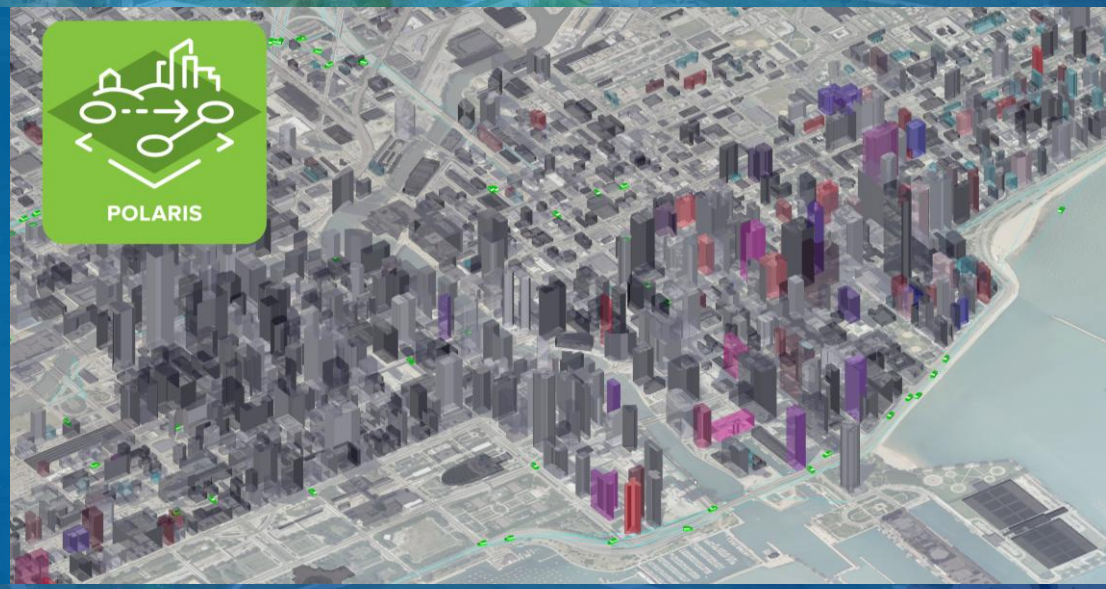
JUNE 12, 2025

CREATING AND CALIBRATING POLARIS MODELS



PRESENTED BY: KRISHNA MURTHY GURUMURTHY

Transportation Systems and Mobility
Vehicle and Mobility Systems Department

U.S. DEPARTMENT OF ENERGY
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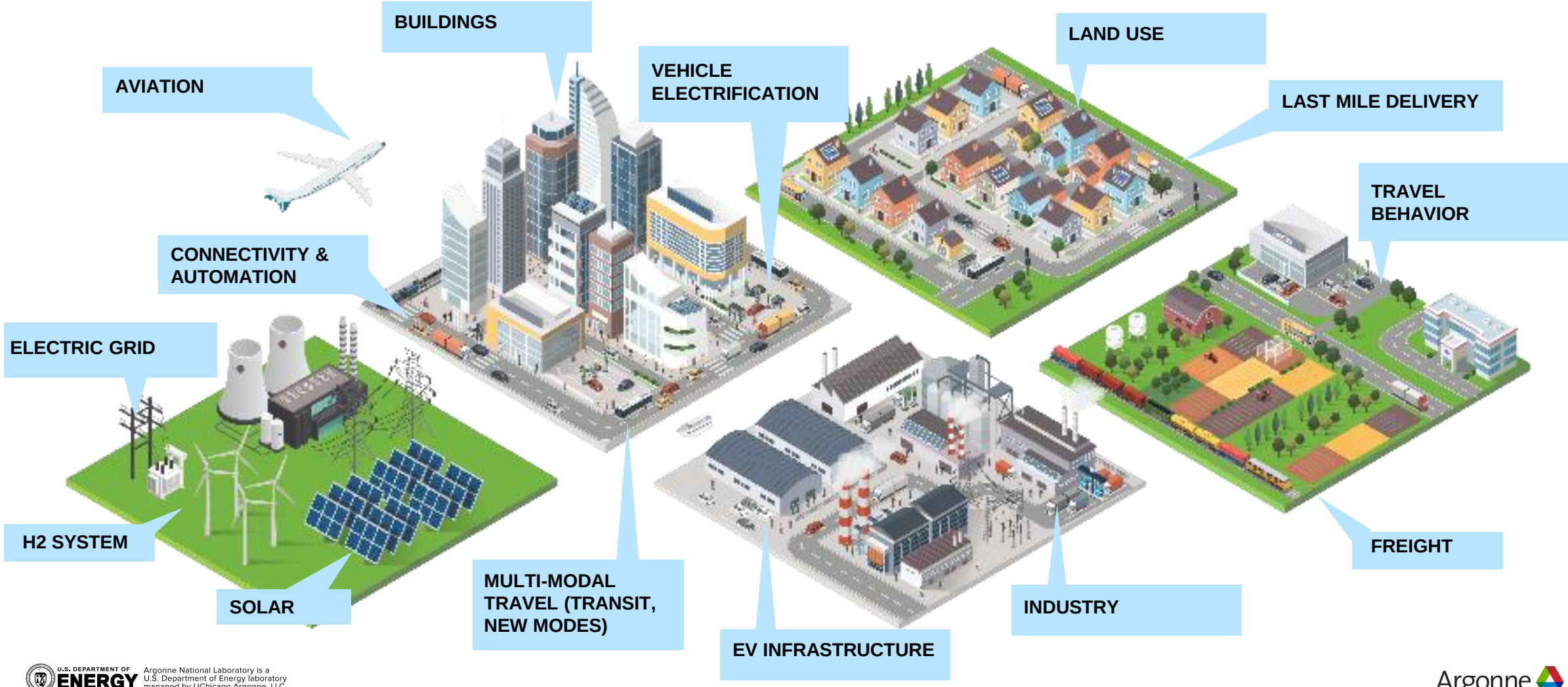
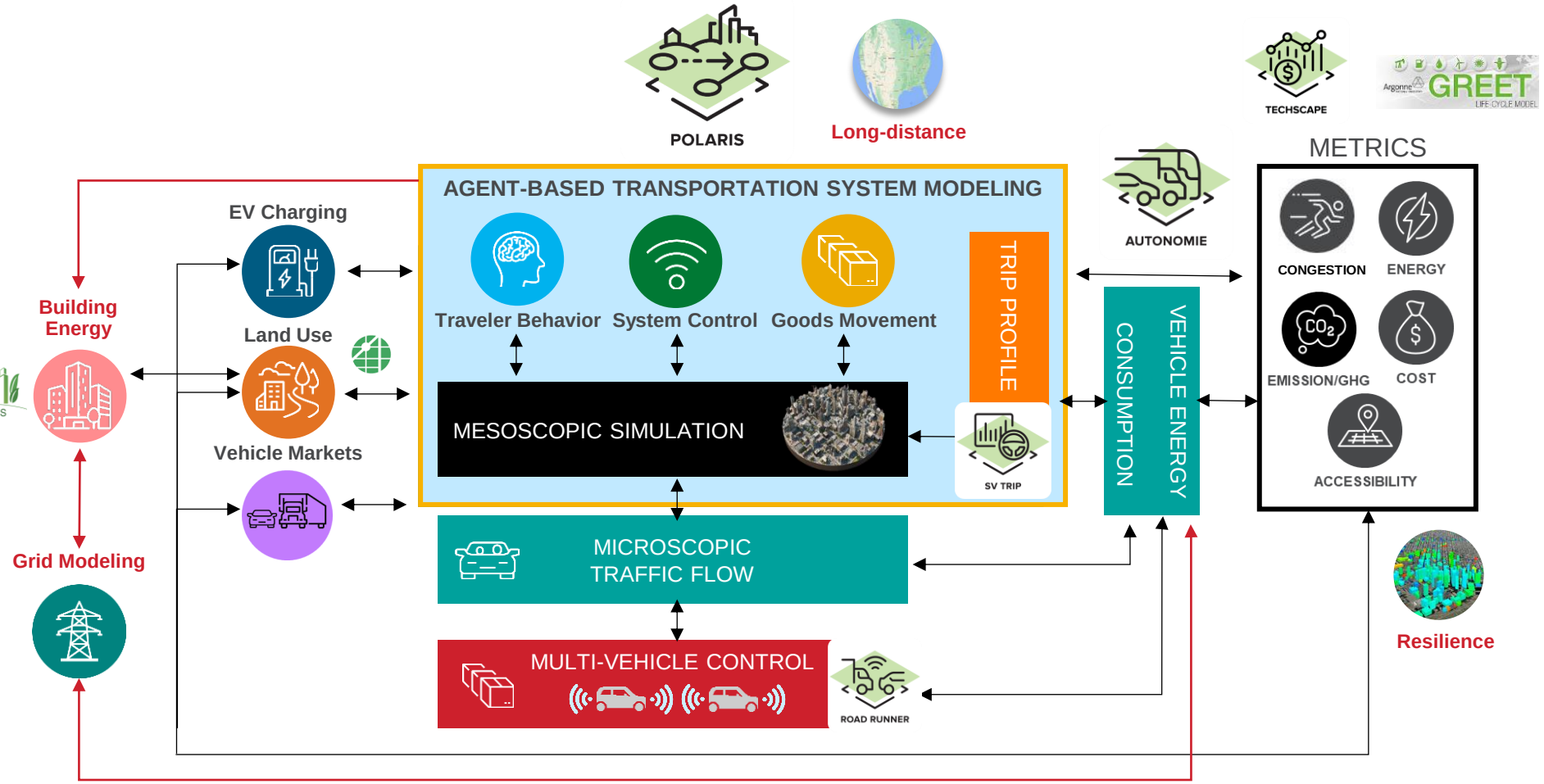
A HOLISTIC APPROACH IS REQUIRED TO ACHIEVE MOBILITY AND ENVIRONMENTAL GOALS

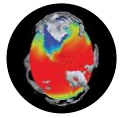
Multi-level, Multi-fidelity Framework Inclusive of all Metrics (e.g., energy, economics, emissions, greenhouse gases, accessibility…)



POLARIS WORKFLOW FOCUSES ON TRANSPORTATION WITH LINKAGES TO GRID AND BUILDING



- What are the intersections between critical sectors like transportation, buildings and grid?
- What are the system level impacts (e.g., building, grid, land use)?
- What are the impacts of policies and technologies on market adoption, travel behavior and infrastructure needs?



