



SSE Modeling

NIST WUI Fire Days 2022

Objectives: Aid experimental design, model validation, and scoping

1) Experimental Design: Wind-only simulations to assess impact of ambient wind on IBHS wind-tunnel generated flow

- Tony Bova, USFS

2) Model Validation: Wind flow at IBHS and heat fluxes from NIST gas burner

- Tom Milac, University of Washington

3) Experimental Design: Heat exposure conditions at roof eaves and in attic

- Xareni Sanchez-Monroy, IBHS

4) Scoping: Bounding the structure separation distance based on heat flux predictions

- Kuldeep Prasad, NIST



FEMA

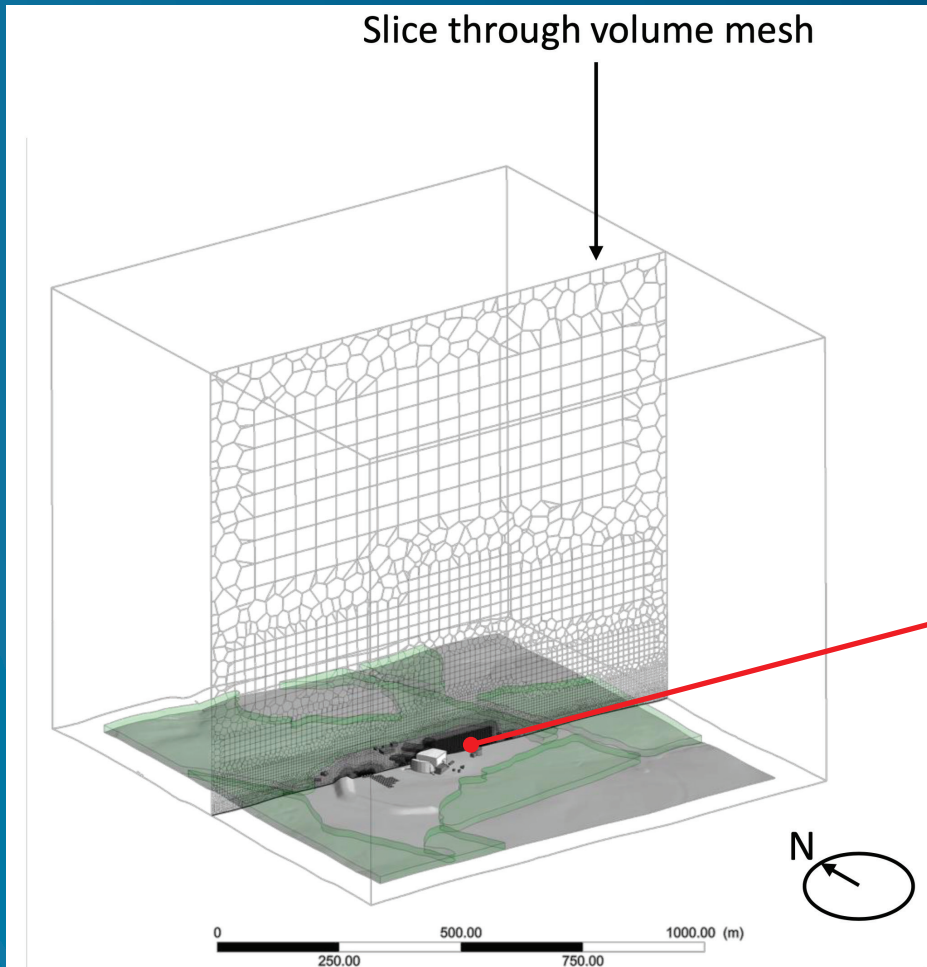
July 13, 2022



Wind-only simulations to assess impact of ambient wind on IBHS wind-tunnel generated flow

