

# Evaluating of Population Exposure to Traffic-related Air Pollution across Demographic Characteristics: Activity-based Model with Path Retention and Streamlined Dispersion Modeling in Atlanta, GA

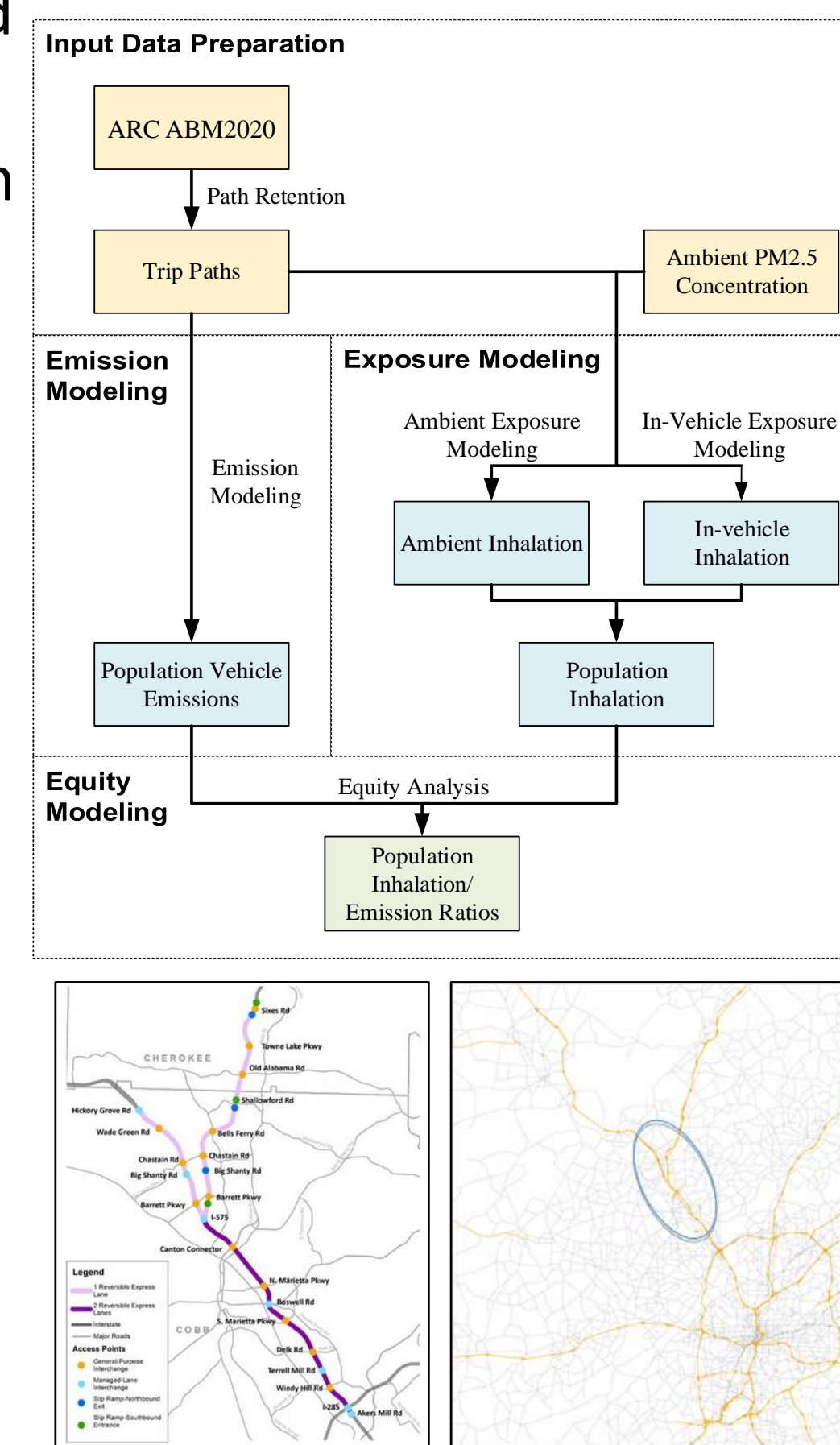


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## Overview

- Modeling framework for traffic-related population exposure:
  - Spatial and temporal high resolution
  - Integration of travel paths, demographic information, on-road traffic operating data (speed, volume, and fleet composition)
  - Complete modeling chain to investigate the propagation of analytical uncertainty
  - Sensitivity analyses for MOVES and AERMOD
- Case study for the I-75/I-575 Northwest Corridor (NWC)
  - Akers Mill Road to Sixes Road and Hickory Grove Road
  - Finished ambient concentration modeling of I-575 NWC



