

Session 5: Nuts and Bolts

- SACSIM Calibration for Corridors Studies: Case Study Caltrans D3 SR 99 Study: Presenter Donald Hubbard, WSP
- Round Table Discussion SACSIM Calibration and Development
- SACSIM Land Use Processing and Project Performance Assessment Tools and Resources
- Travel Patterns and Equity Analysis using SACSIM for Project Evaluation: Presenter John Gibb, DKS
- Round Table Discussion: Equity, Managed Lanes, and Demographic Analysis
- Next Steps and Ongoing Travel Demand Modeling Enhancements



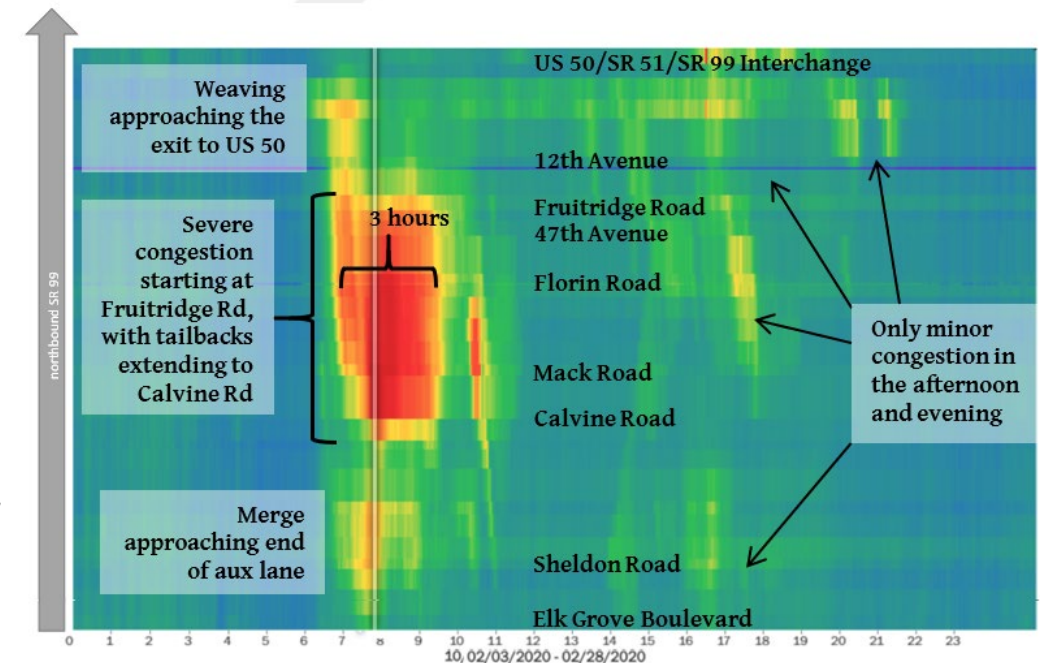
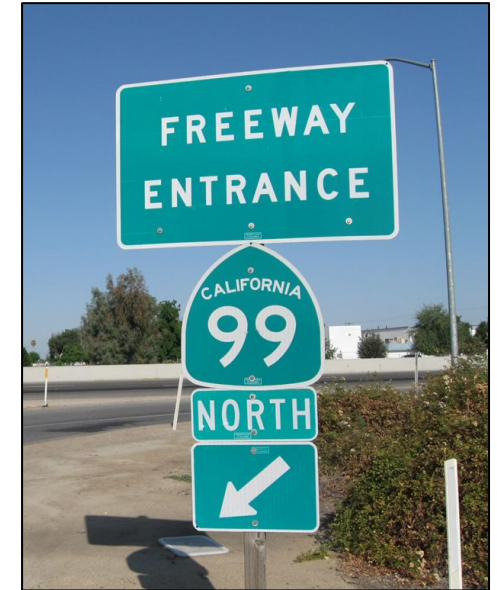
SACSIM19 Calibration for Corridors Studies: Case Study: SR-99/SR-51 Managed Lanes

SACOG Travel Demand Model User Conference March 11,
2021



Topics Covered

- Why Do a Calibration?
- Overview of the Project & Corridor
- Calibration Test and Adjustments
- Dynamic Validation Results



Heat map of Northbound SR-99 just prior to COVID pandemic

Why Do a Corridor-Level Calibration?

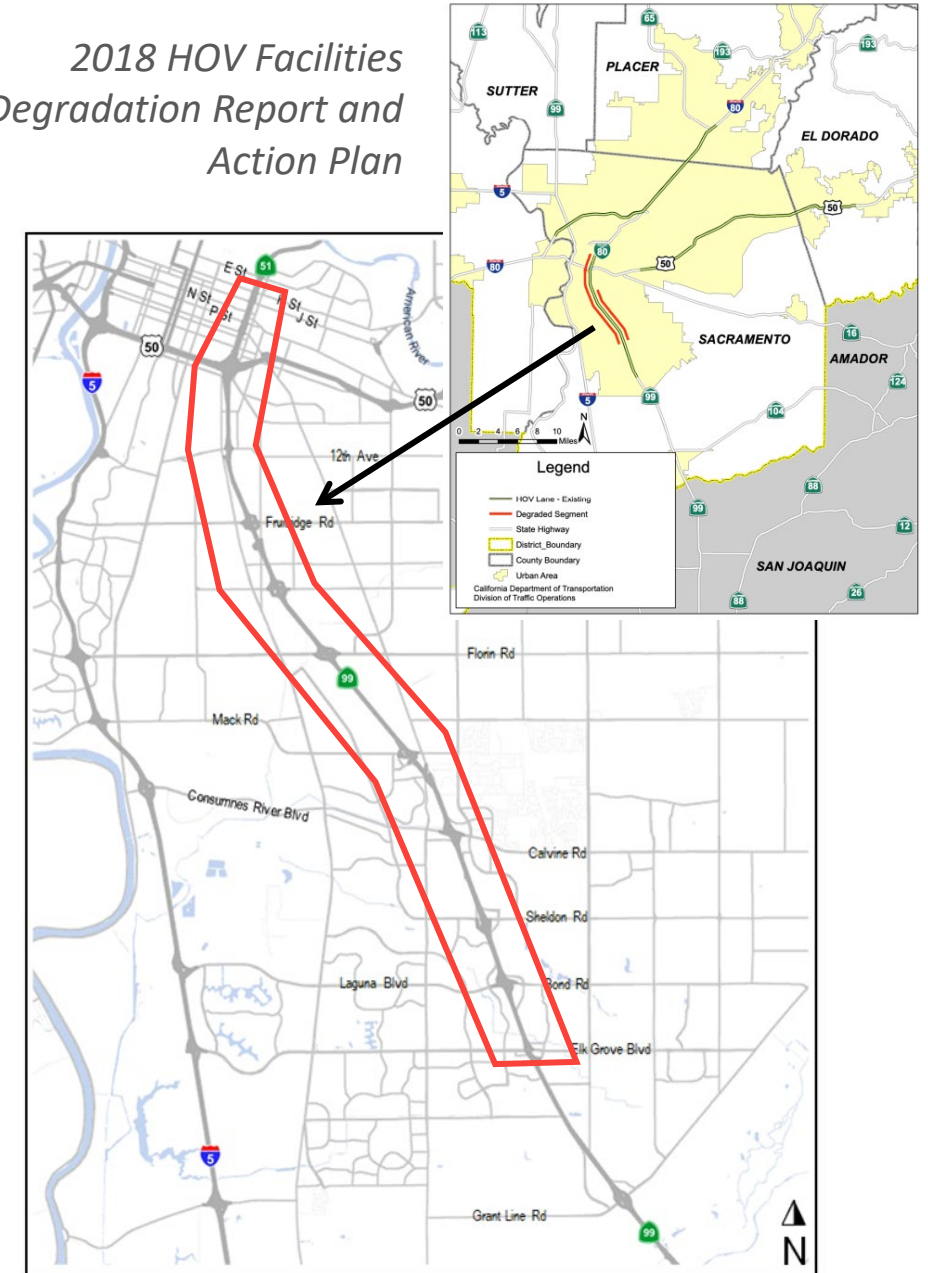
- SACSIM is a 6-county model designed to meet SACOG's modeling needs (air quality conformity, MTP/SCS, etc.)
- SACOG makes it available to other users, but it is the responsibility of the user to determine if it is fit-for-purpose as-is, or needs some adjustment
- Most users are doing something different from SACOG, for example EIRs or design studies. So in most cases, some amount of adjustment will be needed



