

# **MOVES Vehicle Classification and its Interrelationship with VPOP and VMT Distributions**

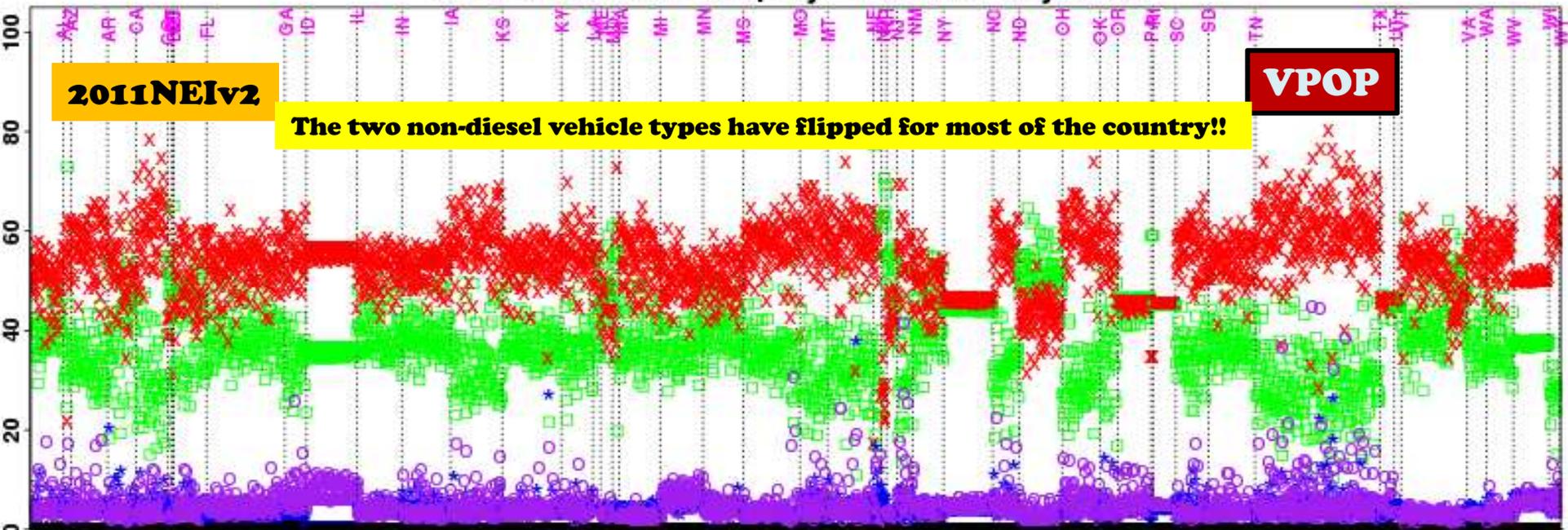
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Virginia Department of Environmental Quality**

**Presented to  
EPA/CRC/MARAMA/LADCO/SESARM  
February 10, 2015**

# Background

- **Non-Diesel passenger car and Non-Diesel truck/bus activity have flipped from MOVES2010b to MOVES2014**
  - **HIGHER** VPOP and VMT for trucks/buses
  - **LOWER** VPOP and VMT for passenger cars
- **Systematic and region-wide**
- **Could be a result of adoption of CRC data**
- **Could be due to differences in assumptions or approach taken to allocate VMT between source types**
- **Emission factors for trucks/buses > passenger cars, so the difference matters**
- **Assumptions should be evaluated carefully**

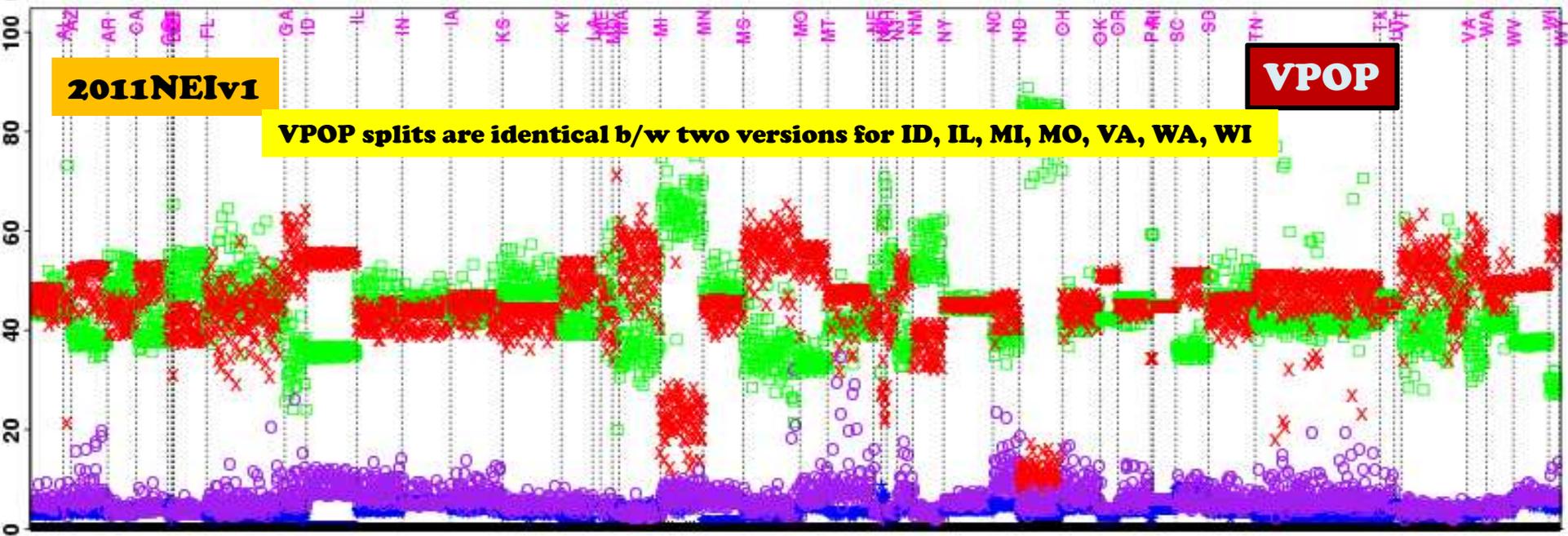
VPOP Percent Makeup by CSCC6 and by State



2011NEIv2

The two non-diesel vehicle types have flipped for most of the country!!

