Department of
CHEMICAL ENGINEERING
THE UNIVERSITY OF UTAH

"Turbulence Still Surprises: Explorations Using a 1D Model"

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Abstract

One computational strategy for capturing micro-scale processes not affordably resolved in multi-dimensional turbulence simulations is to represent these processes by a lower-dimensional formulation. An approach formulated in one spatial dimension, denoted One-Dimensional Turbulence (ODT), is outlined. ODT combines two 1D approaches that have individually proven successful: stochastic iterated maps and dimensional reduction of the governing equations using the boundary-layer approximation. Within ODT, sub-processes based on these two approaches are coupled so as to represent both turbulent cascade dynamics and micro-physics at dissipative scales, including their two-way interaction. ODT has predictive capability for canonical flows and has been implemented as a sub-grid closure for 3D flow simulation. (Its simpler predecessor, the Linear Eddy Model, predicts mixing in specified turbulent flow states.) The use of these models for computationally affordable exploration of otherwise inaccessible flow and mixing regimes has led to surprising insights, indicating that it can be hazardous to extrapolate empirical understanding of turbulence phenomena beyond well studied regimes.

Bio

Dr. Alan Kerstein received his Ph.D. in Applied Statistics from Princeton in 1976. He then worked for Sandia National Laboratories, in Livermore, California, for thirty-five years in the Combustion Research Facility where he was a Distinguished Member of Technical Staff. Dr. Kerstein has been an author or co-author on over one hundred and twenty journal articles, and has personally contributed to the development of combustion-related computational models that are now widely used. In collaboration with University of Utah faculty and students, some of his research accomplishments include: models applying percolation theory to spray combustion, coal combustion, and solid propellant combustion, as well as the Linear Eddy Model and One-Dimensional Turbulence, used for turbulent combustion modeling. He is a fellow of the American Physics Society, and a past member of the editorial board of the Physical Review. Since the end of 2011, Dr. Kierstein serves as a consultant, presently in association with SINTEF Energy Research of Norway, Brandenburg University of Technology in Germany, and Chalmers University in Sweden.