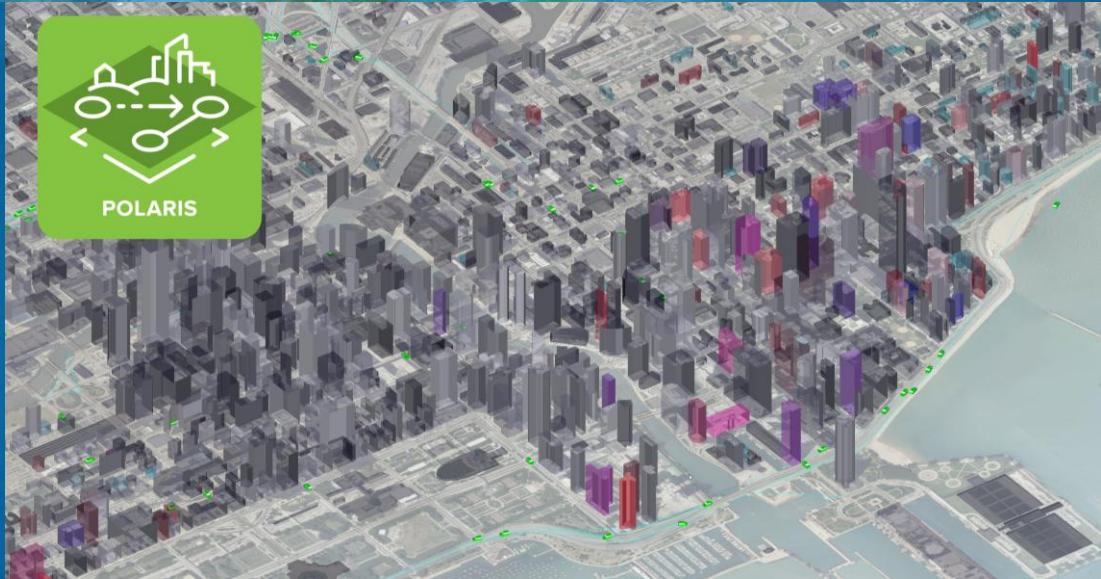


JUNE 12, 2025

CREATING AND CALIBRATING POLARIS MODELS



PRESENTED BY: KRISHNA MURTHY GURUMURTHY

Transportation Systems and Mobility
Vehicle and Mobility Systems Department

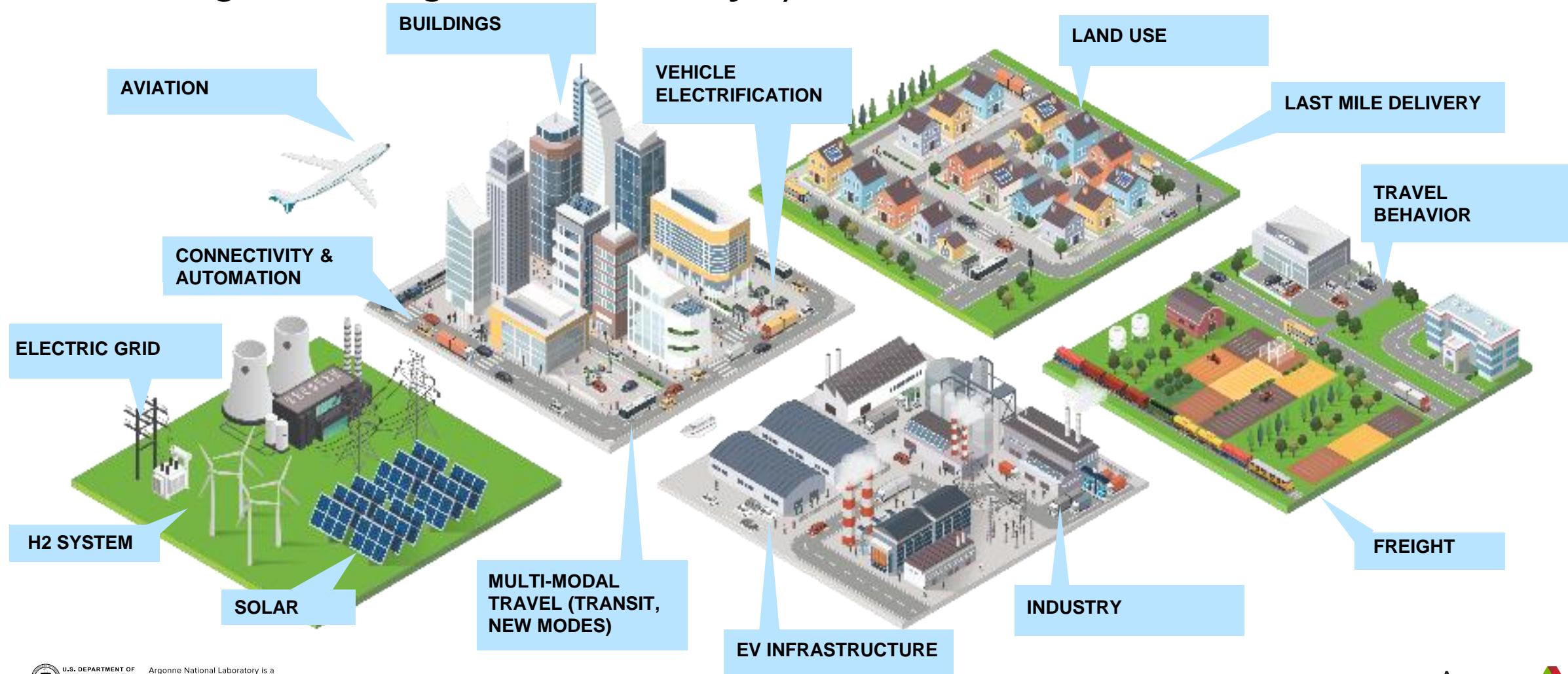


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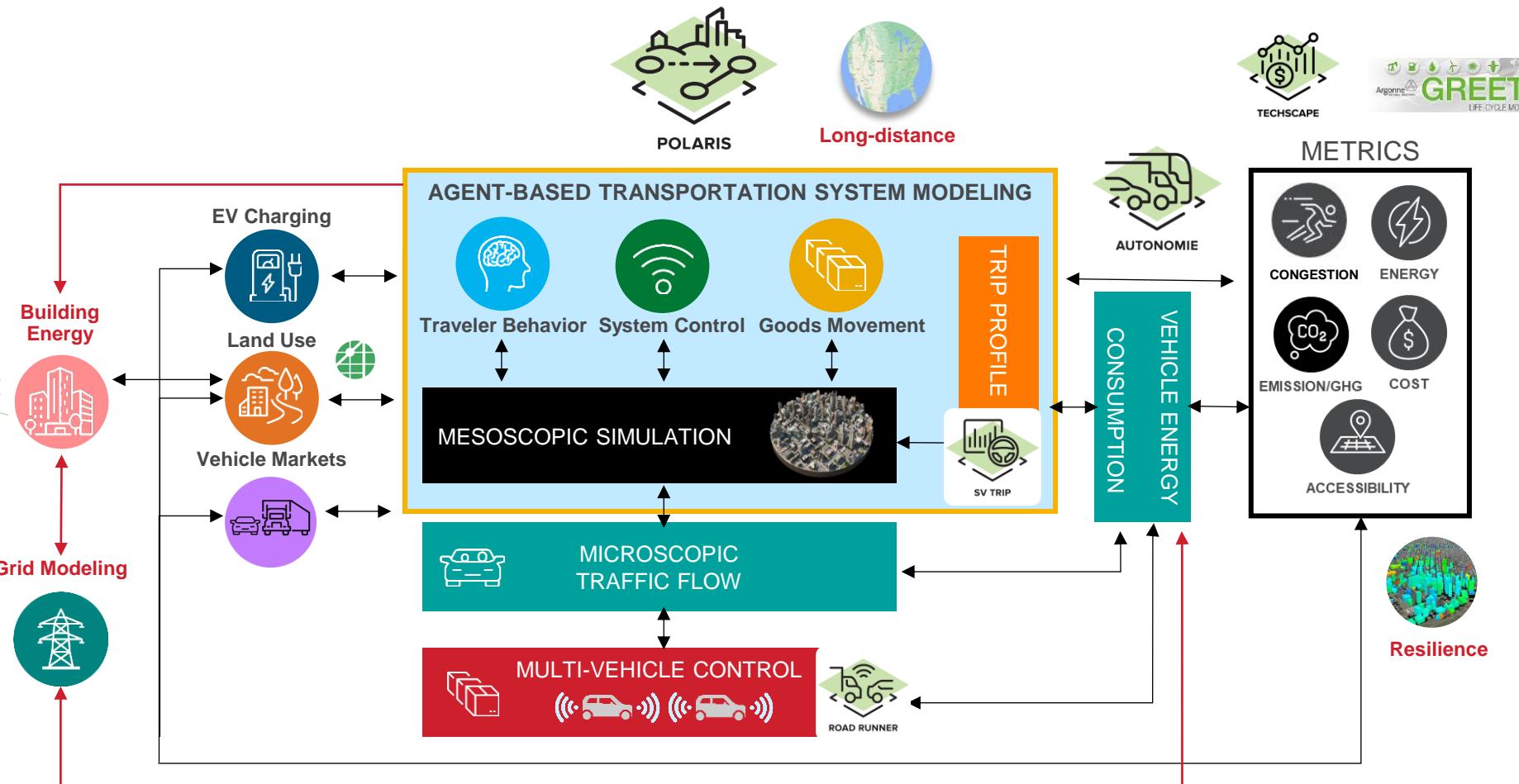


A HOLISTIC APPROACH IS REQUIRED TO ACHIEVE MOBILITY AND ENVIRONMENTAL GOALS

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?

- 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:

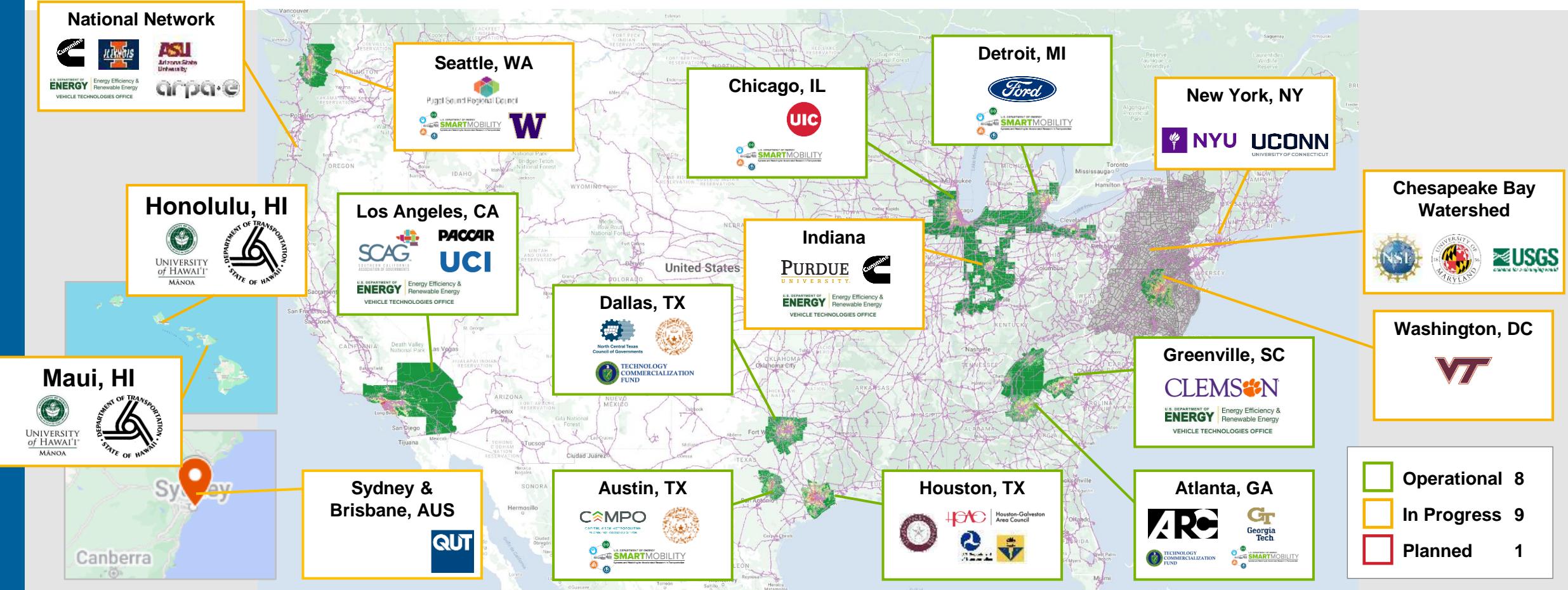
- Full-featured **activity-based** model
- Includes **freight** shipments and local deliveries
- High-fidelity **vehicle energy** consumption
- **Integrated** demand, network assignment and traffic flow
- **EV** charging and **grid** integration
- Connection to UrbanSIM land use
- Traveler **behavior**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



U.S. DEPARTMENT OF
ENERGY

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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>



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POLARIS

Polaris Studio

QPolaris

POLARIS

POLARIS is a high performance, computationally efficient transportation simulation into an integrated modeling platform modeled simultaneously, including:

- Activity generation;
- Activity planning (e.g., departure time, destination choice);
- Multi-modal route choice;
- Activity planning and rescheduling;
- Freight and logistics planning; and
- Fleet and transit service operational controls.