- Link-level energy use and emissions modeling using ABM-predicted on-road traffic operations (monitored data can also be employed)
- Ambient concentration assessment (24-hour x 365 days)
  - High-resolution traditional receptor grids (5m and 20m resolution)
  - Variable adaptive grid
- Exposure modeling via second-by-second ABM person trajectories

## Expected Results

- Modeling framework contributes to future high-resolution environmental justice assessment
- Analyses quantify uncertainty propagation through modeling chains
- Results identify potential reasons for the observed differences in dispersion model outputs across source types
- Sensitivity analyses support project-level air quality impact analysis
- Research helps identify potential equity issues with respect to population exposure to traffic-related pollutants

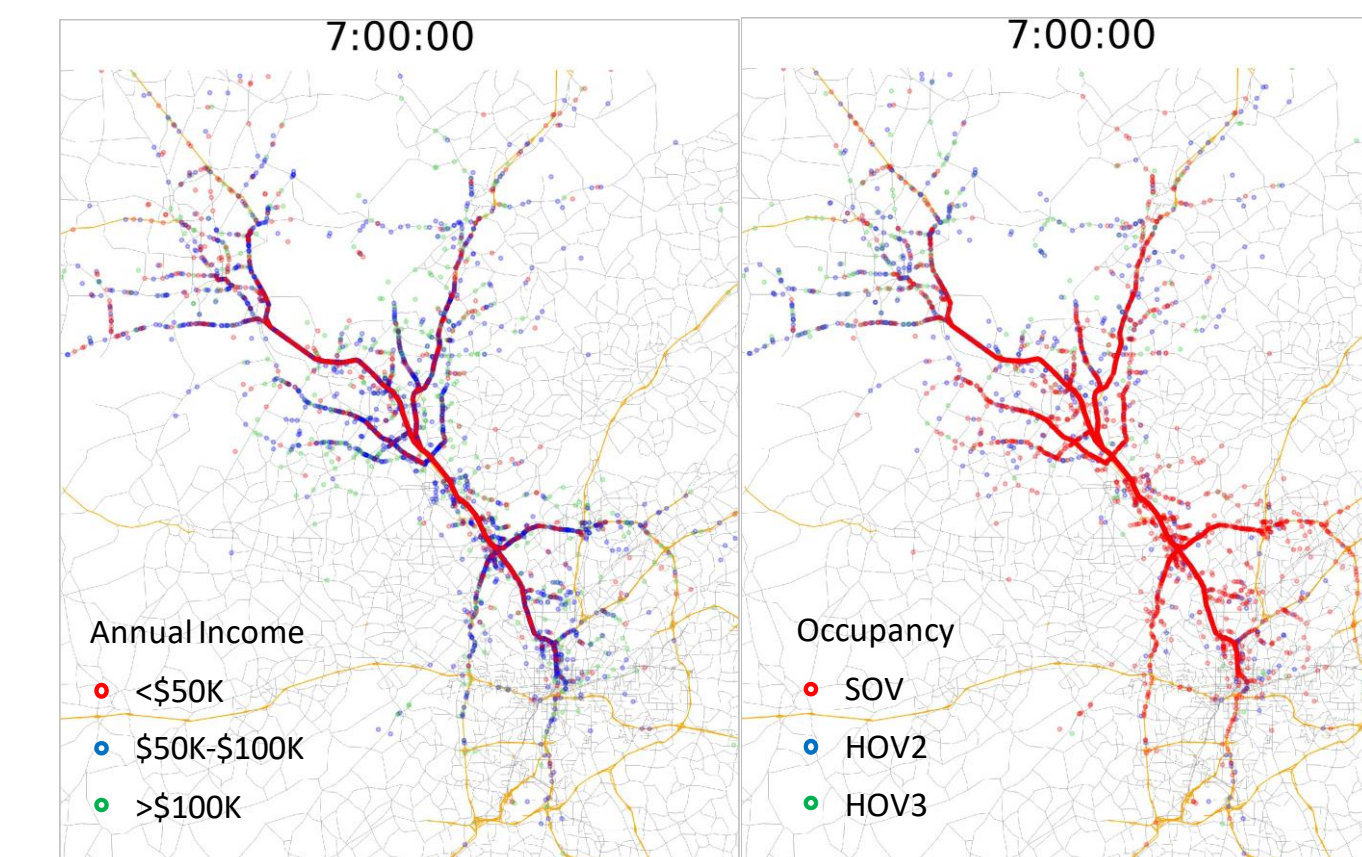
## Partners and Collaboration

- Atlanta Regional Commission (Guy Rousseau)
  - Activity-based travel demand model runs
- University of New Mexico (Dr. Haobing Liu)
  - Source type conversion collaboration
- Gangneung-Wonju National University (Dr. Daejin Kim)
  - Link-screening tools implementation
- Georgia Department of Transportation (Supriya Kamatkar)
  - Project Management
- Virginia DOT (Christopher Voigt) and AECOM (Roger Wayson)
  - Concurrent and parallel modeling approaches
  - Modeling specification and data inputs
  - PACE supercomputing modeling activity
  - AERMOD sensitivity analysis

## Methodology

### Roadway Network and Activity-Based Model

- I-75/I-575 Corridor
  - Freeway lanes and SRTA Express toll lanes
    - With and without noise barriers
  - Ramp intersections and approach arterials
- Modeled traffic volumes and operating speed
  - ARC's ABM2020-TIPA1-2020
  - Same 2020 scenario used to develop the TIP
- Path retention
  - Allows modelers to retain the origin-destination paths derived by Frank-Wolfe algorithms
  - Link-by-link vehicle and person traverses
  - Converted to second-by-second trajectories

