Abstract
In urban areas, vegetation cover has an important effect in modulating the urban heat island (UHI). For example, during the day, trees typically cool the air via evaporative transpiration and shading thereby reducing energy consumption. Nonetheless, their effects are often neglected in microclimate wind modeling studies due to the lack of appropriately-resolved models that include complex flow modifications resulting from vegetation. This study explores the effects of vegetation canopies on the alteration of urban microclimate in highly-vegetated areas. Here, we use a fast-response simple CFD model called Quick Urban Industrial Complex wind field modeling system (QUIC-URB), which uses empirical parameterization along with mass conservation to produce averaged three-dimensional wind fields. This model is used to assess and compare the diurnal cycle of the mean wind field around buildings and vegetation elements using experimental data from near-surface time-averaged wind measurements obtained during the 2015 engineering-quad experiment at the University of Utah. During this experiment, low-cost local energy-budget measurement stations (LEMS) were used to measure wind speed and direction. Three different test cases are investigated including: the no-vegetation canopy model, the default vegetation canopy model in QUIC-URB (that accounts for momentum damping with appropriate attenuation coefficients for different trees species), and a grouped trees with averaged attenuation coefficient. Statistical comparisons during high wind and low wind time frame has been done. Wind speed mean error is 30% and wind direction mean absolute difference is less than 90.

Simulation Setup

- Simple CFD model: Quick Urban Industrial Complex wind field modeling system (QUIC-URB)
- Determine mean wind field in urban areas
- Uses mass- and energy-conserved parametrizations
- From wind tunnel database for building configuration
- \[ \frac{\Delta z}{z_0} = 0.5 \] for all cases
- Wind speed error has been quantified and compares reasonably well compared to Engineering-quad data, specifically NAD is about 30%.
- Wind direction comparison indicates the mean absolute difference for all cases is less 90 degree
- Result suggests longer time period comparison to understand physical aspects of domain

Results

- Qualitative comparison: Qualitative metrics used to compare simulation and experiment include:
  - Normalized Absolute Difference
  - Absolute Difference
  - Fractal bias

Future work

- Develop new model that account for dynamic effect of vegetation
- Improved urban profile based on plan area fraction, wind direction, surface roughness, and leaf index area

Acknowledgements
This material is based upon work supported by the National Science Foundation under the following Grant CBET 1512740.