

California Statewide Freight Forecasting Model

Updates and Enhancements

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FEHR  PEERS

What is the CSFFM?

California Statewide Freight Forecasting Model

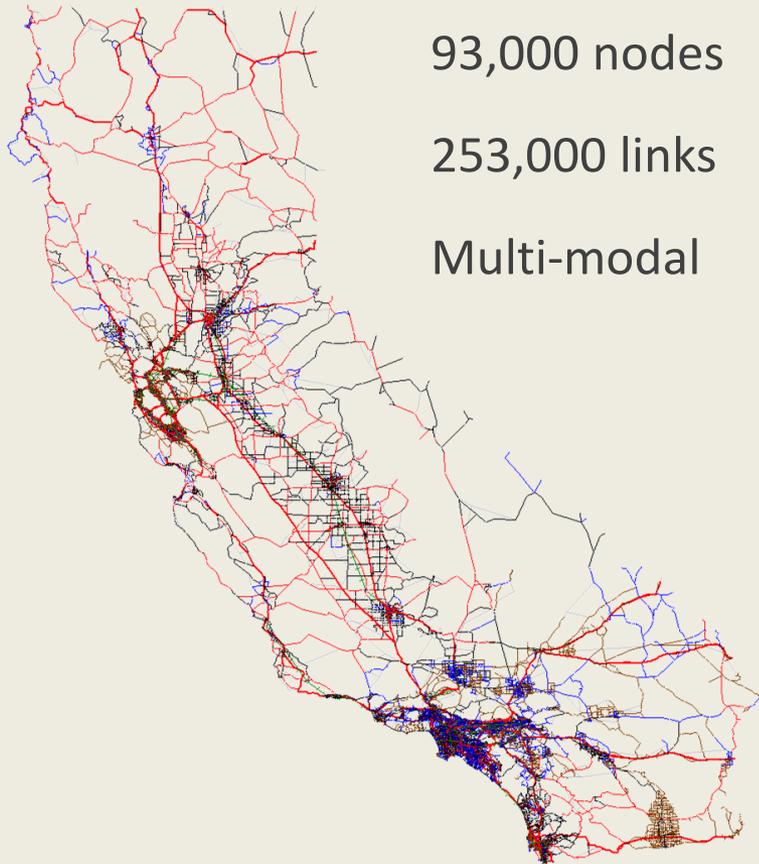
A commodity-based model

Forecasts the **flow of commodities by mode** as a function of **employment, establishment, land use variables** based on **disaggregated FAF zones**, and applied on **integrated CSTDM and FAF transportation network**.

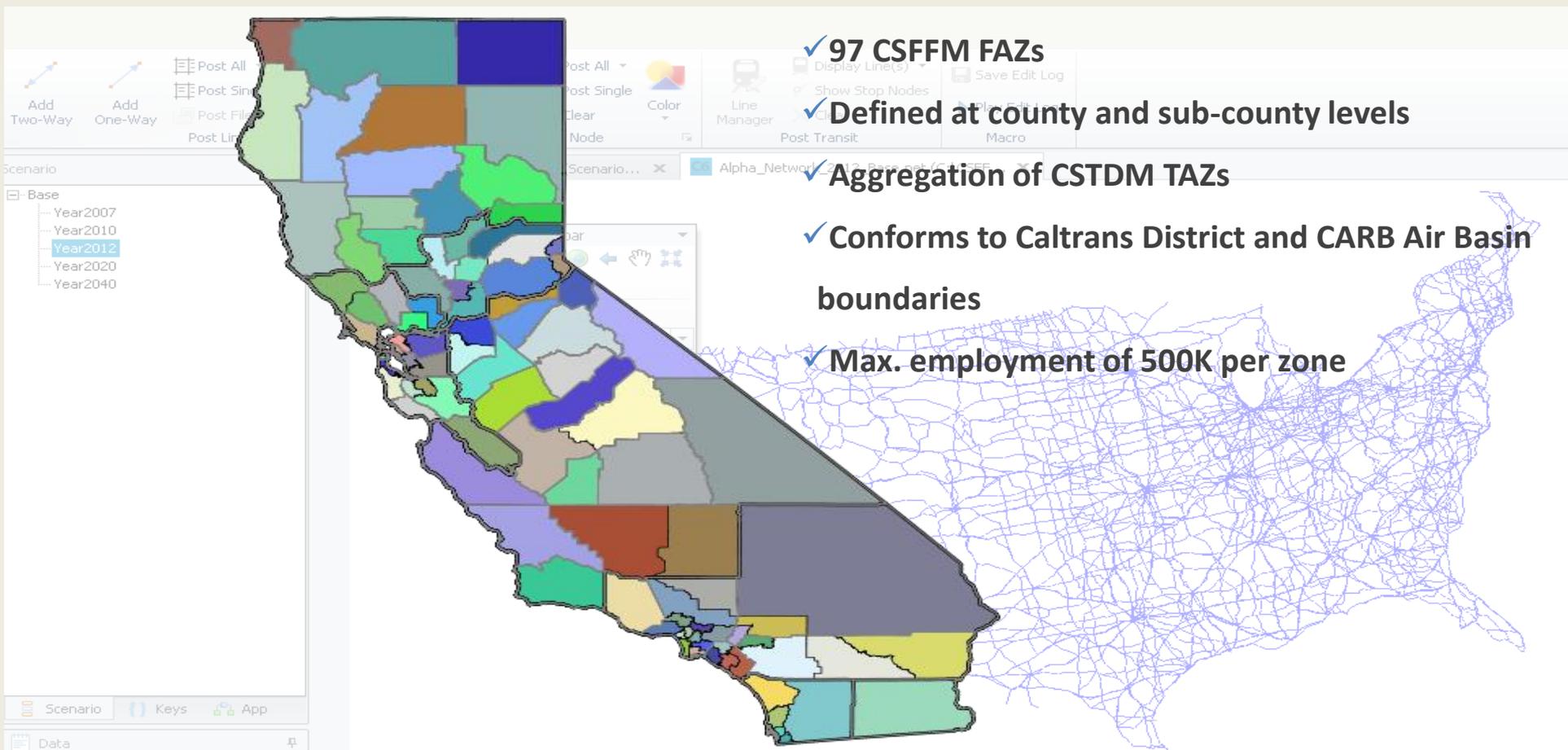
Based on the **FAF 4.4** database, with base year **2015**

CSFFM Commodity Group	CSFFM Commodity Group
G1 Agriculture products	G10 Nonmetal mineral products
G2 Wood, printed products	G11 Metal manufactured products
G4 Fuel and oil products	G12 Waste material
G5 Gravel/ sand and non metallic minerals	G13 Electronics
G7 Food, beverage, tobacco products	G14 Transportation equipment
G8 Manufactured products	G15 Logs
G9 Chemical/ pharmaceutical products	G3 Crude petroleum G6 Coal / metallic minerals

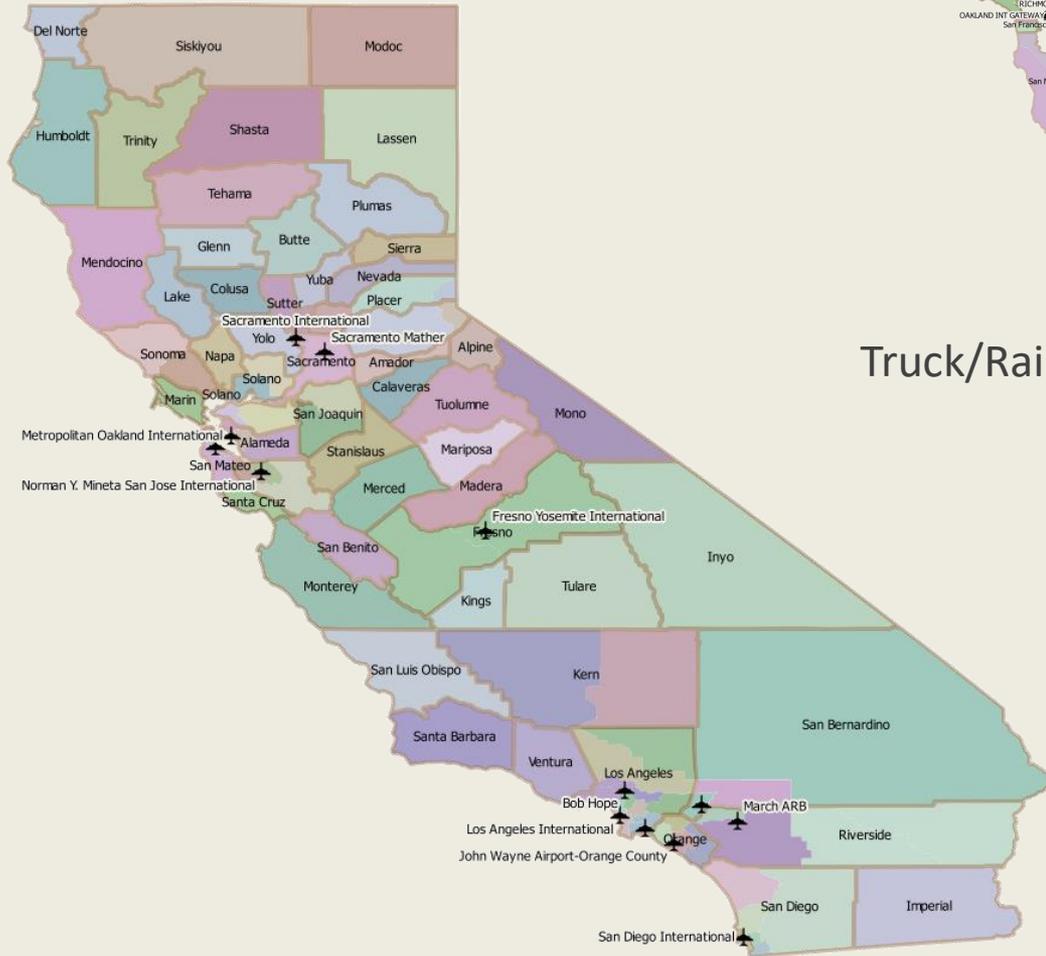
Level 1: Network and TAZs



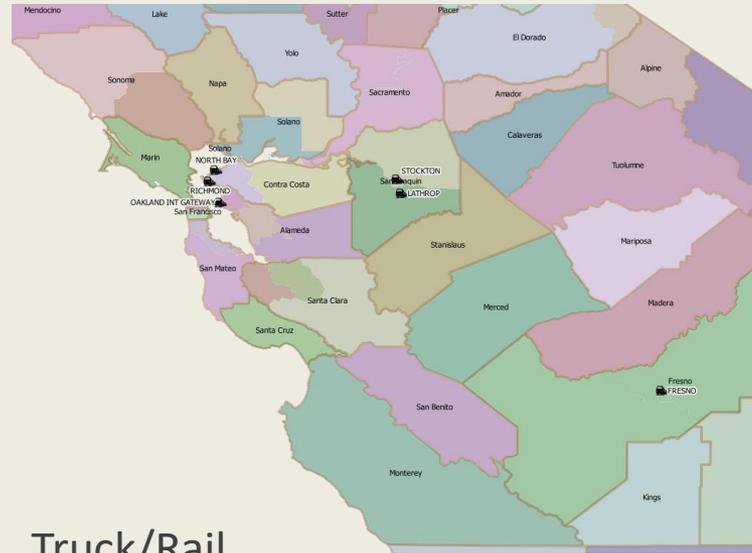
Level 2: FAZs



Transport Logistic Nodes

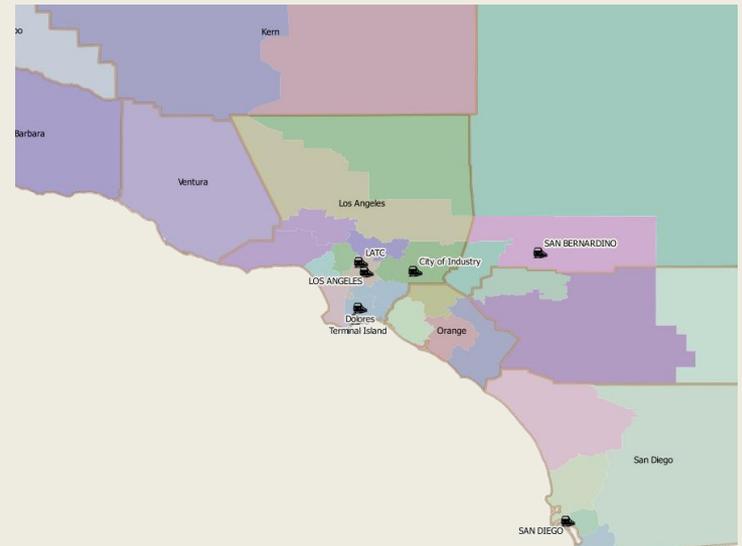


Northern California



Truck/Rail

Southern California



Gateways



No	Seaport
1	Port of San Diego
2	Port of San Francisco
3	Port of Redwood City
4	Port of Humboldt
5	Port of Oakland
6	Port of Richmond
7	Port Hueneme
8	Port of Los Angeles
9	Port of Long Beach
10	Port of Stockton
11	Port of Sacramento