Important

Please cite POLARIS using the following reference (Auld et al. 2018):

Auld, J., Hope, M., Ley, H., Sokolov, V., Xu, Y. (2018). A high performance framework development and implementation for multi-modal transportation simulations. *Transportation Research Part C: Emerging Technologies*, 83, 102–121.

You should also refer to the [citations](#) page for a full list of references.

Contents

[Getting Started](#)

[Get a License](#)

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NATIONAL LABORATORY

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

The screenshot shows a web-based documentation interface for 'polaris 25.03 documentation'. At the top, there are navigation links: 'POLARIS', 'Polaris Studio' (which is highlighted in blue), and 'QPolaris'. Below the links, a 'Note' section contains the text: 'Go to the end to download the full example code.' On the left side, there's a sidebar with a search bar and keyboard shortcut 'Ctrl + K'. The main content area has a vertical navigation bar on the left with sections: 'Getting Started', 'Examples' (which is highlighted in blue), 'Building Models' (which is also highlighted in blue), and a 'Guided creation of a new model from scratch' section at the bottom. The main content area displays several steps under 'Building Models': 'Checking a model for critical errors', 'Simplifying a model network', 'Building a model from GMNS', and 'Creating external locations'. The title of the page is 'Guided creation of a new model from scratch'.

Guided creation of a new model from scratch

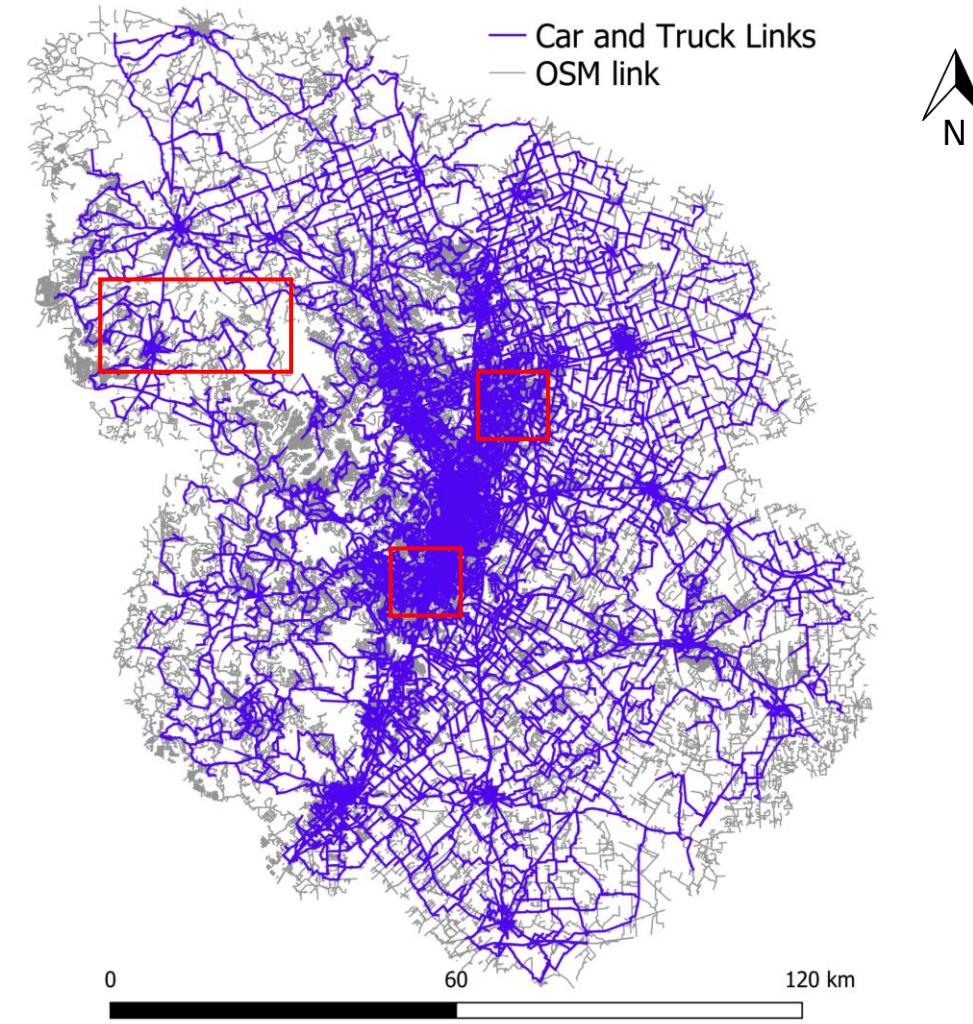
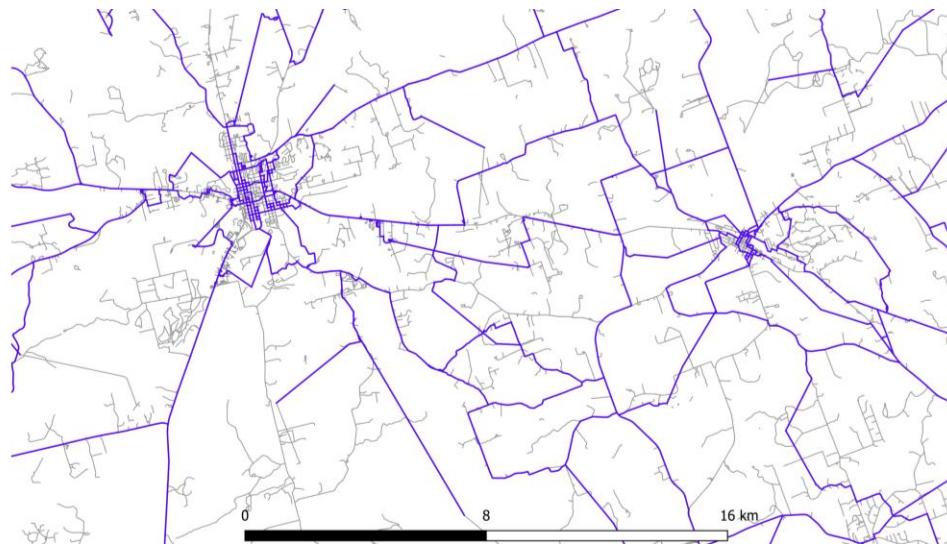
On this example, we show how to use Polaris-Studio tools to start the creation of the most complicated portions of the supply models, including:

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



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SIMPLIFICATION PROVIDED AND CONSISTENT IN ALL AREAS OF THE NETWORK



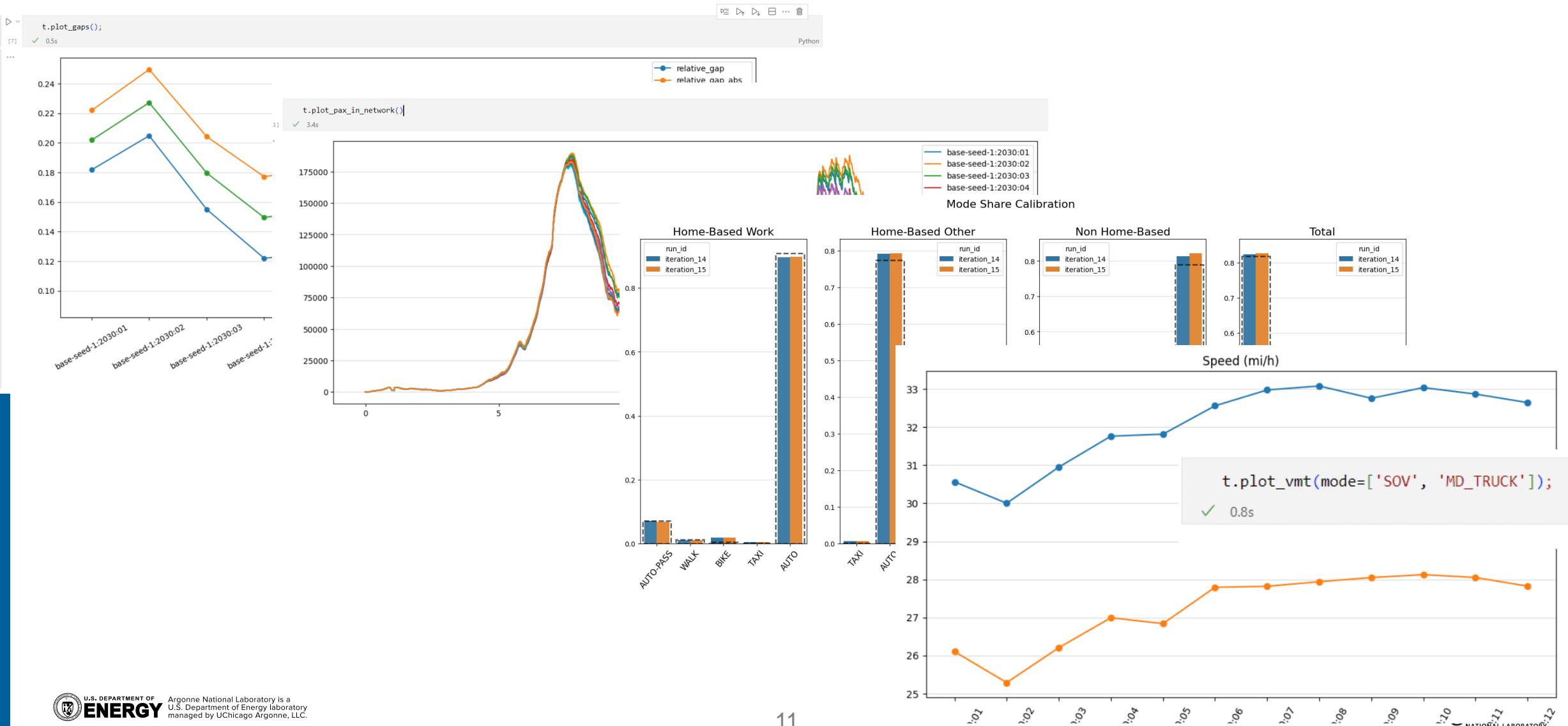
FLEXIBLE CALIBRATION SCHEDULE PROVIDES SUPPORT FOR ON-THE-GO CONVERGENCE

- 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

```
1 db_name: My_City
2 do_abm_init: true
3 do_skim: true
4 num_abm_runs: 120
5 num_threads: 28
6 population_scale_factor: 0.25
7 calibration:
8   enabled: true
9   target_csv_dir: calibration_targets
10  num_planned_activity_iterations: 0
11  calibration_schedule:
12    activity:
13      first_iteration: 1
14      last_iteration: 120
15      pattern: [0,0,0,0,0,0,1,0,0,0]
16    destination:
17      first_iteration: 1
18      last_iteration: 120
19      pattern: [1,0,0,0,0,0,0,0,0,0]
20    mode:
21      first_iteration: 1
22      last_iteration: 120
23      pattern: [0,0,0,0,1,0,0,0,0,0]
24    timing:
25      first_iteration: 1
26      last_iteration: 120
27      pattern: [0,0,0,0,0,1,0,0,0,0]
28      step_size: 2.0
29  workplace_stabilization:
30    enabled: true
31    schedule:
32      first_iteration: 1
33      last_iteration: 60
34      pattern: [1,1,1,1,1,0,0,0,0,0]
```