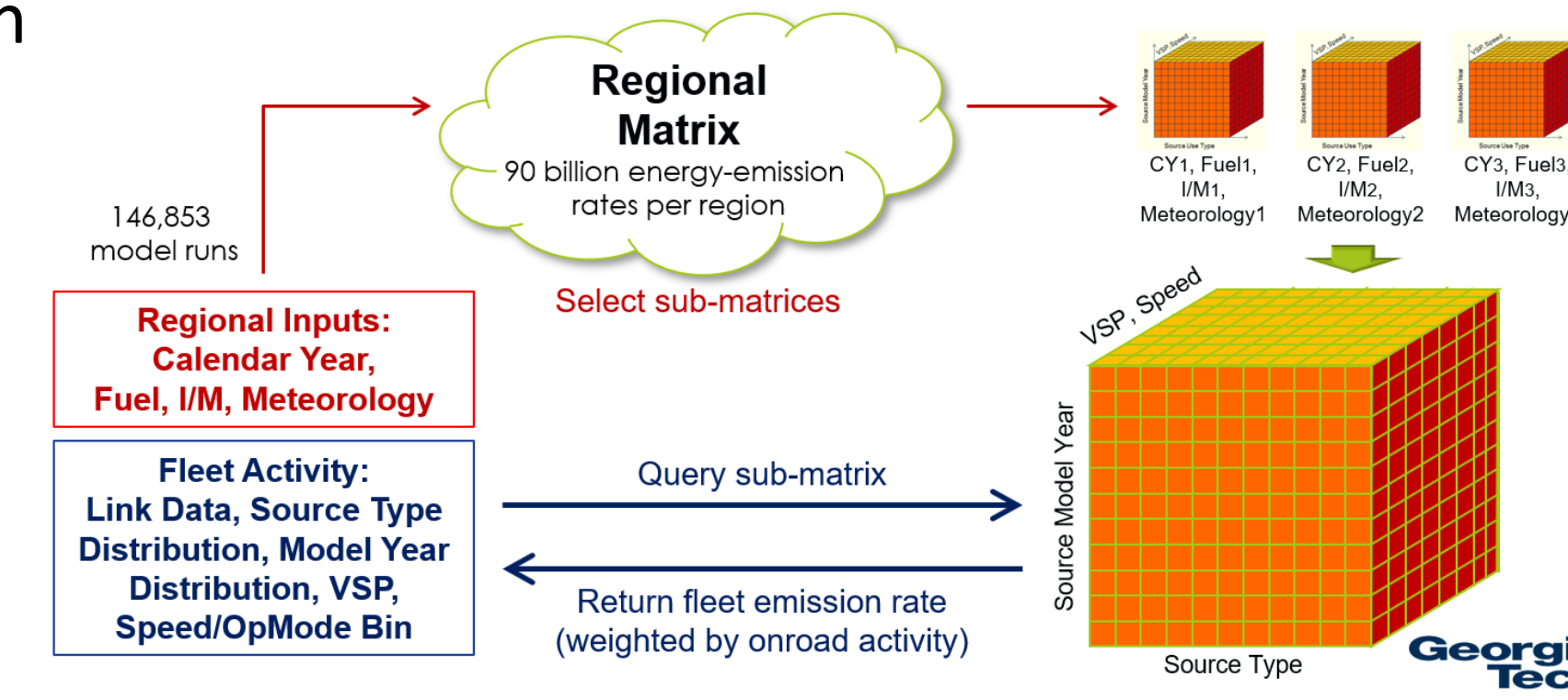
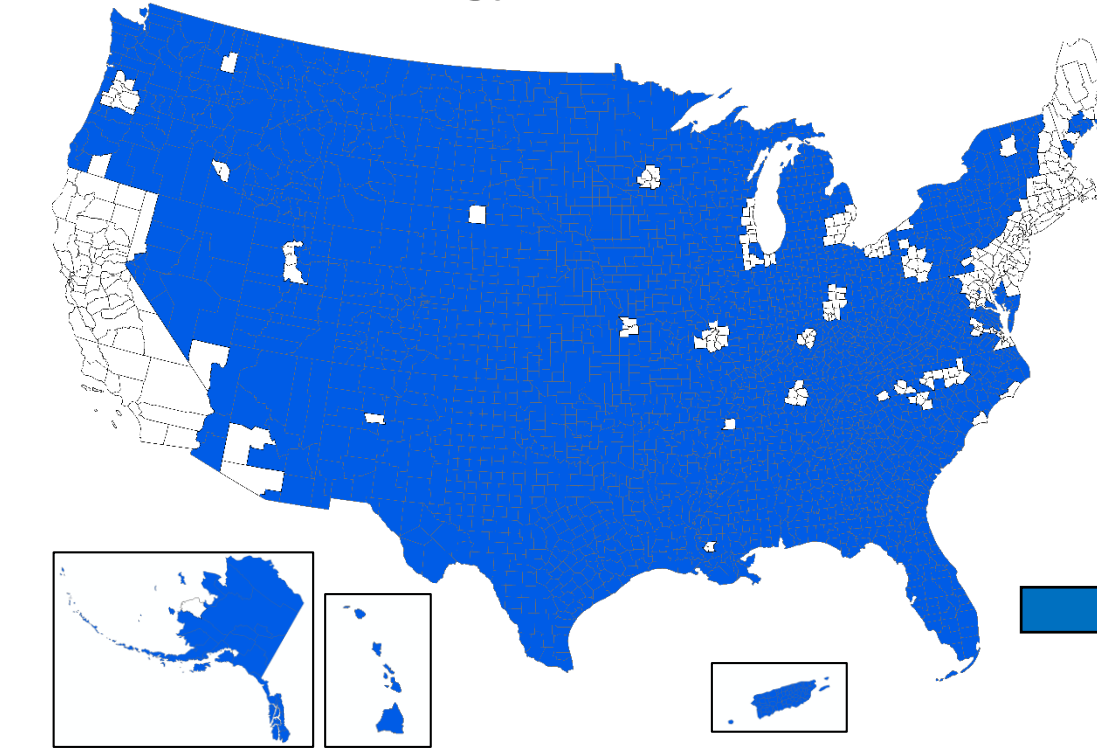


- Demographic Information
  - ARC's Activity Model (2.3+ million households)
  - Licensed Epsilon dataset (2.1 million households)