No	Airport
1	San Diego International
2	San Francisco International
3	Oakland International
4	Fresno International
5	Los Angeles International
6	Long Beach Airport
7	Ontario International
8	March ARB

No	Land port	State	Land Port
1	Tecate	California	truck/rail
2	Calexico	California	truck/rail
3	Calexico-East	California	truck/rail
4	San Ysidro	California	Rail
5	Douglas	Arizona	truck/rail
6	Naco	Arizona	truck/rail
7	San Luis	Arizona	truck/rail
8	Nogales	Arizona	truck/rail

No	Truck port	State
1	Otay Mesa	California
2	Andrade	California
3	San Ysidro	California
4	Lukeville	Arizona
5	Sasabe	Arizona

California Statewide Freight Forecasting Model Update Overview

Substantially update CSFFM - new datasets

- CA-VIUS, GPS O-D, FAF 4, truck traffic counts

Replace long & short distance truck models in CSTDM

- CSFFM freight & non-freight truck models

New base and future year forecasts

Fully integrate CSFFM within CSTDM

Enhanced usability and training materials

Primary CSFFM Applications

Land use scenarios

- Population
- Employment by industry
- Agriculture harvest

Corridor analyses

- Capacity expansion
- New facility
- Network performance
- Truck route users

Air quality analysis

- GHG
- PM

Mode shift analyses

- Trucking cost/toll/fuel prices
- Rail network access/rates

Economic/Industry analyses

- Regional Commodity flow
- Ports' traffic
- Import/export distribution

CSFFM Performance Metrics

Regional goods movement trends

- by mode
- by truck class
- by tonnage

VMT

- by origin zone
- by industry (commodity)
- by truck size
- with/without through trips
- by speed bin
- by trip length

VHT by industry for each origin

Link level truck traffic volumes

Speed profile trends (by type)

Truck route utilizations

Toll revenue

V/C, LOS, delay

Basic GHG estimation

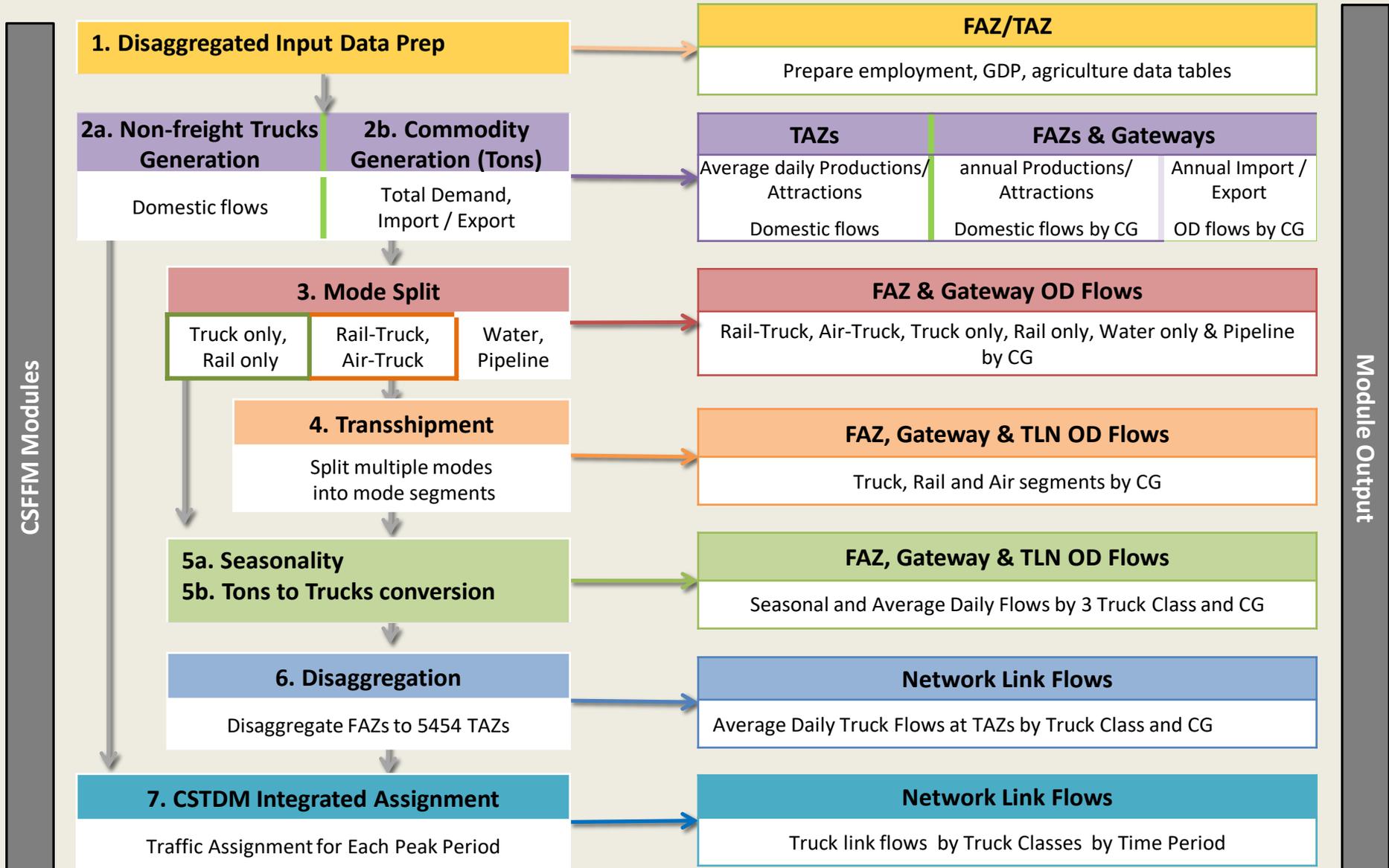
Domestic vs. import / export share

CSFFM Highway Applications

Types of projects	Throughput	Travel time Network speed	Reliability	Congest. reduction/mitigation	VMT & AQ impacts	Bottleneck relief	Safety	Multimodal strategy	Inter-regional benefits	Economic and job growth
Corridor and freeway-freeway interchange studies <i>*Geographic detail: multiple interchanges</i>	Yes	Yes	No	Yes	Yes	Provide inputs for traffic Microsim	Provide inputs for Safety Analysis	Yes (rail, water, air)	Yes[1]	As model inputs
Truck lanes (climbing, freight corridor, truck toll) <i>*Geographic detail: Should be for at least an entire corridor</i>	Yes- allows for custom truck-only max speeds	Yes	No	Yes	Yes (not sensitive to grades)	Provide inputs for traffic Microsim	Provide inputs for Safety Analysis	No	Yes	As model inputs
Truck efficiency (platooning) <i>*Geographic detail: Minimal level is urban corridor</i>	Yes	Yes	No	Yes	Yes	Provide inputs for traffic Microsim	Provide inputs for Safety Analysis	Possibly only for large-scale deployment	Yes	As model inputs
Land use policies	Yes	Yes	No	Yes	Yes	Provide inputs for traffic Microsim	Provide inputs for Safety Analysis	Yes	Yes	As model inputs

[1] a notable area of strength relative to regional models

CSFFM 3.0 Architecture

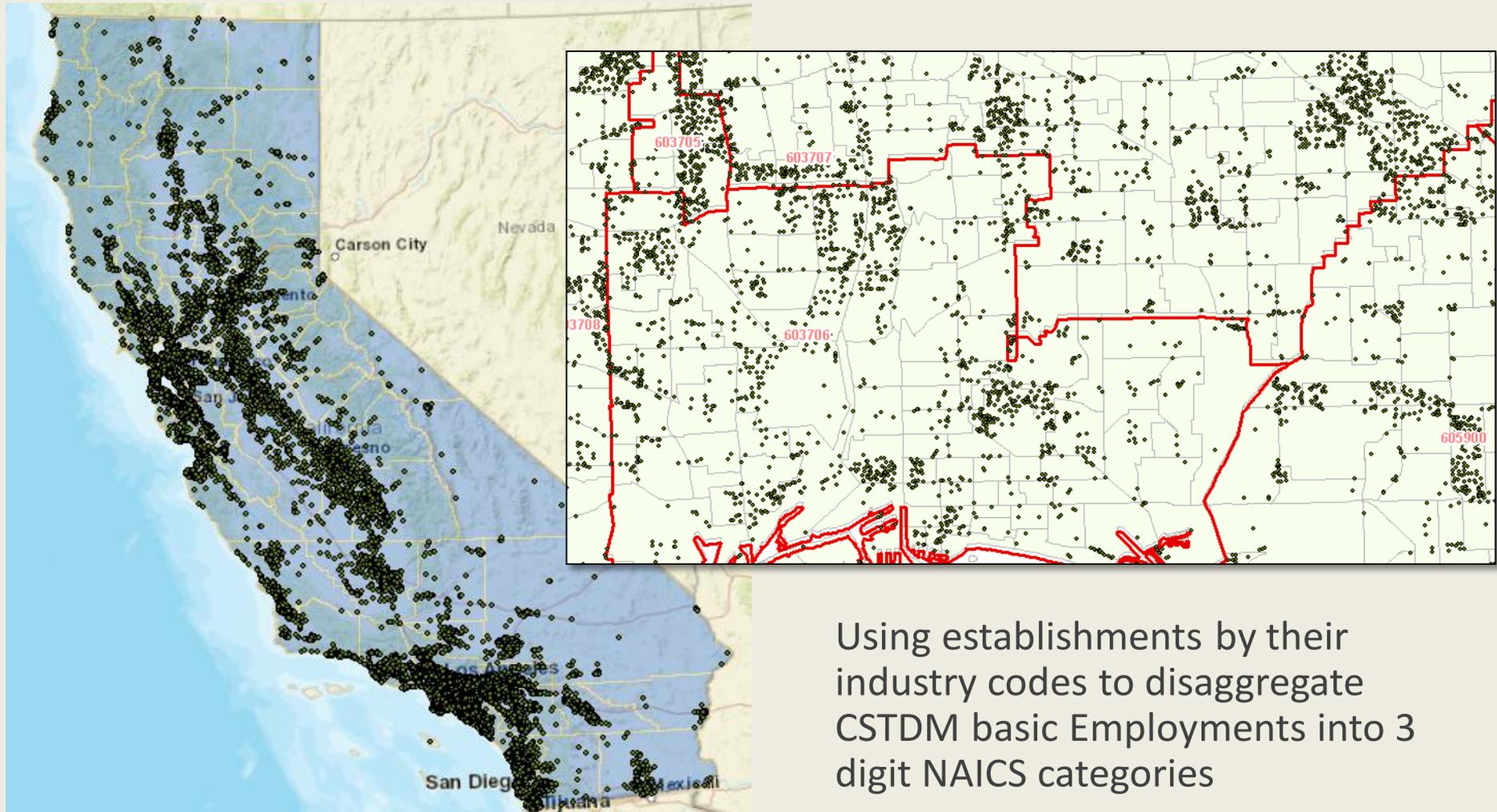


Disaggregated Input Data Preparation

2015 Base Year Data

- **CSTDM TAZ level data**
 - Population
 - Employment (8 groups)
- **Census/Other public data**
 - Establishments and employments
 - Refineries production
 - Manufacturing GDP
 - Acreage of harvested land
 - Tonnage of livestock
- InfoUSA establishment database
 - 105,020 Establishments with 10+ employees with NAICS codes 11- 49 in CA
- Fuel price
- Trucking cost
- Import/export data at each gateway
- Truck GPS data
- Rail waybill

Disaggregated Input Data Preparation



Using establishments by their industry codes to disaggregate CSTDM basic Employments into 3 digit NAICS categories

Disaggregated Input Data Preparation

Assumptions/implementation:

1	TAZ12	County	Military	Prim_Sec	Whole	Tran_U	Office	Retail	EduMed	LeisHosp	OthServ	TotEmp15
2	100	Del Norte	-	124	24	59	751	235	1,226	330	226	2,975
3	101	Del Norte	20	221	12	68	289	476	1,012	533	107	2,718
4	102	Del Norte	-	202	18	8	1,553	45	108	27	-	1,961
5	103	Del Norte	-	252	-	15	163	17	49	204	6	706
6	104	Del Norte	-	23	-	-	53	44	36	58	40	254
7	105	Humboldt	8	1,132	340	537	2,239	1,990	999	1,228	562	9,027



8	EMPOTHER								MODEL NAICS																													
9	Prim_Sec	Whole	Tran_U	Office	Retail	EduMed	LeisHosp	OthServ	Prim_Sec														Prim_Sec															
10	TAZ	OTH_P	OTH_T	OTH_O	OTH_R	OTH_E	eisHos	OTH_O	E113	E114	E115	E211	E212	E213	E236	E237	E238	E311	E312	E313	E314	E315	E316	E321	E322	E323	E324	E325	E326	E327	E331	E332	E333	E334	E335	E336	E337	E339
11	100	48%	0%	0%	86%	0%	0%	11%	2%	2%	0%	0%	0%	0%	6%	2%	9%	3%	20%	0%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	1%
12	101	48%	0%	0%	86%	0%	0%	11%	2%	2%	0%	0%	0%	0%	2%	2%	15%	3%	0%	0%	10%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	9%	0%	0%	3%	0%	1%
13	102	49%	0%	0%	86%	0%	0%	0%	3%	3%	1%	1%	1%	1%	3%	3%	6%	4%	1%	1%	2%	2%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	4%	1%	2%
14	103	48%	0%	0%	86%	0%	0%	17%	2%	2%	11%	0%	0%	0%	2%	2%	5%	3%	0%	0%	1%	1%	0%	1%	0%	9%	0%	0%	0%	0%	0%	8%	0%	0%	0%	3%	0%	1%
15	104	48%	0%	0%	85%	0%	0%	10%	3%	3%	1%	1%	1%	1%	3%	3%	6%	4%	1%	1%	2%	2%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	4%	1%	2%
16	105	14%	0%	0%	47%	0%	0%	6%	13%	0%	5%	0%	0%	0%	5%	3%	16%	19%	9%	0%	0%	0%	0%	8%	0%	0%	1%	3%	1%	0%	0%	0%	1%	0%	0%	0%	1%	

CSTDM Employment



Applied base year 2015 Ratio



Generate Detail employment projection

Freight Module Update

FAF 4.4 database with 2015 estimates

- 9 new FAF zones outside California
- Total trip generation parameters updated
- Direct demand model coefficients updated
- Import/export distribution ratios updated



FAF 4:
fixed share

Border
Crossing

FAF 4:
fixed share

Rail waybill , Trucking cost
Model calibration

Foreign origin:
Fixed share



Step 1

Foreign mode:
Fixed share



Gateway:
Port of
Long beach



Step 2

Domestic destination:
Proportional to
consumption

Destination
choice

Step 3

Domestic mode:
modeled

Mode
split
model

Step 4



Freight Module Update

Reasonable Consistency with Regional Truck models

- Future: total import/export is estimated based on economic factors and production/consumption equations.
- Users can modify allocations to each port

Gateway Group
 Commodity Type

% Total

Import / Export

		USA Region excluding CA
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ New England (FAZ 16-18,47,51,52,66,94,113)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Central Atlantic (19,48-50,67-69,71-75,91-93)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Lower Atlantic (20-28,76-79,95-97,114-117,120)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Midwest (32-42,53-57,59-61,63,80-88,98-101,121,122)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Gulf Coast (1-3,8,43-46,58,70,102-110)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Rocky Mountain (14,15,31,62,111,112,123)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ West Coast (4-7,29,30,64,65,89,90,118,119)
		CA Region
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Sacramento CA (135,136,169,174-176,182,183,213,219,220)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ San Francisco CA (124-126,132,133,161,168,184,193,194,198,199,201-204,208-211)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Los Angeles CA (148-159,170-173,178-181,185-187,218)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ San Diego CA (188-192)
<input type="text" value="0"/>	<input type="text" value="0"/>	▼ Remainder of California (127-131,134,137-147,160,162-167,177,195-197,200,205-207,212,214-217)

Scenario Development Tool

Toll Price at Toll Locations

Toll Locations

FHWA Vehicle Classifications

5. Single Unit 2-Axle Trucks 2 axles, 8 tires (dual rear tires), single-unit  11.14	6. Single Unit 3-Axle Trucks 3 axles, single unit  11.14	7. Single Unit 4 or More-Axle Trucks 4 or more axles, single unit  11.14	8. Single Trailer 3- or 4-Axle Trucks 3 or 4 axles, single trailer  11.14
9. Single Trailer 5-Axle Trucks 5 axles, single trailer  11.14	10. Single Trailer 6 or More-Axle Trucks 6 or more axles, single trailer  11.14	 11.14	
11. Multi-Trailer 5 or Less-Axle Trucks 5 or less axles, multiple trailers  11.14		12. Multi-Trailer 6-Axle Trucks 6 axles, multiple trailers  11.14	
13. Multi-Trailer 7 or More-Axle Trucks 7 or more axles, multiple trailers  11.14			 11.14
all other vehicles (FHWA 1-4) 11.14			

Model Variables List

Single Variable		Employment				Establishment			
Toll Fares	Population	Employment Total	EMP(11) - Agriculture, Forestry, Fishing and	EMP(21) - Mining, Quarrying, and Oil and	EMP(22) - Utilities	Establishment Total	EST(11) - Agriculture, Forestry, Fishing and	EST(21) - Mining, Quarrying, and Oil and	EST(22) - Utilities
Fuel Price	Gross Domestic Production	EMP(23) - Construction	EMP(31) - Food Manufacturing	EMP(32) - wood	EMP(33) - metal	EST(23) - Construction	EST(31) - Food Manufacturing	EST(32) - wood	EST(33) - metal
Rail Waybill	Harvested Land	EMP(42) - Wholesale Trade	EMP(44) - Retail Trade	EMP(45) - Retail Trade	EMP(46) - Transportation	EST(42) - Wholesale Trade	EST(44) - Retail Trade	EST(45) - Retail Trade	EST(46) - Transportation
Truck Distribution by Commodity	Livestock Sold	EMP(49) - Warehousing	EMP(51) - Information	EMP(52) - Finance and Insurance	EMP(53) - Real Estate and Rental and Leasing	EST(49) - Warehousing	EST(51) - Information	EST(52) - Finance and Insurance	EST(53) - Real Estate and Rental and Leasing
Truck Payload by Commodity Type	Refinery Capacities	EMP(54) - Professional, Scientific, and	EMP(55) - Management of Companies	EMP(56) - Administrative and Support and	EMP(61) - Educational Services	EST(49) - Professional, Scientific, and	EST(55) - Management of Companies	EST(56) - Administrative and Support and	EST(61) - Educational Services
Truck Empty Factor	Oil Production	EMP(62) - Health Care and Social Assistance	EMP(71) - Arts, Entertainment, and	EMP(72) - Accommodation and Food	EMP(81) - Other Services (except	EST(62) - Health Care and Social Assistance	EST(71) - Arts, Entertainment, and	EST(72) - Accommodation and Food	EST(81) - Other Services (except



Gateway (FAZ)

Commodity Type

% Total

Import / Export USA Region excluding CA

4	11	New England (FAZ 16-18,47,51,52,66,94)
11	12	Central Atlantic (19,48-50,67-69,71-75,91-93)
8	8	Lower Atlantic (20-28,76-79,95-97,114-117,120)
6	9	Midwest (32-42,53-57,59-61,63,80-88,98-101,121,122)
17	8	Gulf Coast (1-3,8,43-46,58,70,102-110)
7	10	Rocky Mountain (14,15,31,62,111,112,123)
21	9	West Coast (4-7,29,30,64,65,89,90,118,119)

CA Region

3	6	Sacramento CA (135,136,169,174-176,182,183,213,219,220)
4	8	San Francisco CA (124-126,132,133,161,168,184,193,194,198,199,201-204,208-211)
6	8	Los Angeles CA (148-159,170-173,178-181,185-187,218)
2	5	San Diego CA (188-192)
11	6	Remainder of California (127-131,134,137-147,160,162-167,177,195-197,200,205-207,212,214-217)

Scenario Development Tool

Model Variables List

Model Variables List Modify Selected Variable(s)

Single Variable		Employment				Establishment			
Toll Fares	Population	Employment Total	EMP(11) - Agriculture, Forestry, Fishing and	EMP(21) - Mining, Quarrying, and Oil and	EMP(22) - Utilities	Establishment Total	EST(11) - Agriculture, Forestry, Fishing and	EST(21) - Mining, Quarrying, and Oil and	EST(22) - Utilities
Fuel Price	Gross Domestic Production	EMP(23) - Construction	EMP(31) - Food Manufacturing	EMP(32) - wood	EMP(33) - metal	EST(23) - Construction	EST(31) - Food Manufacturing	EST(32) - wood	EST(33) - metal
Empty Trucks	Harvested Land	EMP(42) - Wholesale Trade	EMP(44) - Retail Trade	EMP(45) - Retail Trade	EMP(48) - Transportation	EST(42) - Wholesale Trade	EST(44) - Retail Trade	EST(45) - Retail Trade	EST(48) - Transportation
Gateway Distribution	Livestock Sold	EMP(49) - Warehousing	EMP(51) - Information	EMP(52) - Finance and Insurance	EMP(53) - Real Estate and Rental and Leasing	EST(49) - Warehousing	EST(51) - Information	EST(52) - Finance and Insurance	EST(53) - Real Estate and Rental and Leasing
Truck Payload by Commodity Type	Refinery Capacities	EMP(54) - Professional, Scientific, and	EMP(55) - Management of Companies	EMP(56) - Administrative and Support and	EMP(61) - Educational Services	EST(54) - Professional, Scientific, and	EST(55) - Management of Companies	EST(56) - Administrative and Support and	EST(61) - Educational Services
Rail Truck Mode Split	Oil Production	EMP(62) - Health Care and Social Assistance	EMP(71) - Arts, Entertainment, and	EMP(72) - Accommodation and Food	EMP(81) - Other Services (except	EST(62) - Health Care and Social Assistance	EST(71) - Arts, Entertainment, and	EST(72) - Accommodation and Food	EST(81) - Other Services (except

Scenario Modification Report Reset Selected Variable(s) Export Selected Variable(s)

Non-Freight Truck

Definition: Non-freight trucks are NOT included in FAF database

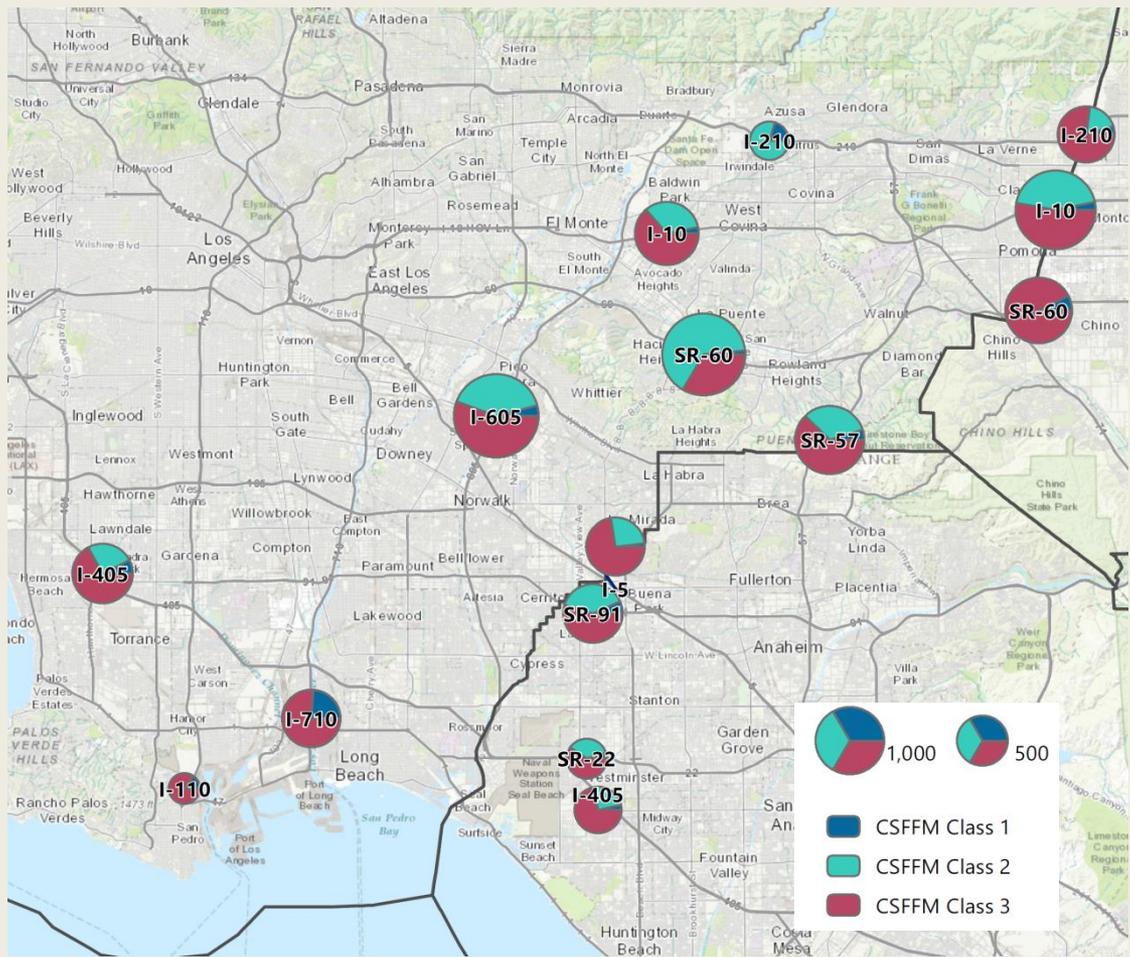
FACT: 40-60% of truck VMTs are non-freight trucks