Climate

Weather

- 3+ National Laboratories, 10+ tools, 25+ R&D Partners, 50+ stakeholders,
- 14 operational models accounting for 25% of the population
- New National POLARIS model

WHY IS THIS WORKFLOW UNIQUE?

Key modeling features:

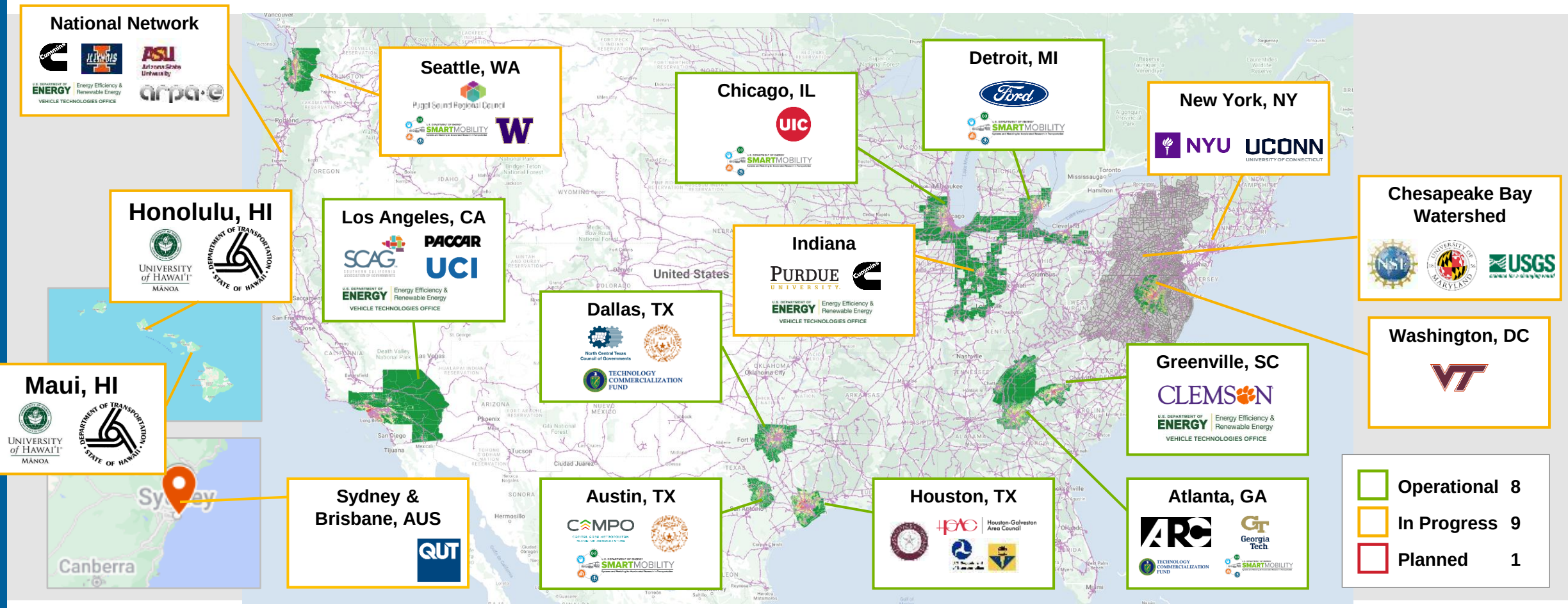
- Full-featured **activity-based** model
- Includes **freight** shipments and local deliveries
- High-fidelity **vehicle energy** consumption
- **Integrated** demand, network assignment and traffic flow
- **EV** charging and **grid** integration
- Connection to UrbanSIM land use
- Traveler **behavior** impacts across many choices and actions

Computational performance:

- Fully **agent-based**
- Integration with external **optimization** solvers (CPLEX, Gurobi, GLPK)
- High-performance **C++ codebase**
- Large-scale models with **100% of agents**
- **4-6 hr runtime** for up to 10 million agents
- Cross-platform implementation can run on Linux **HPC** clusters

EXTENSIVE, NATIONWIDE POLARIS DEPLOYED WITH LOCAL STAKEHOLDERS

17 operational and planned models connected by a national network



BUILDING NEW POLARIS MODELS

POLARIS-STUDIO IS THE PYTHON INTERFACE TO POLARIS

- How does Polaris-Studio support POLARIS?
  - Building and manipulating networks
  - Keeping databases up to date
  - Configuring and running POLARIS
  - Analyzing outputs
  - Report Generation