VPOP



2011NEIv1

VPOP splits are identical b/w two versions for ID, IL, MI, MO, VA, WA, WI

VPOP

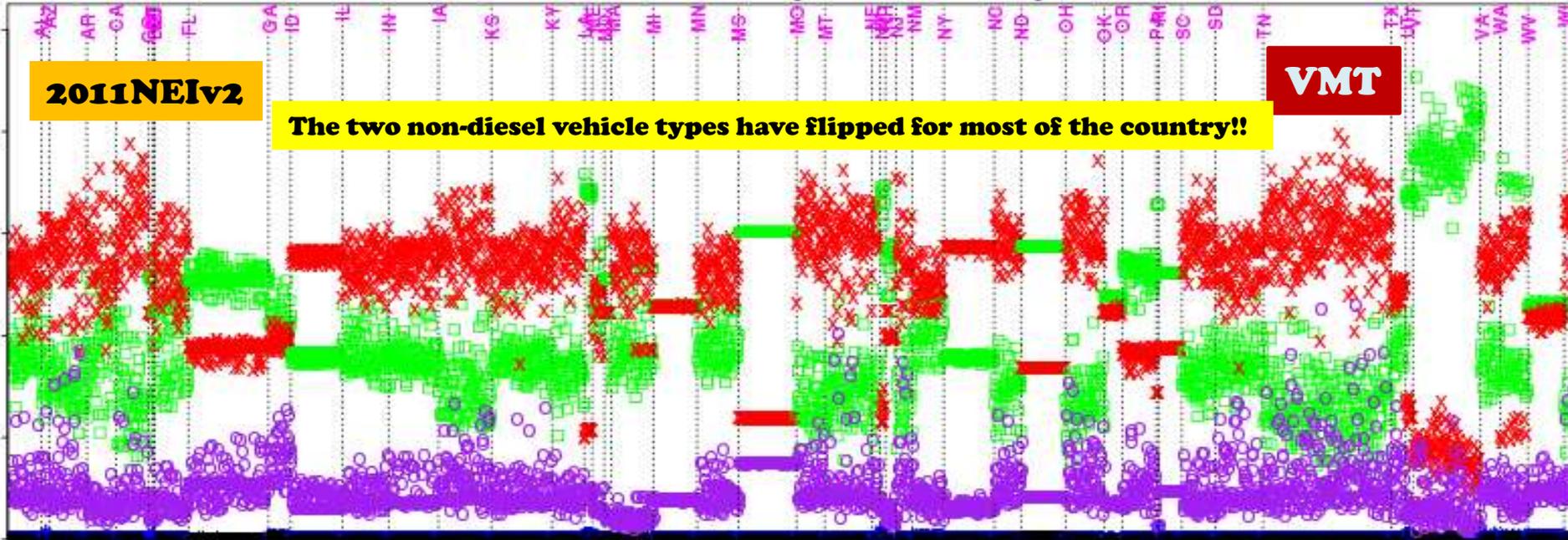
■ Non-Diesel Passenger Cars   
 × Non-Diesel Trucks/Buses   
 ★ Non-Diesel Motorcycles   
 + Diesel Passenger Cars   
 ○ Diesel Trucks/Buses

# VMT Percent Makeup by CSCC6 and by State

**2011NEIv2**

**The two non-diesel vehicle types have flipped for most of the country!!**

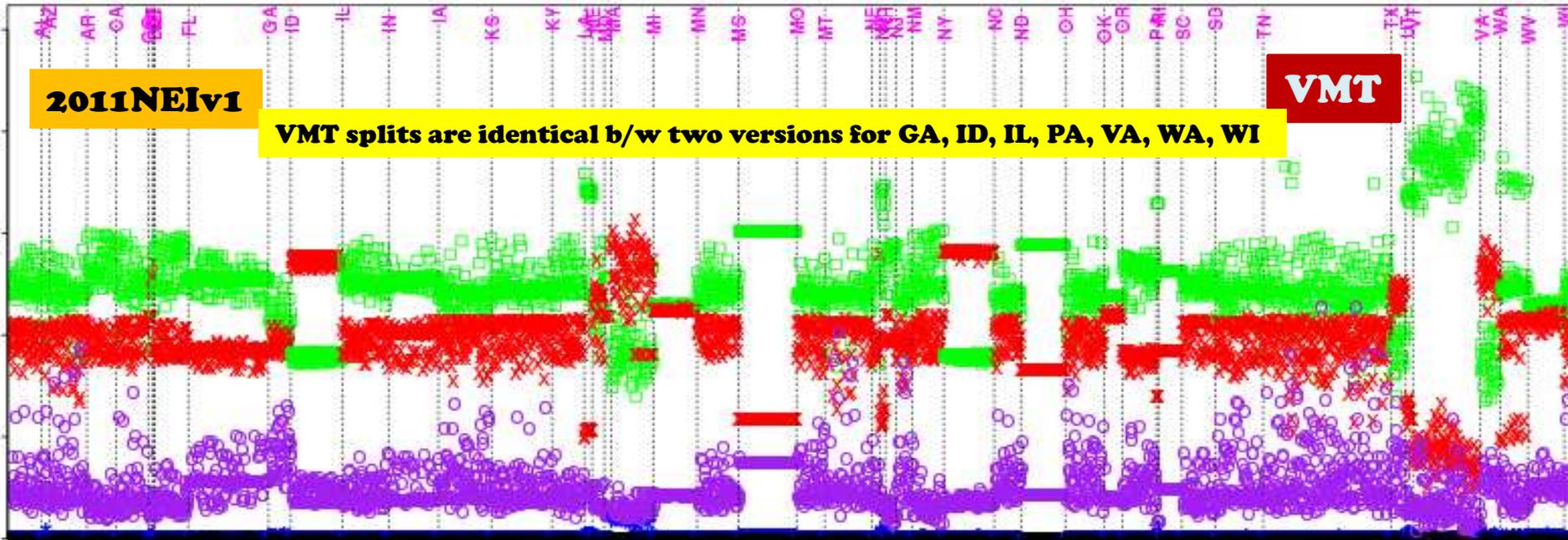
**VMT**



**2011NEIv1**

**VMT splits are identical b/w two versions for GA, ID, IL, PA, VA, WA, WI**

**VMT**



■ Non-Diesel Passenger Cars    
 × Non-Diesel Trucks/Buses    
 ★ Non-Diesel Motorcycles    
 + Diesel Passenger Cars    
 ○ Diesel Trucks/Buses

