# Boulder Fluid Dynamics Seminar Series

Tuesday, June 17, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

## Revisit Monin-Obukhov Similarity Theory and the Bulk Formula for Turbulence Parameterization

Jielun Sun, *National Center for Atmospheric Research, NESL/MMM*

The observations from the Cooperative Atmosphere-Surface Exchange Study in 1999 (CASES-99) field experiment suggest that the turbulent momentum mixing under moderate to strong winds is proportional to the bulk shear (wind speed over observation height), not local wind shear as in Monin-Obukhov similarity theory (MOST). The new result is due to the fact that if the mixing length at a given point in the atmospheric boundary layer is large enough to reach the ground, which happens under near neutral conditions or moderate to strong winds, the effect of the ground on turbulent mixing is significant, and the traditional assumption of the local gradient dependent turbulent mixing is not valid. However, if the mixing length is smaller than the observation height, such as under stable conditions, the effect of the ground on turbulent mixing decreases with height, the local shear becomes more relevant in turbulent strength. Parameterizations of the turbulent momentum and sensible heat fluxes using the traditional bulk formula derived from MOST and a new approach based on the above understanding are compared.

## Examination of Turbulent Flow Effects in Rotating Detonation Engines

Colin Towery, *University of Colorado, Boulder*

Subsonic and low-supersonic propulsion systems based on detonation waves have the potential to substantially improve efficiency and power density compared to traditional engines. Numerous technical challenges remain to be solved in such systems, however, including obtaining more efficient injection and mixing of air and fuels, more reliable detonation initiation, and better understanding of the flow leaving the detonation chamber. These challenges can be addressed using numerical simulations. Such simulations are enormously challenging, however, since accurate descriptions of highly unsteady flow fields are required in the presence of combustion, shock waves, fluid-structure interactions, and other complex physical processes. In this talk, we present high-resolution two- and three-dimensional large eddy simulations of pulsed and rotating detonation engines and examine unsteady and turbulent flow effects on the operation, performance, and efficiency of the engine. These simulations are further used to test the accuracy of common Reynolds averaged turbulence models.