Boulder Fluid and Thermal Sciences Seminar Series

Tuesday, January 19, 2016
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

Ensemble filtering with under-resolved models: inflation, stochastic parameterization, and model numerics

Ian Grooms, *University of Colorado, Boulder*

Ensemble Kalman filters are increasingly used to estimate and predict the state of the atmosphere and oceans. The models used are under-resolved, which leads to three types of errors: numerical errors, subgridscale errors, and representation errors. The state of the system can be separated into a large-scale/resolvable part and a subgrid-scale part. Numerical errors are associated with errors in the discrete representation of the large-scale part; subgrid-scale errors are associated with errors due to the interaction of resolved and unresolved scales; representation errors are associated with the mismatch between what is being observed (the full system state) and what is being modeled (the large-scale part of the system state). There are many approaches to reducing, and accounting for these errors in a filtering scheme; this talk explores three of them – covariance inflation, stochastic subgridscale parameterization, and model numeric – in the context of an idealized fluid system: two-layer quasigeostrophic dynamics.

Non-steady Wind Turbine Response to Atmospheric Turbulence Analyzed Using Hybrid URANS-LES and High Performance Computing

Ganesh Vijayakumar, *University of Colorado, Boulder*

Wind turbines have consistently grown larger and taller over the past decades, interacting with ever larger portions of the highly turbulent lower atmosphere. The Department of Energy (DOE) has stated the goal to produce 20% of the nation's electricity from wind by 2030. To achieve this goal, major reductions in cost of energy for wind energy are required through improvements in wind turbine reliability together with increased wind farm power capture. The DOE "Cyber Wind Facility" at Penn State was designed to be an "experimental" facility using petascale high performance computer systems that closely mimics a utility-scale wind turbine test facility in the field. In this seminar I will present our research on the interactions between the passage of daytime atmospheric turbulence structures through wind turbine rotors and the consequent non-steady wind turbine load transients. Using large-eddy simulation (LES) of the atmospheric boundary layer (ABL), we have shown that the energy containing eddies in the daytime ABL are of the order the blade length in size and pass through the wind turbine rotor plane over multiple rotation time scales of commercial wind turbines. Using a simulation of a single rotating blade from the NREL 5-MW wind turbine operating in a daytime ABL in which we resolve both the atmospheric eddies and the blade boundary layers using hybrid URANS-LES, we segregate the non-steady load changes on the blade into 3 distinct time scales: sub blade-rotation time scale, near blade rotation time scale, and eddy convection time scale. We find that eddy-induced non-steady changes in the velocity angle dominate the load fluctuation dynamics at all time scales.