# EPA Response

- **David Brzezinski (OTAQ) on January 15, 2015 attempted to attribute the flip to a change in the way VMT is calculated in MOVES2014**
- **VMT HPMSVTypeID categories for passenger cars (20) and light-duty trucks (30) have been combined into a single light-duty vehicle category (25) in MOVES2014**
- **The source type “VMT conversion” uses:**
  - **VMT (user input by MOVES HPMS type 10, 25, 40, 50, 60)**
  - **Source type population (user input)**
  - **Source type age distribution (user input)**
  - **Source type relative mileage accumulation rate (default)**
- **The example, calculated for HPMS type 25, yields the percent makeup as:**

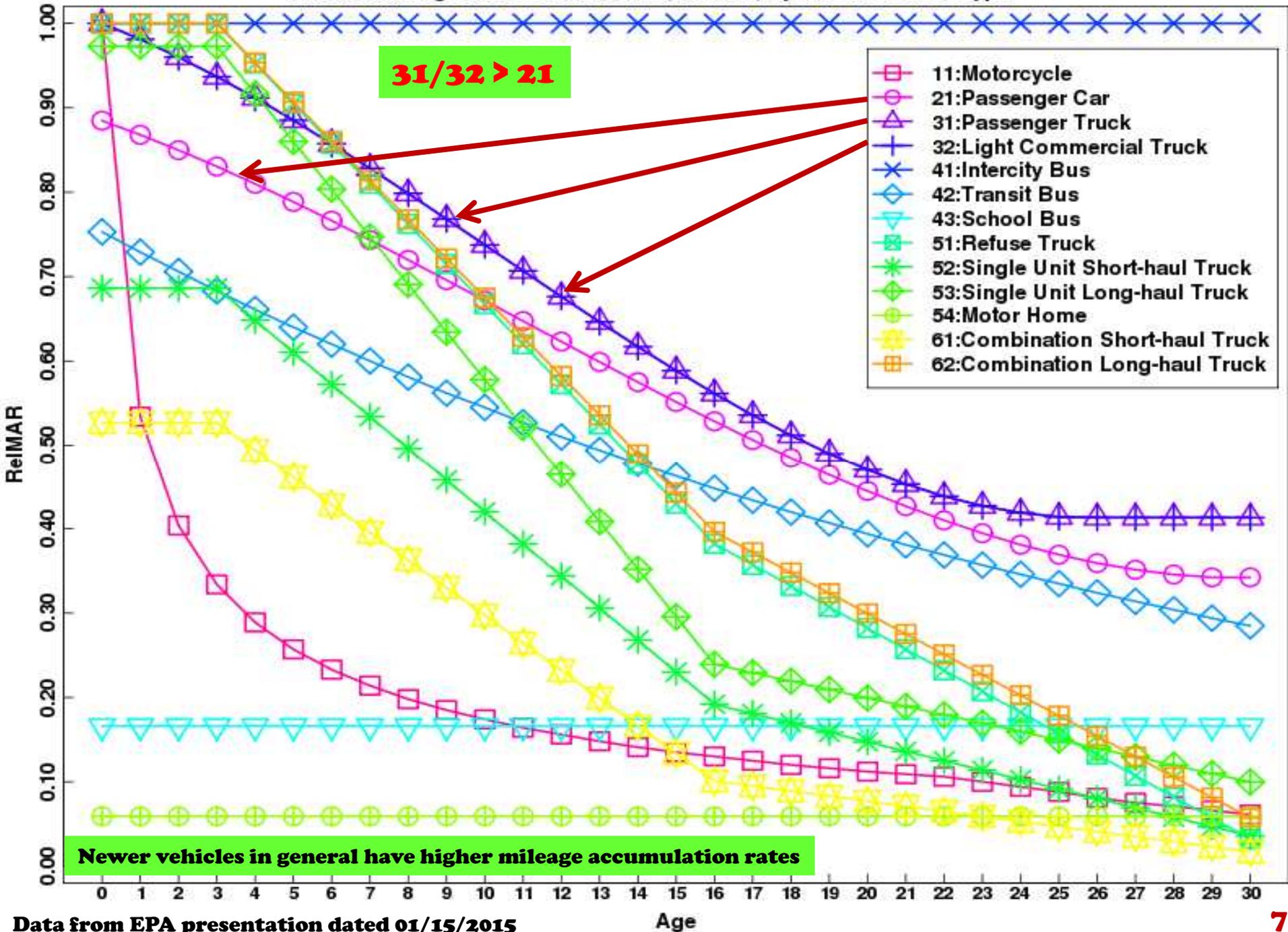
Source Type	21	31	32
VPOP	54.2%	36.8%	9.0%
VMT	51.0%	39.1%	9.9%

- **VPOP ratio of 31+32: 21 is 46%:54% (i.e., historical split)**
- **The EPA Response does not explain the flip**

# **Relative Mileage Accumulation Rate (ReIMAR)**

- **EPA provided information on ReIMAR**
- **ReIMAR is an internal MOVES variable that degrades vehicle usage as they age**
- **Variation of ReIMAR is by (13) MOVES vehicle type**
- **Passenger car (21) usage degrades faster than Passenger Trucks (31) or Light Commercial Trucks (32)**
- **This could explain the flip (will be tested in this study)**

