Traffic Assignment and Feedback Research to Support Improved Travel Forecasting

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December 9, 2015

FTA Research Project Motivation

- Address Congressional interest in highway benefits of major transit improvements
- Examine the congested auto travel times from models that are used for transit forecasting
- Understand the consequences of assignment and feedback convergence for impact assessment

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Project Overview

- Inventory/Assessment of Practices of the 30 Largest MPOs
- Tests with 5 of the better MPO Models
- Examination of Traffic Assignment Methods
- Examination of Feedback Methods
- Project Impact Analysis
- Comparison of Modeled & Measured Travel times
- Cross-cutting Conclusions

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Inventory of Practices circa 2012

- Nearly universal coverage of the 30 largest MPOs
- Widespread deficiencies found in traffic assignment methods
- Use of problematic assignment techniques and closure metrics – only 50% used a good metric
- Of those, low convergence targets for the relative gap-many at .01 or larger, few at .001, 2 at .0001
- Feedback insufficiently computed when attempted-often only one time period, ad hoc methods and closure metrics, often stopping at 5% flow diff.

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Experiments with 5 of the "better" MPO Models

- ARC, NCTCOG, MAG, SANDAG, & PSRC models
- Examination of tighter convergence
- Variations in assignment parameters
- Alternative feedback methods & metrics
- Tests of highway and transit project impacts
- Illustration of the value of a forensic approach to model assessment and validation

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Some of the Research Questions

- How much convergence error is there in deployed MPO models?
- How much convergence is enough for project evaluation?
- How hard is it to achieve with current algorithms and commercial software?
- How significant is feedback convergence?
- How achievable is feedback convergence?
- How realistic are model-generated congested travel times?

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User Equilibrium Assignment Background

- Classical methods don't converge much after a certain point
- Seemingly innocuous & familiar practices can both impair and/or overstate convergence: e.g., using slack closure criteria, a VHT gap instead of the relative gap, V/C limits, a VDF lookup table, or limited precision travel times
- Newer algorithms such as the bi-conjugate FW method are more efficient than the classical FW
- Some path-based algorithms can go low enough to eliminate convergence error

