flameletSMOKE/tree/master/cases

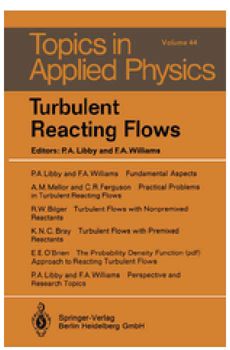
Textbooks on reacting flows



Oran E.S., Boris J.P
Numerical Simulation of Reactive Flow
Cambridge University Press (2001)

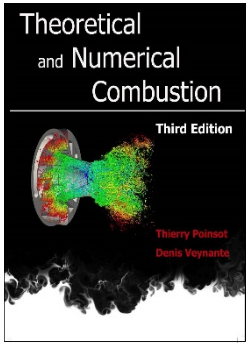


R.J. Kee, M.E. Coltrin, P. Glarborg
Chemically Reacting Flow: Theory and Practice
Wiley, 2 edition, 2017

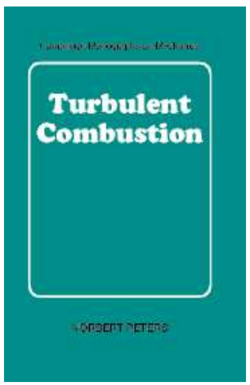


Libby A.L., Williams F. A.
Turbulent Reacting Flows
Academic Press, 1994

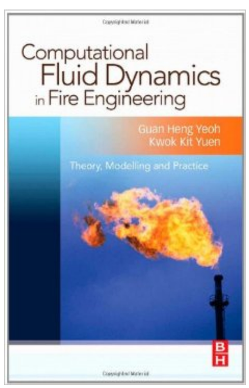
Textbooks on turbulent combustion modeling



Poinsot T., Veynante D.
"Theoretical and Numerical Combustion"
R.T. Edwards, 2nd Edition, 2005



Peters N.
"Turbulent Combustion"
Cambridge University Press, 2000



Yeoh G.H., Yuen K.K.
"Computational Fluid Dynamics in Fire Engineering Theory, Modelling and Practice"
Butterworth-Heinemann Ltd, 2009