Relative Mileage Accumulation Rate (ReIMAR) by Vehicle Source Type



# Relative Mileage Accumulation Rates by SourceType

## MOVES2010

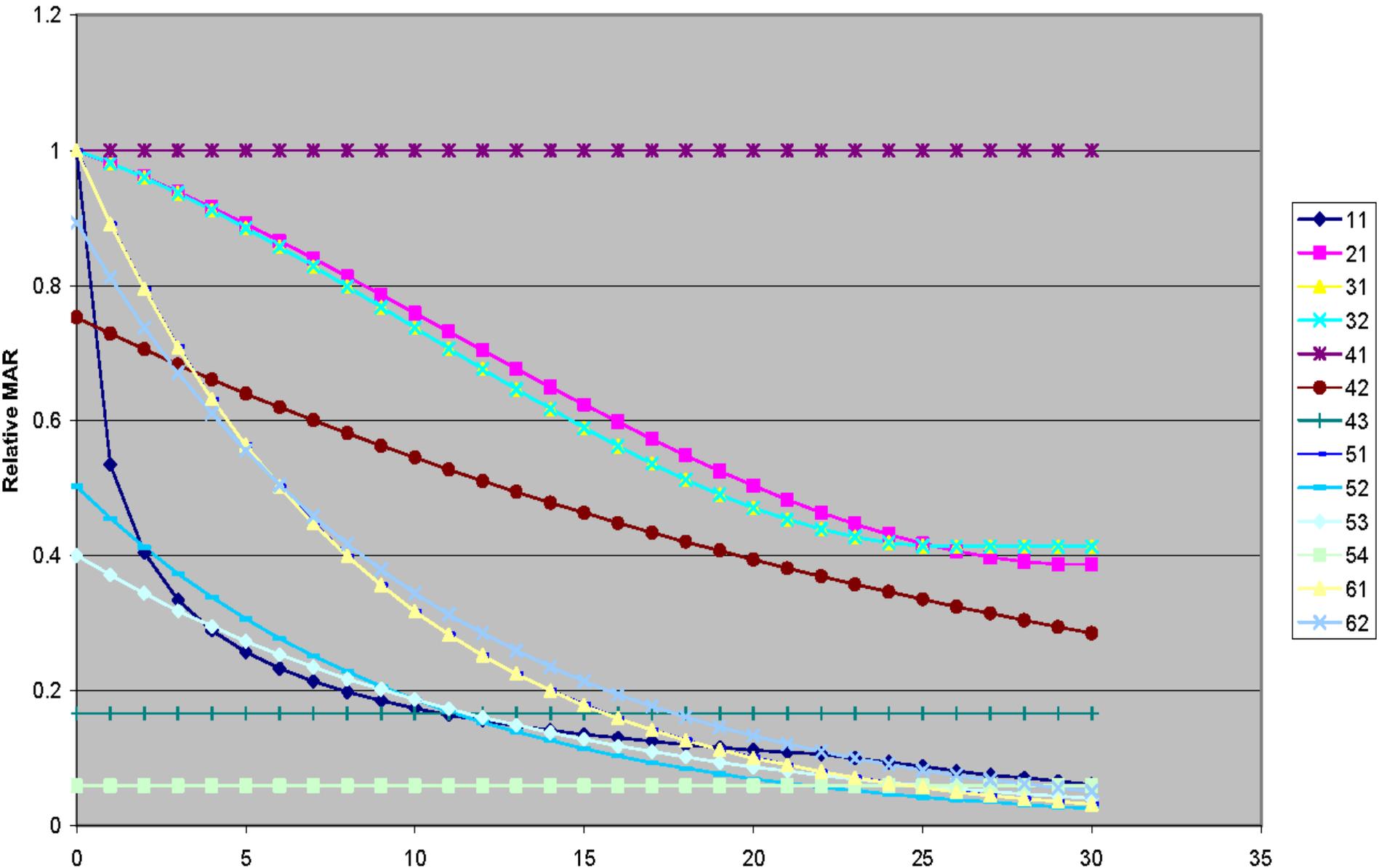


Figure from "MOVES2010 Highway Vehicle: Population and Activity Data" by EPA (Figure 6-1, page 66)

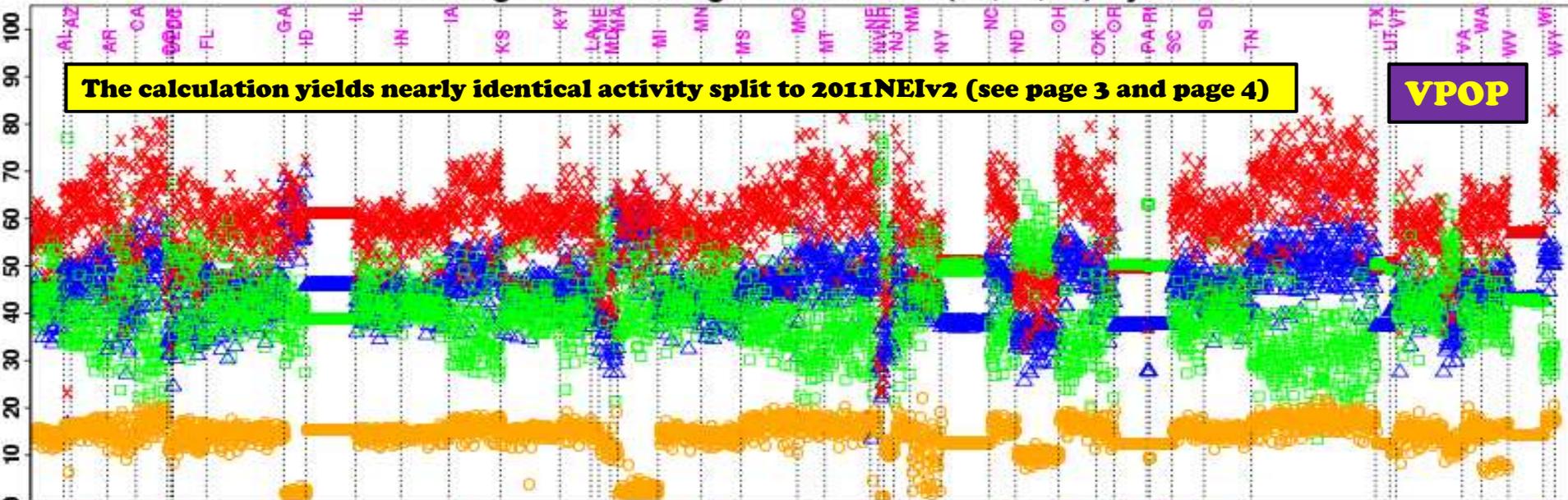
# Sensitivity

# Sensitivity Study

- **Goal of the study is to systematically understand the VMT conversion calculation and to find the cause of the flip**
- **Examine effect on activity by varying one set of inputs at a time (the calculation uses four sets of inputs)**
- **Inputs to the calculation obtained from 2011 NEI v2 CDBs posted by EPA**
- **Calculations conducted for counties in 48 states and District of Columbia (Alaska, Hawaii, Puerto Rico, and Virgin Islands were excluded)**