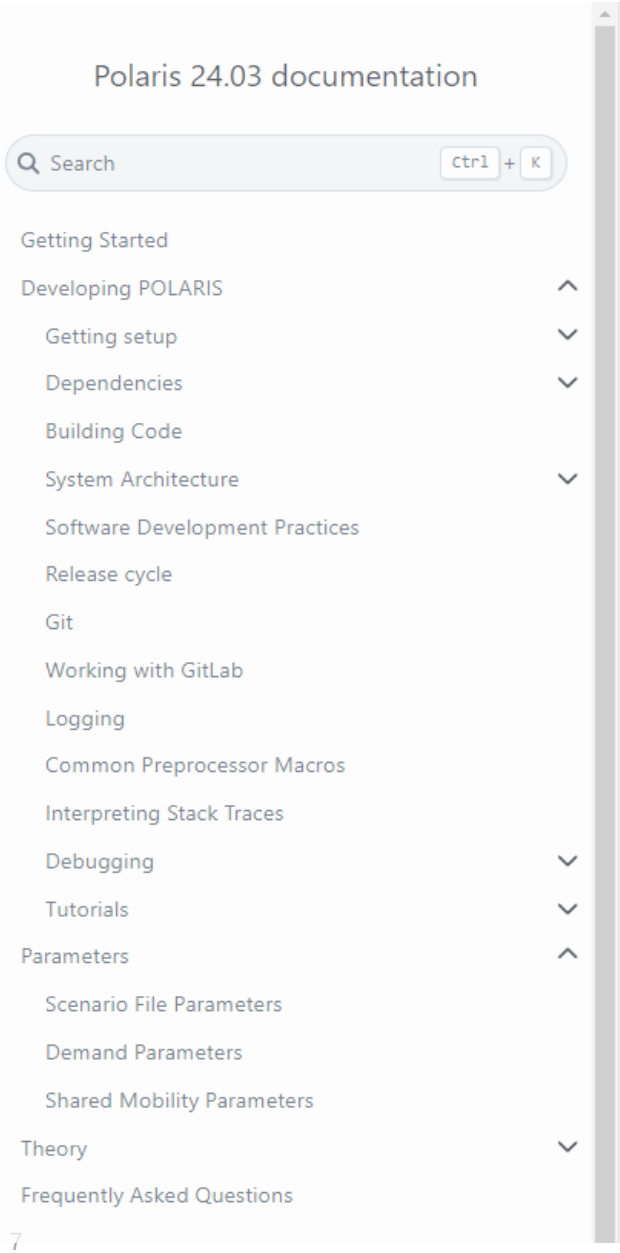
- Available on PyPI

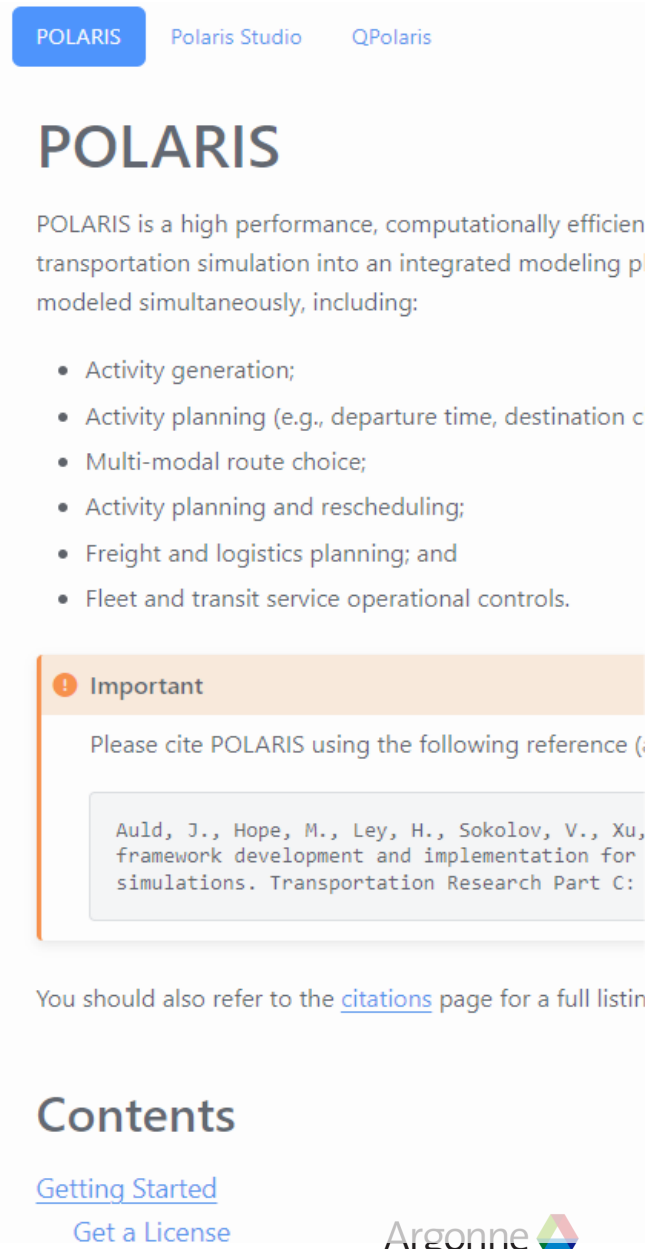
  python -m pip install polaris-studio

- Easiest way to get POLARIS binaries
  - Comes with POLARIS executables for Windows and Linux (certain distros)
  - License required to run POLARIS

- Documentation available

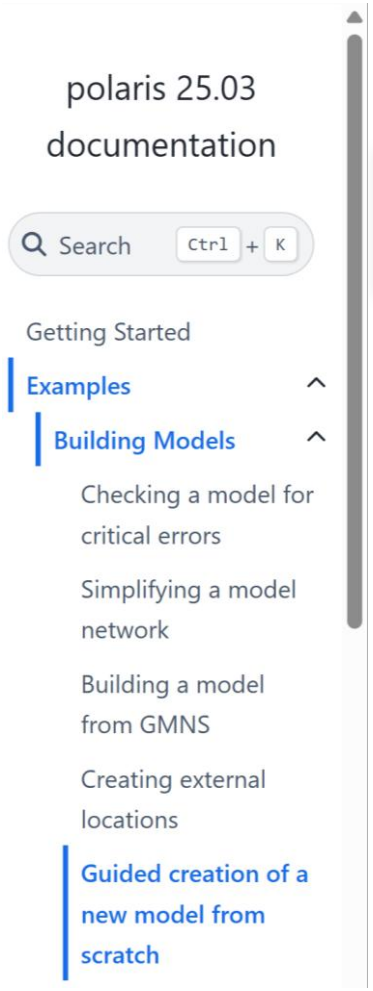
  https://polaris.taps.anl.gov





GUIDED MODEL CREATION STEPS AVAILABLE THAT PULLS IN OPEN-SOURCE DATA

- **Roadway and Transit Networks**
  - **Open-Street maps**
  - **Overture maps** → Support dependent on third party software
  - **GTFS**
- **Activity Locations with Land-Use Information**
  - **Open-Street maps**
  - **Overture maps**
- **Population Synthesis**
  - Census, specifically American Community Survey (ACS) products
  - Data pre-specified with the appropriate linkers between files



POLARIS | Polaris Studio | QPolaris

Note

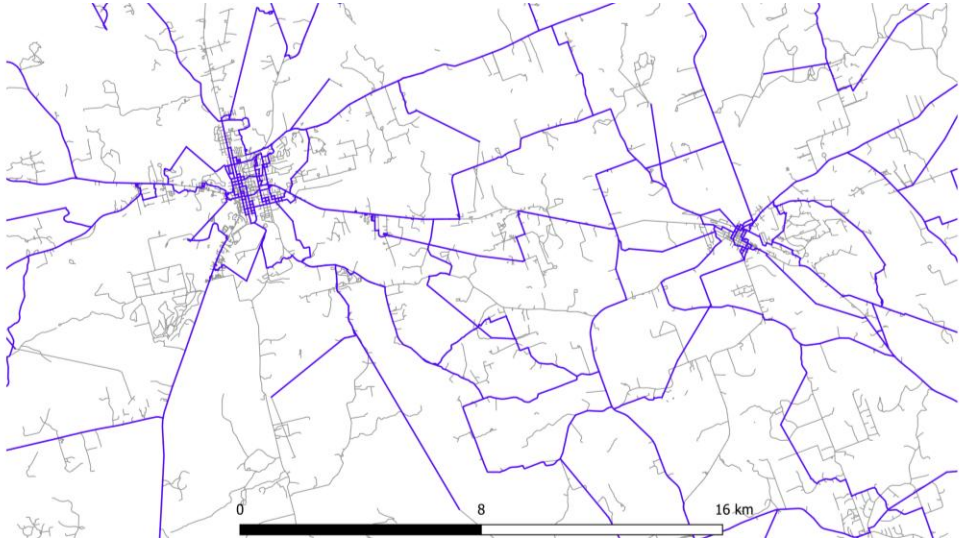
Go to the end to download the full example code.

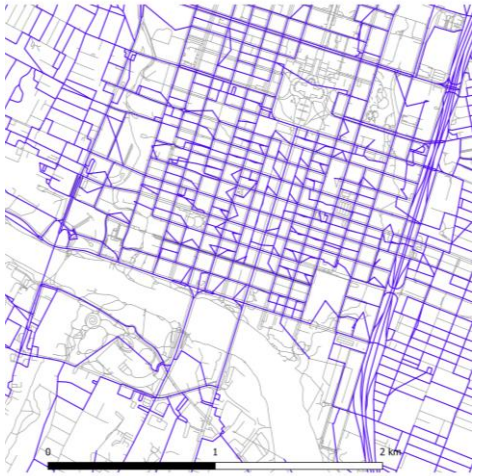
Guided creation of a new model from scratch

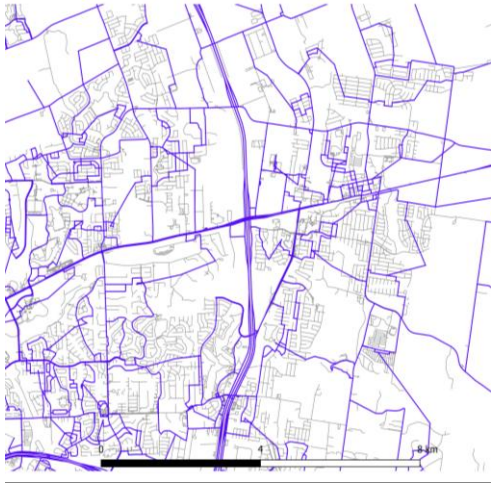
On this example, we show how to use Polaris-Studio tools to start the creation of the most complicated portions of the supply models, including:

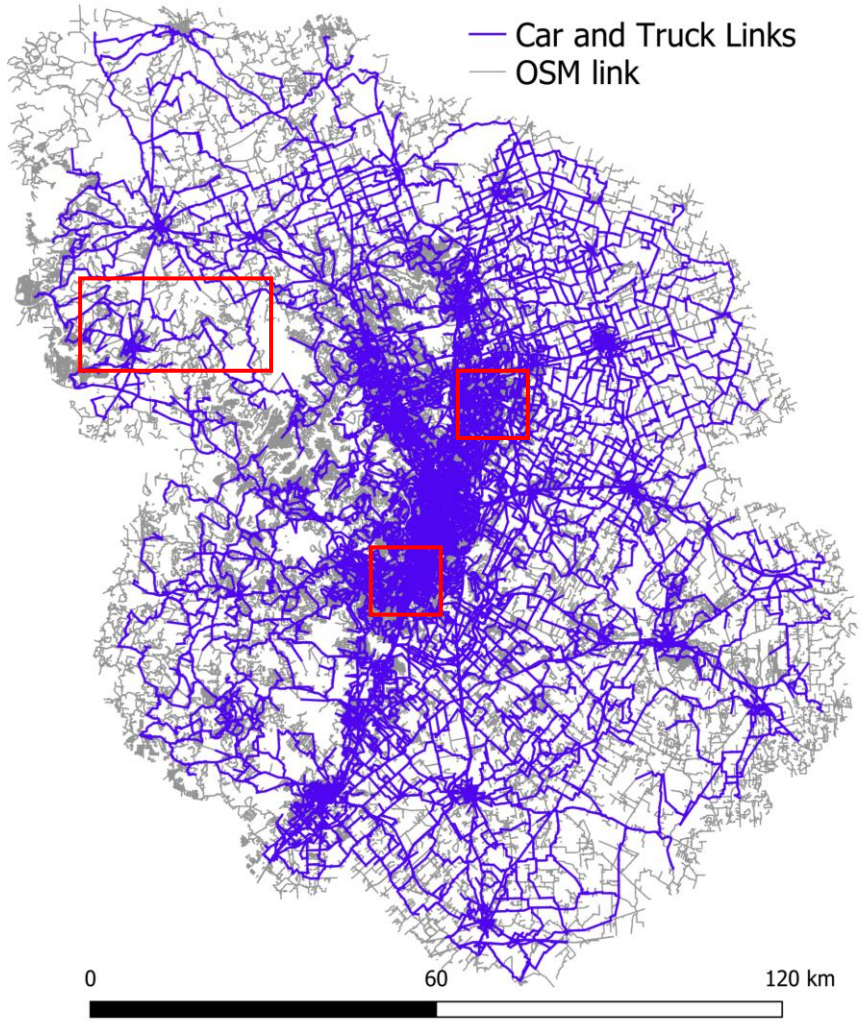
- Network from OpenStreetMaps
- EV Charger locations from NREL
- Zoning system from the Census
- Transit routes from GTFS provided by MobilityData (if available)