- Municipality, service, maintenance, construction, local deliveries, moving, emergency response, empty trucks

Non-freight trucks are needed for:

- Complete truck flow assignments, model validation, VMT calculation, air quality analysis

Non-Freight Trucks



Average weekday non-freight trips (partial)

TAMS database Jan-July 2017
 Identified by body classification

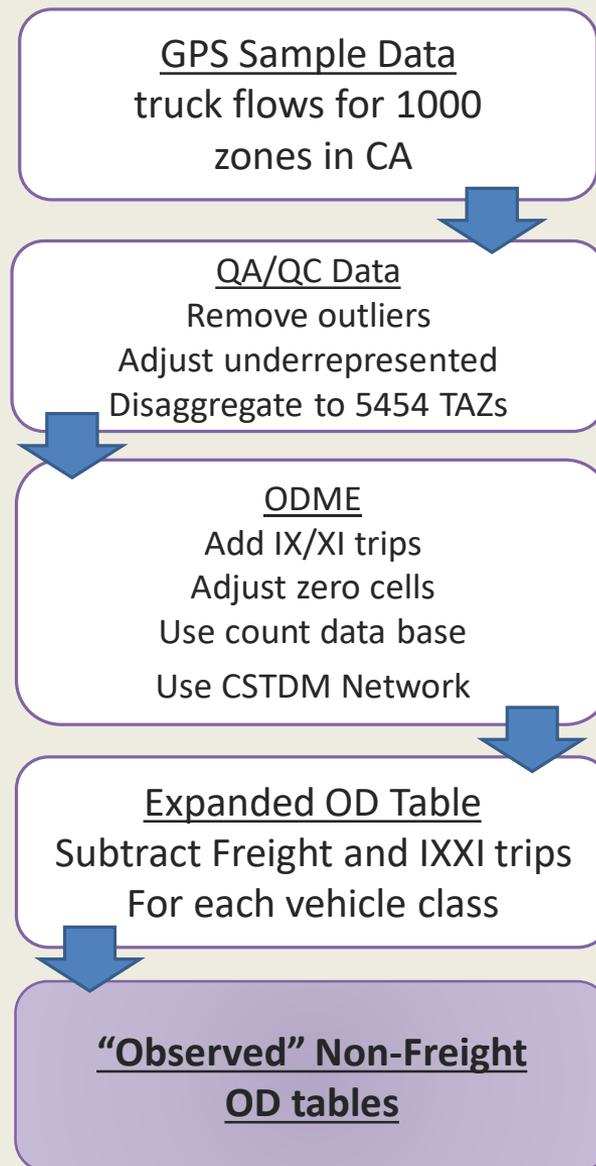


Non-freight Trucks

An **implementable** model with available resources; a **functional**, policy **sensitive** model

Assumption/Process:

1. Truck OD table from GPS sample is expanded to match the counts → *This is ALL truck flows*
2. FAF truck OD table is subtracted → *This is all non-FAF trucks including empties and service trucks*
3. The Non-Freight OD table is used to estimate trip generation rates based on employment and population
4. Use GPS data sample as seed for trip distribution



Module Split Module

Value of time (VOT) in mode choice models



- No available data, assumption \$1/ h
- It is included in the constant of the cost for each commodity

$$\begin{aligned}
 & \$Utility_{i,j,m} \\
 & = \$Constant_m + \$CostCoeff \times (fixed\ cost_m + VarCost_{i,j,m}) \\
 & + \$TimeCoeff \times (fixed\ time_m + vartime_{i,j,m}) \times VOT
 \end{aligned}$$

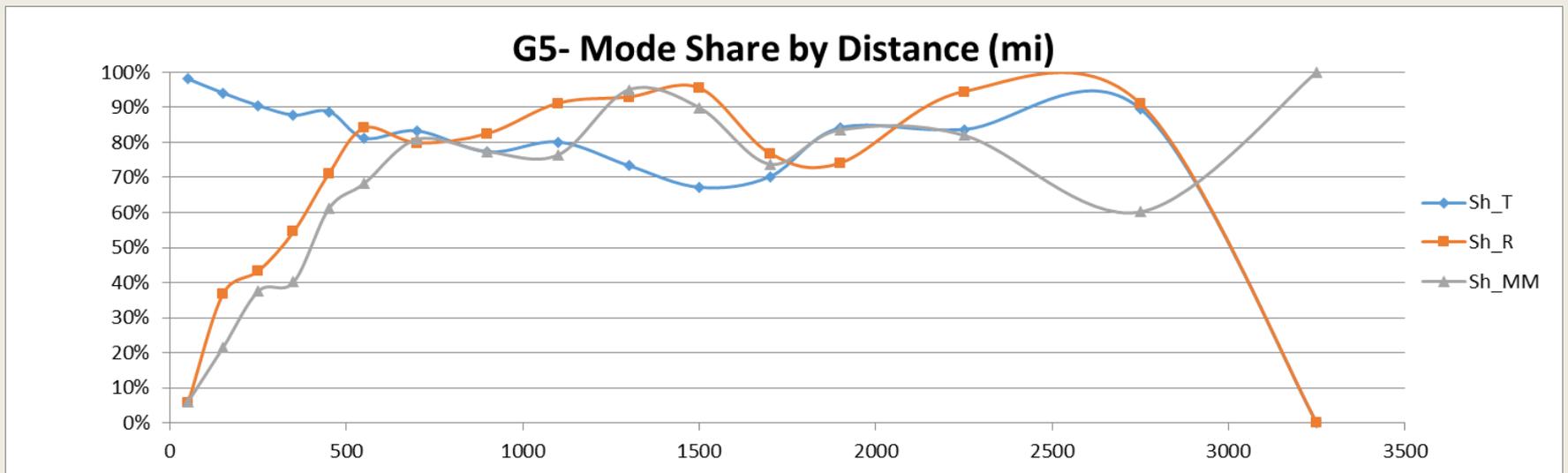
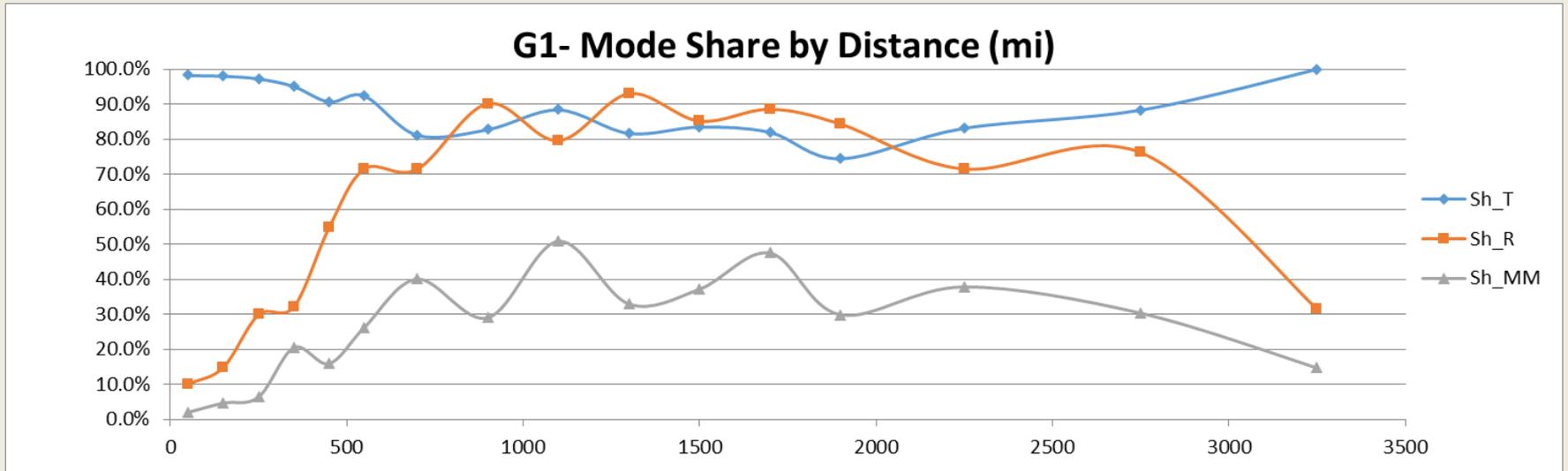
Module Split Module

- Develop an Excel tool to evaluate various cost functions
 - Increase model stability by identifying minimum economic distance for each commodity for each mode