# Control Case -- Calculation Based on 2011NEIv2 CDBs

Percentage for Passenger Cars/Truck (21,31,32) by State



Legend:   
 ■ Passenger Cars (21)   
 ▲ Passenger Trucks (31)   
 ● Light Commercial Truck (32)   
 ✕ Sum of Two Trucks (31+32)   
 top: VPOP; bottom: VMT

# Sensitivity

Sensitivity	Effect	Details
<b>Sensitivity 1</b>	<b>Relative MAR</b>	<b>Replace 31/32 mileage accumulation rates with those of 21</b>
<b>Sensitivity 2</b>	<b>Age Distribution</b>	<b>Use constant age fraction (1/31) for all vehicles and counties</b>
<b>Sensitivity 3</b>	<b>VPOP</b>	<b>Replace 2011NEI<sub>v2</sub> VPOP with 2011NEI<sub>v1</sub> VPOP</b>
<b>Sensitivity 4 to 8</b>	<b>VPOP fractions</b>	<b>Vary 21/31/32 split (see below)</b>

Data source for sensitivity 3 was FF10 in 2011NEI<sub>v1</sub>, which has different SCC source types, thus, one-to-one mapping to vehicle types between two versions was necessary (see page 19/20).

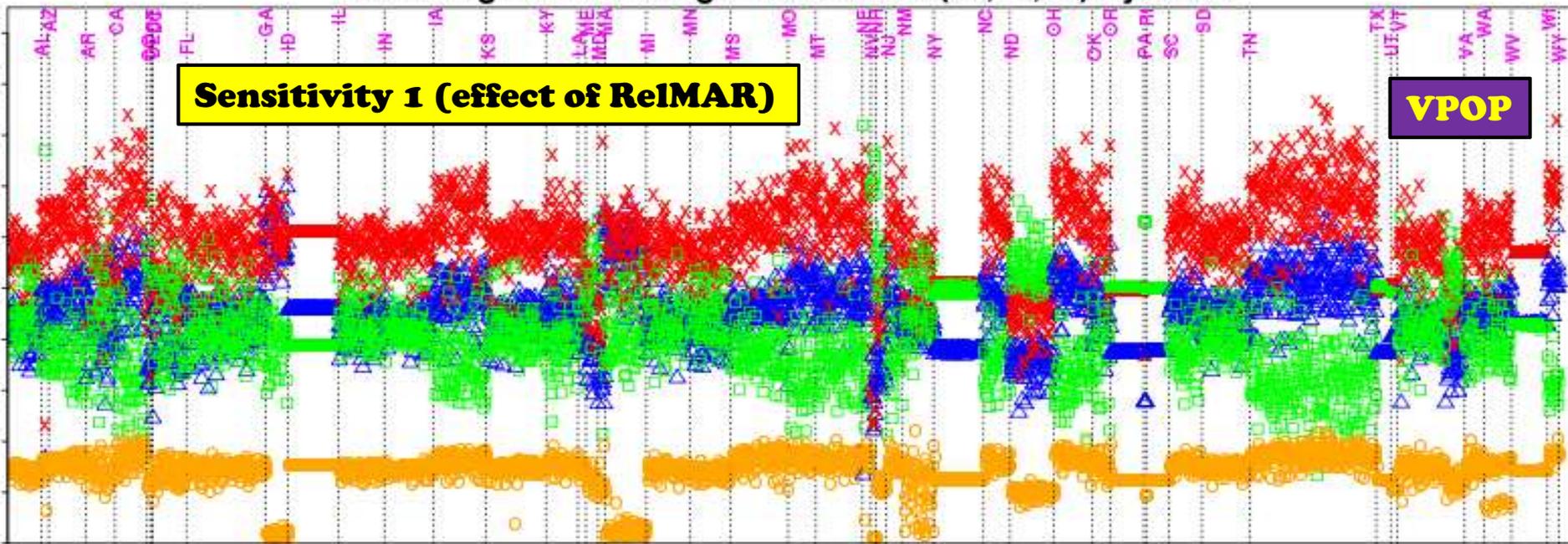
Source type	Sensitivity 4	Sensitivity 5	Sensitivity 6	Sensitivity 7	Sensitivity 8
<b>21</b>	<b>70</b>	<b>60</b>	<b>50</b>	<b>40</b>	<b>30</b>
<b>31</b>	<b>20</b>	<b>25</b>	<b>30</b>	<b>35</b>	<b>40</b>
<b>32</b>	<b>10</b>	<b>15</b>	<b>20</b>	<b>25</b>	<b>30</b>

Sensitivity 4 to 8 use the same total 2011NEI<sub>v2</sub> VPOP and the various splits for the three vehicle types all sum to **100** percent.