SIMPLIFICATION PROVIDED AND CONSISTENT IN ALL AREAS OF THE NETWORK









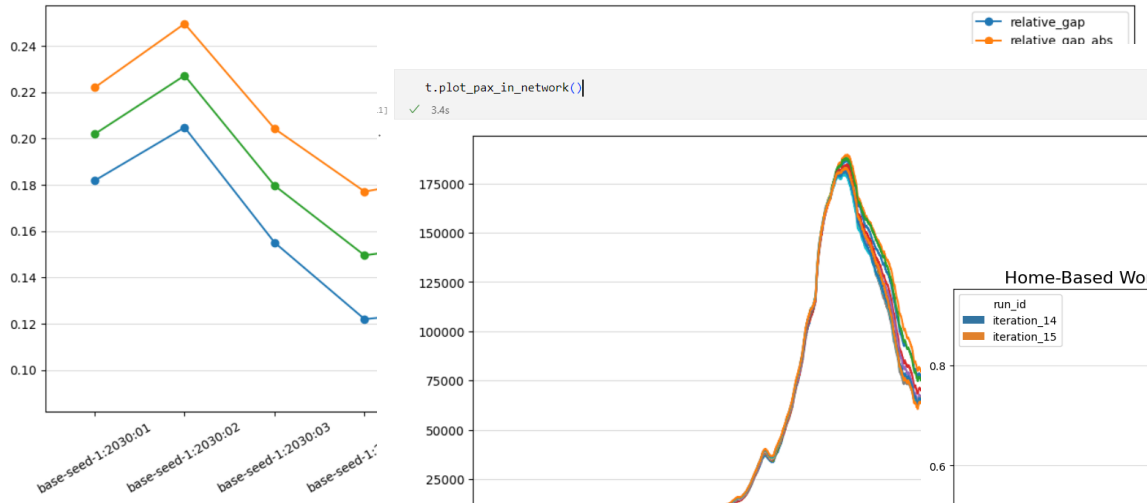
FLEXIBLE CALIBRATION SCHEDULE PROVIDES SUPPORT FOR ON-THE-GO CONVERGENCE

- For each model:
  - Start iteration
  - End iteration
  - Pattern
- In conjunction with workplace re-simulation
- Parameters correspond to heuristic values that have achieved good convergence in the past

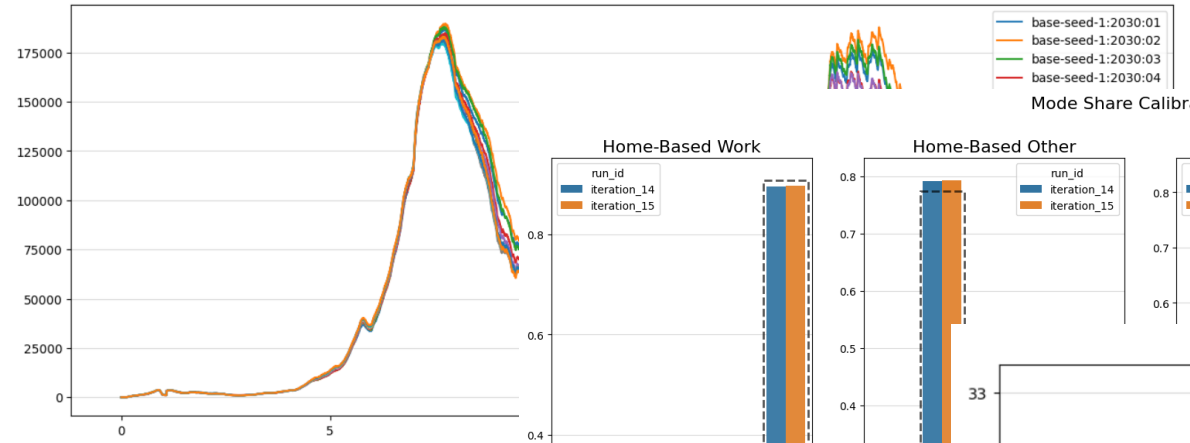
```yaml
db_name: My_City
do_abm_init: true
do_skim: true
num_abm_runs: 120
num_threads: 28
population_scale_factor: 0.25
calibration:
    enabled: true
    target_csv_dir: calibration_targets
    num_planned_activity_iterations: 0
    calibration_schedule:
        activity:
            first_iteration: 1
            last_iteration: 120
            pattern: [0,0,0,0,0,0,1,0,0,0]
        destination:
            first_iteration: 1
            last_iteration: 120
            pattern: [1,0,0,0,0,0,0,0,0,0]
        mode:
            first_iteration: 1
            last_iteration: 120
            pattern: [0,0,0,0,1,0,0,0,0,0]
        timing:
            first_iteration: 1
            last_iteration: 120
            pattern: [0,0,0,0,0,1,0,0,0,0]
    step_size: 2.0
workplace_stabilization:
    enabled: true
    schedule:
        first_iteration: 1
        last_iteration: 60
        pattern: [1,1,1,1,1,0,0,0,0,0]
```

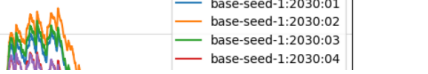
GENERATES STANDARD PLOTS FOR CALIBRATION & OTHER METRICS

```
t.plot_gaps();
```
0.5s Python