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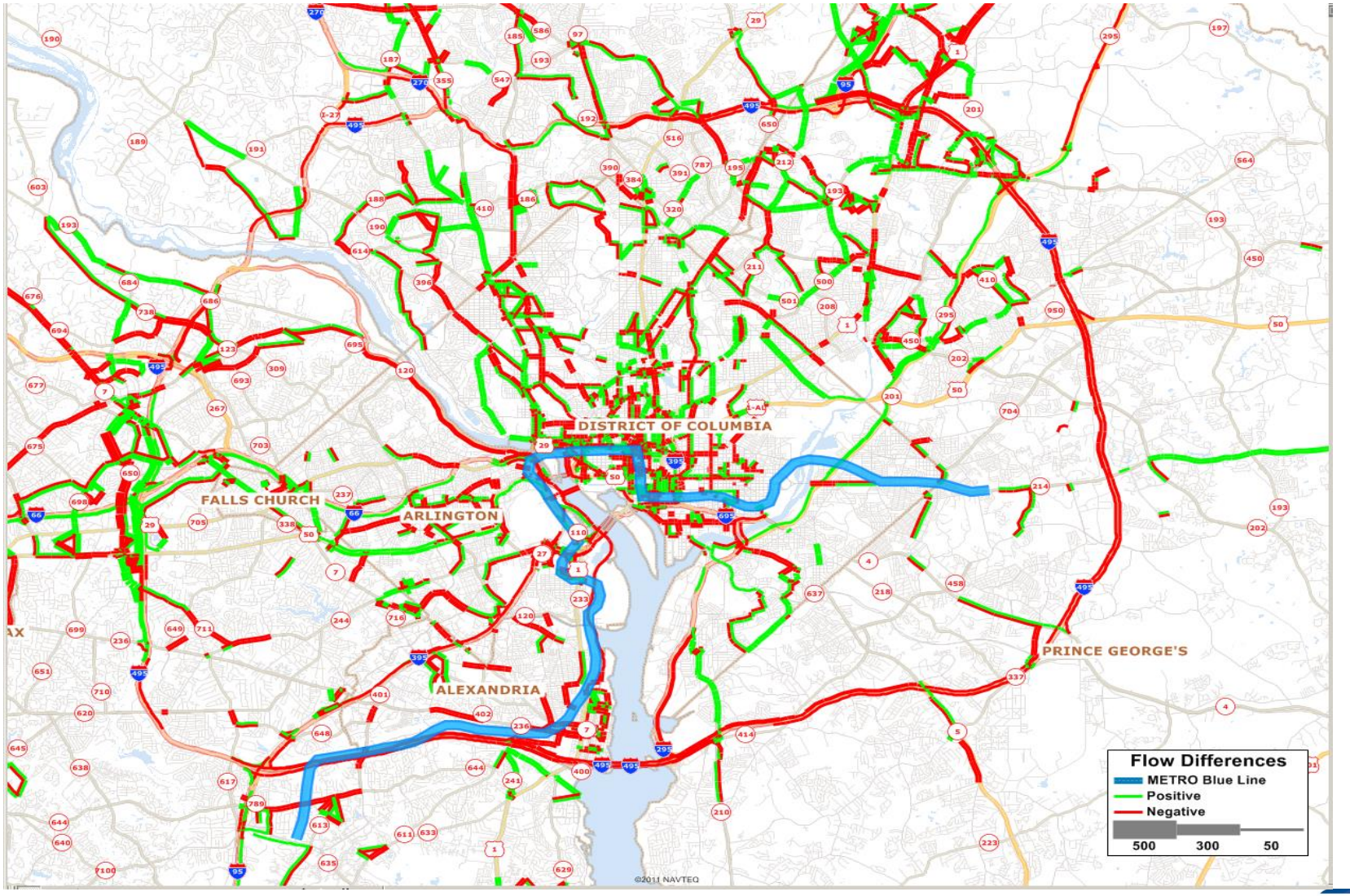
Why it matters-An Example of Convergence Error: Impact of Blue Line Service Improvement at 1% Relative Gap



