Insights Obtained from Direct Numerical Simulations of Highly Turbulent Combustion

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Time: 9:00 – 10:00 AM
Location: 22 Deike Building
Coffee and donuts will be provided

Abstract: Turbulent premixed combustion is a multi-scale, multi-physics problem involving coupled nonlinear interactions between turbulence and flame chemistry. However, in many engineering and natural systems, including scramjets, detonation engines, high swirl multi-nozzle gas turbine combustors, and supernova explosions, turbulent fluid motions can be intense relative to effects from the flame. In this talk, the coupled interactions between high-intensity turbulence and premixed flames will be explored from a fundamental perspective using direct numerical simulations of canonical flame configurations spanning a range of conditions. Highly turbulent premixed flames represent a relatively unexplored terra incognita in combustion research, and this talk outlines results from novel Lagrangian and scale-dependent diagnostic techniques that are intended to address three fundamental research questions: (i) How does high intensity turbulence affect premixed flame structure and dynamics? (ii) How are turbulent energy transfer and dynamics affected by premixed flames? (iii) How do flame properties depend on configuration and operating conditions? Physical understanding resulting from these questions will allow refinement of prevailing theories, including those encompassed in classical regime diagrams, as well as provide guidance on improvements to subgrid-scale models for large eddy simulations that can be used to increase efficiency, enhance performance, and reduce emissions of next-generation energy systems.

Biography: Dr. Peter Hamlington is an Assistant Professor and Vogel Faculty Fellow in the Department of Mechanical Engineering at the University of Colorado, Boulder (CU), with a courtesy appointment in the Department of Aerospace Engineering Sciences at CU and a joint appointment with the National Renewable Energy Laboratory. Research in his group, the Turbulence and Energy System Laboratory (tesla.colorado.edu), is focused on understanding and modeling turbulent flows in both engineering and geophysical problems using large eddy and direct numerical simulations. Dr. Hamlington and his group have used numerical simulations for the study of a broad range of applications, including unsteady, boundary layer, chemically reacting, and oceanic flows, as well as boundary layer flows relevant to renewable energy systems. The primary emphasis in many of these studies has been to understand fundamental flow physics and to use the resulting insights for the development of physically accurate, computationally efficient models for large-scale simulations of real-world problems. Dr. Hamlington has a B.A. in Physics from the University of Chicago and M.S. and Ph.D. degrees in Aerospace Science from the University of Michigan, Ann Arbor.