### MOVES-Matrix: On-Road Fleet Emission Rates

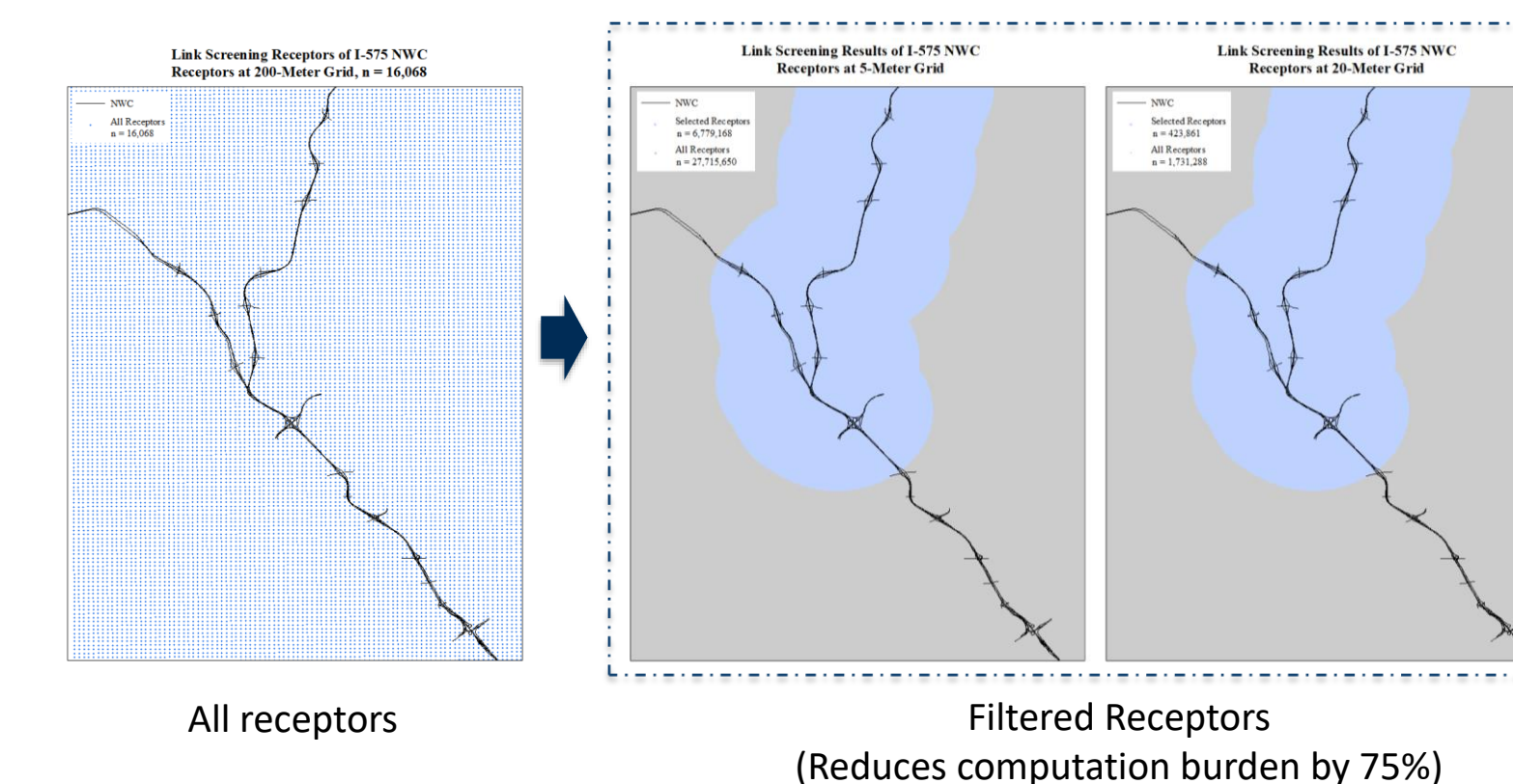
- Runs USEPA's MOVES in iterations across all combinations of model inputs
- Outputs processed into a multi-dimensional matrix
- Generates exactly the same outputs as MOVES 2014b
- Corridor-level analyses can run up to 200x faster
- 117 unique fuel and I/M program combinations
  - About 5 days per region in the PACE supercomputing
- Current coverage is 2,885 out of 3,228 US counties
  - Currently developing MOVES3 Matrix
- MOVES-Matrix can be applied at any spatial and temporal scale and can be linked with any model via Python scripts
  - Regional travel demand models
  - Corridor/scenario analysis
  - Vissim™ and other microscopic simulation models
  - App-based vehicle energy/emissions modeling
  - Microscale pollutant dispersion modeling