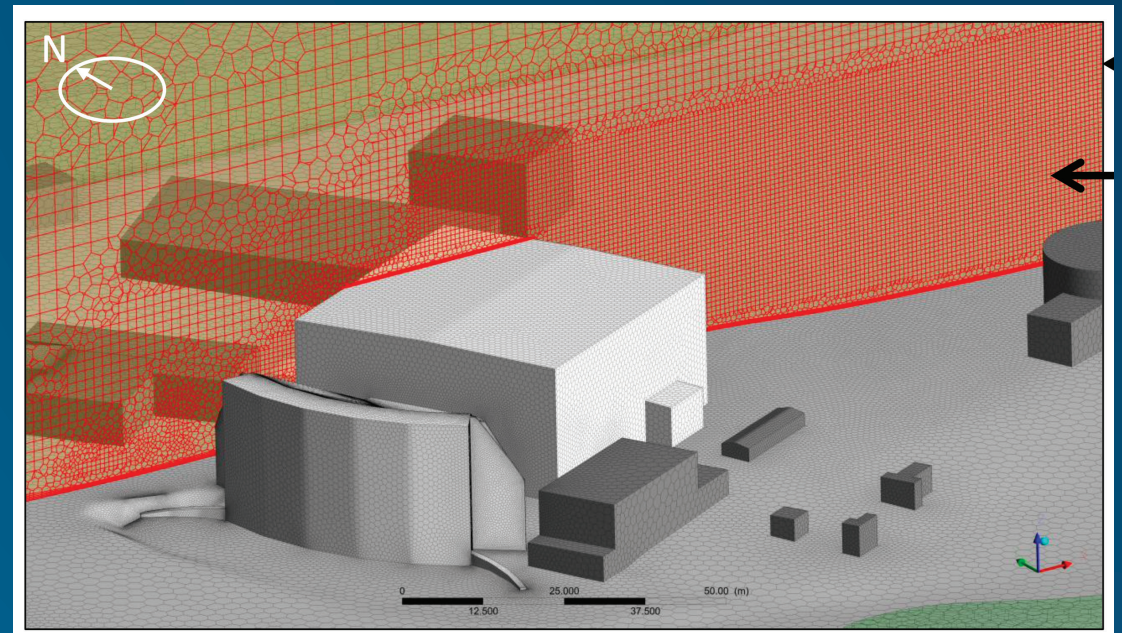
- The Forest Service hired a wind engineering firm, CPP, Inc., to provide advanced CFD simulations...
 - to assess how will ambient wind, particularly crossflow, affect the flow field in the outdoor test area,
 - for comparison with equivalent simulations performed using NIST's Fire Dynamics Simulator (FDS), and
 - to potentially provide a comparison between CFD simulations, scale model wind tunnel simulations and full-scale wind measurements.

Computational Mesh

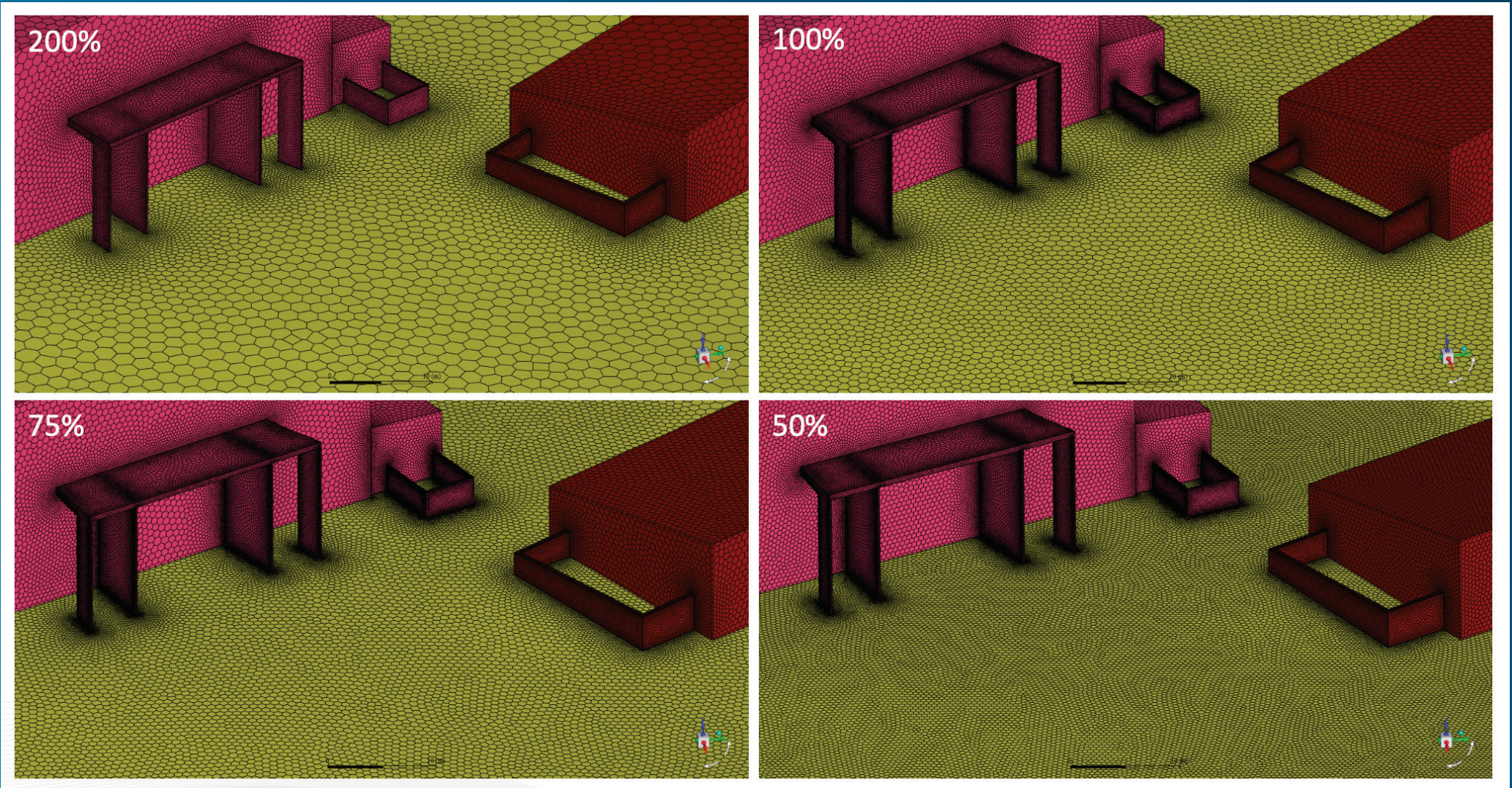


full-scale domain was modeled, including surrounding trees (transparent green areas) as a source of drag

