Department of Aerospace and Mechanical Engineering

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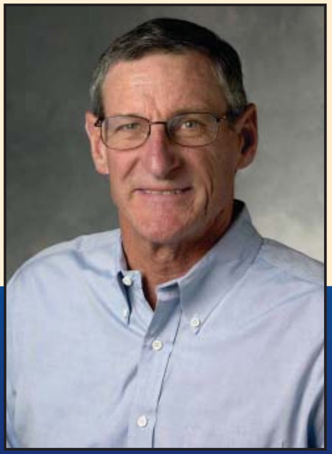
Using Magnetic Resonance Imaging and Machine Learning to Understand and Model Turbulent Mixing

Wednesday, November 1st, 2017 3:30P.M.

245 DeBartolo Hall

Refreshments served 365C Fitzpatrick Hall at 3:00 pm.

Turbulent mixing is the controlling process in many systems including atmospheric dispersion of gaseous or particulate pollutants, fuel combustion, gas turbine film cooling, and myriad other processes in nature and technology. Mixing rates can be accurately predicted by fully-resolved, direct numerical simulations of the Navier-Stokes equations, but lower fidelity models meant for practical computations do not have predictive capability. Flow measurement techniques based on Magnetic Resonance Imaging (MRI) are enabling a paradigm shift in how we study turbulent mixing in complex geometries. MR Velocimetry (MRV) measures 3-D mean velocity fields without flow tracers or optical access, and an entire velocity field comprising millions of individual data points can be measured in a few hours. MRT, MRC, and MRP measure flow temperature, scalar concentration, and particle concentration fields respectively. Velocity and scalar concentration fields will be shown for gas turbine film cooling flows to demonstrate how the 3D measurements lead to new physical understanding. We are developing new scalar transport models for Reynolds-averaged Navier-Stokes (RANS) computations using modern machine learning techniques. The models are trained and evaluated using a combination of high fidelity simulations and the MRI data sets. A random forest model for the scalar diffusivity implemented in a commercial RANS code provides substantial improvements in contaminant concentration predictions relative to conventional turbulence models showing the potential for data-driven model development.



Dr. John Eaton
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If you are interested in meeting individually with Dr. Eaton, please contact Carly at 631-5431.

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