Boulder Fluid Dynamics Seminar Series

Tuesday, November 11, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Optimization and perturbation methods for predicting the onset of convection in CO_2 sequestration

Nils Tilton, *Colorado School of Mines*

The sequestration of carbon dioxide in subsurface aquifers is an interesting process that poses fundamental questions concerning hydrodynamic stability, optimization methods, and perturbation methods. Following the injection of CO_2 into an aquifer, the CO_2 slowly dissolves into underlying groundwater. Because the density of the groundwater increases with the dissolution of CO_2, this produces an unstable density gradient in which layers of heavy CO_2-rich water overly layers of lighter water with low CO_2 concentration. This leads to overturning and mixing of the groundwater that play a dominant role in the long term transport and dissolution of CO_2. Unfortunately, though studied extensively, there is wide disagreement concerning the onset of this mixing. This presentation will demonstrate that previous disagreement stems from a sensitivity to how flow instabilities are measured. Furthermore, due to unique physical constraints, traditional hydrodynamic stability methods do not predict realistic results. To address these issues, we develop novel optimization and weakly nonlinear methods to predict the time required for onset of mixing as well as the flow structures associated with this mixing. All results are further validated by comparison to direct numerical simulations using high-order spectral methods.

Could Crop Roughness Impact the Wind Resource at Agriculturally Productive Wind Farm Sites?

Brian Vanderwende, *University of Colorado, Boulder*

The high concentration of both large-scale agriculture and wind power production in the United States Midwest region raises new questions concerning the interaction of the two activities. For instance, it is known from internal boundary layer theory that changes in the roughness of the land-surface resulting from crop choices could modify the momentum field aloft, which may impact the properties of the winds encountered by modern turbines. As direct observation of such interaction would require impractical interference in the planting schedules of farmers, we use numerical modeling to quantify the magnitude of crop-roughness effects. A hypothetical farm is inserted into the WRF model near the real location of the 2013 Crop Wind Energy Experiment (CWEX). A month-long period spanning August 2013 is used to evaluate the differences in flows above corn (maize) and soybean crops at the mature, reproductive stage. Simulations are performed comparing the flow above each surface regime, both in the absence and presence of a wind farm, which consists of a parameterized 11x11 array of 1.8 MW Vestas V90 turbines. Appreciable differences in rotor-layer wind speeds emerge, which we use to estimate the economic impact of crop selection on wind power producers.