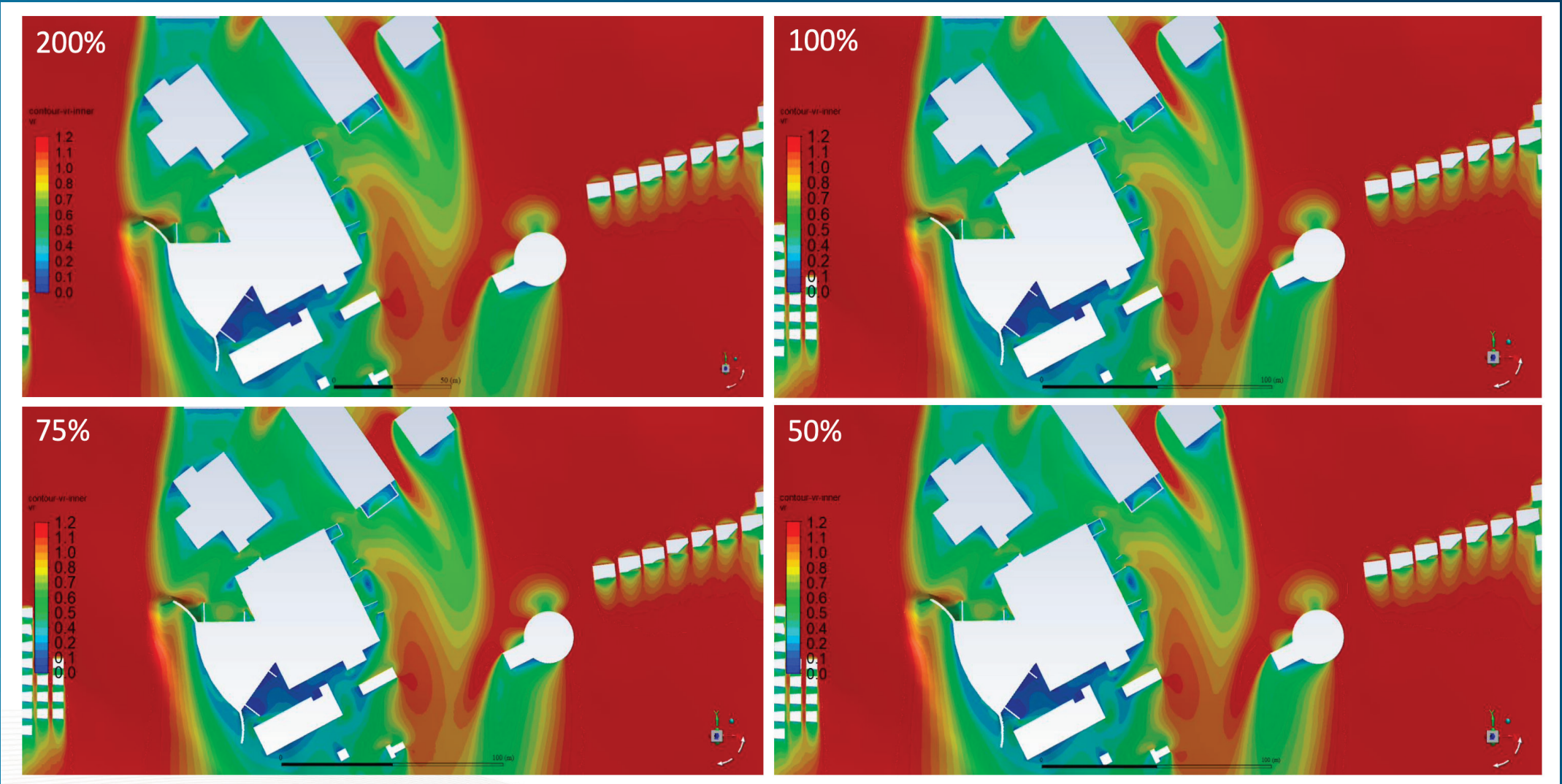
Detail showing mesh refinement



Mesh Sensitivity

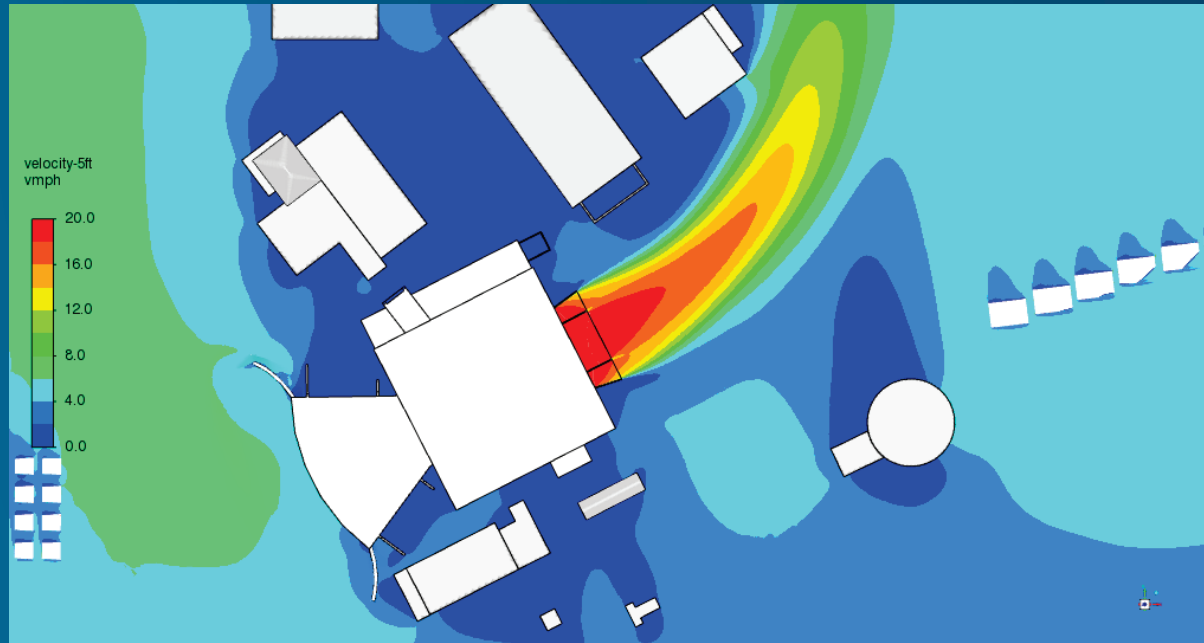


Mesh independence

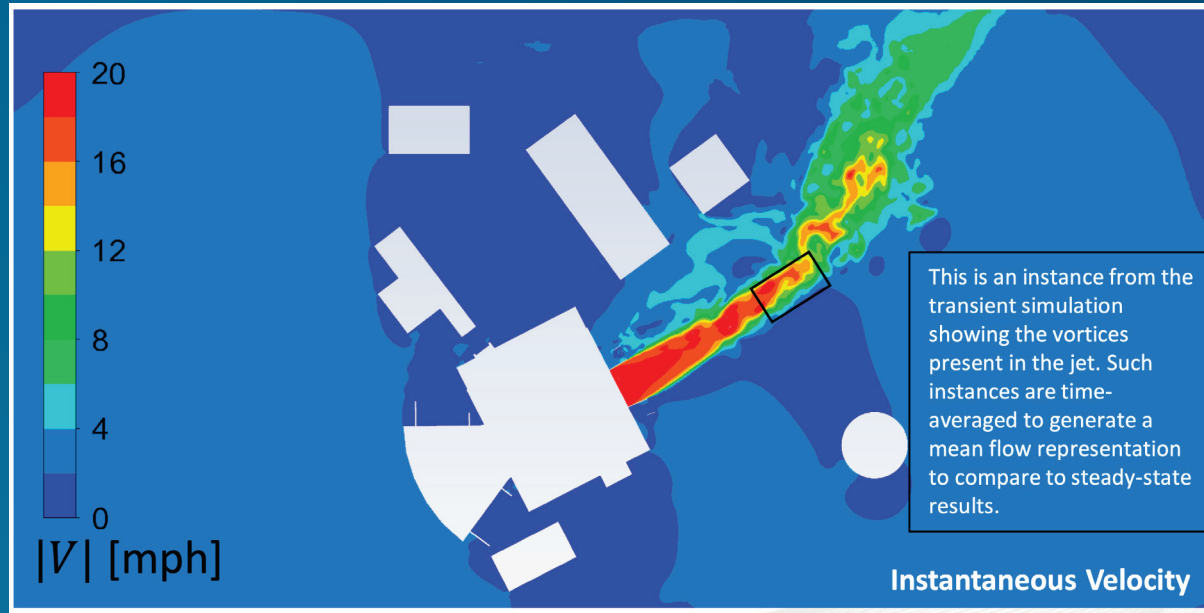


Turbulence

- Steady-state model: Reynolds Averaged Navier Stokes (RANS)



- Large Eddy Simulation (LES) / Unsteady RANS (URANS)





Turbulence Sensitivity

On average only a 2% difference between speeds at test points in the steady-state (RANS) and transient (LES) simulations