GENERATES STANDARD PLOTS FOR CALIBRATION & OTHER METRICS



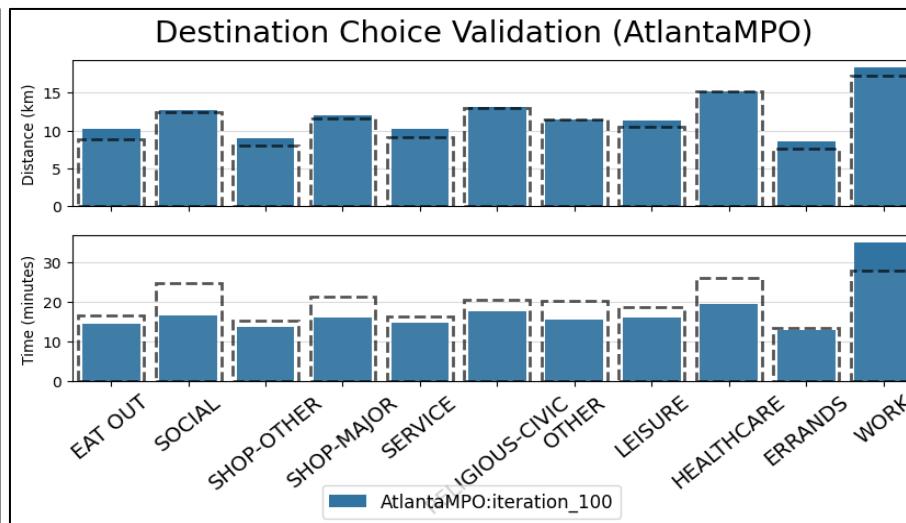
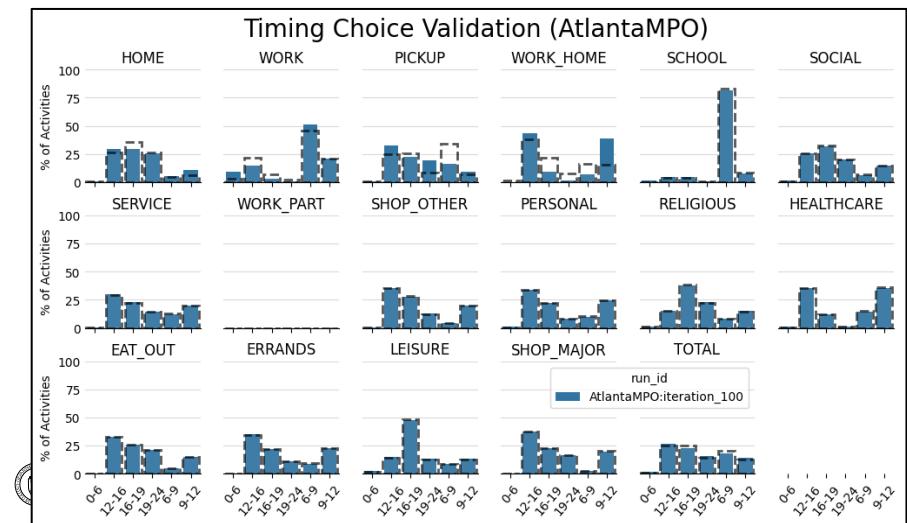
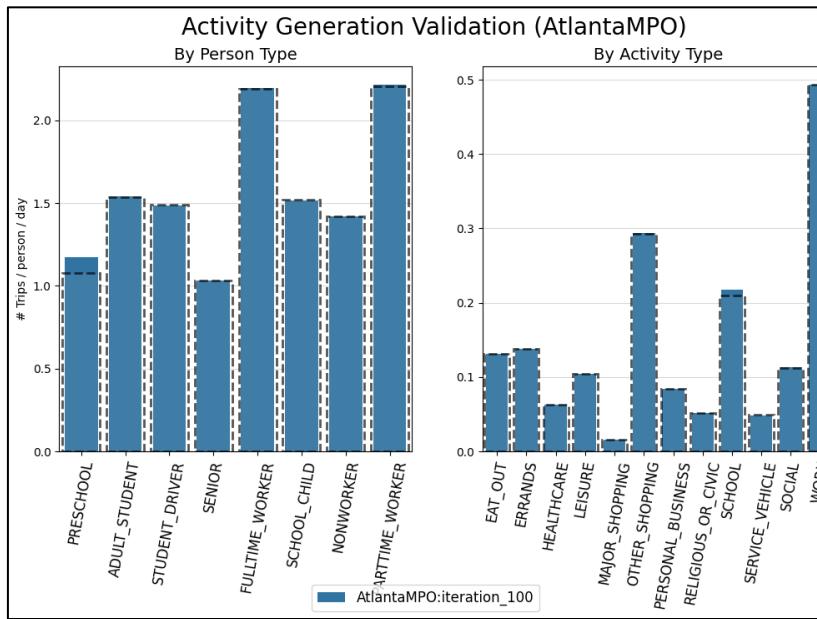
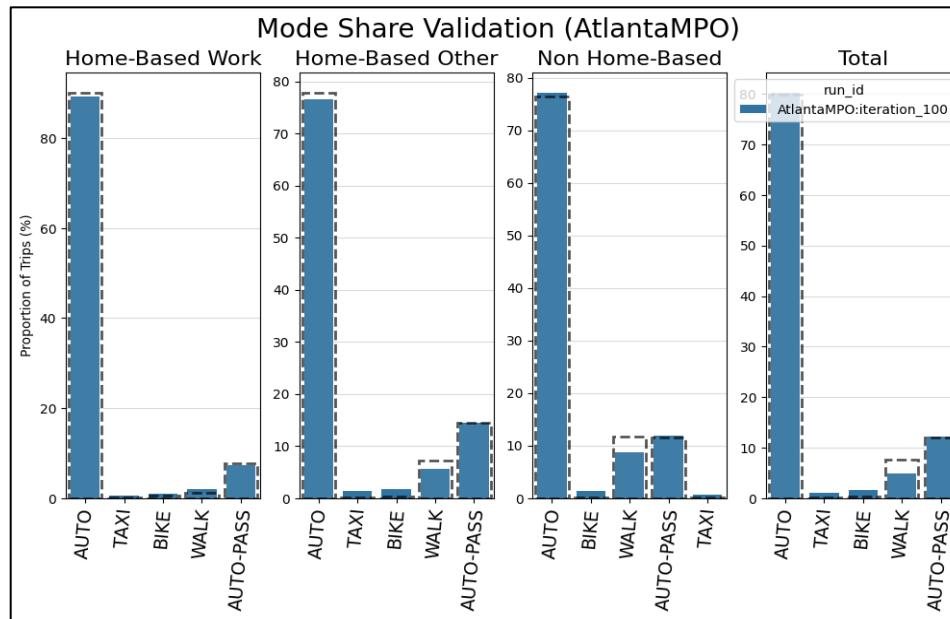
BASELINE CALIBRATION EXAMPLES