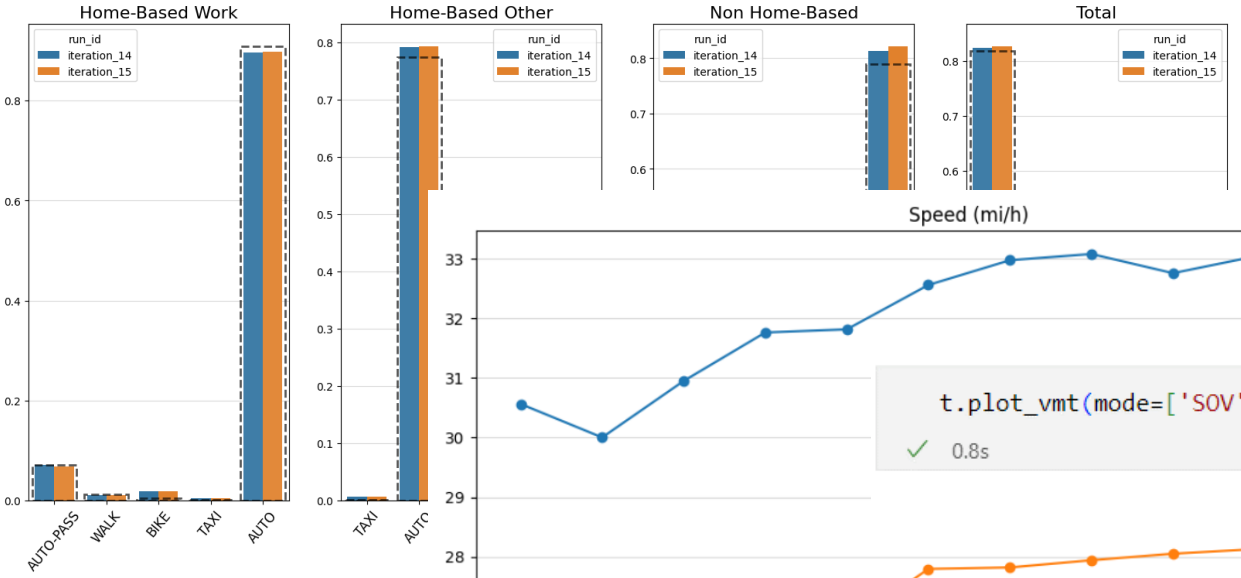



```
t.plot_pax_in_network()
```
3.4s

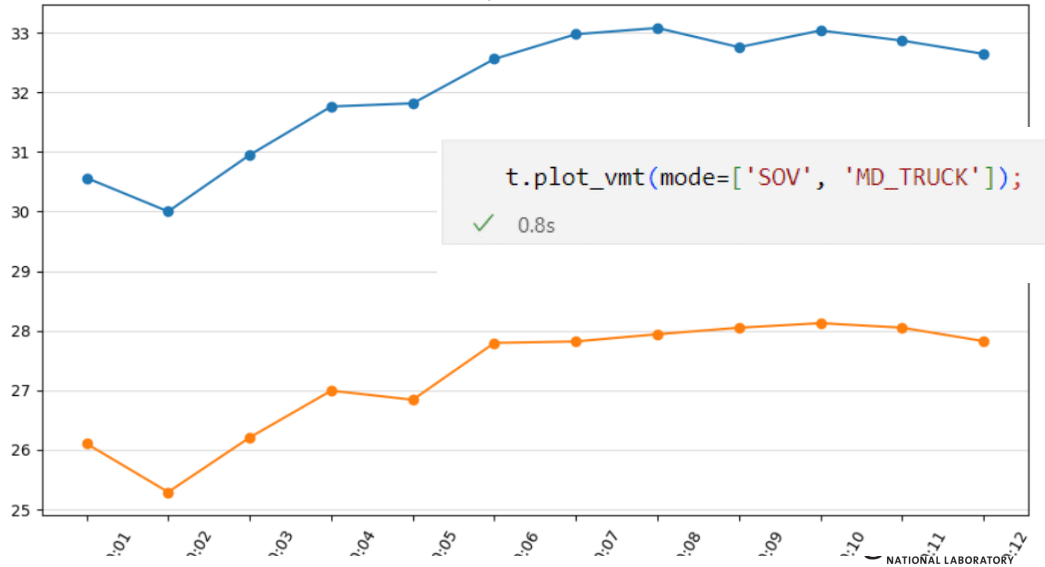




Mode Share Calibration



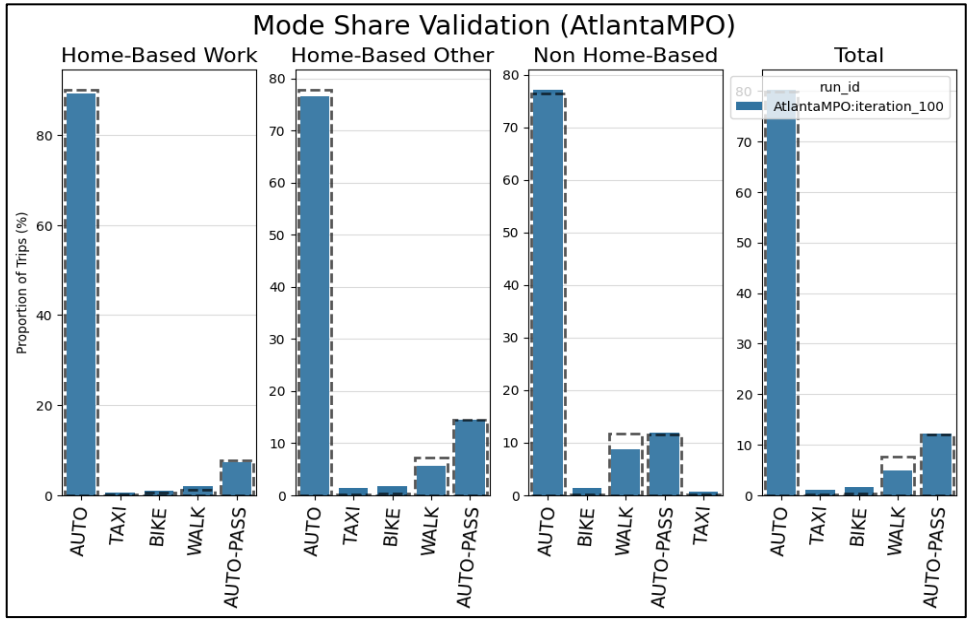
Speed (mi/h)

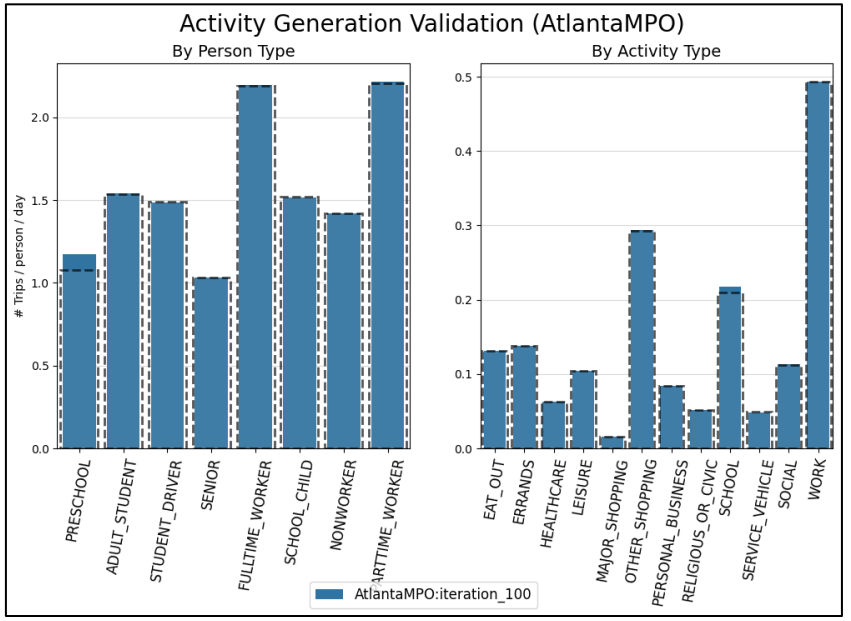


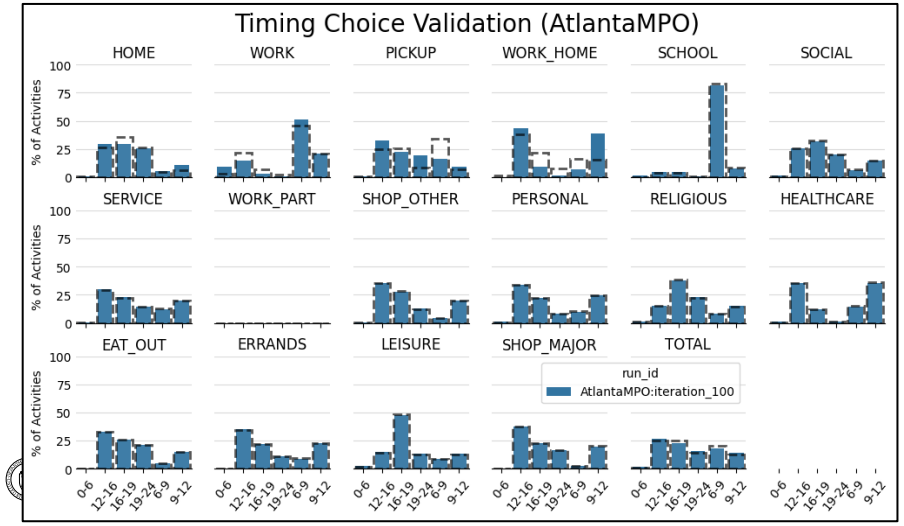

```
t.plot_vmt(mode=['SOV', 'MD_TRUCK']);
```
0.8s