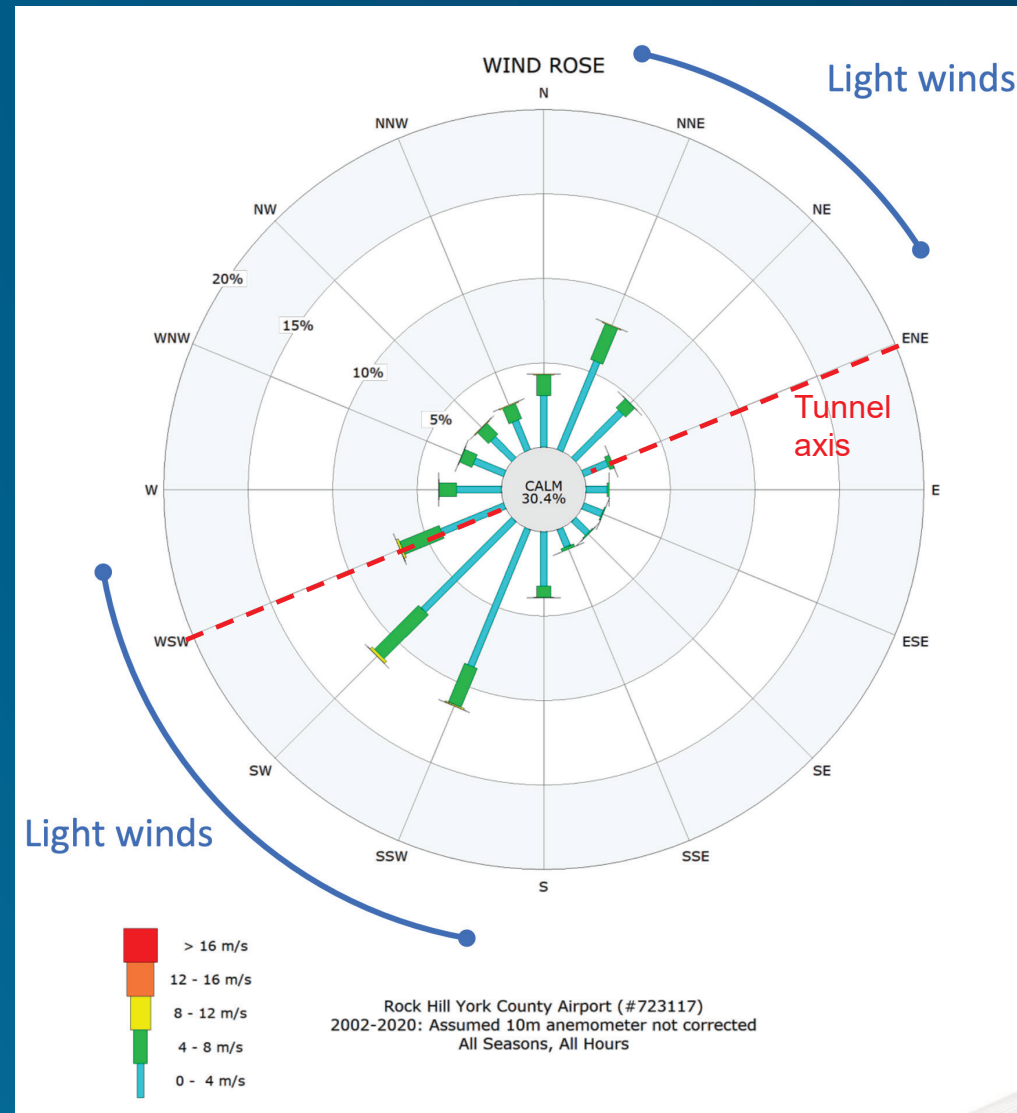
| Location | Steady-state (m/s) | Transient (SRS) (m/s) | % difference |
|--------------------------|--------------------|-----------------------|--------------|
| Point (at the test area) | 8.1371 | 8.2852 | 1.79% |
| Point (at the test area) | 8.1512 | 8.3014 | 1.81% |
| Point (at the test area) | 7.7145 | 7.8753 | 2.00% |