Project Description

- Task order under Caltrans District 3 Managed Lanes On-Call contract
- Project is to analyze potential managed lanes alternatives for the SR-99/SR-51 Corridor
- SACSIM19 is being used to forecast future demand
- Also using a toll optimization model to post-process the results

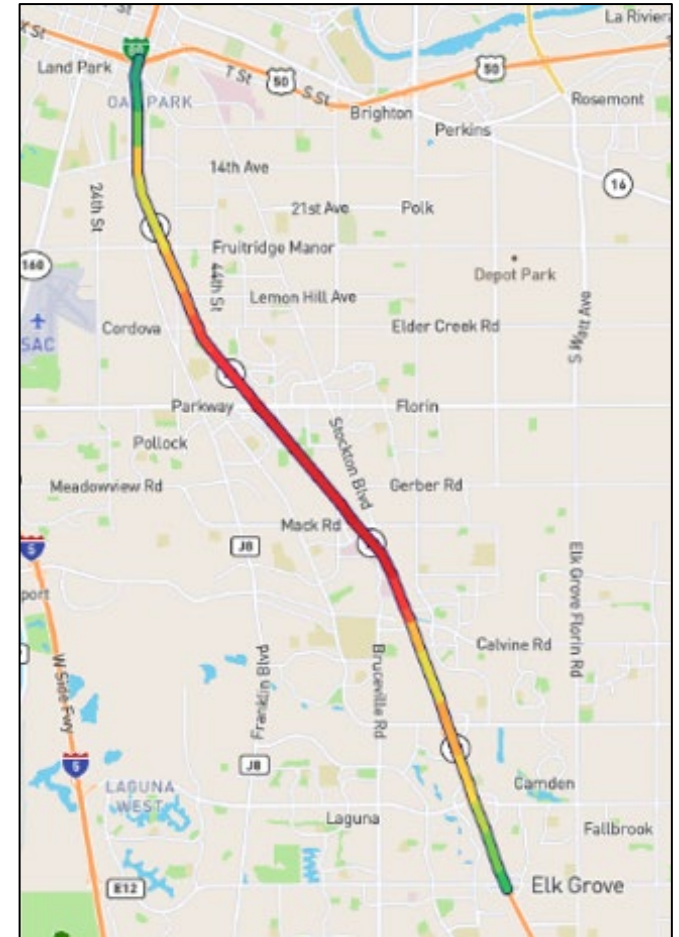
2018 HOV Facilities
Degradation Report and
Action Plan



The Needs for this Particular Study

Because this was a managed-lanes study, we needed accuracy in:

- Peak-Hour and Peak Period Conditions
- Representation of highly congested conditions
- Vehicle classes pertinent to managed lanes (HOV2, HOV3+, trucks, electric vehicles, etc.)
- Speeds relative to competing routes



Congestion Levels on NB SR-99 between Elk Grove Boulevard and US-50 (October 2019)

Calibration Starting Point

SACSIM 19 meets calibration criteria for daily period, but not for AM or Pm peak hour

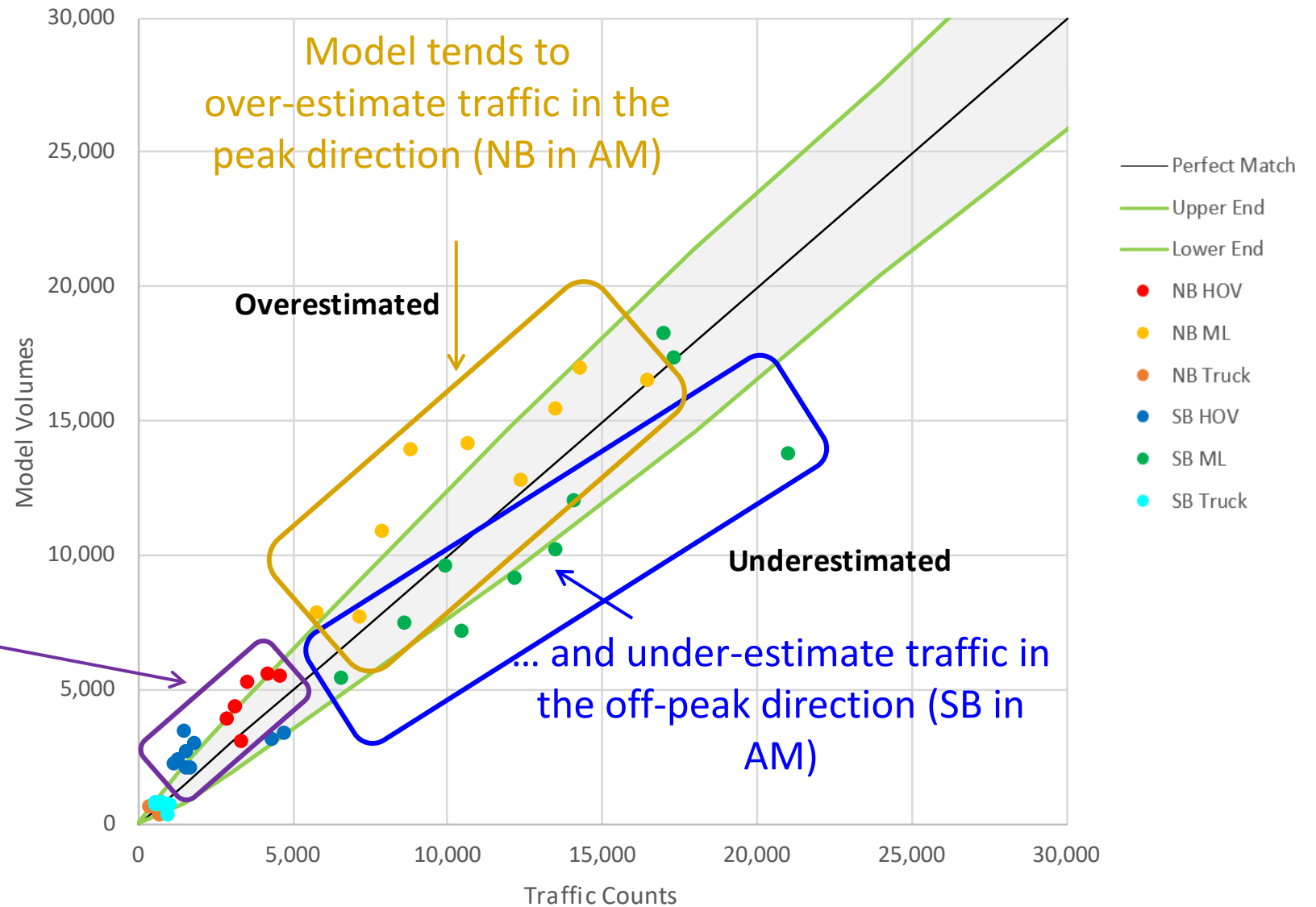
Caltrans Travel
Forecasting
Guidelines, Nov
1992