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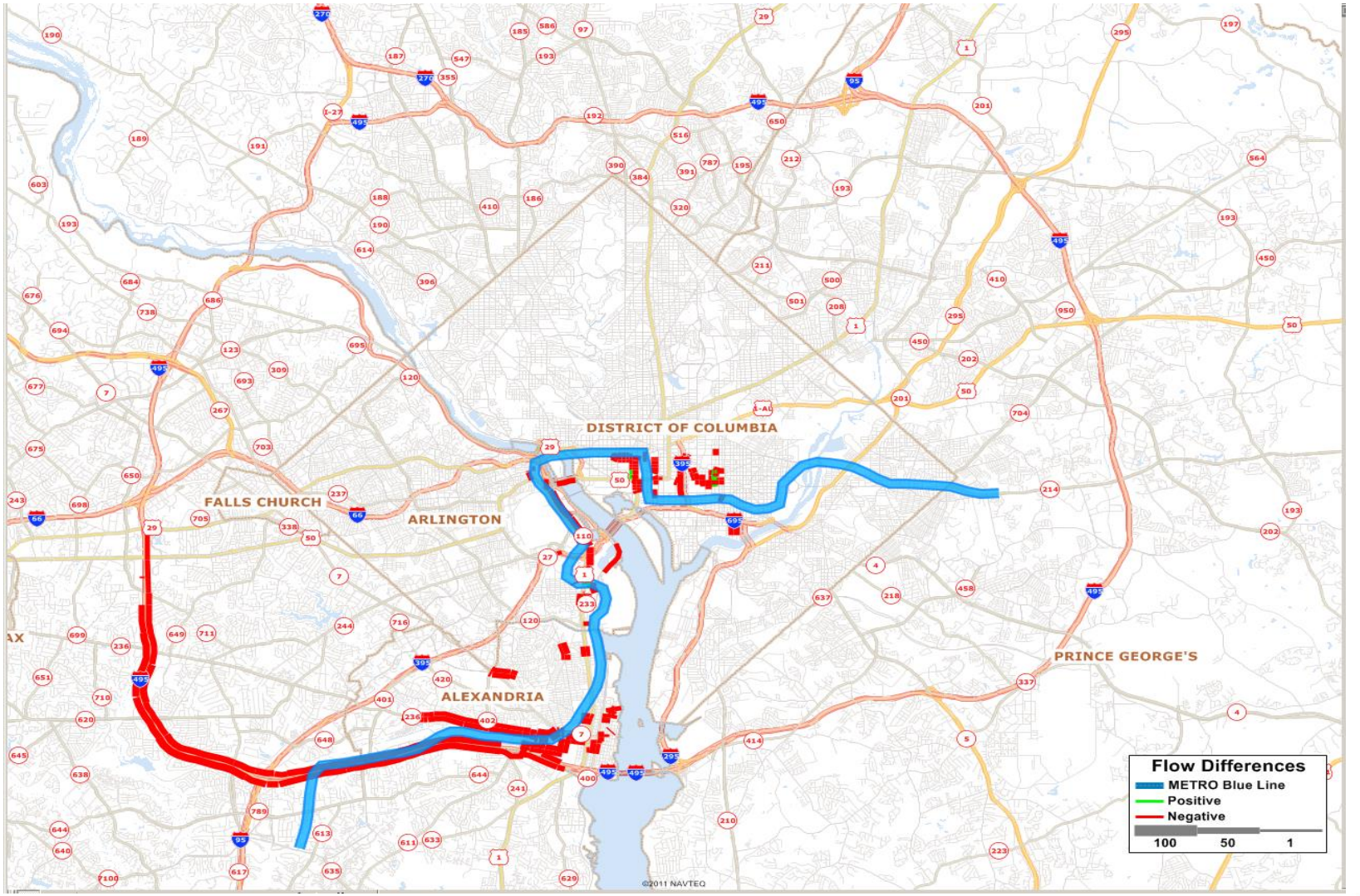
Why it matters- Road Impacts of Blue Line Service Improvement at 1E-6 Relative Gap



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Good Convergence Need Not Take too Long

MPO	ARC	MAG	NCTCOG	PSRC	SANDAG ABM	SANDAG trip-based
METHOD	BFW	BFW	BFW	BFW	BFW	BFW
TIME PERIOD	AM	PM	AM	AM	AM	AM
CONVERGENCE	1.E-4	1.E-4	1.E-4	1.E-4	1.E-4	1.E-4
NUMBER OF ITERATIONS	80	51	153	66	45	39
COMPUTATIONAL TIME	1 h 4 min	8 min 22 s	1 h 2 min	1 h 24 min	1 h 1 min	48 min
TOTAL VMT	40,264,910	29,356,528	35,209,830	13,122,656	16,934,816	15,727,276
TOTAL VHT	1,244,615	889,645	1,089,180	447,006	490,625	443,313

