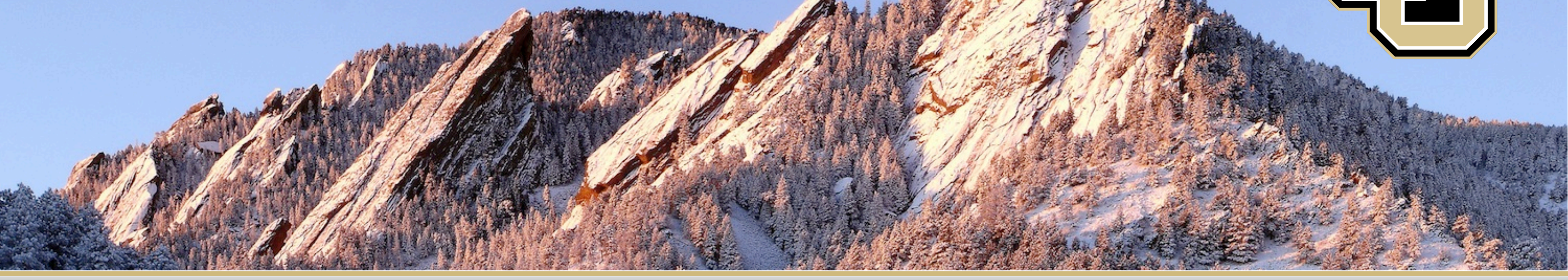
Boulder Fluid and Thermal Sciences Seminar Series



Tuesday, February 14, 2017
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

An Analytical Formulation for Optimal Dynamic Mode Decomposition

Ryan King, *National Renewable Energy Laboratory*

Dynamic Mode Decomposition (DMD) is a powerful data-driven technique for model reduction that learns a low-dimensional, linear model which approximates the behavior of a high-dimensional, possibly nonlinear system. By using this low-dimensional operator, modern control theory can be applied to control the behavior of complex systems such as turbulent flows or the electrical grid. Conventional DMD finds the best linear operator for data projected onto a subspace spanned by the Proper Orthogonal Decomposition (POD) modes of the input data snapshots. These POD modes optimally capture the energy content of the data, but are not necessarily optimal for encoding system dynamics. In this talk we derive an optimal basis for the projection subspace that minimizes the error in reconstructing full state dynamics from the low-dimensional system. We show that this optimal basis constitutes an error-free projection on the span of the full state outputs. We validate the performance of the optimal projection subspace by reconstructing turbulent channel flow data and demonstrate the temporal evolution of the resulting DMD modes.

Numerical Simulation of the Acoustical Propagation of Thunder

Jon Rood, *National Renewable Energy Laboratory*

Previous models for generating synthetic thunder lacked wave interaction due to lightning channel tortuosity. In this work, a two-dimensional CFD model based on the Navier-Stokes equations is selected for utilization. This model includes the effects of shear viscosity, bulk viscosity, thermal conductivity, wind shear, refraction, and is capable of applying the effect of dispersion due to molecular relaxation of nitrogen and oxygen. The model is numerically solved using a hybrid of schemes in space for the purpose of both stability and efficiency, and a Runge-Kutta scheme used in time. The technique of adaptive mesh refinement (AMR) is implemented through the Structured Adaptive Mesh Refinement Application Infrastructure (SAMRAI) developed by Lawrence Livermore National Laboratory. To insert the complex geometry of a lightning channel source, a combination of mathematical functions is developed to allow the source to be sufficiently smooth at arbitrary resolutions for stability. The final result is a physically-based model capable of running on a large-scale parallel platform that can reproduce the acoustic signature of arbitrary tortuous lightning channel geometries while including the effects of wave interaction.