MOVES-Matrix Coverage as of May 2021 (On-road Energy and Emissions Rates)



### AERMOD: Dispersion Modeling

- Various source types applied and compared
  - AREAPOLY, VOLUME, LINE, RLINE, etc.
- Input sources (polygons, lines, etc.) generated automatically (Dr. H. Liu)
  - Aligns w/ABM network (manually verified)
- Link screening tools implemented (Dr. D. Kim)
  - Machine learning process
  - Source-receptor pairs examined and filtered (Dynamic Receptor Model)



### PACE: Supercomputing Cluster

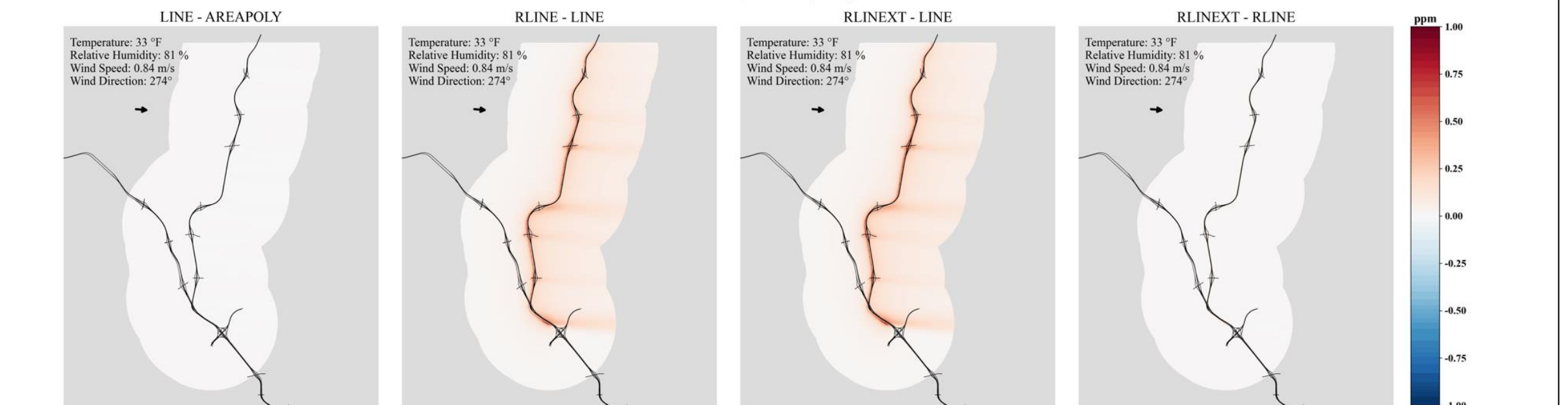
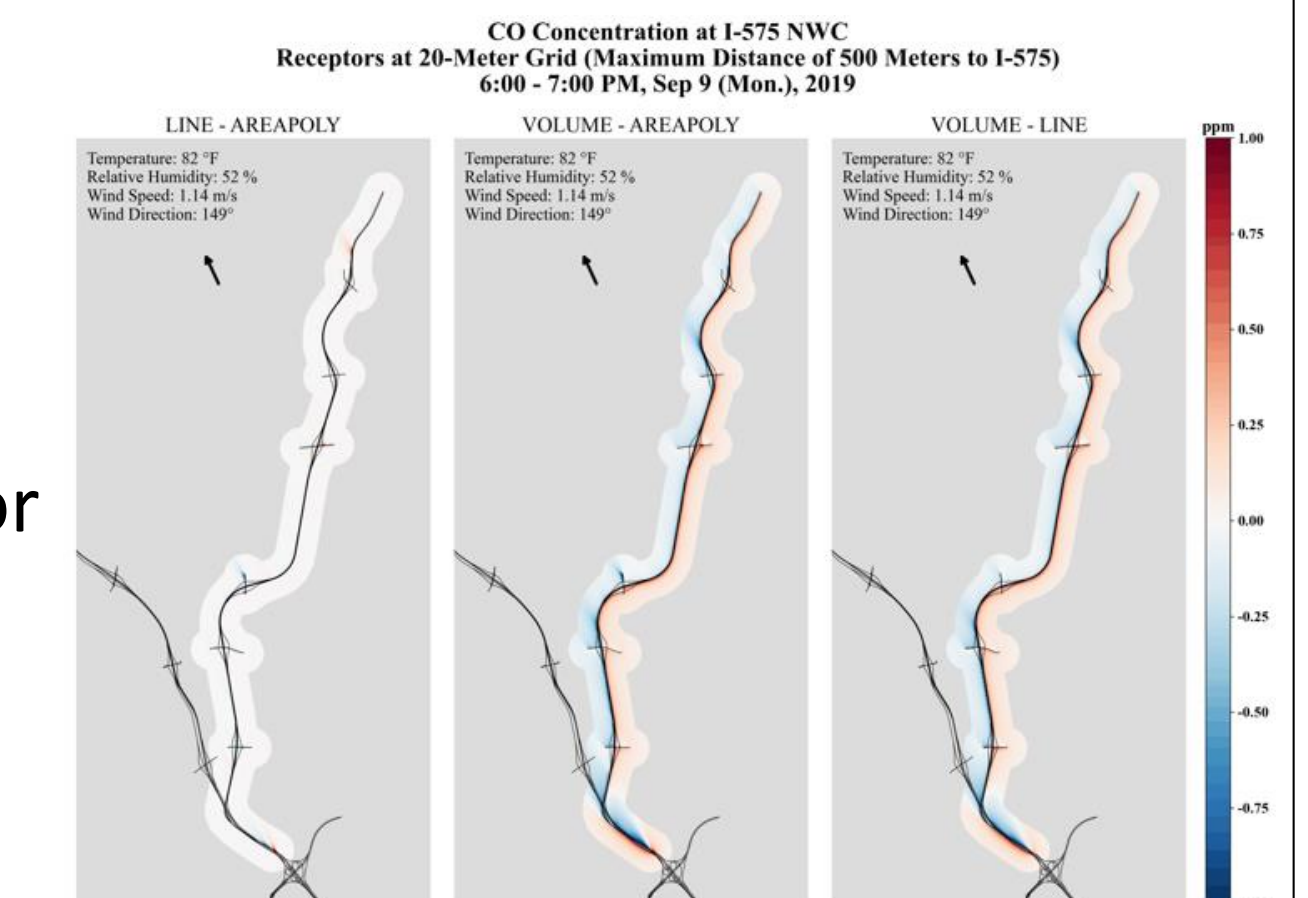
- Model runs on the PACE supercomputing cluster
  - GT computing co-op
- Full utilization of 5,000 CPU cores
- 2.8+ million MOVES runs to date
- 5.0+ million AERMOD runs to date