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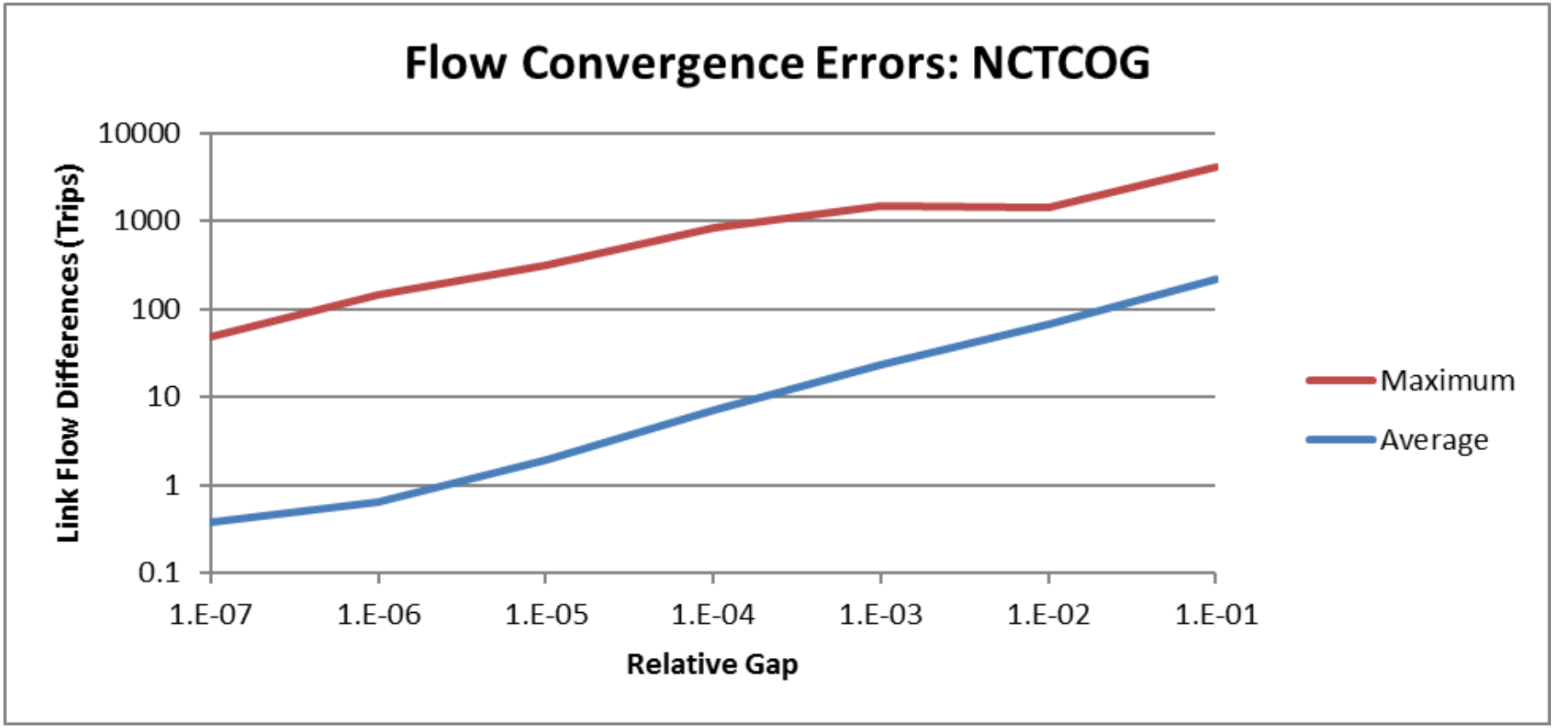
Convergence Error as a Function of the Relative Gap



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Other Assignment Problems Encountered

- Missing turn prohibitions
- Too few centroid connectors
- Poor volume-delay functions
- Constrained minimum and maximum speeds
- Not enough traffic counts by direction and time period for even minimal validation

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Traffic Assignment Findings

- Tighter convergence is useful and achievable with published methods
- Deployed models have substantial convergence error and yield spurious project impacts
- The degree of convergence that is useful is problem-dependent and can be assessed through straightforward comparisons
- Basic errors in network assignment models are fairly widespread even in the better models