Criterion	Criterion for Acceptance (daily basis)	Daily	AM Peak Period	PM Peak Period
Model/Count Ratio for Freeways	Within 7%	-1% ✓	+5% ✓	14% ✗
Percent Within Caltrans Maximum Deviation	At Least 75%	86% ✓	59% ✗	61% ✗
Correlation Coefficient	At Least 88%	98% ✓	94% ✓	97% ✓
Percent Root Mean Square Error	Less than 30%	20% ✓	34% ✗	33% ✗
Coefficient of Determination (R^2)	At Least 77%	95% ✓	89% ✓	93% ✓

Volumes in the Study Corridor (AM Peak)

Found 3 separate problems, each requiring a different solution

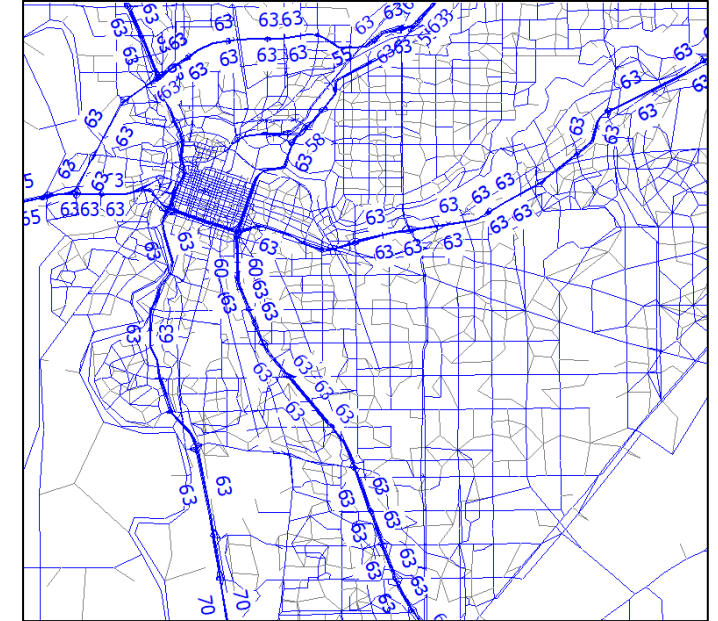
Also tends to over-estimate traffic in the HOV lanes



Under-Estimate of Off-Peak Traffic

In uncongested conditions, SACSIM under-estimates traffic on freeways. Solutions:

- Increase free-flow speed on SR-99
- Reduce speeds on parallel arterials



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Nighttime (free flow) Speeds

ID	Facility	Segment	Distance (mi)	INRIX		SACSIM Base	
				SB	NB	SB	NB
1	SR 99	Elk Grove to US 50	11.78	69	67	58	59
12	SR 51	US 50 to Cal Expo	3.42	65	67	56	56
17	I-5	Elk Grove Blvd to US 50	11.97	63	68	61	60
21	Franklin Blvd	Elk Grove Blvd to 12th	9.41	34	32	37	37
22	Stockton Blvd	Mack Road to Alhambra Blvd	6.91	29	29	33	33

Uncongested speeds on SR-99
are too low

Uncongested speeds on arterial
are too high

Over-Estimate of Peak-Direction Traffic

SACSIM over-estimates traffic on freeways in congested conditions.
Solution: Adjust the volume/delay function

$$T_c = T_0 * \min\{([\text{conical congestion function in original model}] + 3.5 * \max(0, V/C - 0.8)), \max(T_c)\}$$

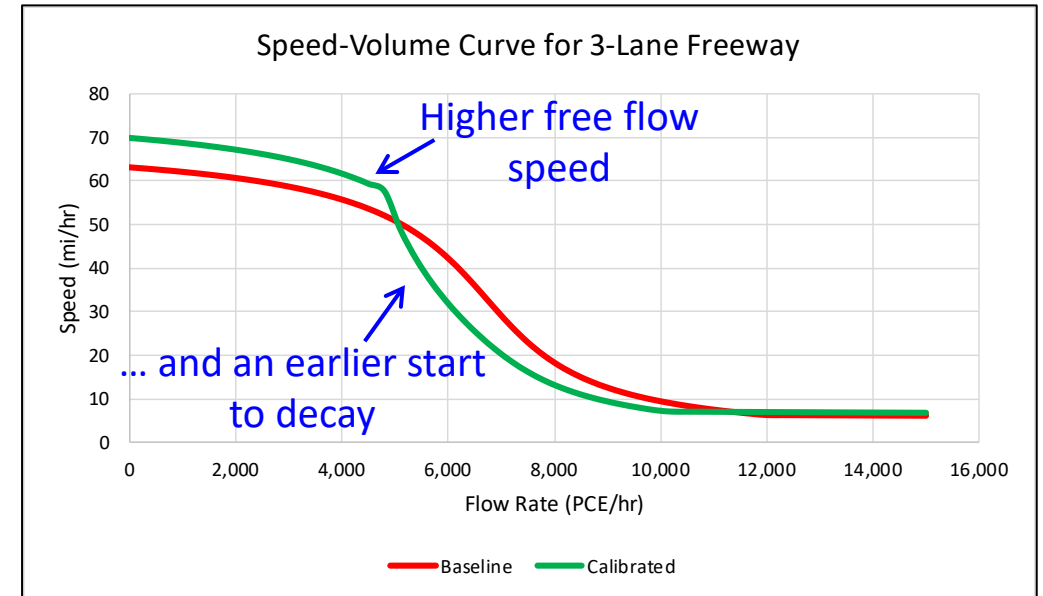
Where:

T_c = congested travel time

T_0 = “free flow” travel time

$\max(T_c)$ = ceiling value

3.5 is a parameter set through experimentation.