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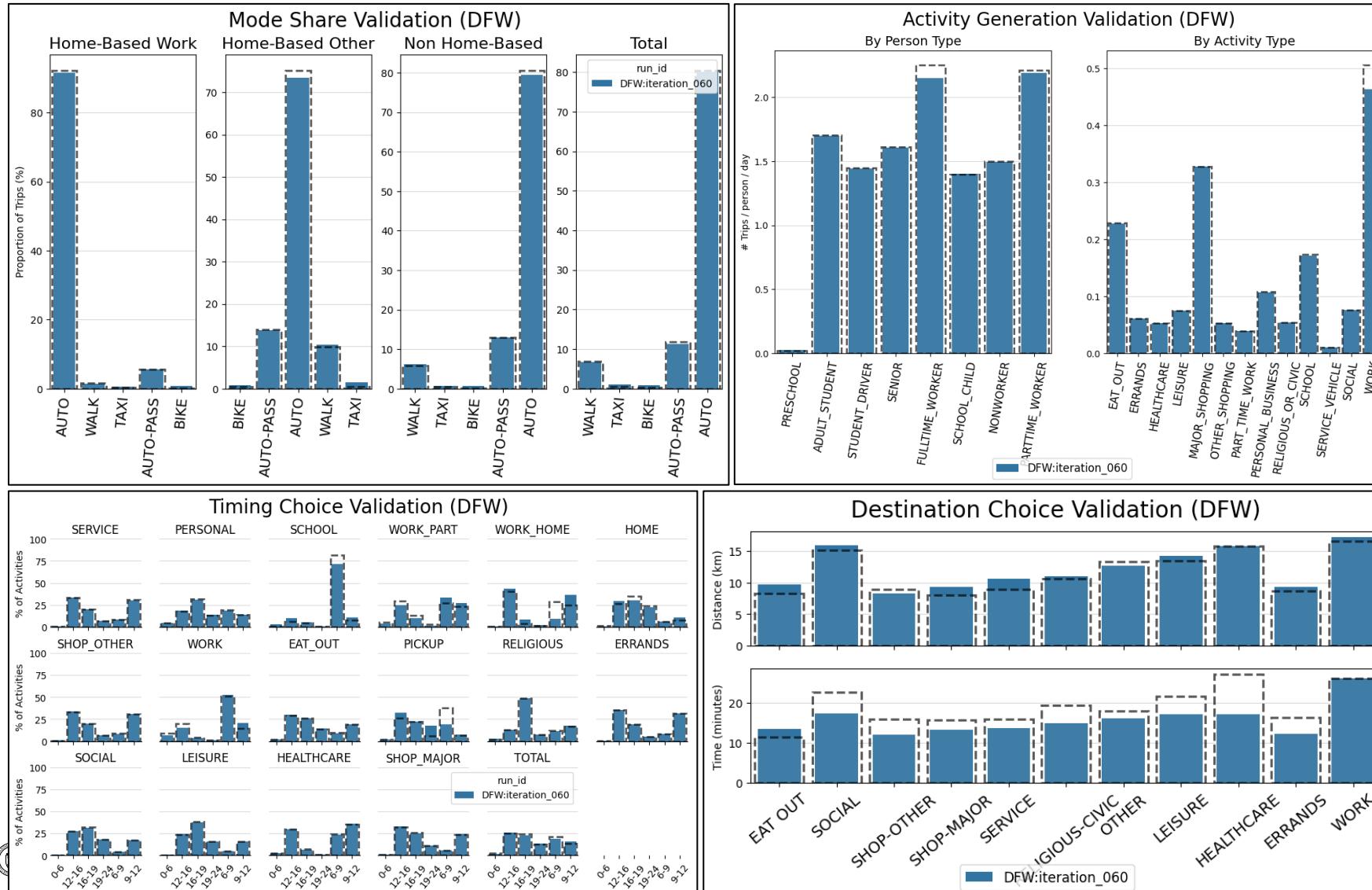