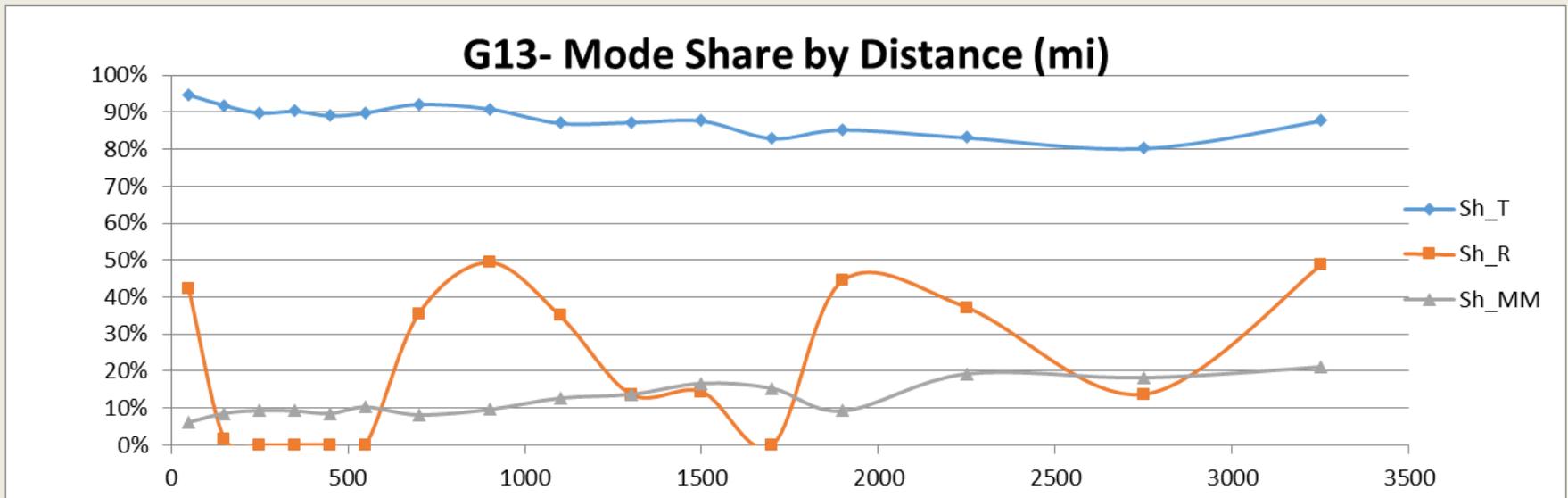
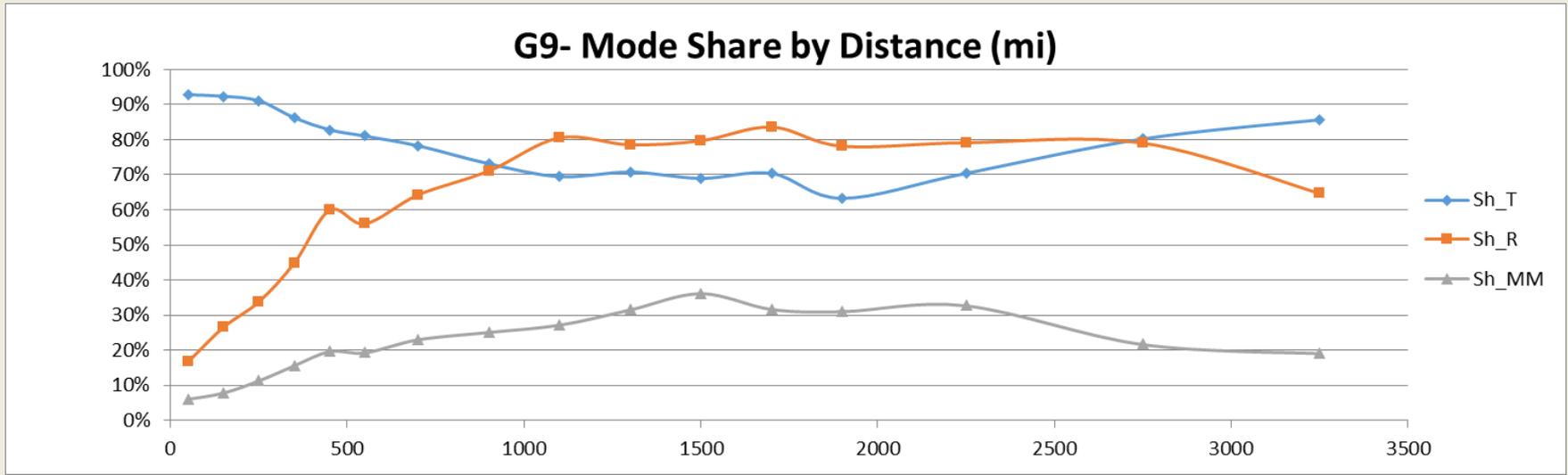
CG	group	Cost_T	Cost_R	Cost_M	Time_T	Time_R	Time_M
1	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$	$\log(\text{RAIL_RATE} * \text{RAIL_DISTANCE} + \text{RAIL_VOT} * \text{RAIL_TT})$	$\log(\text{MM_RATE} * \text{RAIL_DISTANCE} + (\text{DRAY_O} + \text{DRAY_D} + \text{L}) / \text{PF} + \text{MM_VOT} * \text{MM_TT})$			
2	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$	$\log(\text{RAIL_RATE} * \text{RAIL_DISTANCE} + \text{RAIL_VOT} * \text{RAIL_TT})$	$\log(\text{MM_RATE} * \text{RAIL_DISTANCE} + (\text{DRAY_O} + \text{DRAY_D} + \text{L}) / \text{PF} + \text{MM_VOT} * \text{MM_TT})$			
2	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$	$\log(\text{RAIL_RATE} * \text{RAIL_DISTANCE} + \text{RAIL_VOT} * \text{RAIL_TT})$	$\log(\text{MM_RATE} * \text{RAIL_DISTANCE} + (\text{DRAY_O} + \text{DRAY_D} + \text{L}) / \text{PF} + \text{MM_VOT} * \text{MM_TT})$			
4	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF})$					
5	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF})$					
5	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF})$					
7	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
7	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
8	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF})$					
9	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
9	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
10	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
10	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
11	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF})$					
13	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
13	2	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					
14	1	$\log(\text{TRUCK_RATE} * \text{TRUCK_DISTANCE} / \text{PF} + \text{TRUCK_VOT} * \text{TRUCK_TT})$					

CG	Group	Name	Value	Std err	t-test	p-value	Sample si	Init Log Li	Final Log	Likelihood	Rho-squa	Rho-square-bar
1	1	ASC_RAIL	-0.0695	0.164	-0.42	0.67	1740	-1754.48	-693.54	2121.89	0.605	0.602
1	1	ASC_TRUCK	-5.86	0.429	-13.67	0						
1	1	B_COST	-1.5	0.0737	-20.31	0						
1	1	B_Z_M_GRAINS	0.152	0.259	0.59	0.56						
1	1	B_Z_R_GRAINS	0.477	0.19	2.51	0.01						
2	1	ASC_RAIL	-0.205	0.085	-2.41	0.02	3104	-3340.88	-1643.02	3395.72	0.508	0.507
2	1	ASC_TRUCK	-4.31	0.255	-16.92	0						
2	1	B_COST	-1.13	0.0452	-25.09	0						
4	1	ASC_RAIL	0.618	0.168	3.68	0	975	-1015.12	-419.525	1191.19	0.587	0.584
4	1	ASC_TRUCK	-8.84	0.632	-13.99	0						
4	1	B_COST	-1.81	0.101	-17.9	0						
5	1	ASC_RAIL	0.0751	0.118	0.64	0.53	1412	-1456.76	-782.191	1349.14	0.463	0.461
5	1	ASC_TRUCK	-4.36	0.368	-11.84	0						
5	1	B_COST	-0.964	0.0547	-17.63	0						
7	1	ASC_RAIL	-0.713	0.128	-5.55	0	3864	-3829.76	-1218.28	5222.96	0.682	0.681

Module Split Module

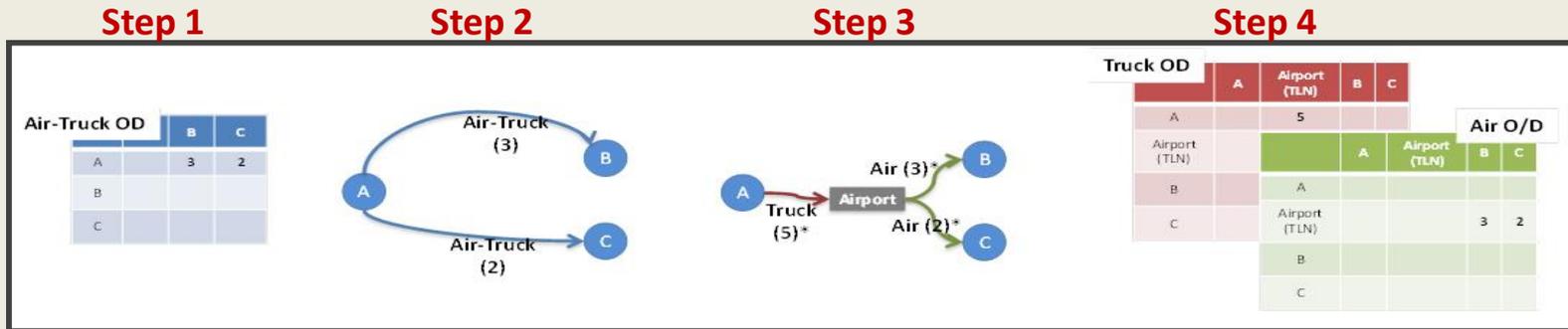


Module Split Module



Transshipment Module

An inverse optimization model:



Modifications:

- POLA/POLB: share of on-dock rail, near-dock rail terminals and truck-only modes are user inputs
- New option: user can overwrite model estimated shares by local data

Flow	2015 (TEU)
On-Dock	
Total On-dock	2,227,203
% of Total Throughput	26.20%
Total Off-Dock	692,974
% of Total Throughput	8.20%
Total On & Off-dock *	
Total*	2,920,177
% of Total Throughput	34.40%
Total **	8,495,592

Tons to Trucks (GVW)

FHWA Class		Light	Medium 1	Medium 2	Heavy
2 Axles 4 tires (<i>Not included</i>)	Class 3	36%	53%	9%	2%
2 Axles 6 tires	Class 5	18%	61%	17%	3%
3 Axles – Single unit	Class 6	2%	9%	12%	78%
4 Axles – Single unit	Class 7	0%	0%	7%	92%
3/4 Axles Single trailer	Class 8	1%	3%	5%	92%
5 Axles Single trailer	Class 9	0%	1%	1%	97%
6+ Axles Single trailer	Class 10	0%	1%	3%	95%
5 Axles Multi trailer	Class 11	0%	0%	4%	96%
6 Axles Multi trailer	Class 12	0%	0%	0%	100%
7+ Axles Multi trailer	Class 13	0%	0%	0%	100%

* Source: CA-VIUS 2017

- Light trucks (8,500 to 14,000 lbs.)
- Medium 1 trucks (14,000 to 26,000 lbs.)
- Medium 2 trucks (26,000 to 33,000 lbs.)
- Heavy trucks (>33,000 lbs.)

Considerations:

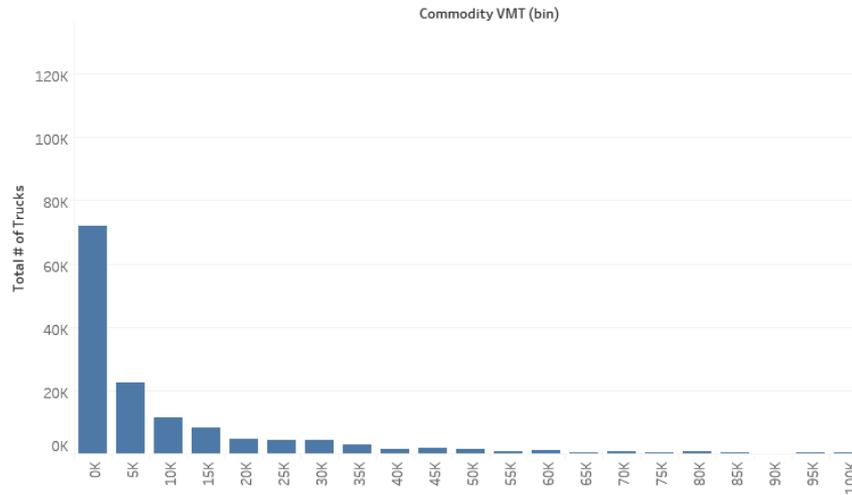
- Consistency with SCAG HDT
- Consistency with ARB AQ tools

Tons to Trucks Conversion

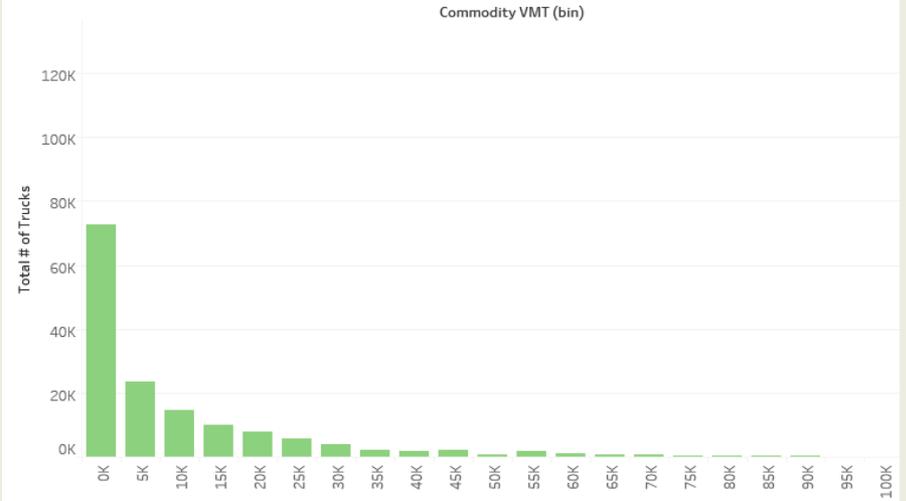
- The commodity flow OD tables are estimated in average annual tonnage
 - FAF and CFS are estimated annually
- The tonnages are distributed to average annual weekday
- The average weekday tonnages are distributed to 4 vehicle classes based on distance between origin and destination TAZs
- VMT for each vehicle class from CA-VIUS is used to guide the vehicle allocations for each distance bin