Percentage of HOVs

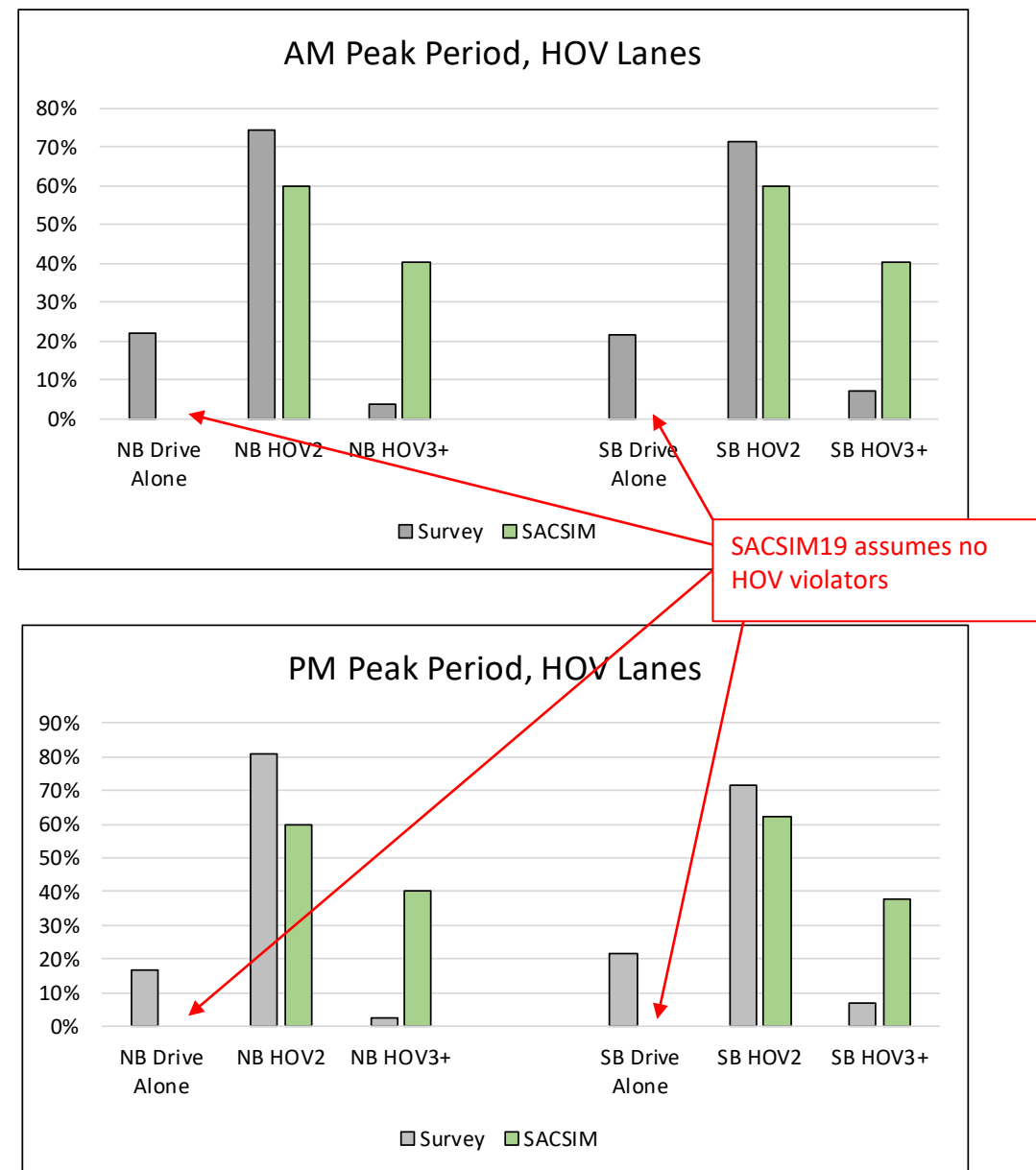
- SACSIM19 seriously over-estimates HOV3+ in the SR-99 corridor
- If left uncorrected, this could distort our analyses of vehicle occupancy policies

Vehicle Occupancy	All Lanes			
	AM Peak Period		PM Peak Period	
	Survey	SACSIM	Survey	SACSIM
NB Drive Alone	77%	73%	80%	76%
NB HOV2	22%	16%	19%	14%
NB HOV3+	1%	11%	1%	9%
SB Drive Alone	85%	76%	75%	72%
SB HOV2	13%	14%	23%	17%
SB HOV3+	1%	9%	2%	10%

- Corrected by factoring down HOV3+ trip table while factoring up HOV2s and SOVs to maintain the vehicle control total

HOV Violators

- Previous versions of SACSIM had a mechanism that allowed for some HOV violators; SACSIM19 does not
- This distorts the forecast of traffic in the HOV lane and hampers our ability to assess the value of better enforcement
- Can be corrected through post-processing



Check of Truck Percentages

SACSIM 3-axle truck percentages are close

A little low
at the north
end

At Turnbridge Overcrossing (between Florin & 47th)

Period	NB		SB		Two-Way	
	PeMS	SACSIM	PeMS	SACSIM	PeMS	SACSIM
Daily	6%	4%	6%	4%	6%	4%
AM Peak Period	5%	3%	6%	6%	5%	4%
PM Peak Period	4%	2%	3%	1%	4%	2%

A little high
at the south
end

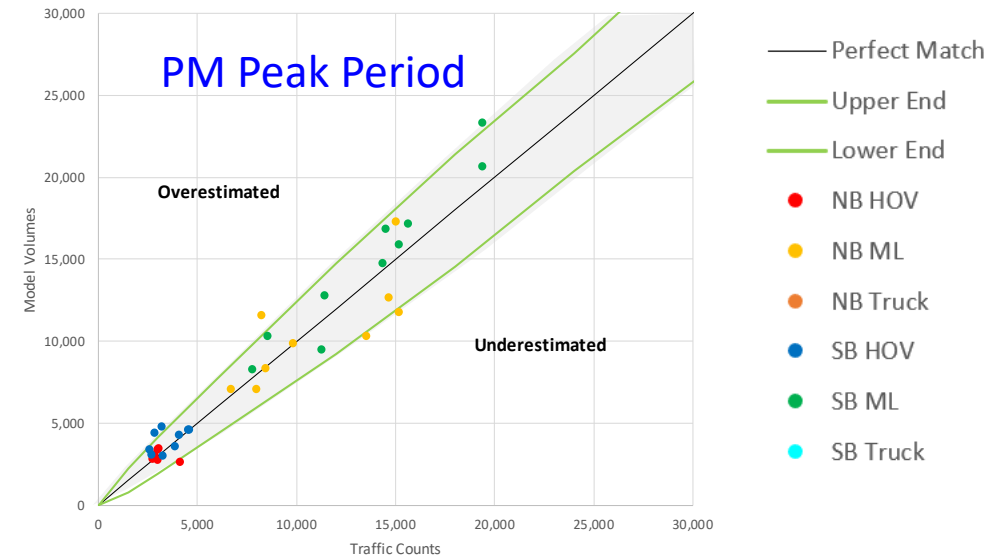
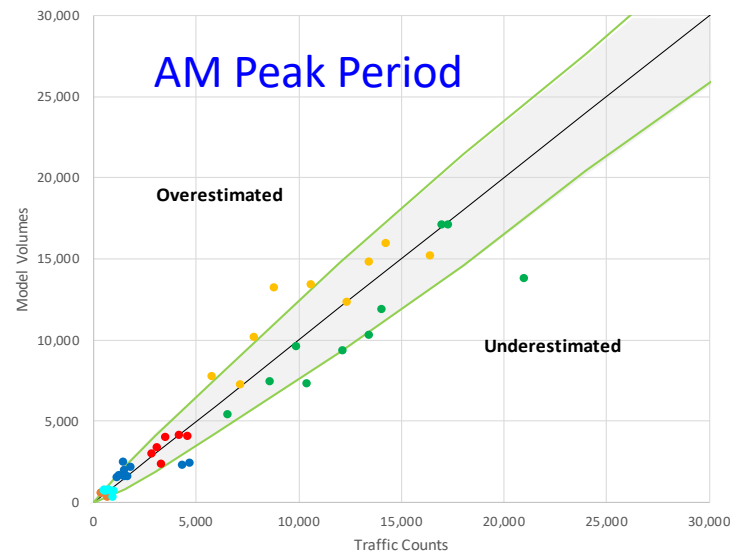
At Calvine Road

Period	NB		SB		Two-Way	
	PeMS	SACSIM	PeMS	SACSIM	PeMS	SACSIM
Daily	4%	6%	4%	7%	5%	6%
AM Peak Period	3%	5%	4%	9%	5%	6%
PM Peak Period	3%	3%	2%	3%	4%	3%

