abstract
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. 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. ODT has been successfully applied to many flows, including flames, fires, and multi-phase flows. Results and limitations of the ODT model are presented and compared to DNS of soot formation, and flame extinction and reignition phenomena. Three-dimensional extensions of the model are also discussed in the context of affordable, direct multi-scale simulation of turbulent flows.

biosketch
Dr. Lignell is an Assistant 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 object-oriented implementation of the ODT model. Current research areas include flame propagation in biomass fuel beds with application to fire spread, mixing and precipitation of aqueous carbonate, soot formation and transport, aerosol dynamics and particle dispersion and transport, and flame extinction and reignition.