Percentage for Passenger Cars/Truck (21,31,32) by State

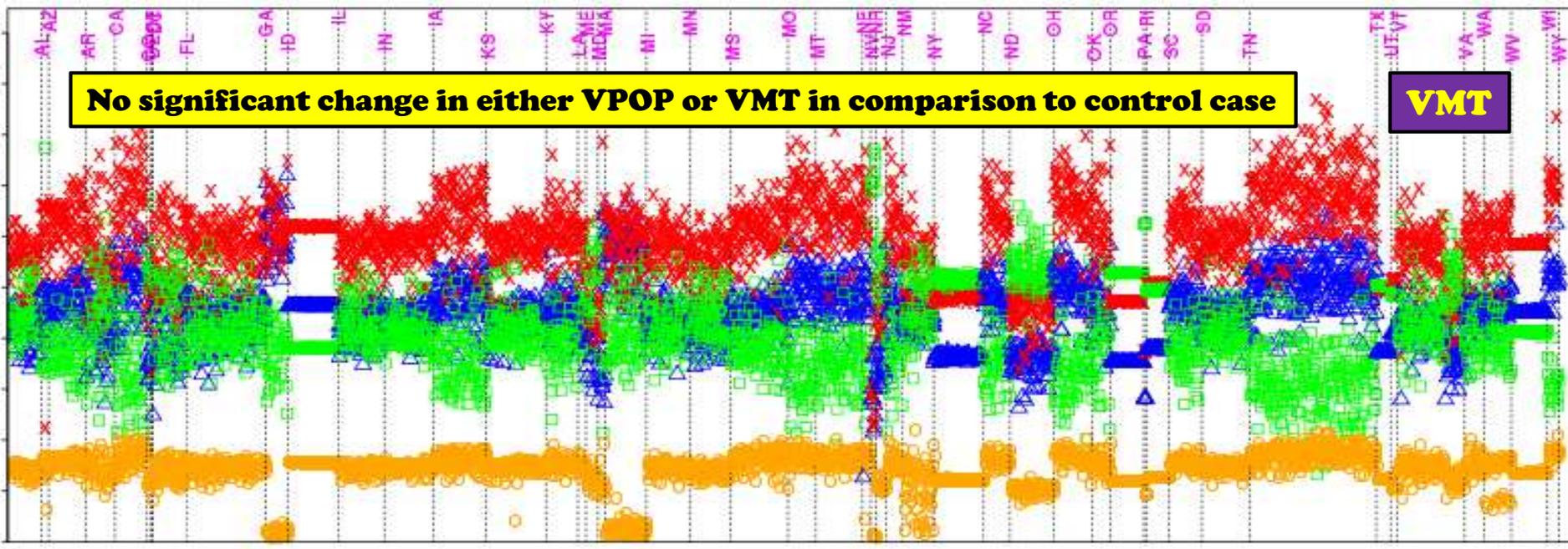
**Sensitivity 1 (effect of RelMAR)**

**VPOP**



**No significant change in either VPOP or VMT in comparison to control case**

**VMT**

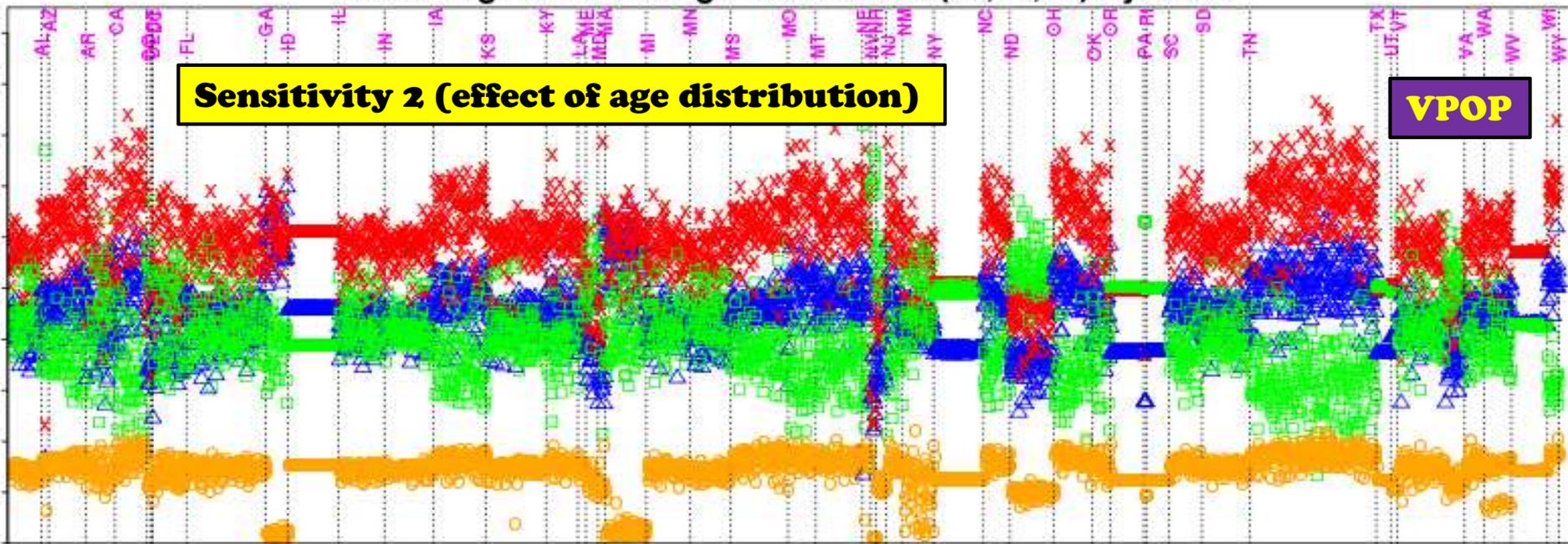


■ Passenger Cars (21)   
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 X Sum of Two Trucks (31+32)   
 top: VPOP; bottom: VMT