VMT Distribution by Commodity - Longer TLD

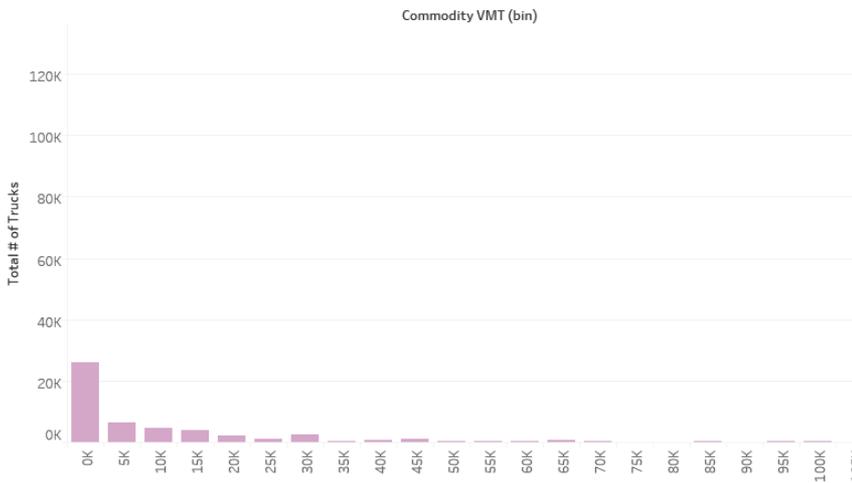
California VMT Distribution by Commodity- Agriculture products



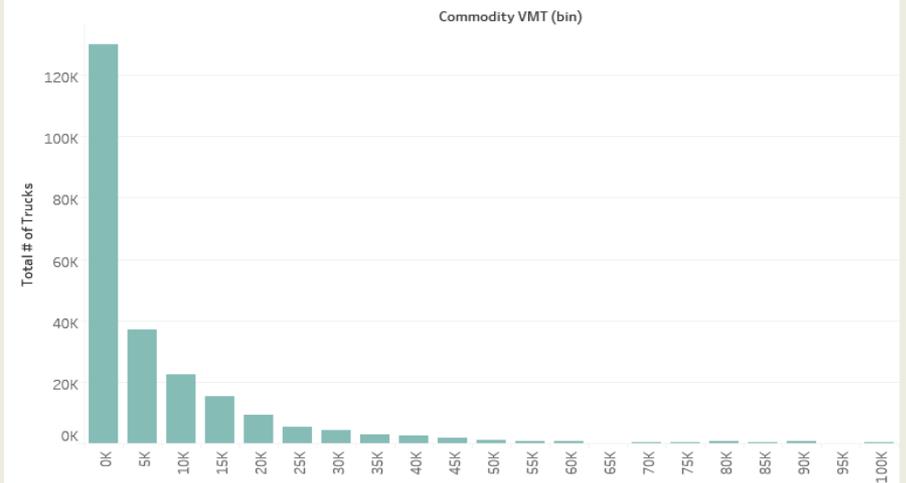
California VMT Distribution by Commodity- Food, beverage, tobacco products



California VMT Distribution by Commodity- Gravel / Sand and nonmetallic minerals

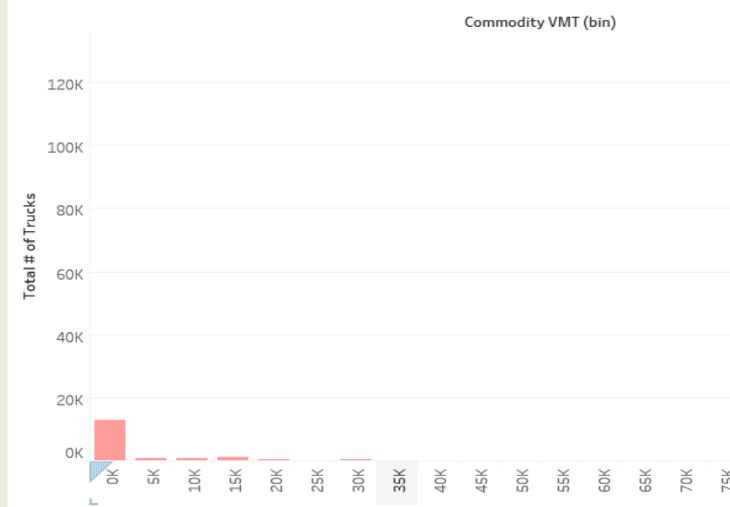


California VMT Distribution by Commodity- Manufactured products

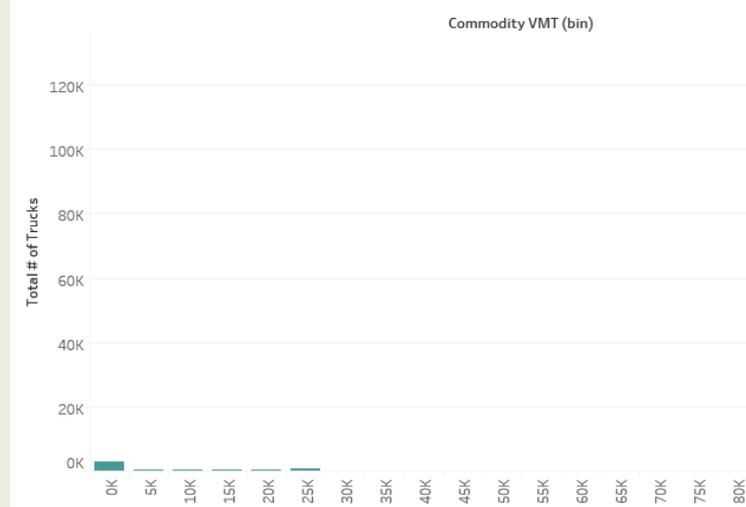


VMT Distribution by Commodity - Shorter TLD

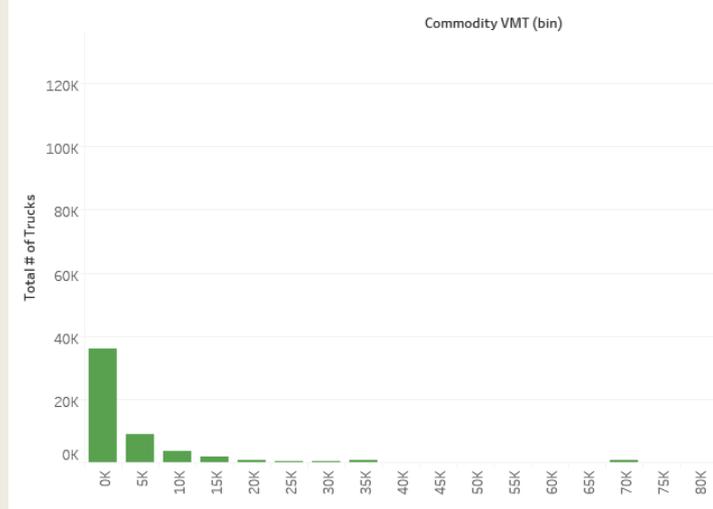
California VMT Distribution by Commodity- Nonmetal mineral



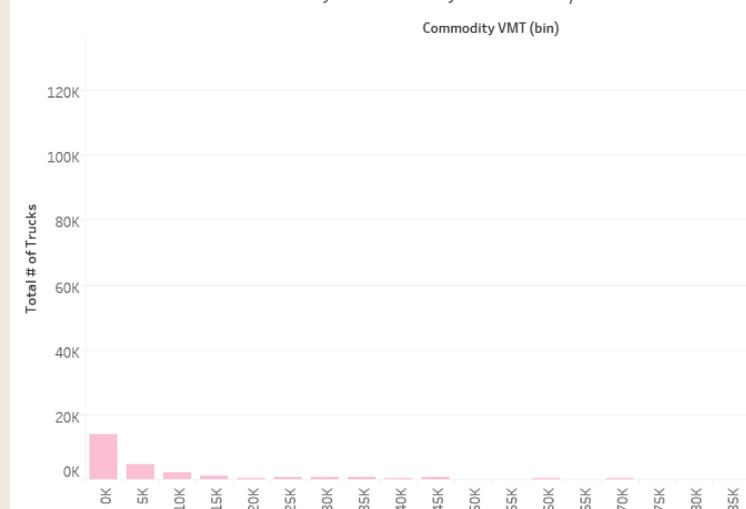
California VMT Distribution by Commodity- Logs



California VMT Distribution by Commodity- Electronics



California VMT Distribution by Commodity- Chemical / Pharmaceutical



Payloads Distribution

Truck Allocation

Distance Bin		GVW Truck Class				
MIN	MAX	Light	Medium1	Medium2	Heavy	sum
0	50	0.9%	9.0%	8.8%	81.3%	100%
50	100	0.5%	5.0%	2.6%	91.9%	100%
100	200	0.6%	3.0%	2.8%	93.6%	100%
200	500	0.3%	2.0%	2.2%	95.5%	100%
500	Or more	0.3%	2.0%	2.2%	95.5%	100%

Payloads

Commodity Groups	Light	Medium1	Medium2	Heavy
G1 Agriculture products	3,320	5,902	14,618	40,653
G2 Wood, printed products	1,585	5,569	9,757	38,711
G4 Fuel and oil products	1,189	4,355	10,066	36,822
G5 Gravel/ sand and non metallic minerals	2,235	5,679	18,394	46,112
G7 Food, beverage, tobacco products	2,479	5,236	12,266	38,500
G8 Manufactured products	2,361	4,711	9,354	34,209
G9 Chemical/ pharmaceutical products	2,364	3,609	12,933	37,348
G10 Nonmetal mineral products	2,235	4,834	18,394	46,648
G11 Metal manufactured products	2,822	5,489	12,980	36,338
G12 Waste material	1,961	4,552	10,503	35,360
G13 Electronics	995	3,334	11,126	20,792
G14 Transportation equipment	2,705	4,600	10,803	37,836
G15 Logs	2,364	5,788	12,393	41,333

Time of Day Distribution

Average annual daily flows to CSTDM peak periods

- AM period: 6 am -10 am
- Midday period: 10 am - 3 pm
- PM period: 3 pm -7 pm
- Night period: 7 pm - 6 am

Probe data and available counts will be used to developed daily distribution

- Trips longer than one period will only be assigned based on the “start time” of the trip

Freight Truck Disaggregation

- Freight flows are estimated in two levels due to lack of required data at CSTDM TAZs
- Total commodity flows and share of each mode will be estimated at 97 FAZs, gateways, and TLNs
- Only Truck matrices will be disaggregated from 97 FAZs to 5454 TAZs