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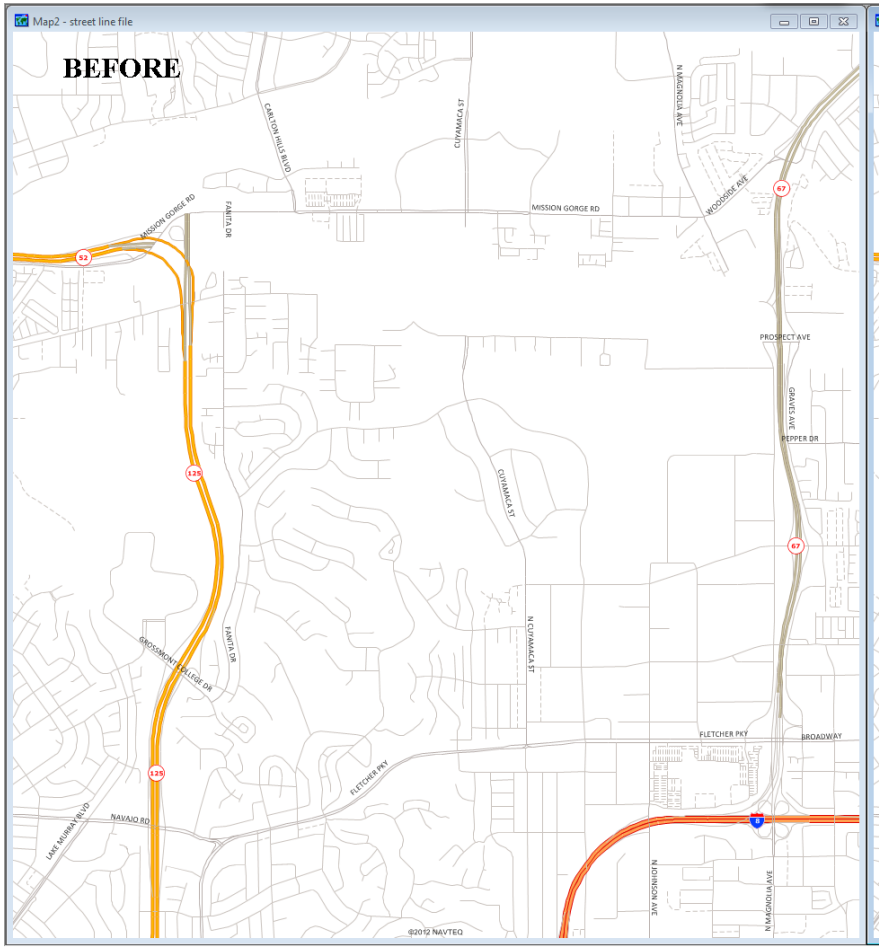
Impact of a SANDAG Region Road Project— New Section of SR 52



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Impacts with Different Modeling Protocols

Highway assign Rel. Gap	Type of model run	Δ AM VMT (Project-base)	Δ AM VHT (Project-base)	Δ AM veh trips (Project-base)	Δ AM Transit trips (Project-base)
5e-4	Highway AM assignment only	-33,360	-14,035	0	N/A
1.E-5	Highway AM assignment only	-56,950	-3,172	0	N/A
1.E-6	Highway AM assignment only	-56,850	-3,179	0	N/A
5e-4	Single loop run of ABM	-18,324	-1,262	+700	+1167
1.E-6	Single loop run of ABM	-28,519	-1,644	+275	+30
5e-4	Full model with feedback	-17,582	-1,214	+658	+1161
1.E-5	Full model with feedback	-33,774	-1,952	+88	+1004
1.E-6	Full model with feedback	-26,197	-1,565	+390	+43

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Congested Travel Time Research

- Model outputs were compared with 3 sources of commercial data
- HERE real time data were harvested for comparisons at the traffic message channel (TMC) level
- INRIX archival link data were used for MAG model comparisons
- Google data were queried for travel times to the CBD and District to district O-D times