Wind Climate at the IBHS Facility



Wind Rose

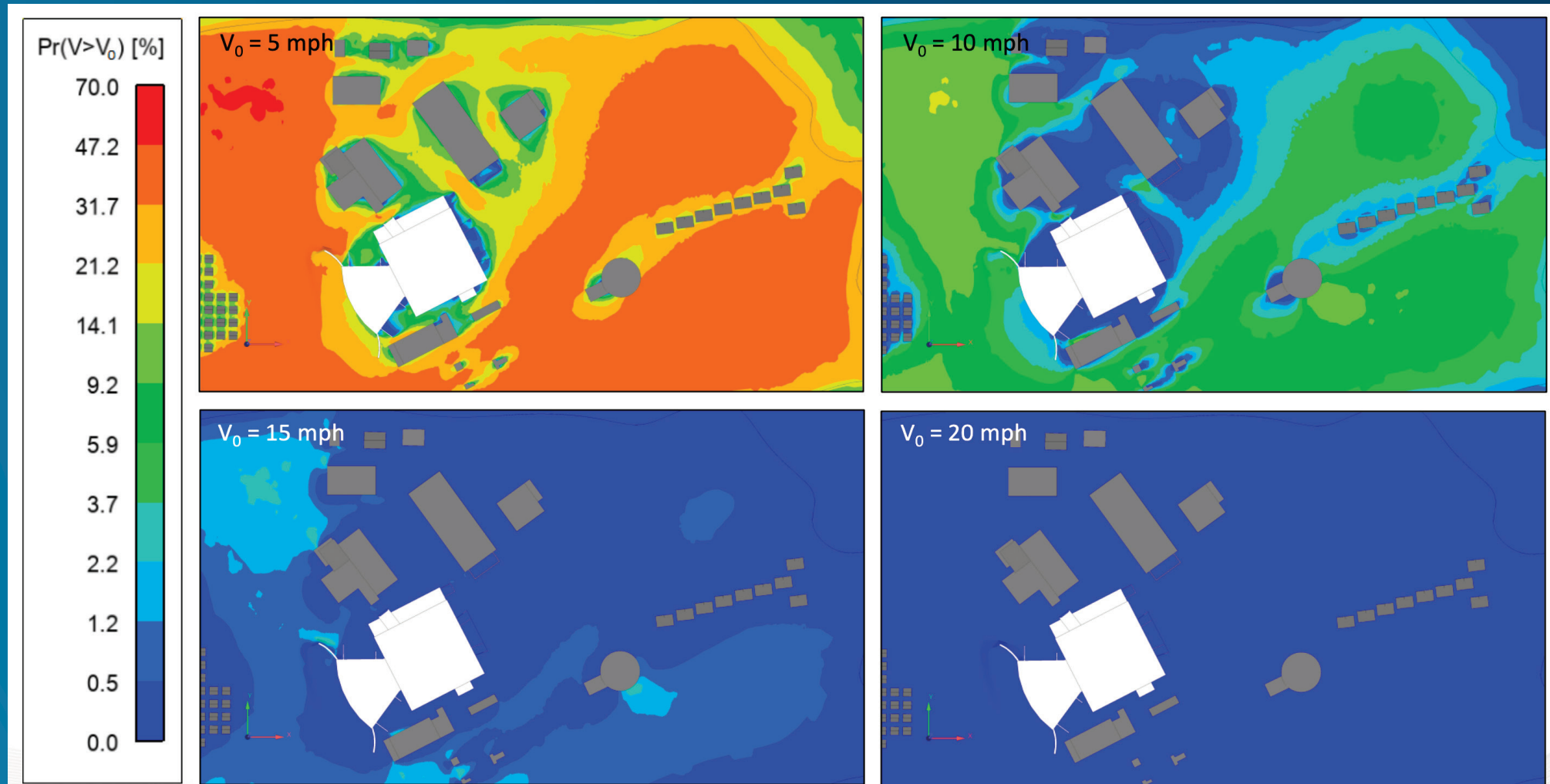
- Wind climate data from Rock Hill – York County Airport is considered applicable to the site location.
- The wind climate is calm 30% of the time with predominantly light winds.
- Winds are typically from the northeast and southwest quadrants.



