Department of Chemical and Environmental Engineering

2015—2016 Seminar Series

Friday, October 30, 2015

9:30-10:30am
WCH 205/206

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Simulation of turbulent reacting flows using ODT, DNS, and LES

Turbulent reacting flows are important and challenging problems in engineering. Approximately 83% of U.S. energy use derives from combustion of fossil fuels. Accurate modeling and simulation of these processes enable efficient equipment design, predictions of air pollutant emissions, and hazard analysis. Such simulation is complicated because it is multi-scale, with length and time scales ranging from the finest dissipation scales of turbulence to large device scales. Only direct numerical simulation (DNS) is able to resolve all scales of turbulent motion, but at a very high cost. Typical combustion DNS require millions of CPU-hours for small domains and run times, in simple canonical configurations. Simulations of practical configurations (such as furnaces, or engines) require models for unresolved subgrid processes. Such configurations are typically simulated using large eddy simulation (LES). The one-dimensional turbulence (ODT) model is a reduced dimensional model that is able to resolve a full-range of turbulent scales at a much lower cost than DNS, allowing it to be applied to parameter ranges not available to DNS. Simulations of flame extinction and reignition, and soot formation will be presented using DNS, LES, and ODT. The simulation approaches are compared, along with advantages and limitations.

BioSketch: Dr. Lignell is an Associate Professor of Chemical Engineering at Brigham Young University. His research focuses on turbulent reacting flow simulation using direct numerical simulation (DNS), large eddy simulation (LES), and one-dimensional turbulence (ODT). Dr. Lignell received his Ph.D. in Chemical Engineering from the University of Utah in 2008. His graduate research was conducted at the Combustion Research Facility (CRF) at Sandia National Laboratories in Livermore California where he worked on simulation of turbulent ethylene jet flames. He performed post-doctoral research at the CRF where he developed an advanced implementation of the ODT model. Current research areas include soot formation and transport in nonpremixed flames, flame extinction and reignition processes, aerosol dynamics, and particle dispersion and transport. Dr. Lignell teaches courses in Computational Tools, Combustion, Numerical Methods, and Fluid Mechanics.

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