Source Type	# of Link-Receptor Pairs
AREAPOLY	194,552,199
LINE	912,572,733
VOLUME	14,467,223,652
RLINE	912,572,733
RLINEXT without barriers	912,572,733
RLINEXT with barriers	912,572,733

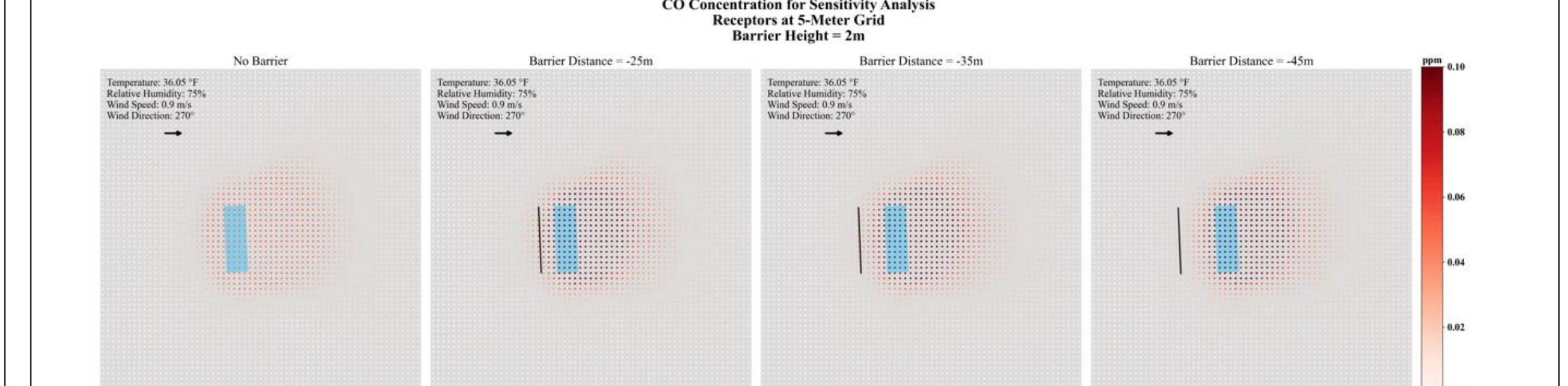
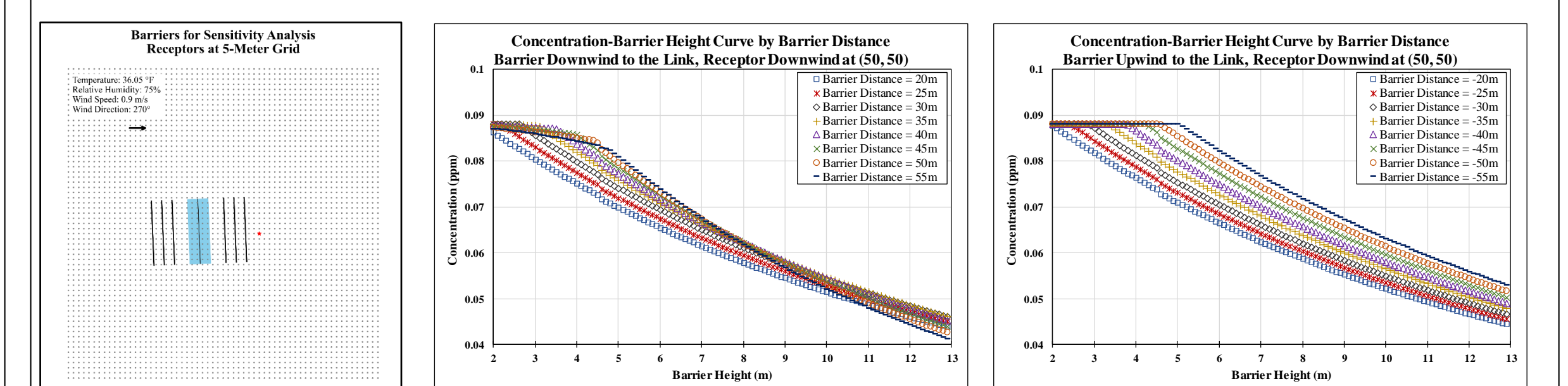


## Case Study

- Uncertainty associated with temporal and spatial aggregation of on-road traffic operation inputs
  - Speed, volume, and fleet composition
  - Presented as a separate research
- Differences identified in concentration outputs across AERMOD source types
  - LINE, AREAPOLY, VOLUME, RLINE, RLINEXT
  - No significant differences for AREAPOLY vs. Line and for RLINE vs. RLINEXT (without barriers)
  - But, there are differences across other source types



- RLINEXT barrier setup for sensitivity analysis
  - Only one barrier can be attached to each source link
  - Each barrier only impacts the source link to which it is attached
  - Barrier offsets change along freeways
  - Concentration at downwind receptors decrease with the increase of barrier height
  - Smaller impacts for more distant barriers



- Inconsistency found for over-the-roadway receptors
  - Sensitivity analysis underway for receptor height
  - The way that long roadway links are split impacts model outputs
- Modeling work is ongoing for RLINEXT with barriers and I-75 NWC
- Modeling work is ongoing for assessment of human exposure and analyses across demographic groups

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