Wind Climate at the IBHS Facility



Probabilities of Exceedance

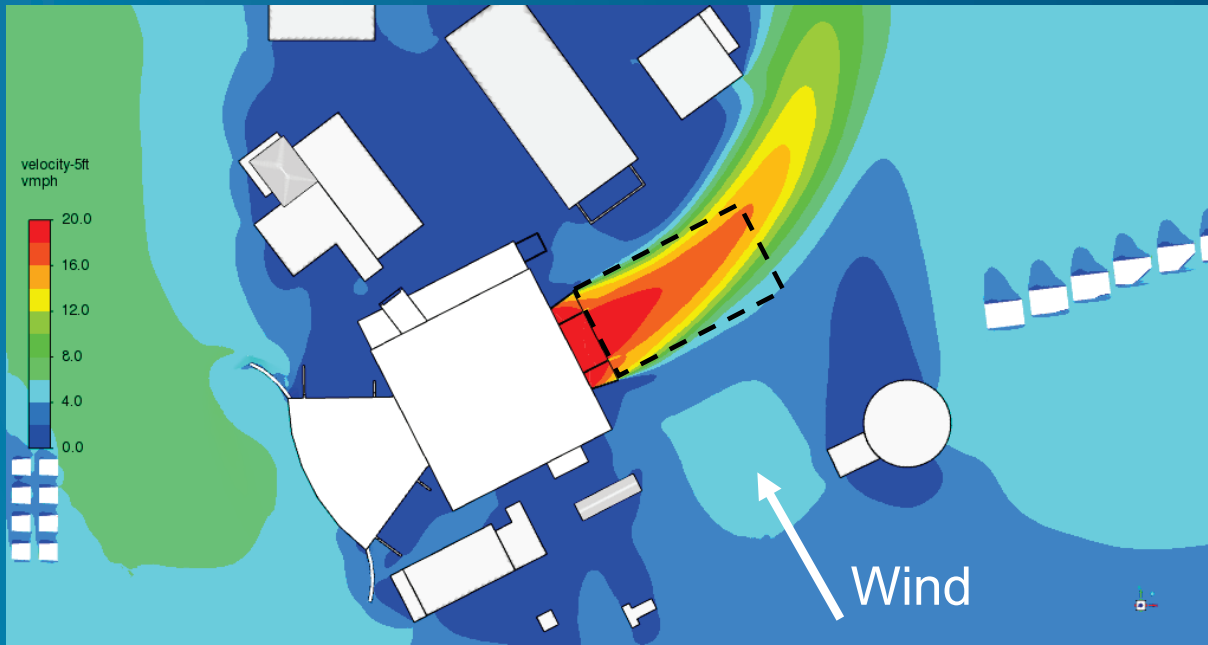


Jagged edges in the contours in the above plots (and all subsequent plots) are due to the interpolation method used.

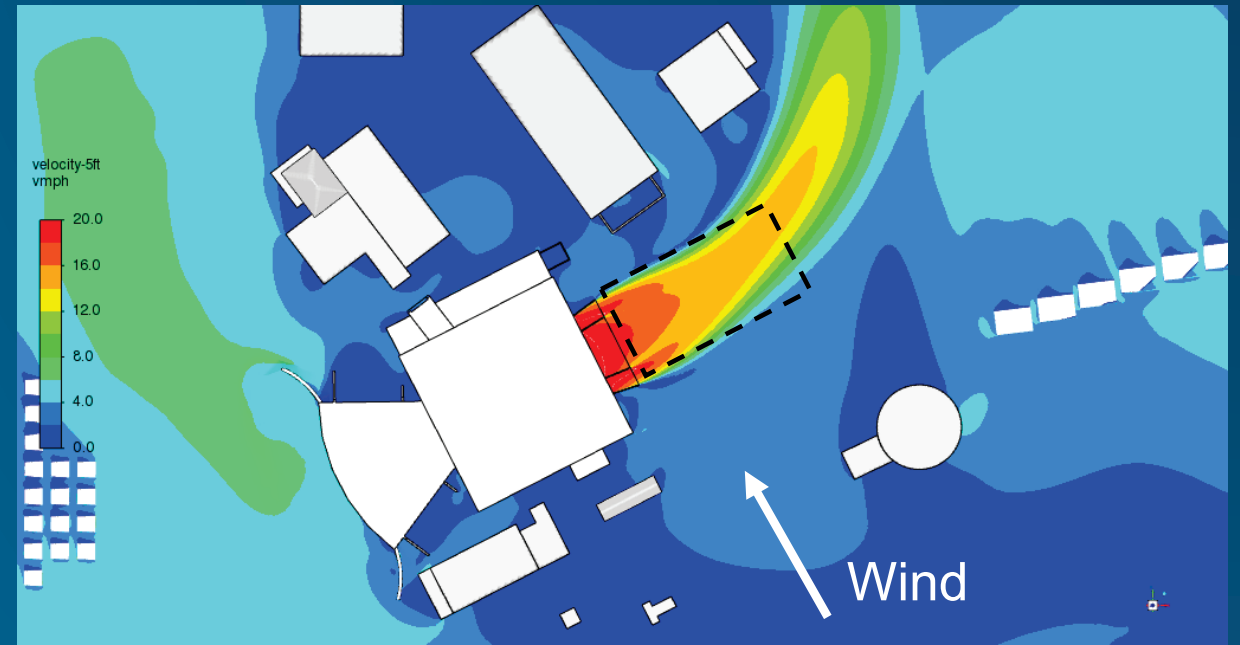
Preliminary Results – 6 mph SE (cross) wind



Doors Parallel to Flow (5 ft AGL)