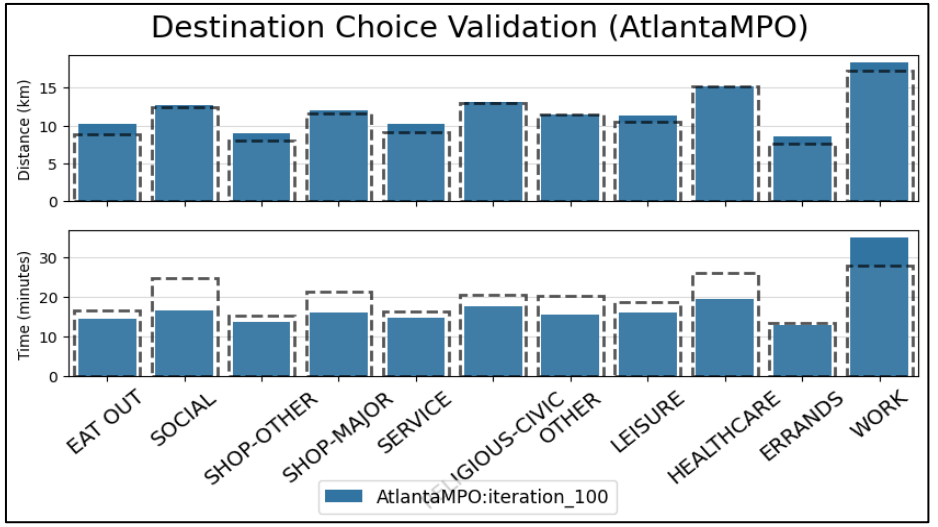
BASELINE CALIBRATION EXAMPLES

ATLANTA BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH ARC









Simulated value

Target from survey data

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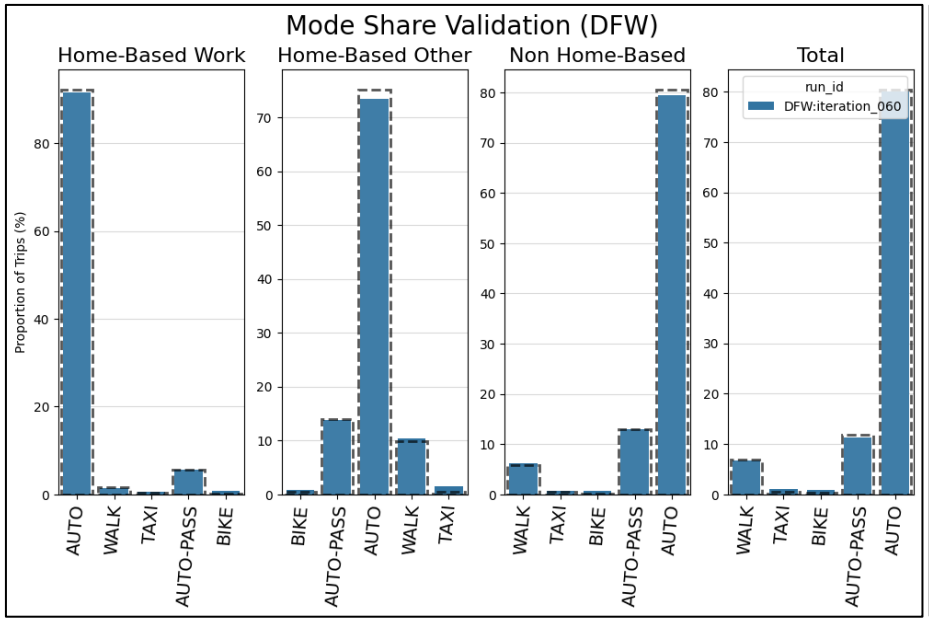
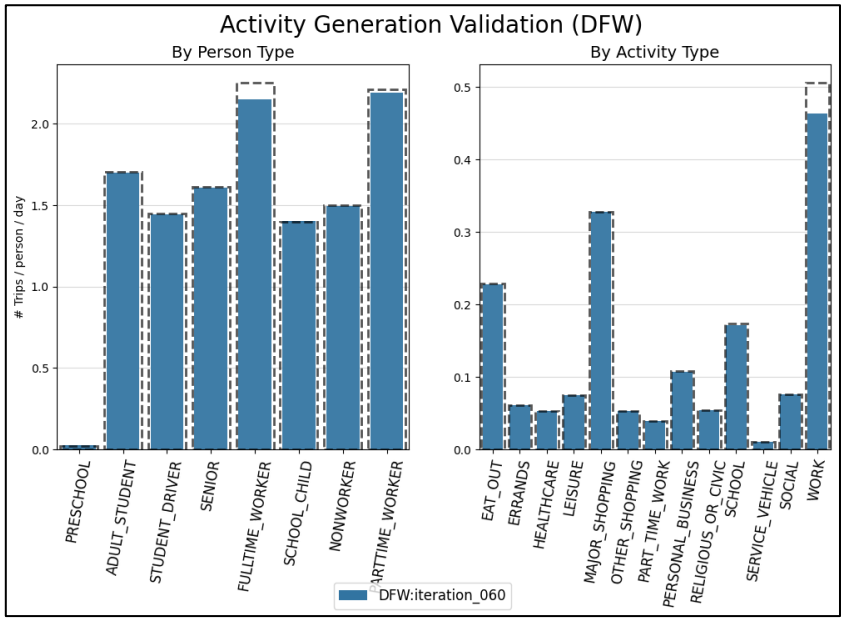
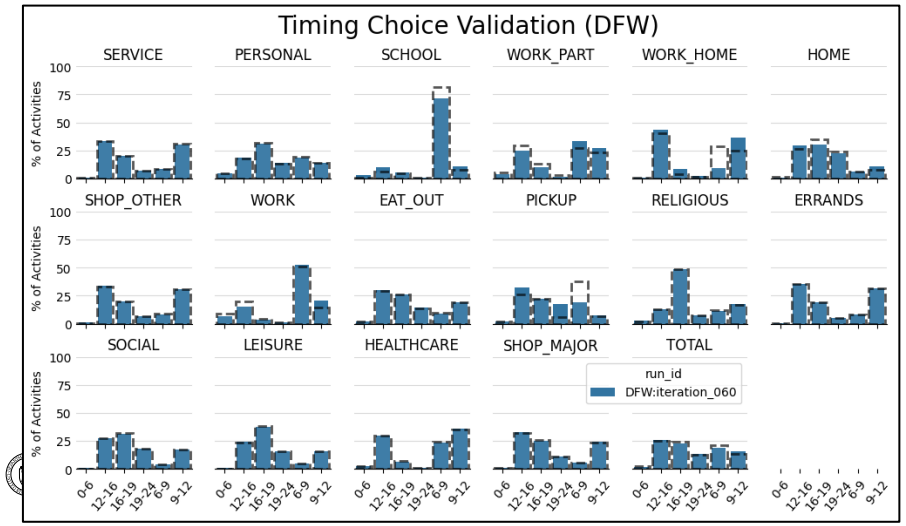
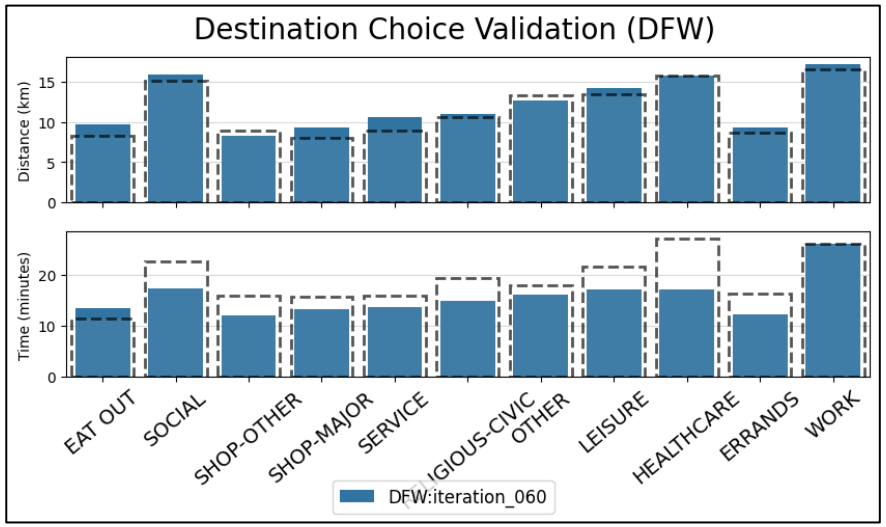
DFW BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH NCTCOG

North Central Texas Council of Governments









Simulated value

Target from survey data

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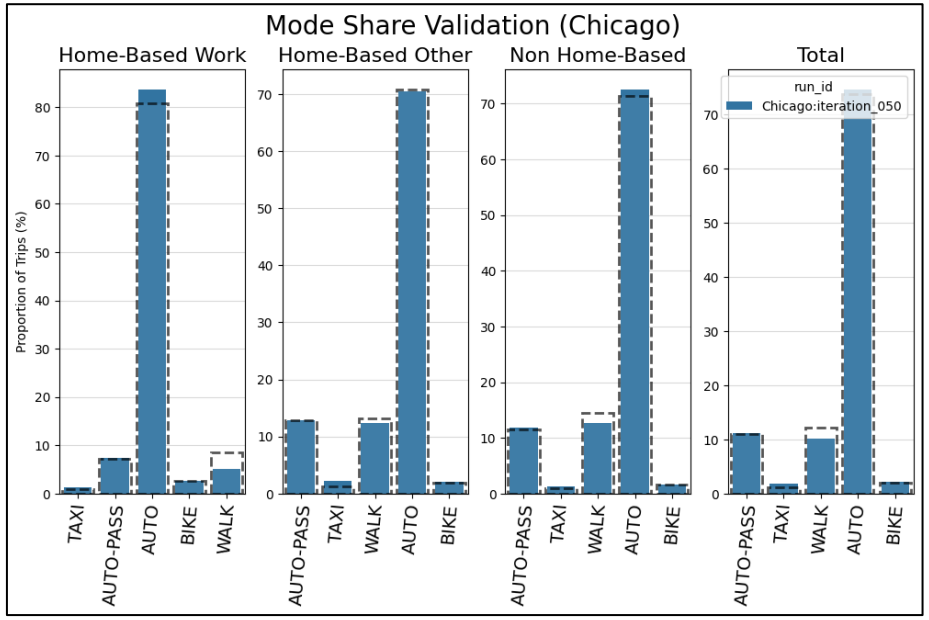
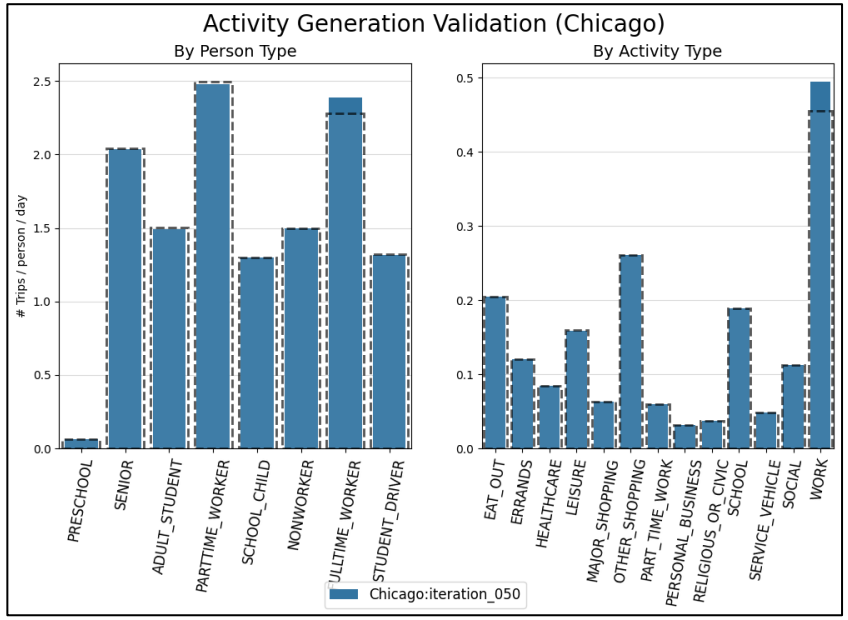
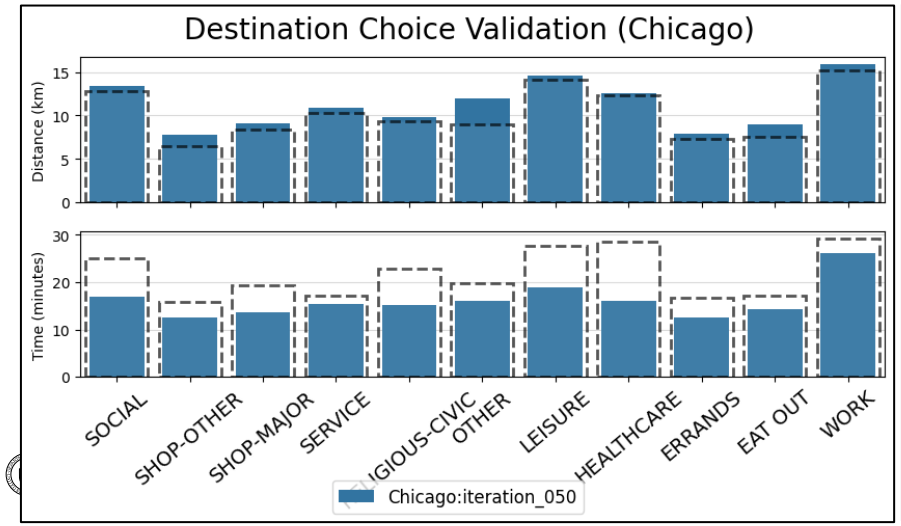
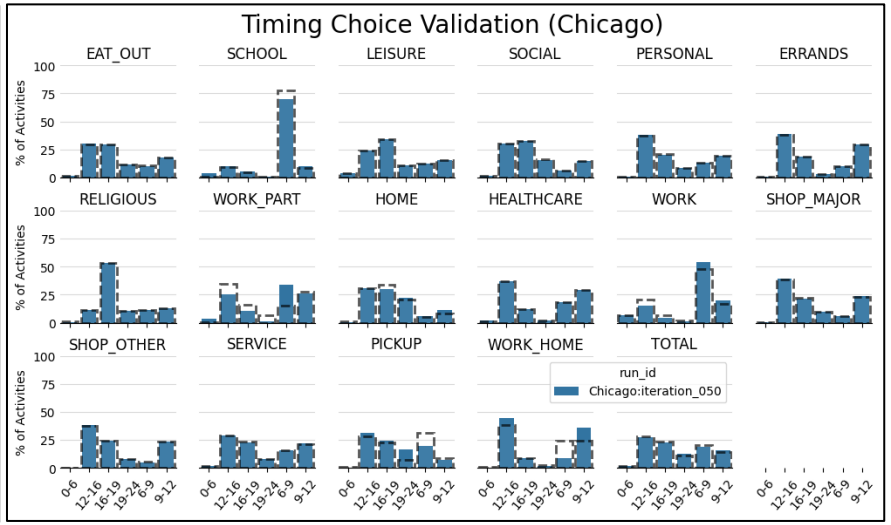
CHICAGO BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH CMAP