Calibration Results

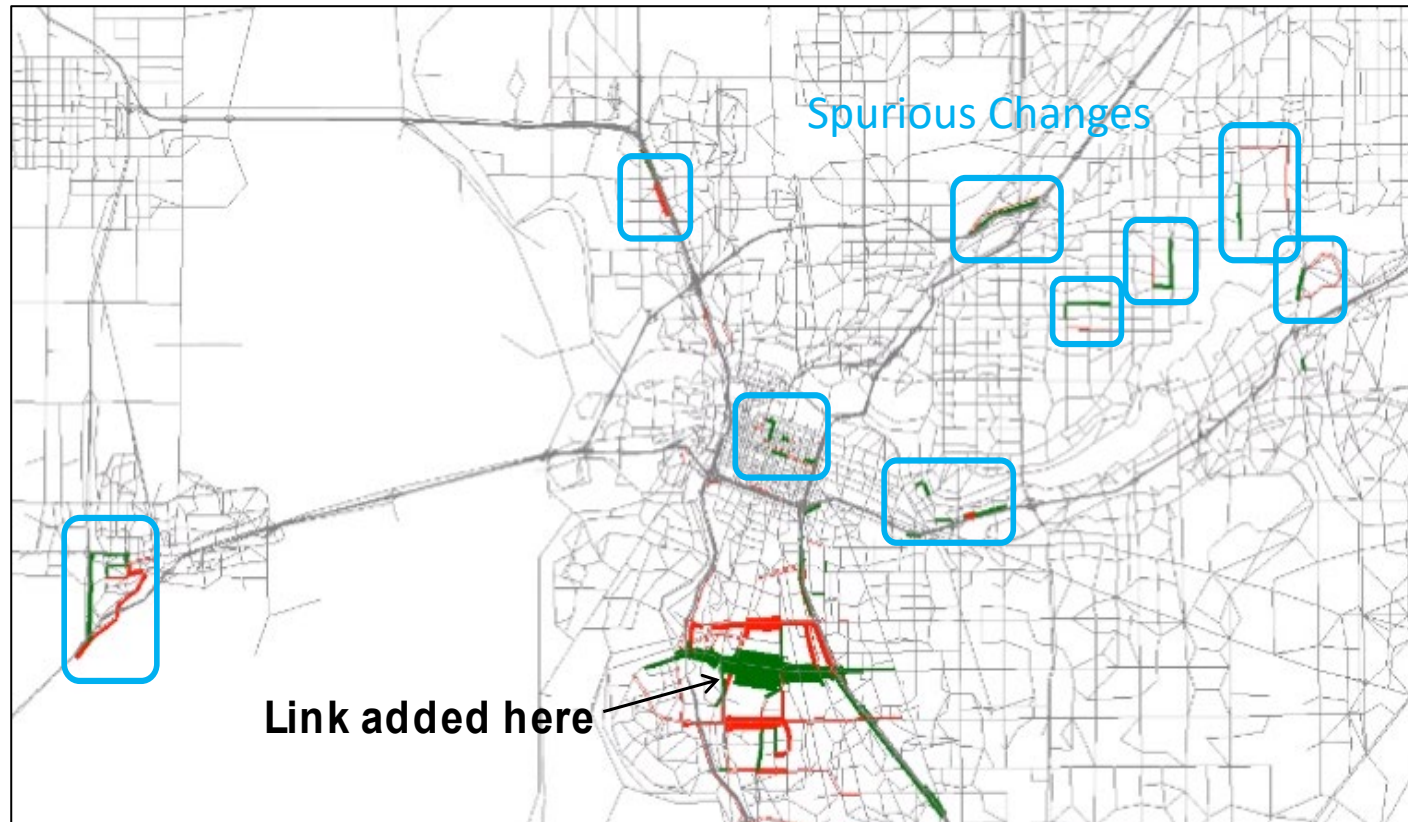
All acceptance criteria met for all time periods

Criterion	Criterion for Acceptance	Daily		AM Peak Period		PM Peak Period	
		Original	Focused	Original	Focused	Original	Focused
Model/ Count Ratio for Freeways	Within 7%	-1% ✓	-4% ✓	+5% ✓	0% ✓	+14% ✗	+7% ✓
Percent Within Caltrans Maximum Deviation	At Least 75%	86% ✓	92% ✓	59% ✗	76% ✓	61% ✗	84% ✓
Correlation Coefficient	At Least 88%	98% ✓	99% ✓	94% ✓	95% ✓	97% ✓	98% ✓
Percent Root Mean Square Error	Less than 40%	20% ✓	17% ✓	34% ✓	30% ✓	33% ✓	24% ✓
Coefficient of Determination (R^2)	At Least 77%	95% ✓	96% ✓	89% ✓	91% ✓	93% ✓	96% ✓

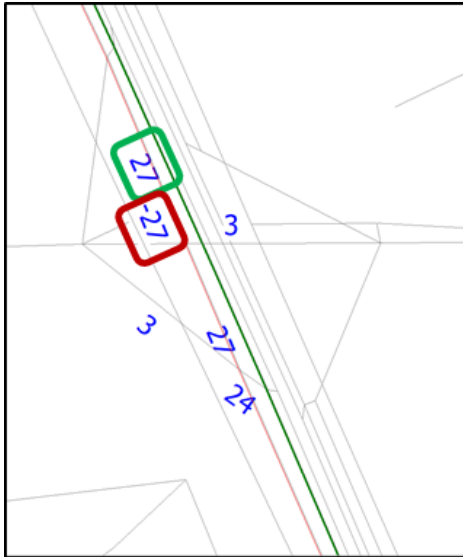


Dynamic Validation

Test to see if the model responds appropriately to changes in inputs



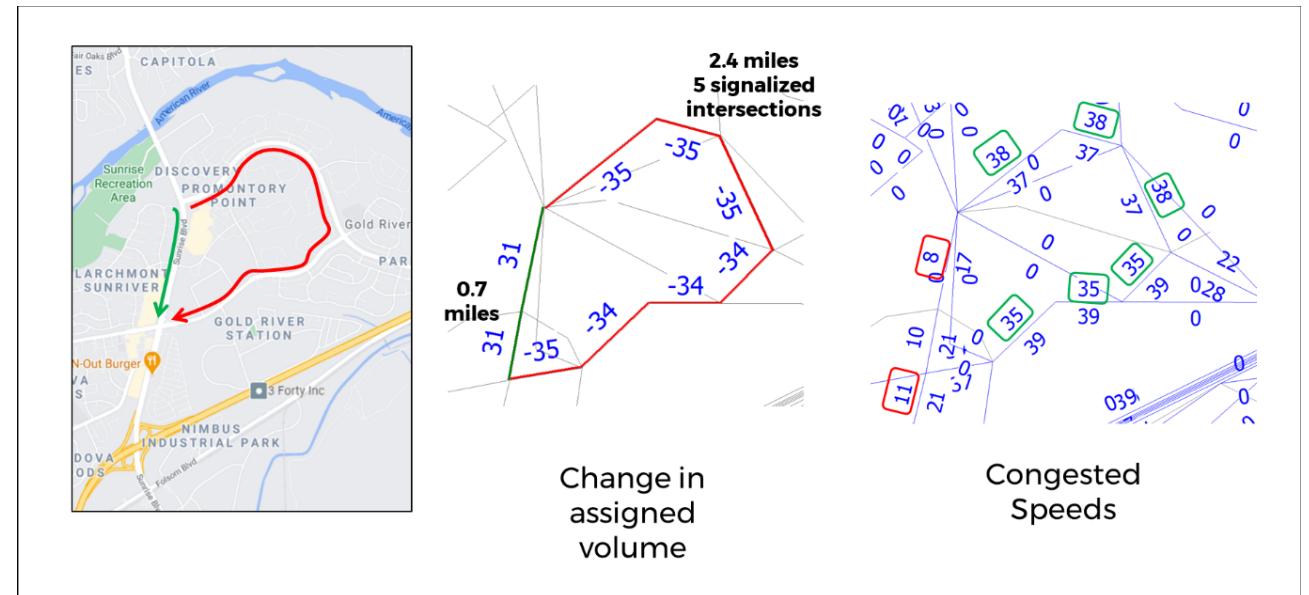
Dynamic Validation



Traffic switches between GP and aux lanes.
Inconsequential because does not affect routing or regional VMT.