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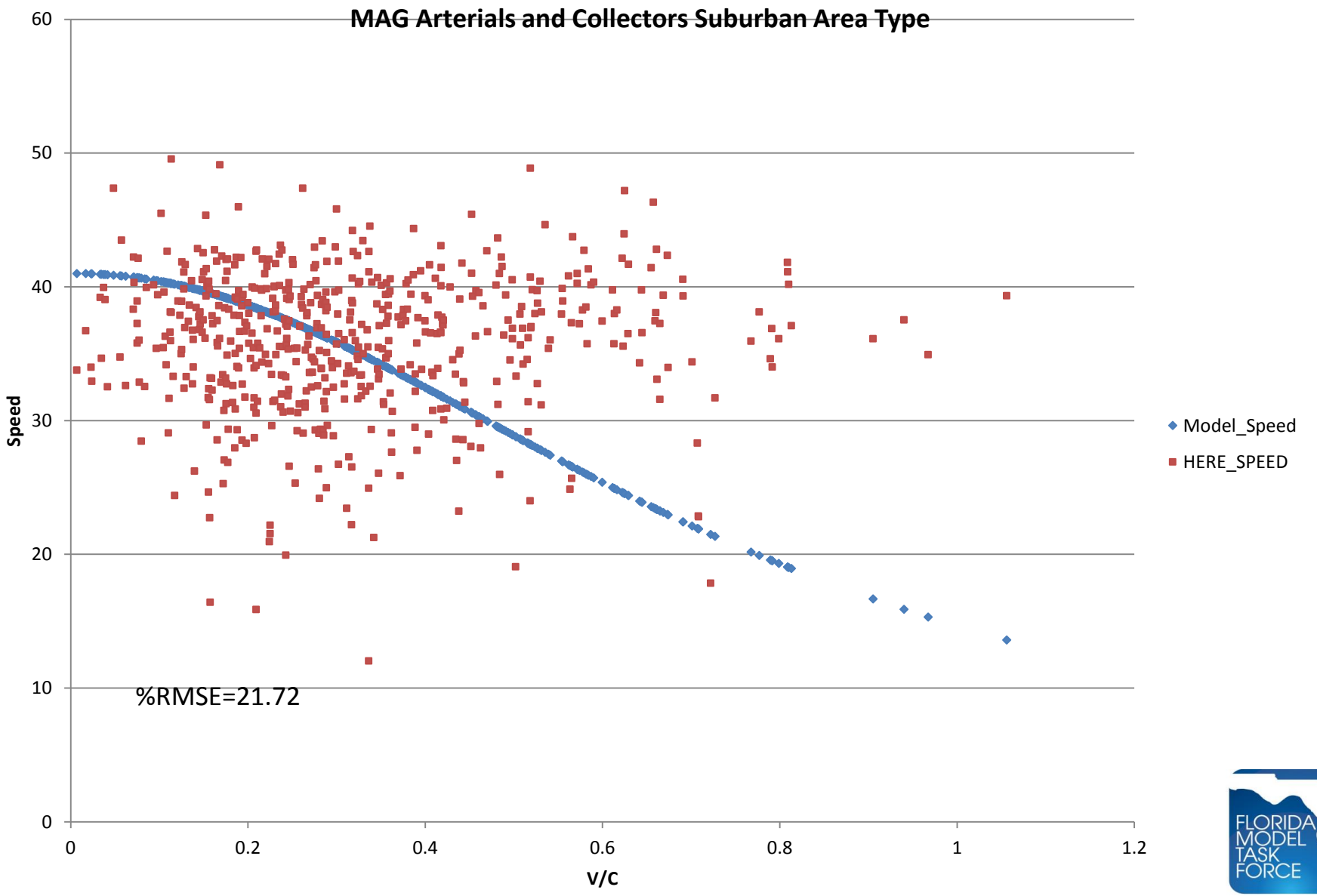
Comparison of MAG model & HERE Speeds