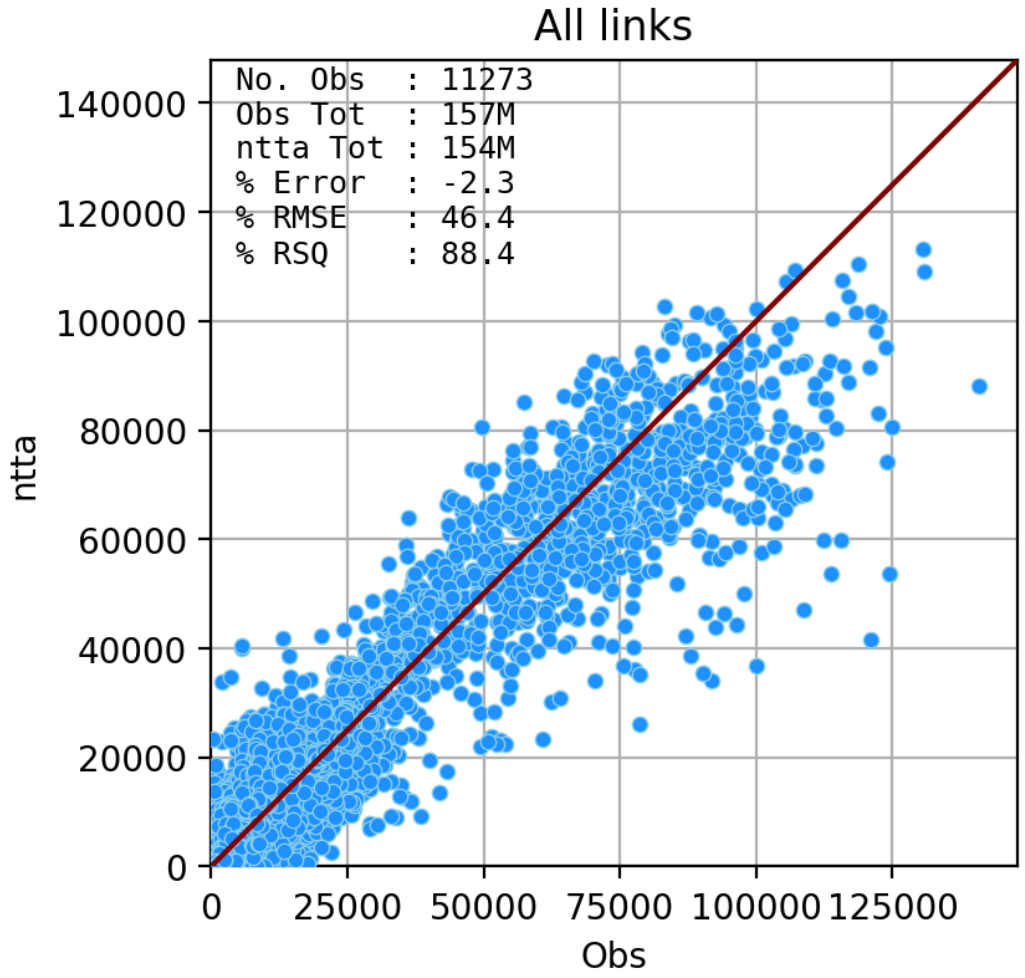


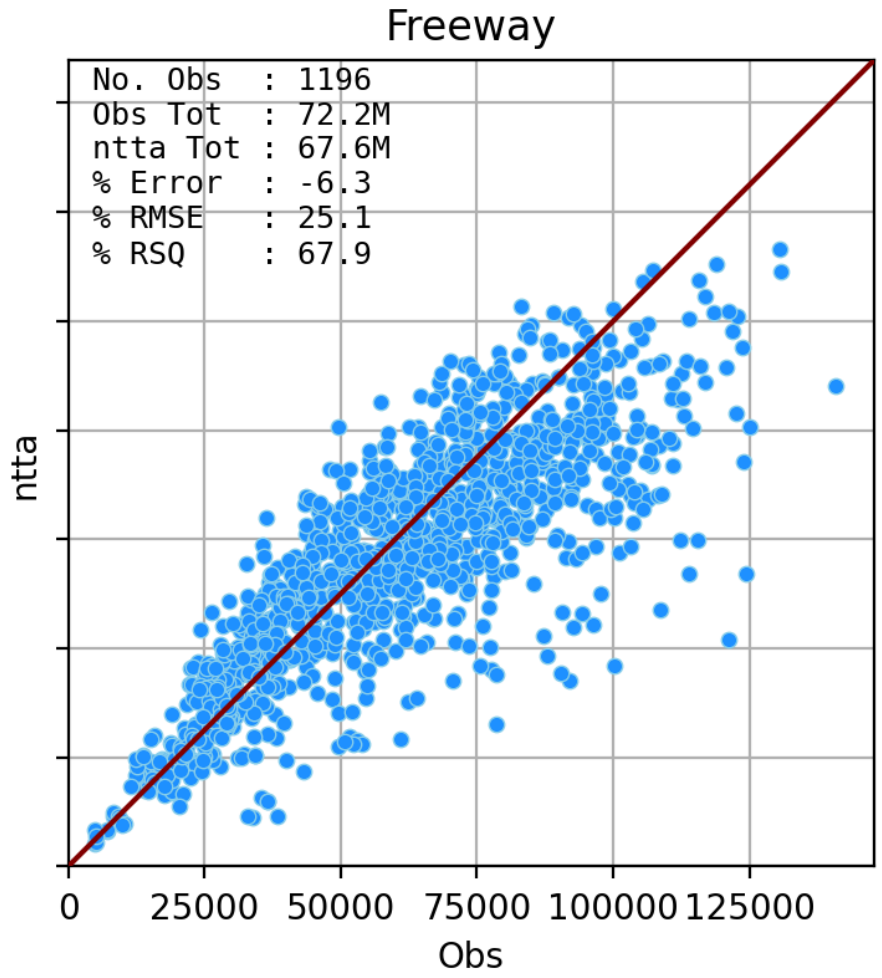
Simulated value

Target from survey data

COUNT DATA HELPED VALIDATE 2019 BASELINE CALIBRATION IN DFW

North Central Texas Council of Governments

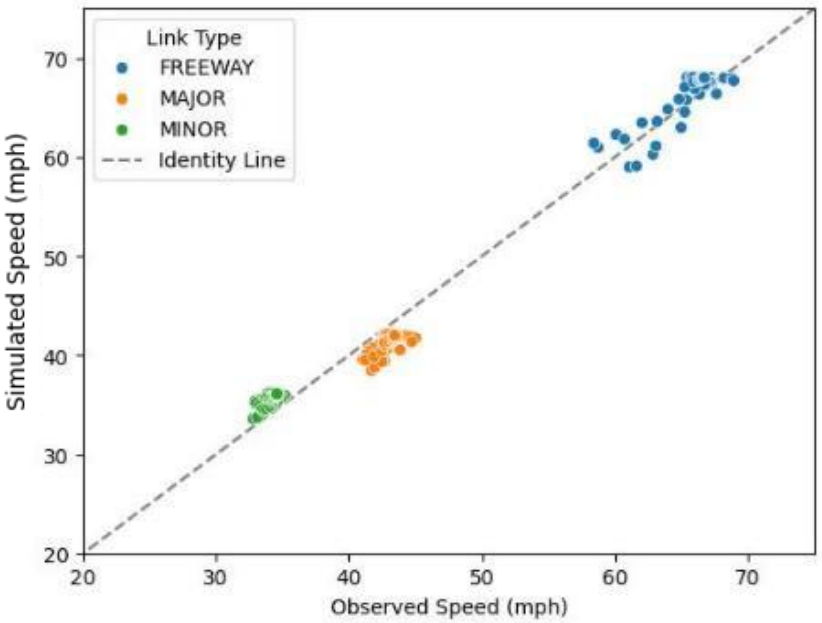




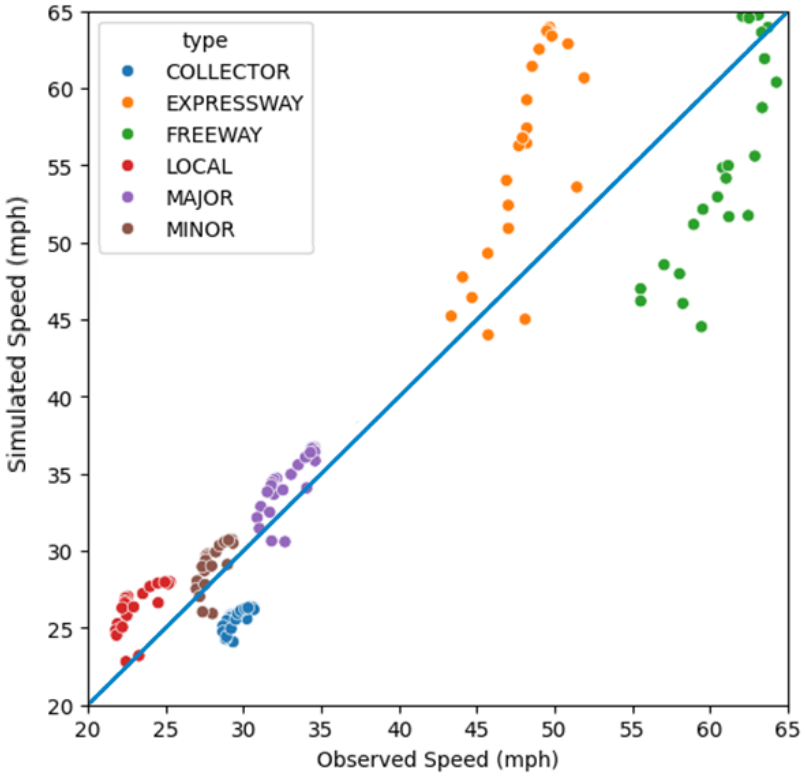
INRIX & NPMRDS SPEED DATA USED TO VALIDATE FACILITY TYPE & HOURLY SPEED DISTRIBUTION

Each point represents hourly averages of speed

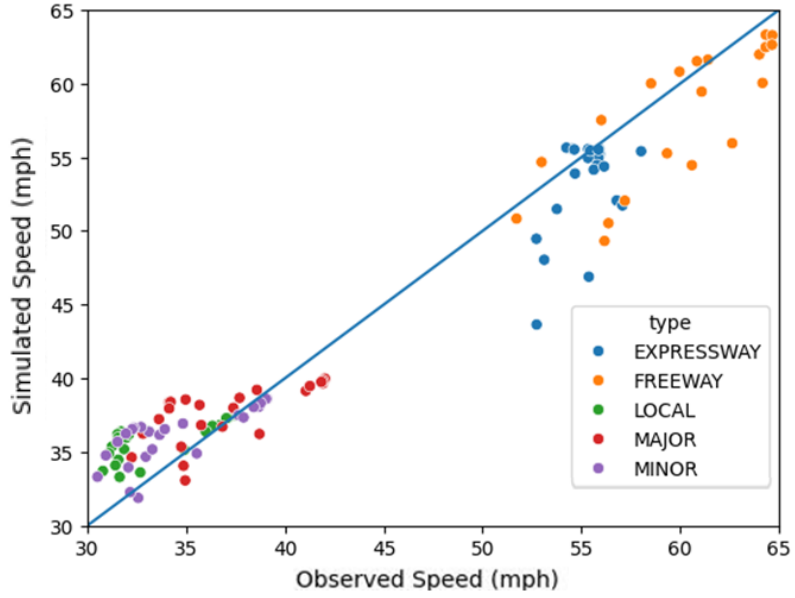
Dallas Ft. Worth



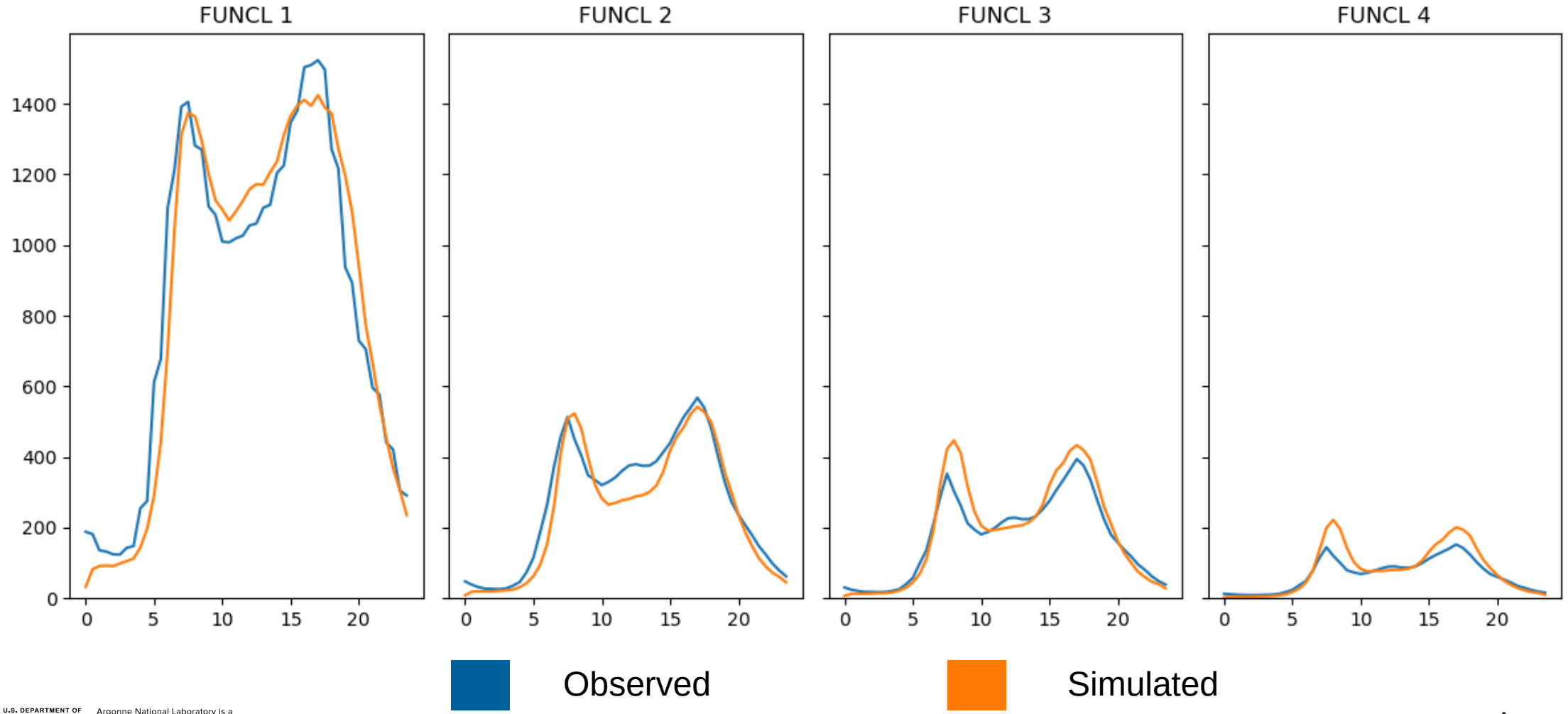
Chicago [Unweighted]



Atlanta [Unweighted]



VOLUMES WEIGHTED BY LINK LENGTHS REVEAL MATCHING TEMPORAL DISTRIBUTION



IN THE WORKS…

- We’re standardizing additional calibration routines
  - Telecommuting rates (based on Census or target for future years)
  - E-commerce use rates by households
  - Freight point-of-entry mode choice (truck vs rail vs air)
  - More to follow!
- Adding appropriate KPIs to track the calibration quality
- Updating target generation process through NHTS or alternate data sources
- Updating the calibration routine in polaris-studio for a flexible setup

THANK YOU! QUESTIONS OR COMMENTS?

PLEASE CONTACT US AT:

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