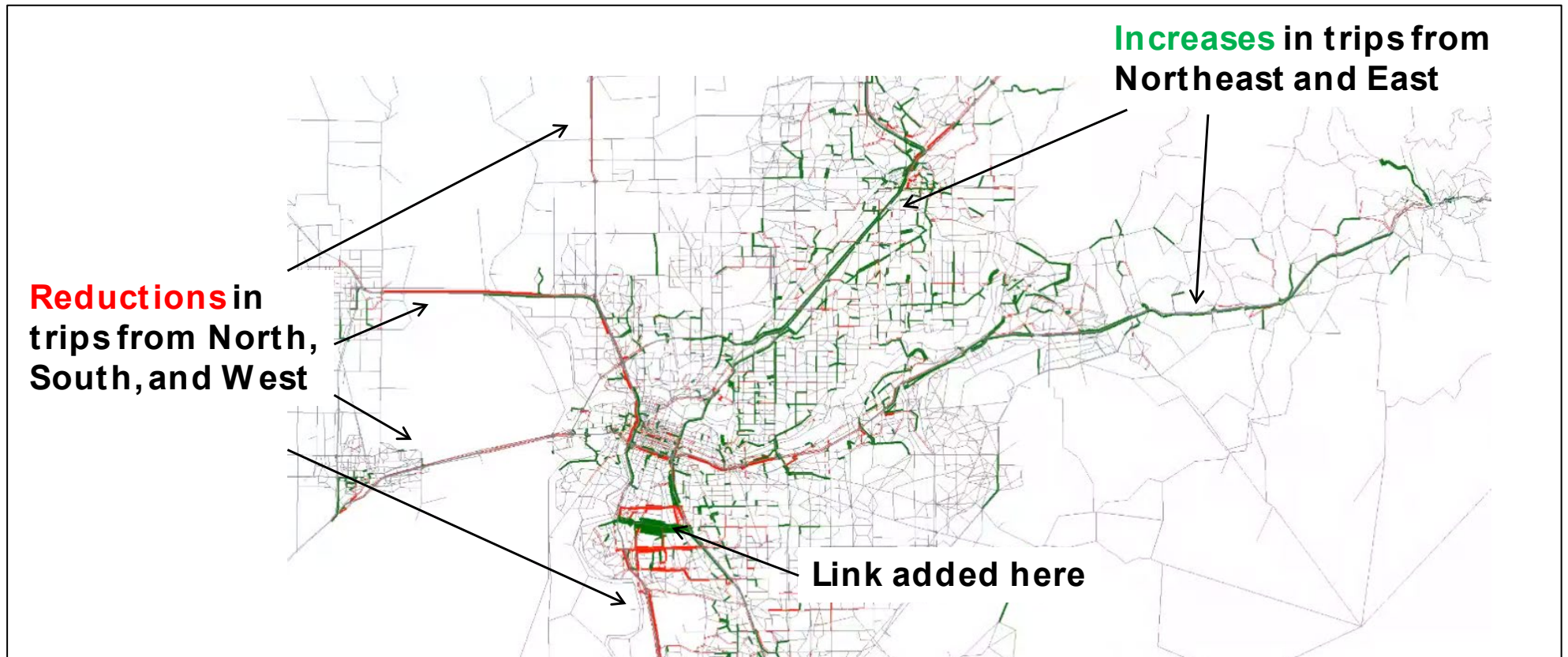
Traffic switches roads. Could be consequential depending on what is being studied. Will affect regional VMT.

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Dynamic Validation - Full Model Run

Doing a full model run rather than assignment-only **greatly** increases the spurious changes because they then include changes to the O-D matrix



Conclusions

- Most users should do a calibration prior to using SACSIM19, or any regional model, for a corridor-level study
- The factors that need to be checked and possibly adjusted depend on the project
- SACSIM19 is good enough “off the shelf” that relatively small adjustments should suffice
- Be very cautious about doing full model runs for VMT analysis

Detailed characteristics of travelers of selected roadways

DKS Associates

March 2021



Volume-components assignment

- It's possible to do parallel-trace assignments on a limited number of categories.



Characteristics of the Daysim trips

Assignment knows...	Assignment doesn't know...
• OTAZ • DTAZ • Period • Mode (occupancy) • Value-of-time class	• Whether from Daysim or auxiliary • If from Daysim... - Activity purpose - Person - Age - Employment - Household - Income - Others...

Problem: How to get the trip characteristics that assignment doesn't know?

Select-link assignment estimates probability of link use

- Prob(i,j,p,m,v uses select link)
$$= \frac{\text{select link veh trips}(i,j,p,m,v)}{\text{all veh trips}(i,j,p,m,v)}$$
- Depends on
 - Origin and destination (i,j)
 - Assignment period of day (p)
 - Mode (m , i.e. occupancy 1, 2, 3+)
 - Value-of-time class (v)
- Independent of other attributes, or whether Daysim or submodel

Probability of link use

- Some have used group-average approximations

e.g.
$$\frac{\sum_{p,m,v} \text{select link veh trips}(i,j,p,m,v)}{\sum_{p,m,v} \text{all veh trips}(i,j,p,m,v)}$$

- May be a fair approximation if no tolls or managed lanes, or where income or v.o.t. not distinguished

Caveat:

- Equilibrium link flows are unique, but path choices are not, so select-link and component flows are not fully determined.
- The assignment's multi-iteration average is still a fair approximation of proportional flows.
- Expect some random differences when comparing scenarios.
(These arise from assignment, not inputs.)

Select-link assignments

i	j	period	name	DA1_vol	S21_vol	S31_vol	...(12 cols)	DA1_sl1	S21_sl1	S31_sl1	...(12 cols)	DA1_sl2	S21_sl2	S31_sl2	...(12 cols)
1	285	3 h09		1.55	0.82	0.32		1.55	0.82	0.32		0	0	0	
2	82	3 h09		0.01	0	0		0	0	0		0	0	0	
2	83	3 h09		0.01	0	0		0	0	0		0	0	0	
2	86	3 h09		0.01	0	0		0	0	0		0	0	0	
2	88	3 h09		0.02	0	0		0	0	0		0	0	0	
2	113	3 h09		0.01	0	0		0	0	0		0	0	0	

A record for each combination (having trips) of

- Origin TAZ
- Destination TAZ
- Period
- Occupancy
- Value-of-time class

Trip file from Daysim

Blue = known
in assignment
(at least
categorically)