Percentage for Passenger Cars/Truck (21,31,32) by State

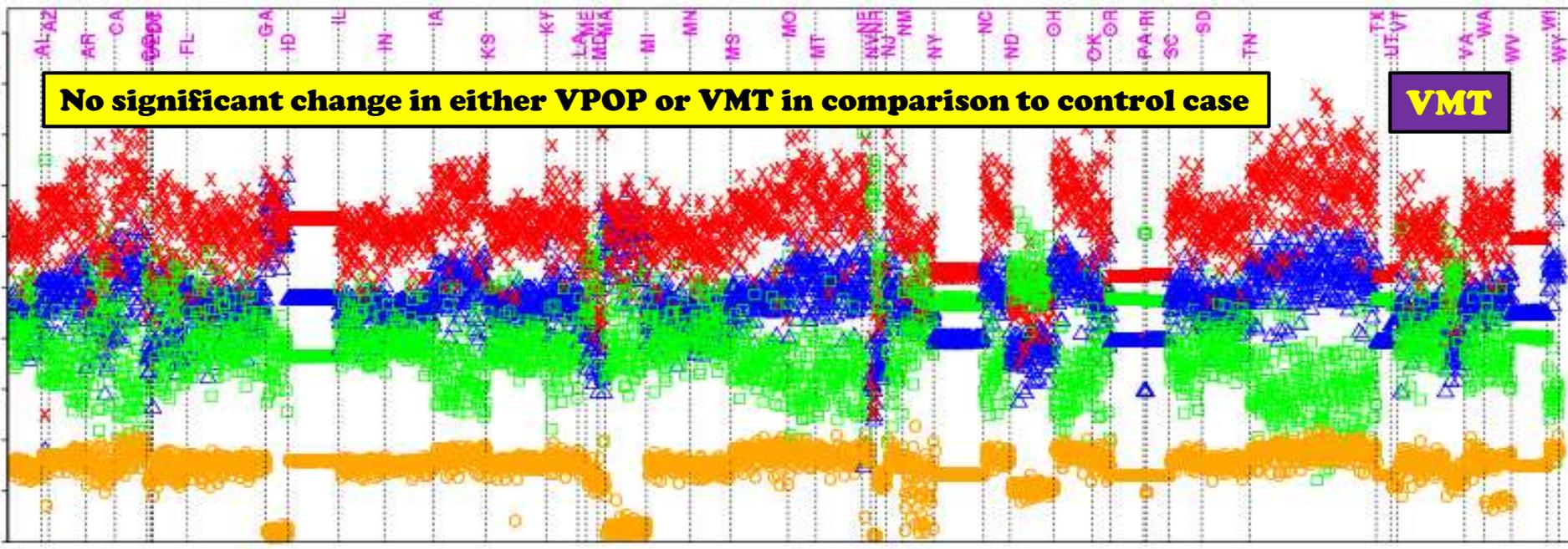
**Sensitivity 2 (effect of age distribution)**

**VPOP**



**No significant change in either VPOP or VMT in comparison to control case**

**VMT**

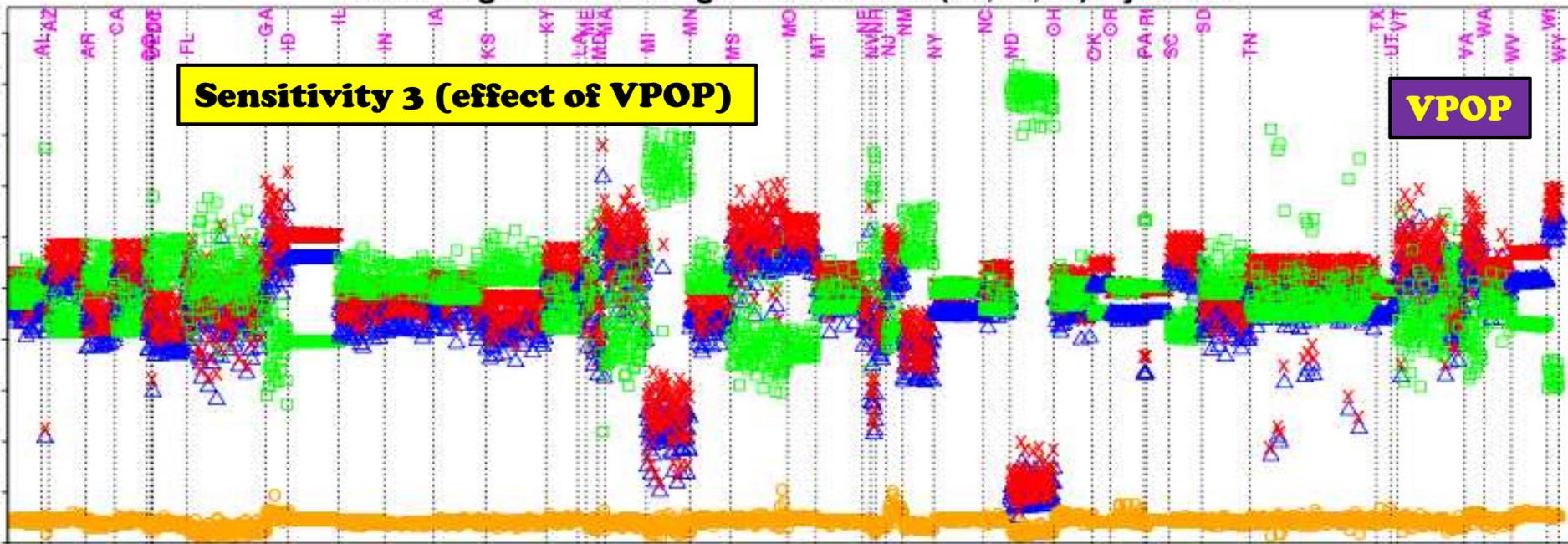


■ Passenger Cars (21)   
 ▲ Passenger Trucks (31)   
 ● Light Commercial Truck (32)   
 × Sum of Two Trucks (31+32)   
 top: VPOP; bottom: VMT