ATLANTA BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH ARC



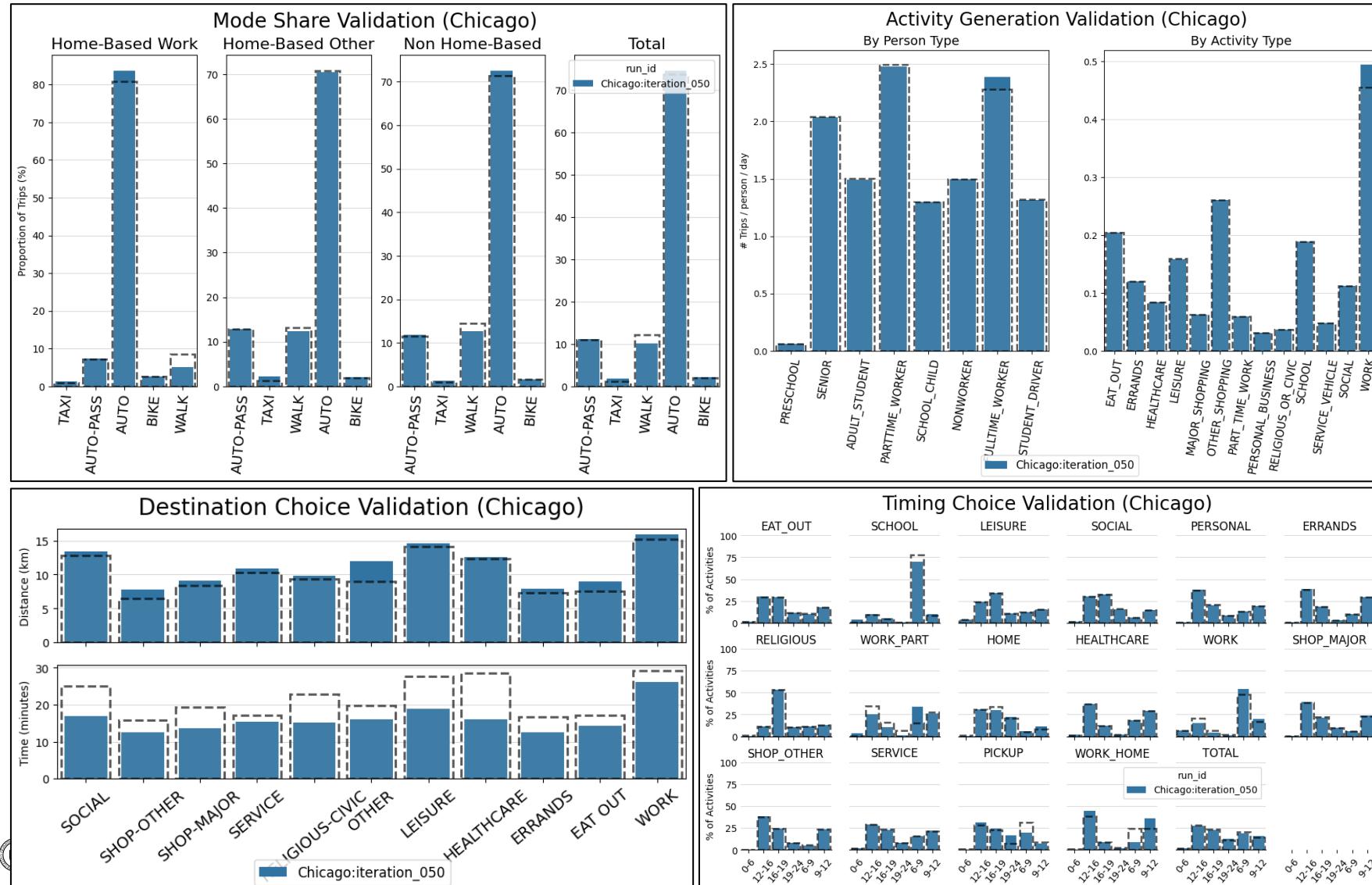
Simulated value
Target from survey data

DFW BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH NCTCOG



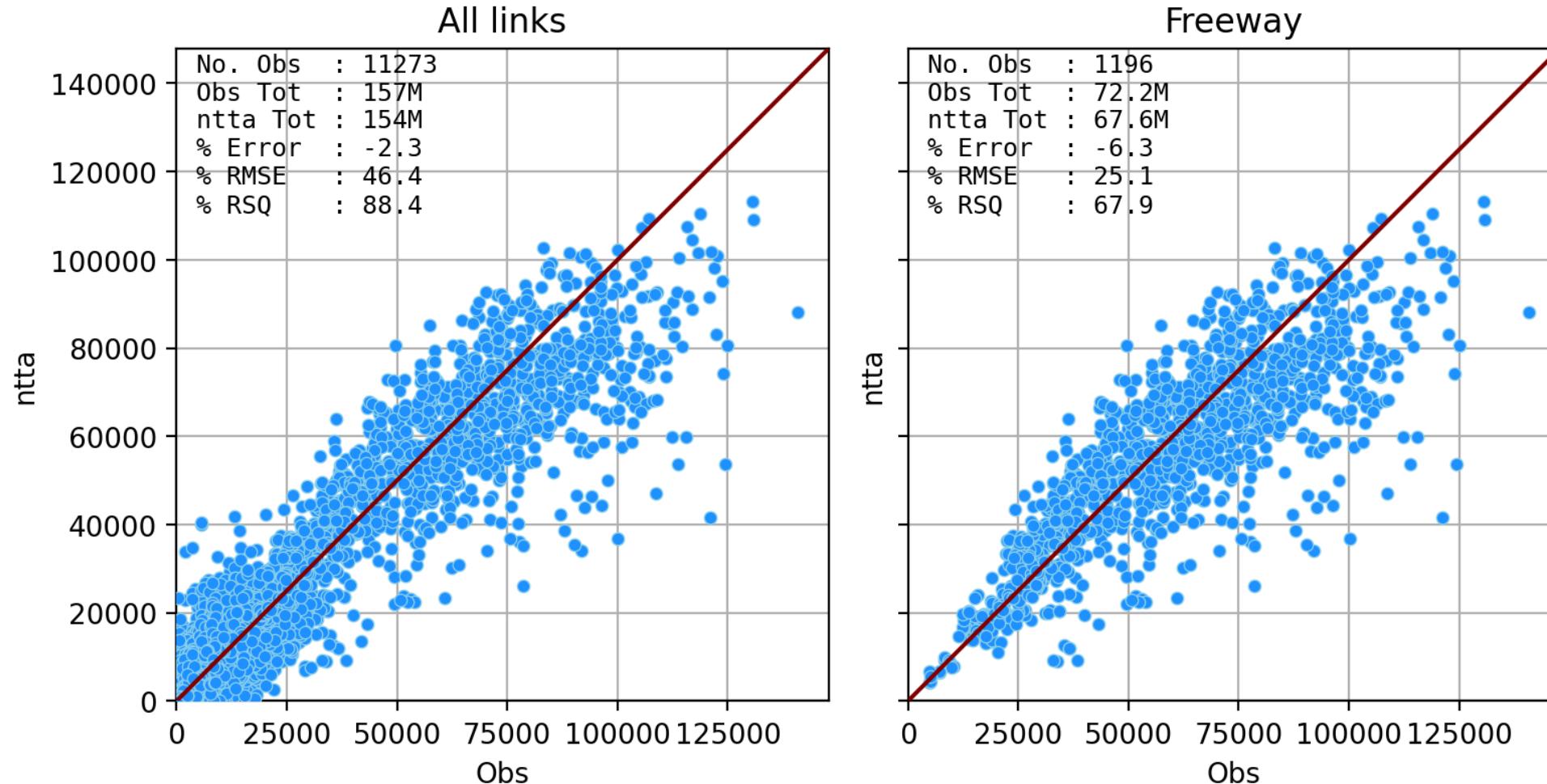
Simulated value
Target from survey data

CHICAGO BASE YEAR CALIBRATED IN CLOSE COORDINATION WITH CMAP



Simulated value
Target from survey data

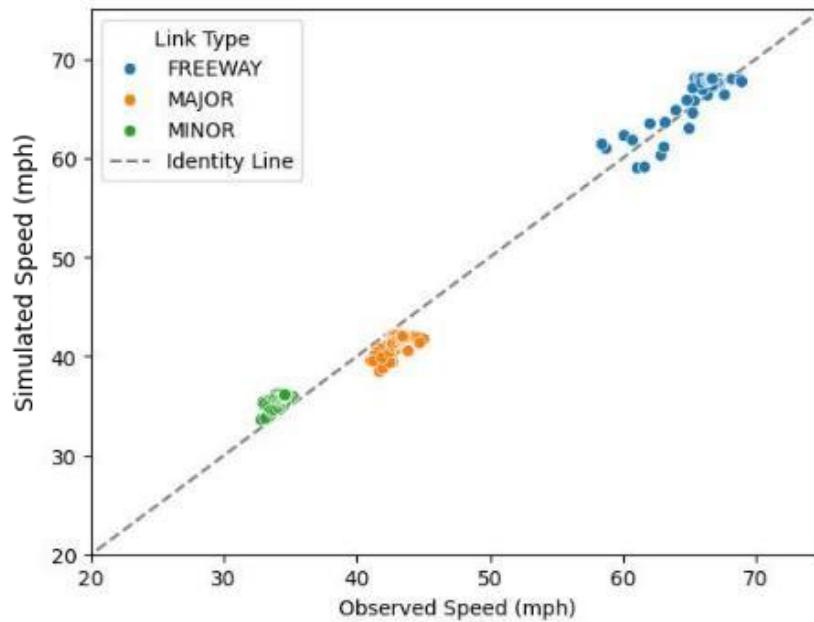
COUNT DATA HELPED VALIDATE 2019 BASELINE CALIBRATION IN DFW