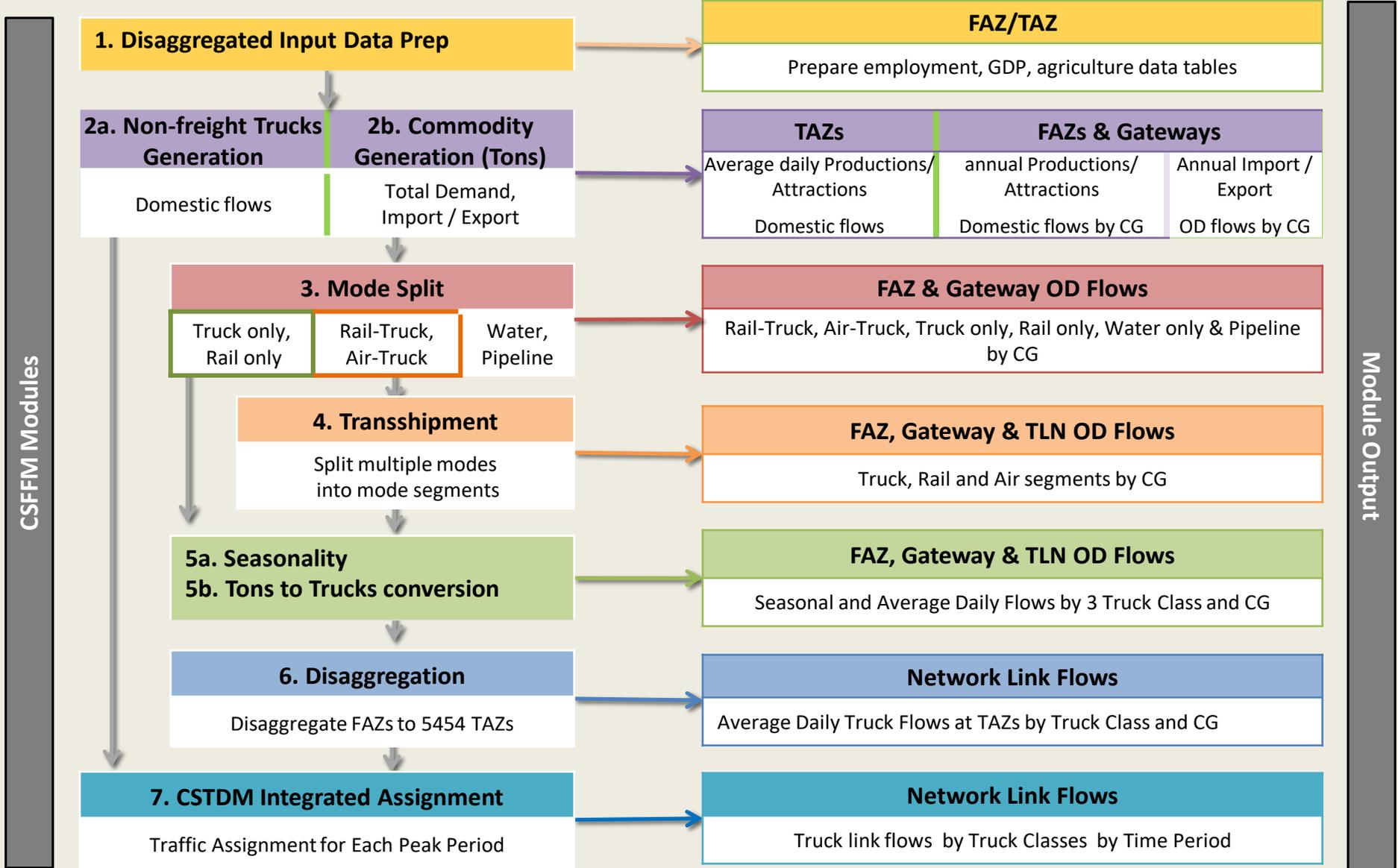
Disaggregation Module

Disaggregate truck matrices from 97 FAZs to 5454 TAZs

1. Disaggregated employment data (module 1) used to develop simple trip production and trip attraction regression equations for each CG (at FAZ level)
2. These equations are applied to TAZs and estimate trip production and attraction for each commodity at each TAZ
3. Allocate FAZ truck flows based on proportional share of each TAZ

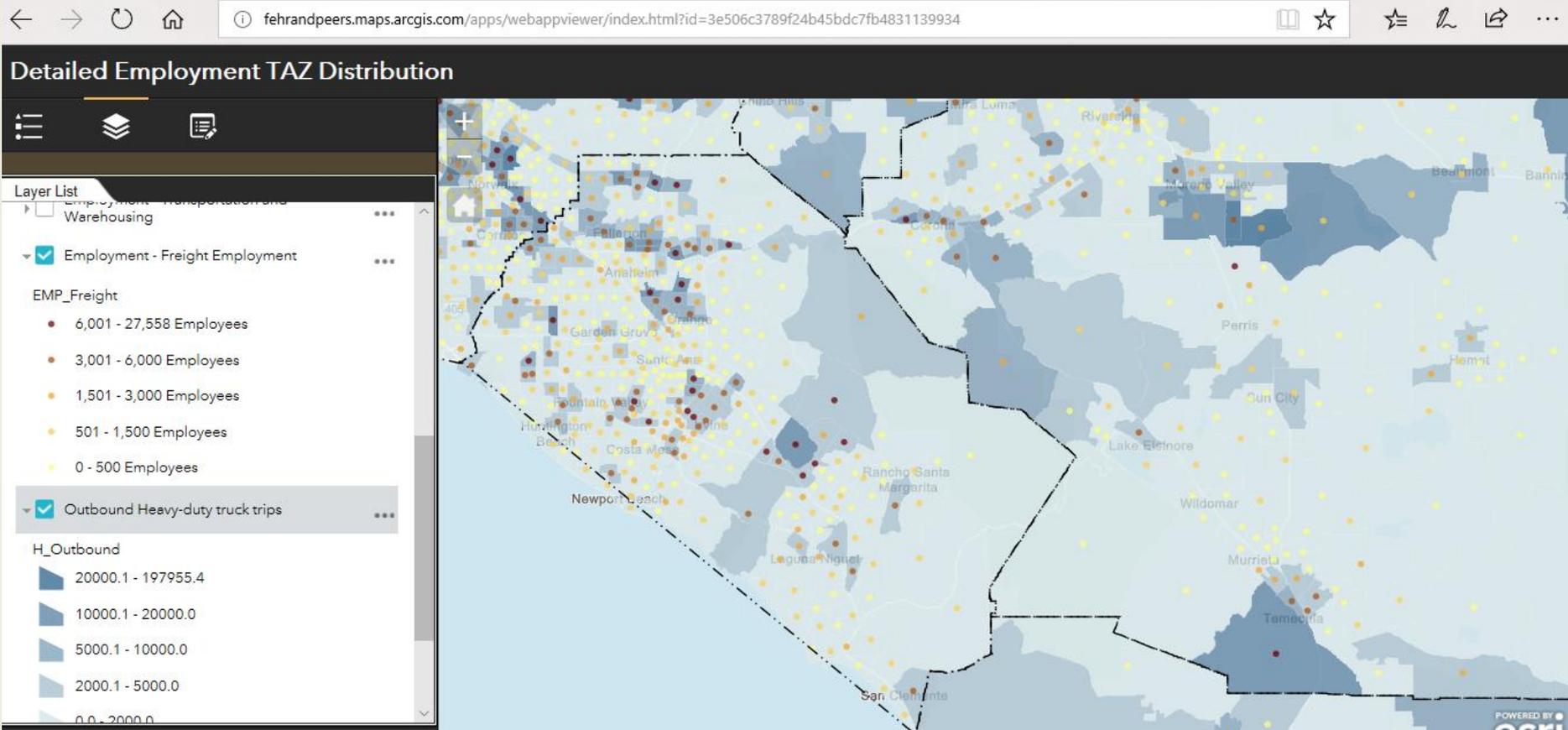
Average annual daily flows to time periods

CSFFM 3.0 Architecture



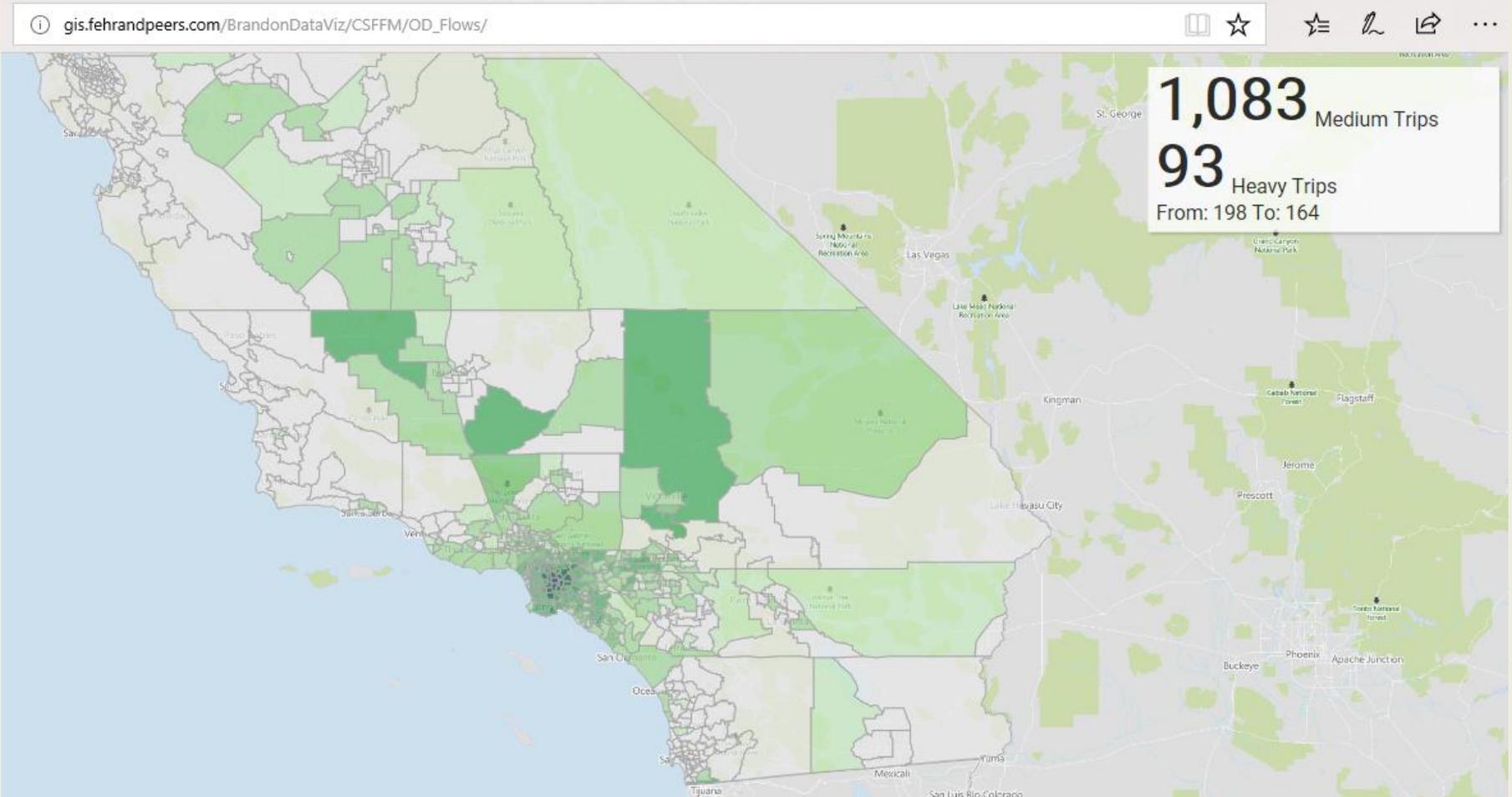
Supplement data – Establishments

Outbound trips by TAZ | Total Freight Employment



Supplement data – GPS ODs

Probe data visualization



Supplement data – GPS Routes

Bench March: Probe data

Benefit:

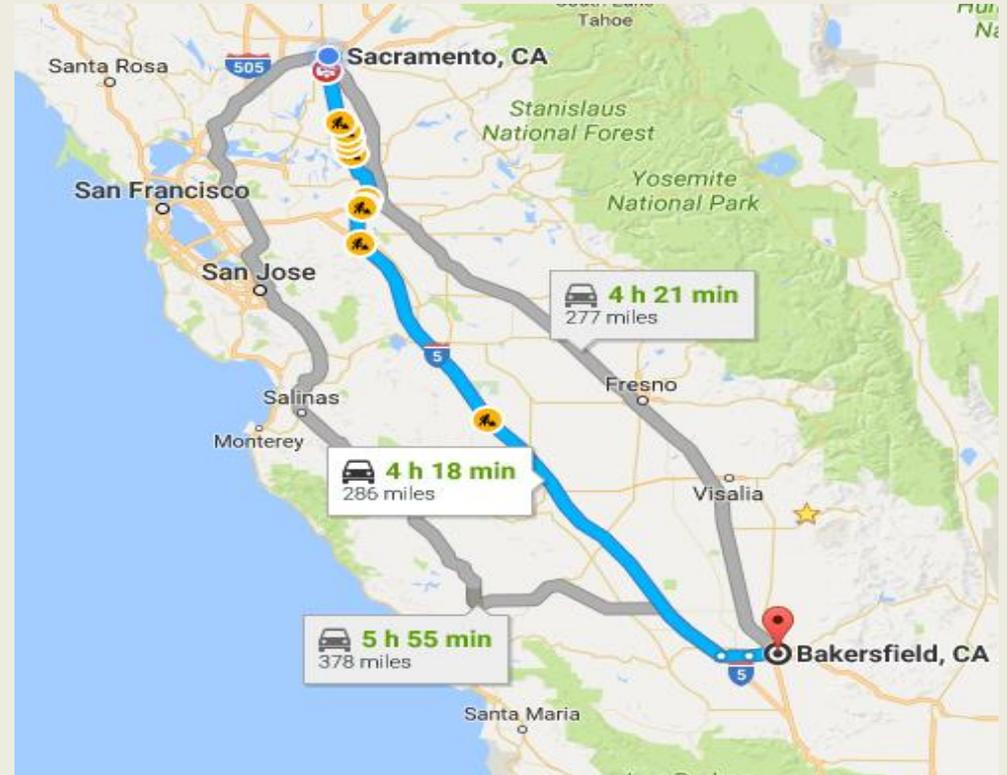
- Large sample
- Continuous historic data

Application:

- Route distribution
- OD distribution

Limitations:

- Under-representation of short-haul trips
- Under-representation of owner-operator trucks



Supplement data – GPS Distribution

Port Of Los Angeles

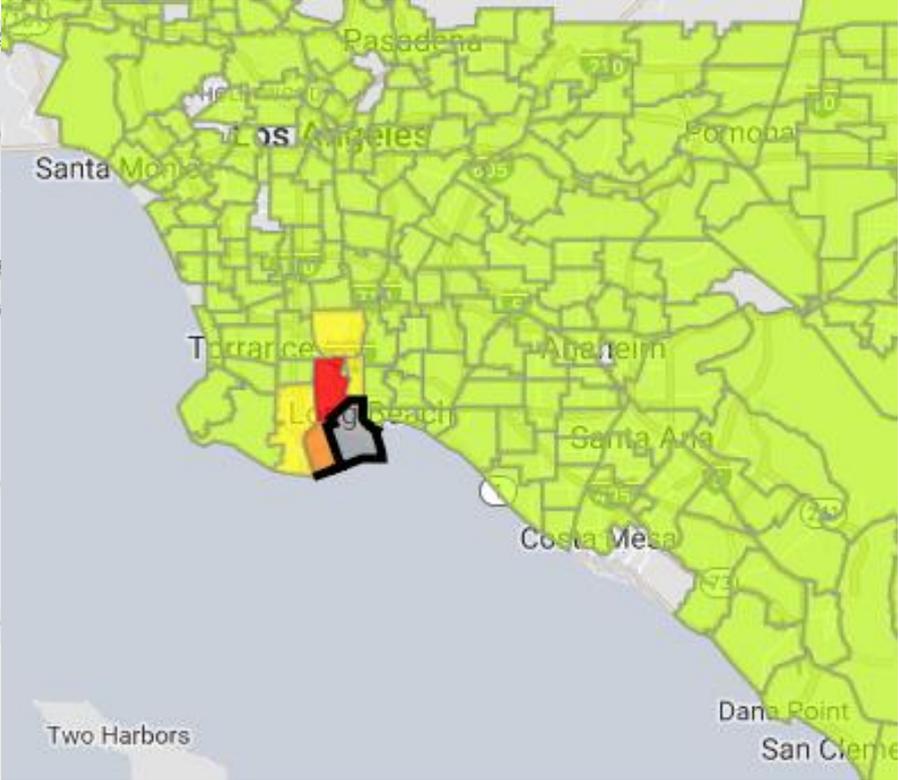
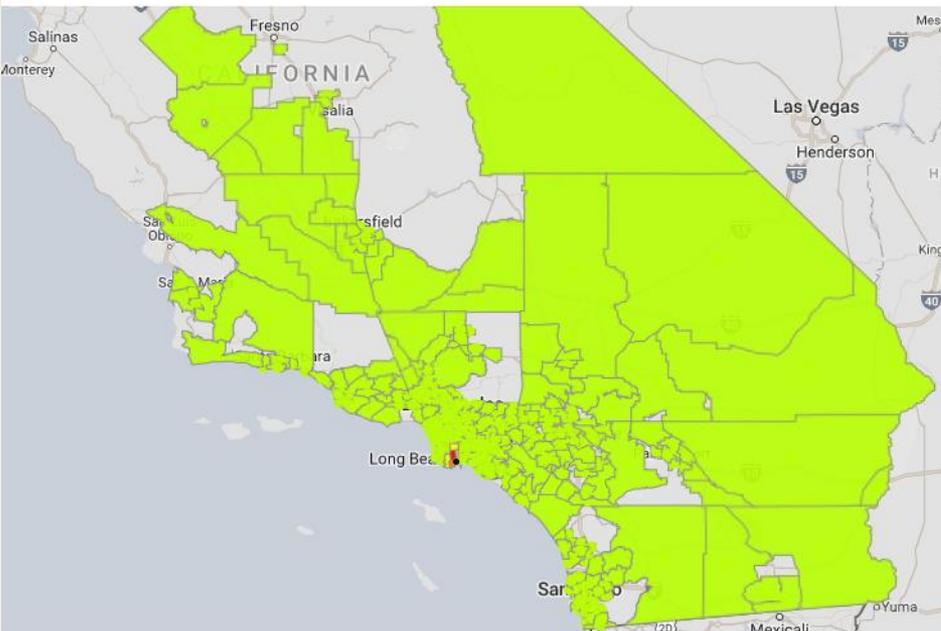
ODwith990zones | O-D Analysis (GPS Data)

Origin | Average Day (M-Su) | All Day (12am-12am) | Commercial (Heavy) | StreetLight Trip Index and Percent

Colors Indicate the Traffic Volume (StreetLight Trip Index) to each destination Zone during the selected time period.

Insufficient Trips 1 - 1,397 (0 - 2.4%) 1,398 - 4,888 (2.4 - 8.5%) 4,889 - 6,889 (8.5 - 11.9%) 6,890 - 10,995 (11.9 - 19%)

Origin Zone

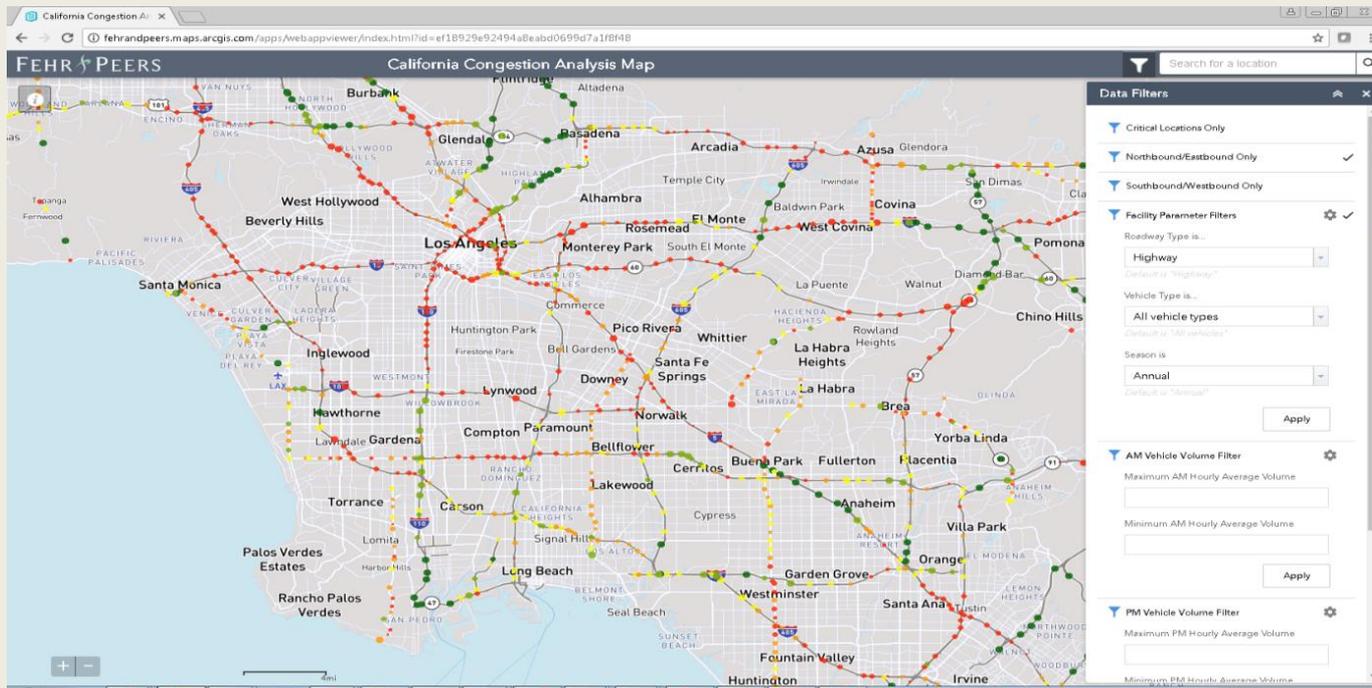


StreetLight data 2017

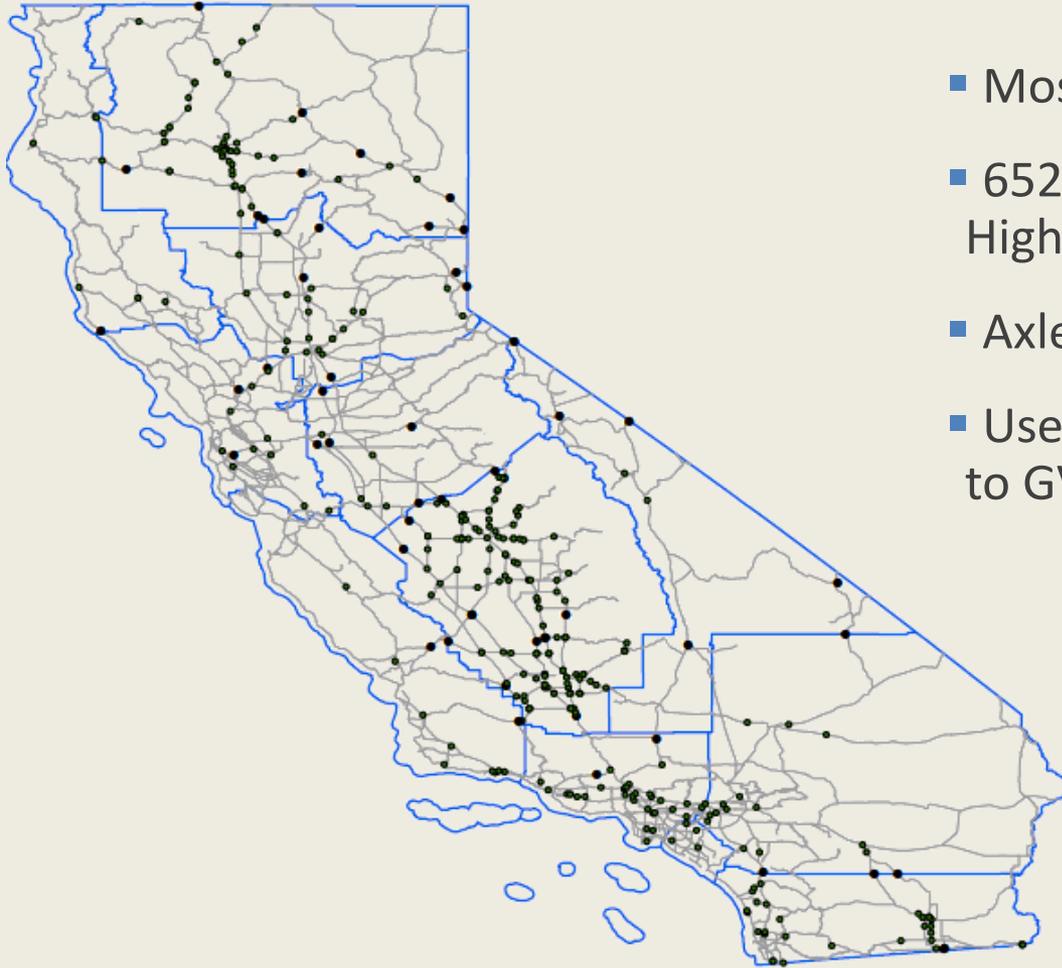
Supplement data – GPS Speed

Travel time validation

- NPMRDS truck travel time data for 2015 is processed.
- The data is summarized and available on California Congestion Analysis Online Tool for detail review



Comprehensive Count Data Base



- Mostly 2015, few from 2016
- 652 directional locations on state Highways
- Axle based classified counts
- Use VIUS survey to convert counts to GVW classes

Final Steps

Finalize base year updates

Static Validation

- Truck Trip Distribution
- Highway Network Assignment
- Travel Time

Dynamic Validation/Sensitivity analysis

- Land Use Test
- Highway Network Modification Test
- Mode Shift Test

Highway Network Assignment Validation

Static validation:

- Validation spread sheet tool
- Over 400 Links are selected
- A set of 25+ screen lines are defined

METRIC	VALUE	REQ.	TEST
Model Deviation	8%	+/- 10%	PASS
Meet Max Dev.	79%	> 75%	PASS
RMSE	32%	< 40%	PASS
Correlation	0.91	> 0.88	PASS
Screenline Max Dev.		100%	
<i>External Max Dev.</i>			
<i>External Deviation</i>			
<i>External RMSE</i>			

Validation Screenlines



California Statewide Freight Forecasting Model

Updates and Enhancements

Fatemeh Ranaiefar, PhD

FEHR  PEERS