Red =
Recomputed

Variable	Definition	Type	Import	Export
ID	internal Daysim record ID	ID	Added by Dasyim	As is
TOUR_ID	internal Daysim record ID	ID	Added by Dasyim	As is
HHNO	Household id	ID	Yes	As is
PNO	person seq no on file	ID	Yes	As is
DAY	Diary / simulation day ID	ID	Yes	As is
TOUR	tour id	ID	Yes	As is
HALF	tour half	ID	Yes	As is
TSEG	trip seggment no within half tour	ID	Yes	As is
TSVID	original survey trip id no.	ID	Yes	As is
OPURP	trip origin purpose	Categorical	Yes	As is, set in models
DPURP	trip dest purpose	Categorical	Yes	As is, set in models
OADTYP	trip origin address type	Categorical	Yes	As is, set in models
DADTYP	trip destination address type	Categorical	Yes	As is, set in models
OPCL	trip origin parcel	ID	Yes	As is, set in models
OTAZ	trip origin zone	ID	No	Use parcel corresp.
DPCL	trip dests parcel	ID	Yes	As is, set in models
DTAZ	trip dest zone	ID	No	Use parcel corresp.
MODE	trip mode	Categorical	Yes	As is, set in models
PATHTYPE	transit submode	Categorical	Yes	As is, set in models
DORP	trip driver or passenger	Categorical	Yes	As is, set in models
DEPTM	trip departure time (min)	0000-1439	Yes- convert	Set in models, reconvert
ARRTM	trip arrival time (min)	0000-1439	Yes- convert	Set in models, reconvert
ENDACTTM	trip dest activity end time	0000-1439	Yes- convert	Set in models, reconvert
TRAVTIME	network travel time (min)	Continuous	No	From skim matrices
TRAVCOST	network travel time (min)	Continuous	No	From skim matrices
TRAVDIST	network travel distance (miles)	Continuous	No	From skim matrices
VOT	trip value of time (cents/minute)	Continuous	Added by Dasyim	From distribution
TREXPFAC	trip expansion factor	Continuous	Yes/recompute**	As is
TREXPFAC	Recomputed to portion of period	Continuous	Duplicate to split among multiple periods	
PERIOD	Assignment time period (h07, h08, etc.)	Categorical		
VEHTRIPS	Computed from MODE	Continuous	Split TREXPFAC * (DA=1, S2=0.5, S3=0.3)	

Trip-list with assignment labels

A few of the trip file records,
Selected fields shown

tour_id	mode	deptm	arrrtm	vot	votclass	period	trexpfac	vehtrips	Clock times	
1561	4	530	536	6.96	1	2	1	0.5	8:50-8:56	
1561	1	927	938	4.28	1	5	1	0	15:27-15:38	
1561	4	957	961	6.96	1	5	0.75	0.375	15:57-16:01	
1561	4	957	961	6.96	1	6	0.25	0.125	15:57-16:01	
1951	3	1065	1068	4.5	1	7	1	1	17:45-17:48	

- VOTclass 1-3 from VOT
- Period: duplicate record for each (*1=h07, 2=h08, etc.*)
- Trexpfac split among periods
- Vehtrips computed from mode and TrExpFac
- Adapted from trip processing already in Sacsim

Individual link users

$$= \left\{ \begin{array}{l} \text{triplist.vehtrips} \\ \text{or triplist.trexpfac} \end{array} \right\} * \text{Prob}(i,j,p,m,v \text{ uses select link})$$

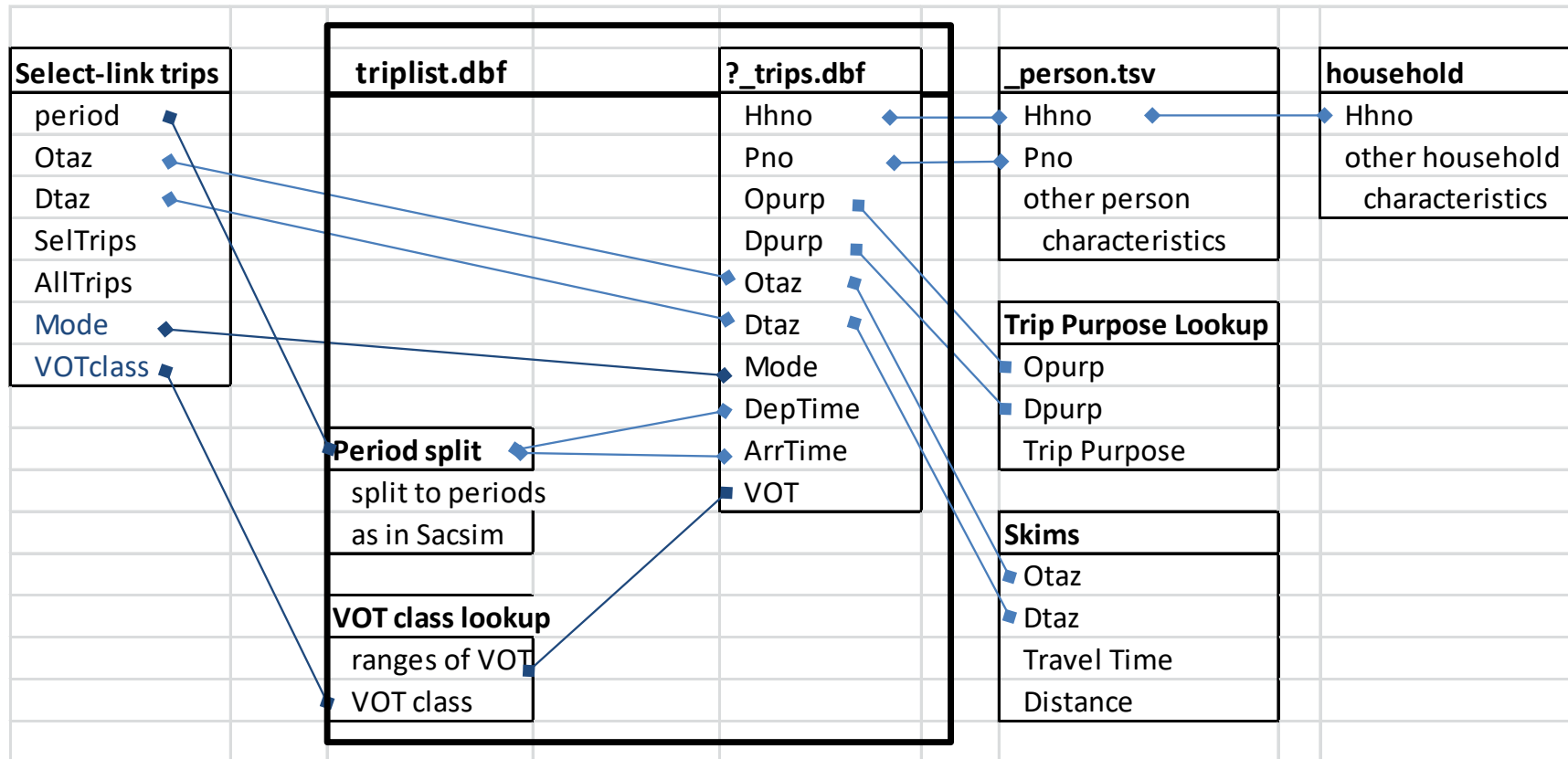
$$= \left\{ \begin{array}{l} \text{triplist.vehtrips} \\ \text{or triplist.trexpfac} \end{array} \right\} * \frac{\text{select link veh trips}(i,j,p,m,v)}{\text{all veh trips}(i,j,p,m,v)}$$

where i = otaz, j = dtaz, p = period,

m = mode, v = votclass

- Choose trexpfac for person-users, vehtrips for vehicle-trips or drivers
- Daysim trips using link can be summarized on any attribute in the trip-list, or related to it.