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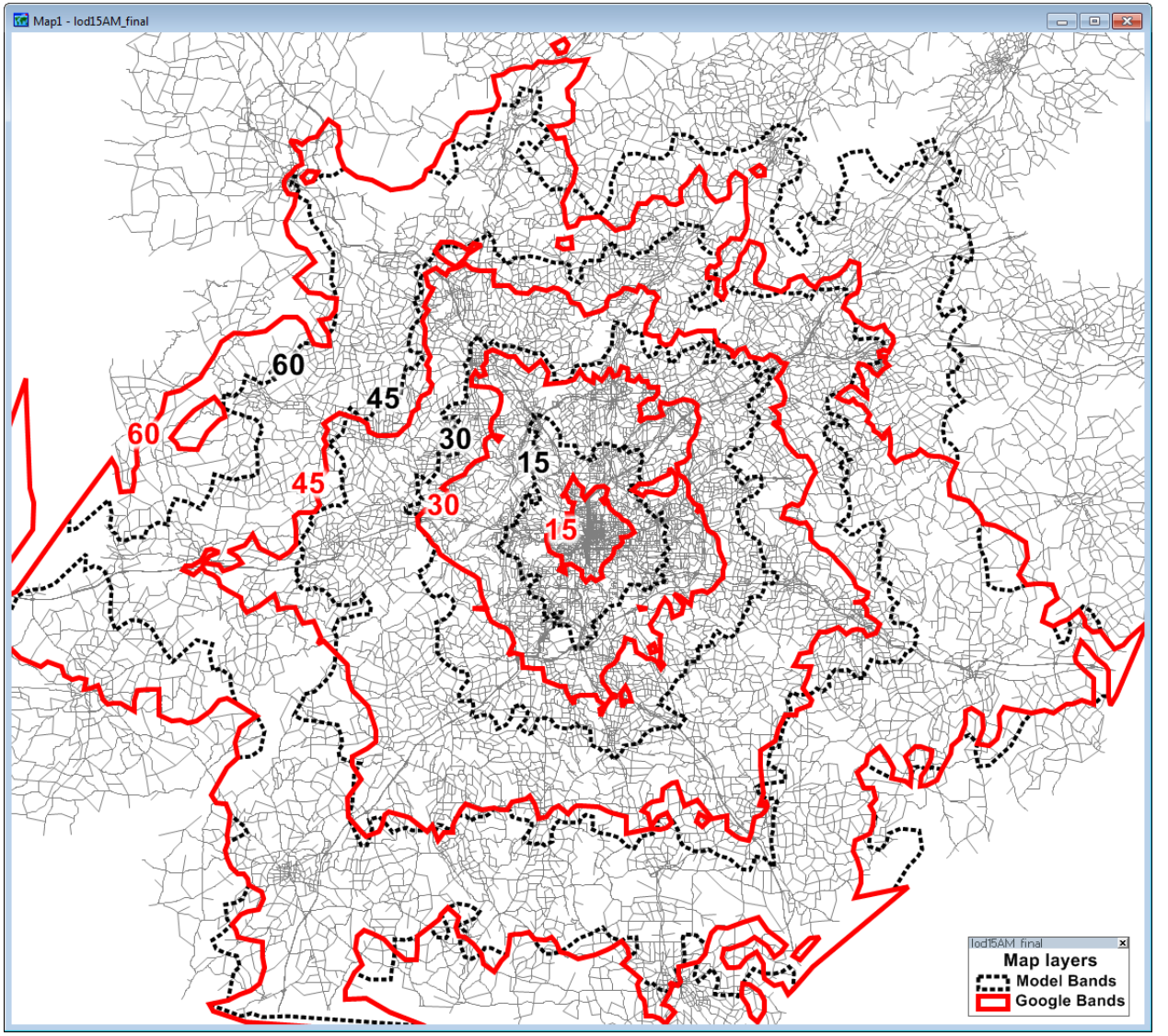
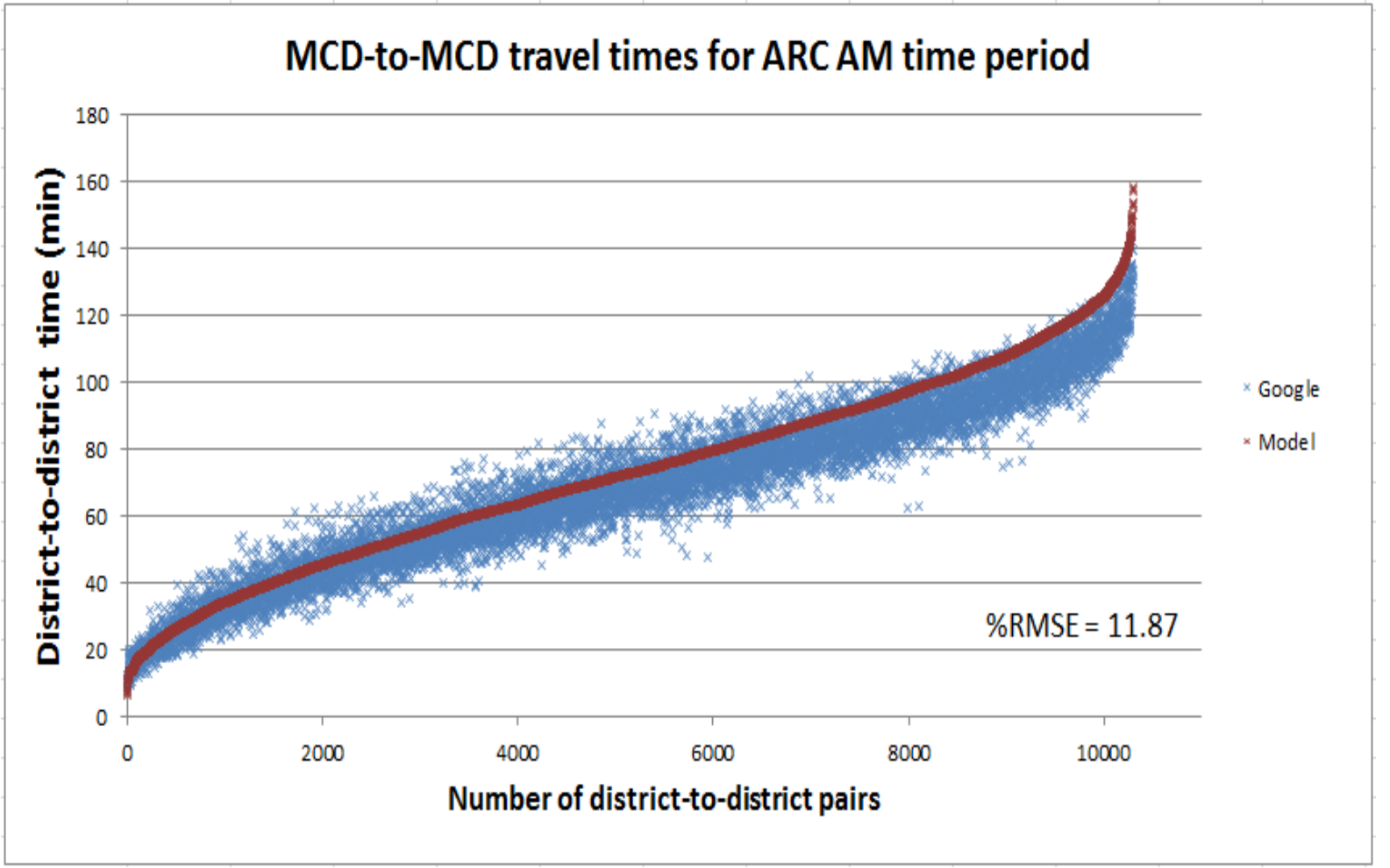
Comparison of ARC and Google Times to the CBD



District to District AM O-D times for ARC



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Congested Travel Time Comparisons

- MPO models do a poor job of matching measured congested travel times from commercial sources
- In general, modeled auto travel times are higher than the those that are measured
- Consequently, VHT tends to be overstated by models
- Performance measurement should not be based on modeled speeds from MPO models

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Some Observations & Conclusions

- MPO models are continuously changing so characterizations are dated as soon as made
- Estimates of project impacts vary significantly with assignment convergence levels
- More convergence is needed, but convergence is, by itself, not enough
- Better practices and better quality control are required
- So are better modeled speeds and better validation
- Existing methods appear to be able to resolve project impacts including the highway impacts of transit projects when properly implemented
- Models need to provide evidence of their efficacy

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For Further Info

The project final report can be downloaded from

http://www.fta.dot.gov/documents/traffic-assignment-and-feedback-research-to-support-improved-travel-forecasting.pdf

or

http://www.caliper.com/PDFs/traffic-assignment-and-feedback-research-to-support-improved-travel-forecasting.pdf

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