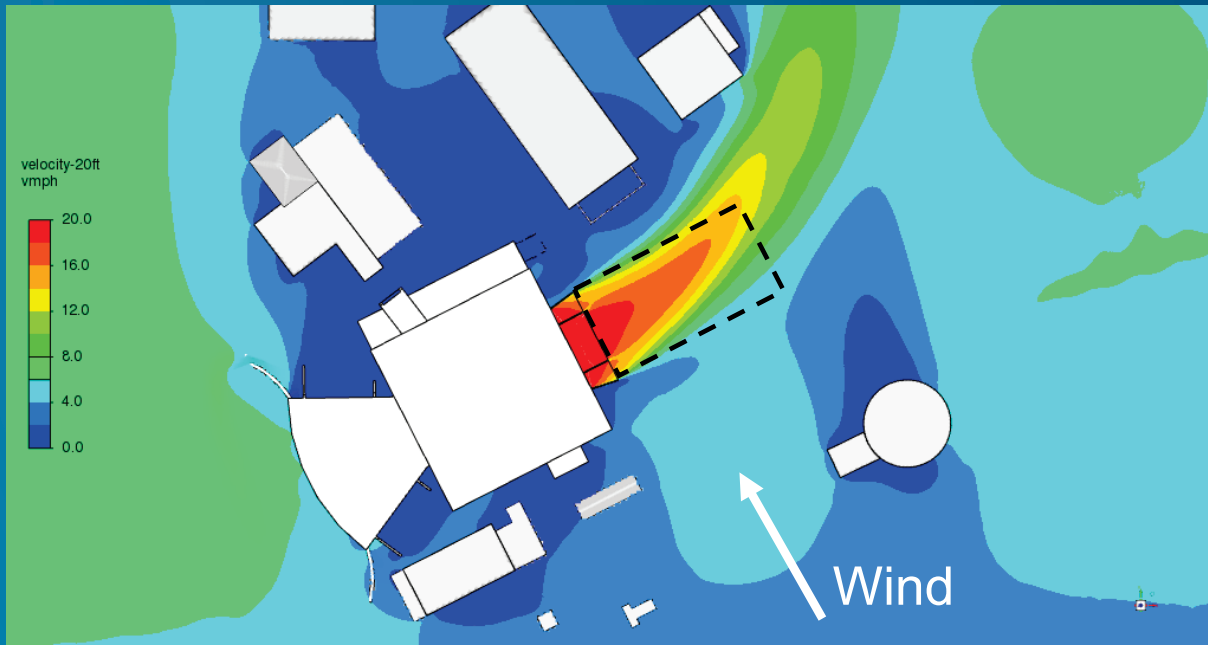
Doors Flared (actual configuration) (5 ft AGL)



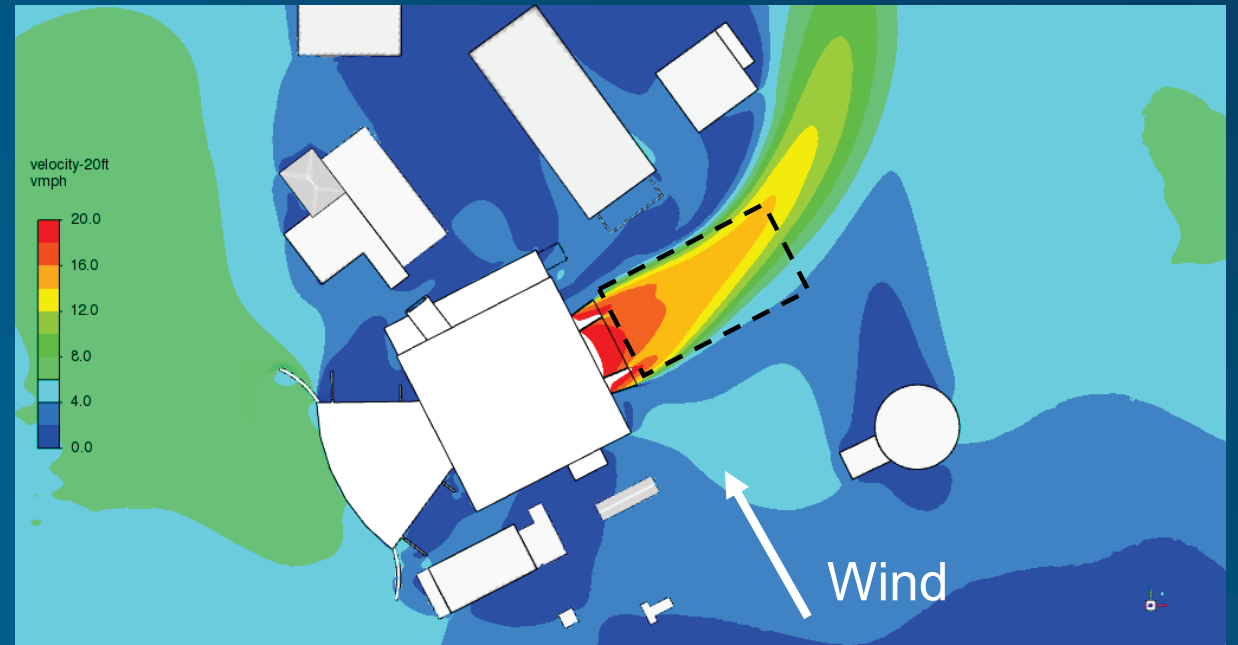
Preliminary Results – 6 mph SE (cross) wind



Doors Parallel to Flow (5 ft AGL)



Doors Flared (actual configuration) (20 ft AGL)



Preliminary Results



At lower wind tunnel speeds (~20 mph), a crosswind, or crosswind component, greater than 6 mph is likely to interfere with tunnel outflow in the test area.

| Wind speed (mph) | ENE | SSE |
|------------------|-------|-------|
| 1 | 1.85% | 1.30% |
| 3 | 1.76% | 1.11% |
| 6 | 1.21% | 0.64% |



End