Table relations for select-link auto trips to traveler characteristics



*Triplist.dbf or .csv assembled in a Voyager script;
Mike Mauch applied the other relations in Matlab.*

Table 11: Traveler Trip Origin and Destination Type

Trip End	Northbound				Southbound			
	Origin		Destination		Origin		Destination	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Home	9,720	35.9%	13,645	50.4%	13,760	49.4%	9,321	33.5%
Usual Workplace	4,089	15.1%	6,732	24.9%	7,021	25.2%	4,515	16.2%
Usual School	946	3.5%	905	3.3%	1,086	3.9%	963	3.5%
Other	12,331	45.5%	5,803	21.4%	5,992	21.5%	13,060	46.9%
Total	27,085	100%	27,085	100%	27,859	100%	27,859	100%
Note: The data is for I-5 between the SR-99 and Airport interchanges. Source: SACSIM base year 2016 travel demand model								

Table 12: Travelers by Age

Age	Northbound		Southbound	
	Number	Percent	Number	Percent
< 4 years	857	3.2%	862	3.1%
5 to 14 years	1,380	5.1%	1,356	4.9%
15 to 17 years	448	1.7%	455	1.6%
18 to 24 years	2,726	10.1%	2,907	10.4%
25 to 34 years	4,925	18.2%	5,101	18.3%
35 to 64 years	14,223	52.5%	14,648	52.6%
> 65 years	2,525	9.3%	2,530	9.08%
Total	27,085	100%	27,859	100%

Note: The data is for I-5 between the SR-99 and Airport interchanges.

Source: SACSIM base year 2016 travel demand model

Table 13: Travelers by Employment Status

Employment Status	Northbound		Southbound	
	Number	Percent	Number	Percent
Full time worker	13,732	50.7%	14,169	50.9%
Part time worker	1,726	6.4%	1,773	6.4%
Non-working adult age 65+	2,478	9.1%	2,481	8.9%
Non-working adult age < 65	4,438	16.4%	4,520	16.2%
University student	1,986	7.3%	2,208	7.9%
High school student age 16+	362	1.3%	367	1.3%
Child age 5-15 years	1,506	5.6%	1,479	5.3%
Child age 0-4 years	857	3.2%	862	3.1%
Total	27,085	100%	27,859	100%

Note: The data is for I-5 between the SR-99 and Airport interchanges.

Source: SACSIM base year 2016 travel demand model

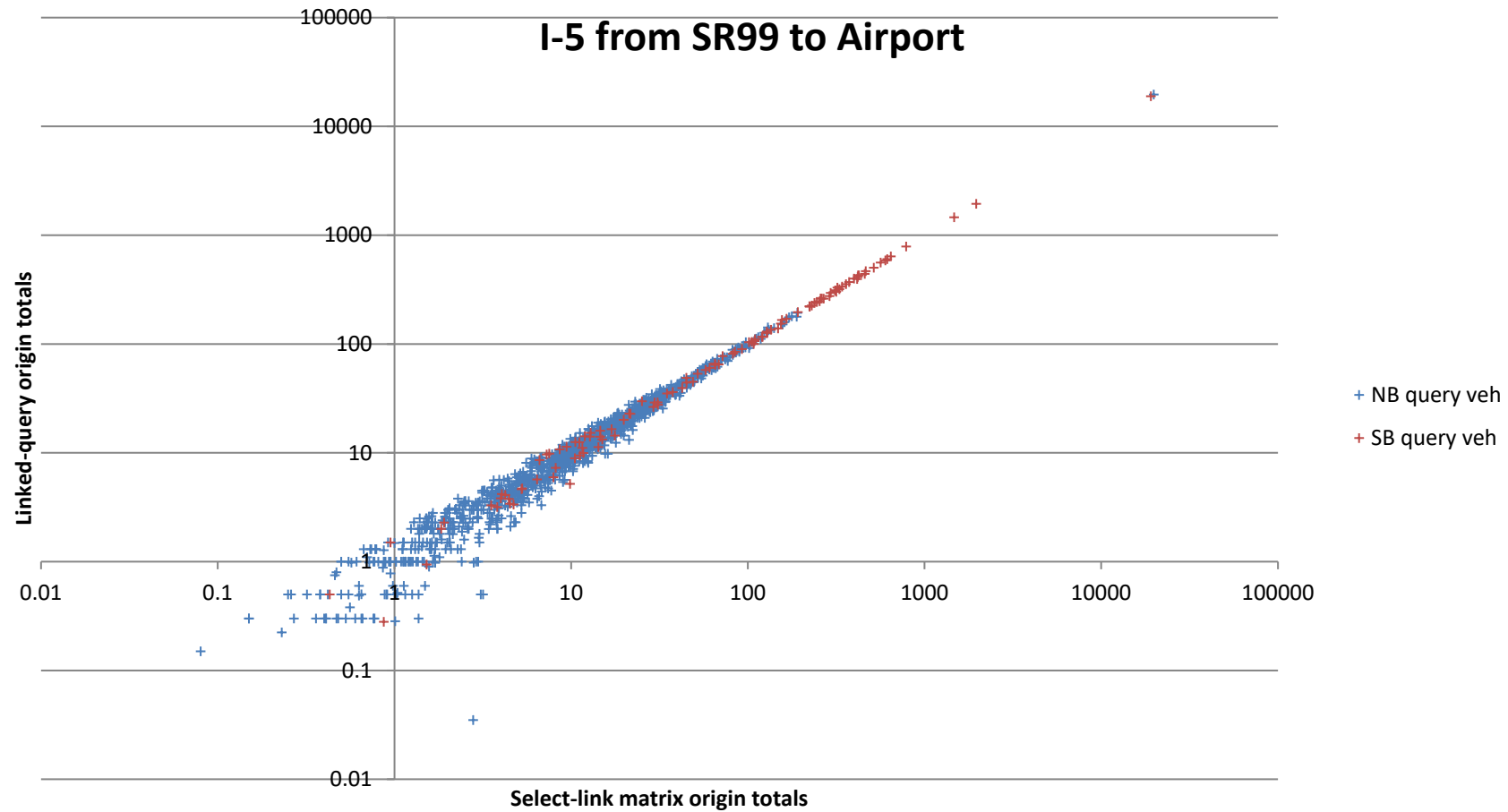
Table 14: Travelers by Income

Income	Northbound		Southbound	
	Number	Percent	Number	Percent
\$0 to \$20,000	3,282	12.1%	3,378	12.1%
\$20,000 to \$40,000	5,287	19.5%	5,403	19.4%
\$40,000 to \$80,000	9,796	36.2%	10,053	36.1%
\$80,000 to \$100,000	2,423	8.9%	2,537	9.1%
≥ \$100,000	6,297	23.2%	6,487	23.3%
Total	27,085	100%	27,859	100%

Note: The data is for I-5 between the SR-99 and Airport interchanges.

Source: SACSIM base year 2016 travel demand model

“Audit-check” of common term of linkage



Project Performance Assessment (PPA) Tool

- Questions?
- Tool home page:
 - <https://www.sacog.org/project-performance-assessment>
- Contact:
 - Darren Conly – dconly@sacog.org

SACOG GitHub Now Available

- Platform for sharing source code for travel model and other SACOG data tools
- Goals:
 - Transparency
 - Share code that others can use/repurpose
 - Provide forum for feedback and comments
- <https://github.com/SACOG>