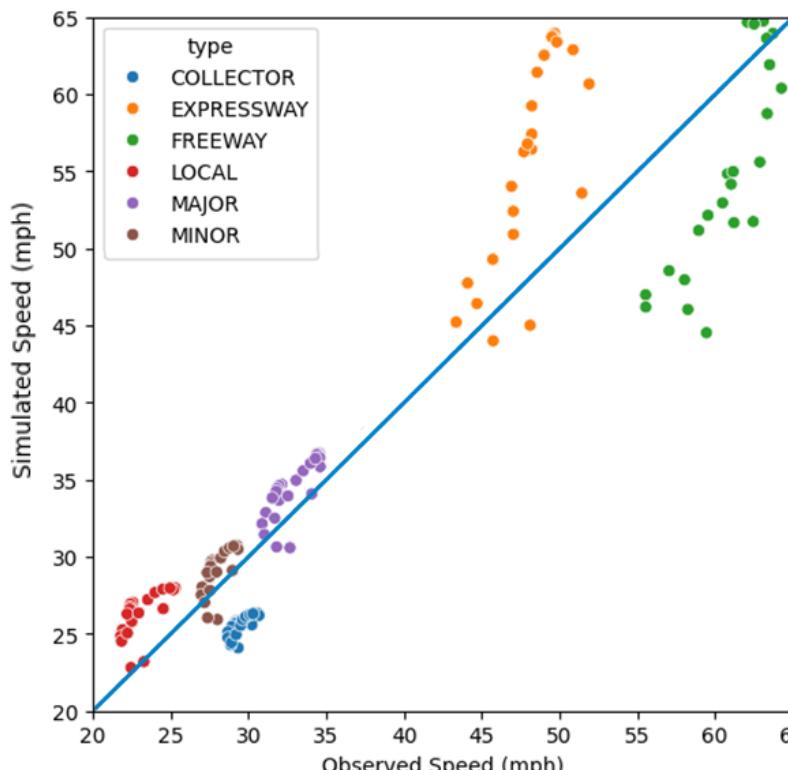
INRIX & NPMRDS SPEED DATA USED TO VALIDATE FACILITY TYPE & HOURLY SPEED DISTRIBUTION

Each point represents hourly averages of speed

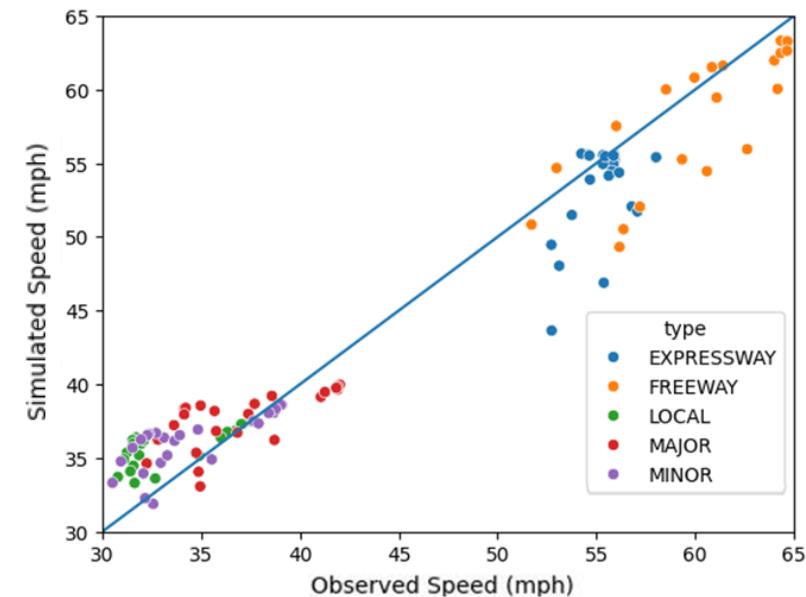
Dallas Ft. Worth



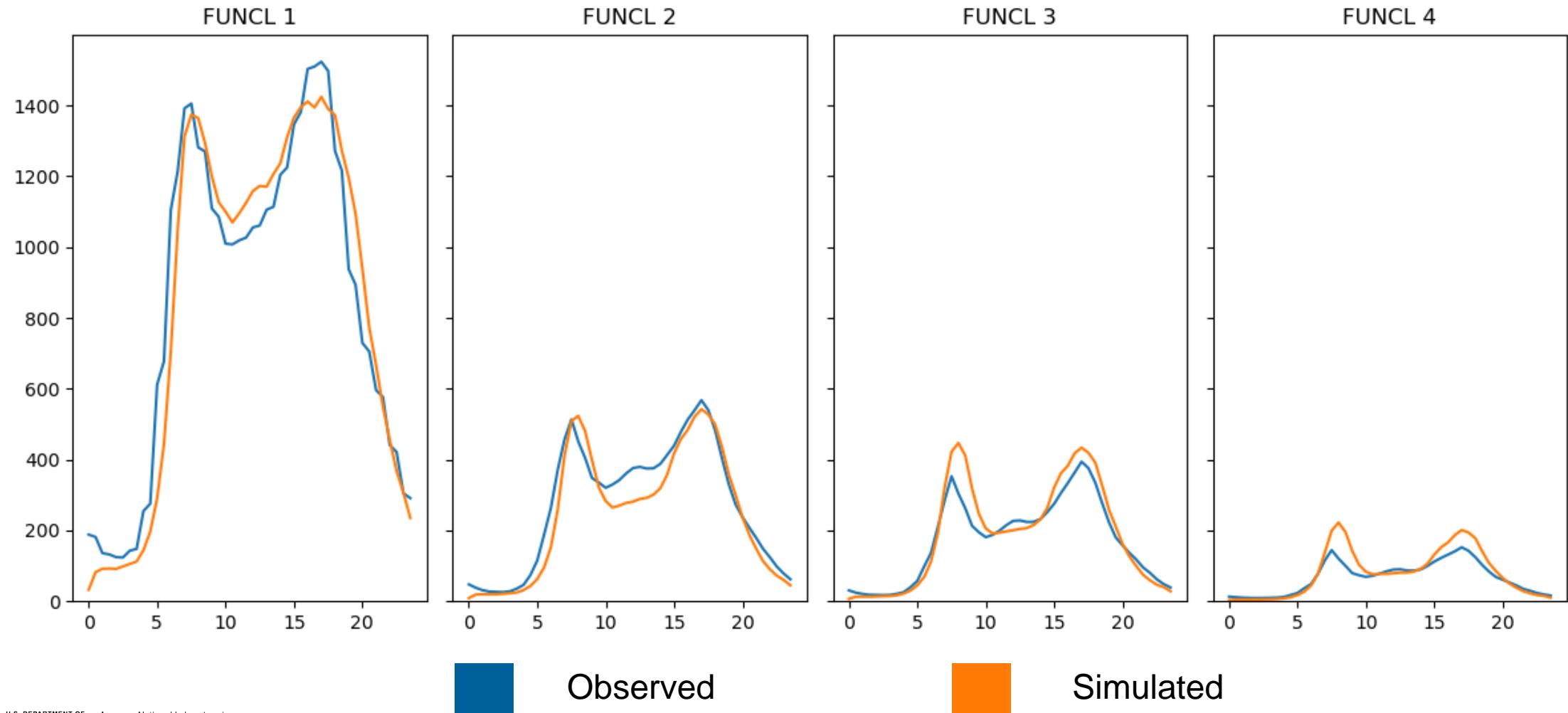
Chicago [Unweighted]



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

An aerial photograph of the Argonne National Laboratory campus, showing a mix of green fields, roads, and industrial buildings.

THANK YOU! QUESTIONS OR COMMENTS?

PLEASE CONTACT US AT:

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KGURUMURTHY@ANL.GOV



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