# Percentage for Passenger Cars/Truck (21,31,32) by State

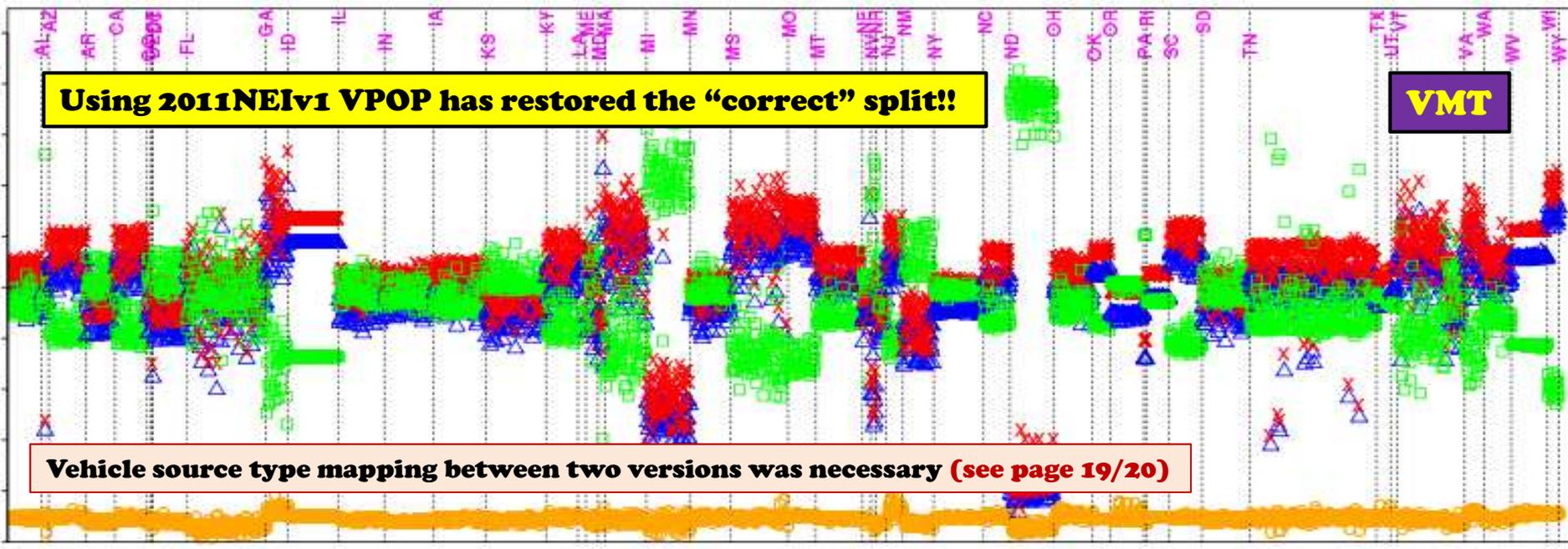
**Sensitivity 3 (effect of VPOP)**

**VPOP**



**Using 2011NEIv1 VPOP has restored the "correct" split!!**

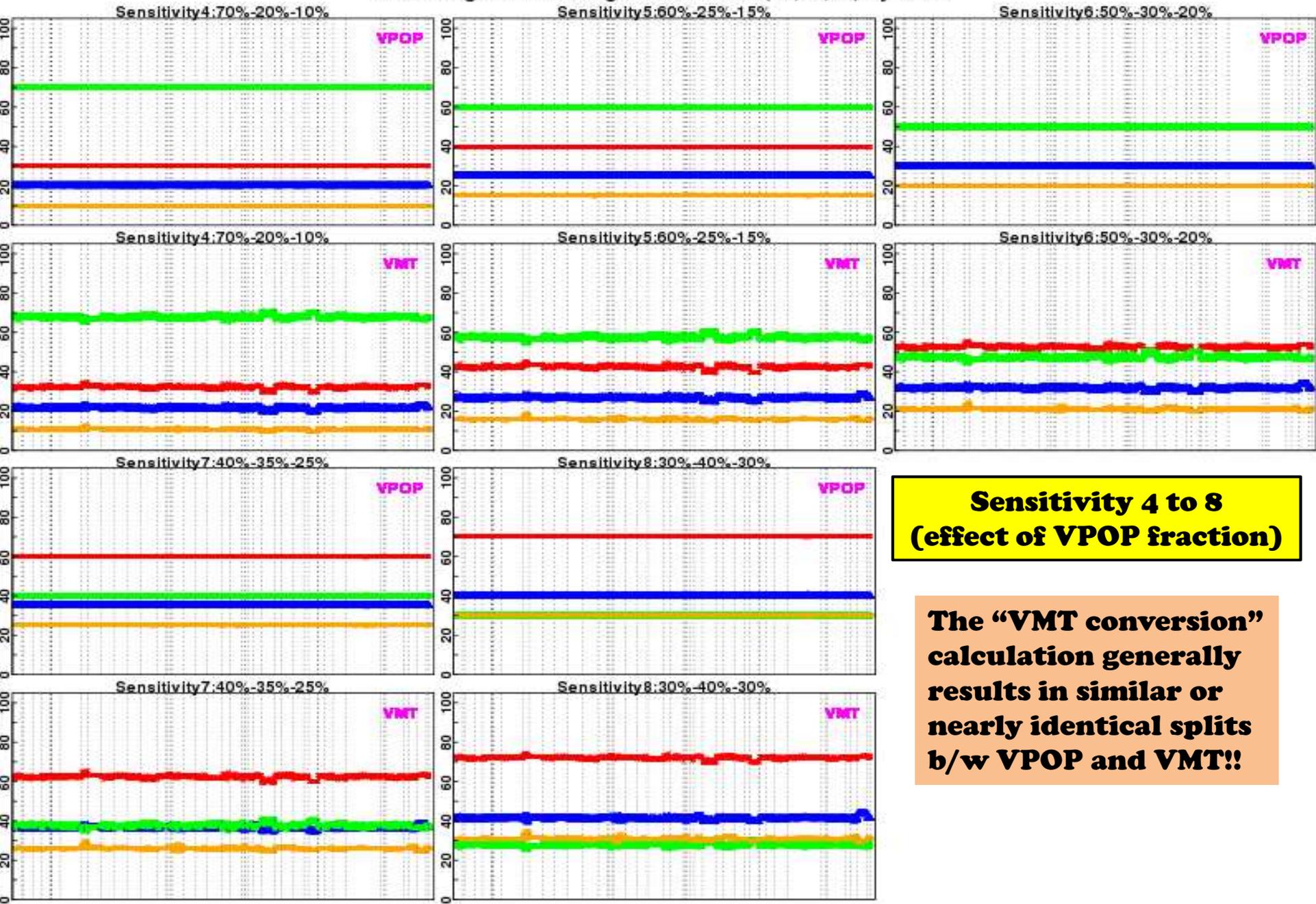
**VMT**



**Vehicle source type mapping between two versions was necessary (see page 19/20)**



**Percentage for Passenger Cars/Truck (21,31,32) by State**



**Sensitivity 4 to 8  
(effect of VPOP fraction)**

**The “VMT conversion”  
calculation generally  
results in similar or  
nearly identical splits  
b/w VPOP and VMT!!**

# Summary on Conversion Calculation

- **Among the inputs to the “VMT conversion” calculation, only VPOP (or VPOP split) has appreciable effect on VMT distribution. The other inputs (relative MAR and age distribution) have little or no effect on VMT split**
- **The “VMT conversion” calculation yields a very similar distribution between VPOP and VMT for the three light duty vehicle types**
- **VPOP (or its split) determines VMT distribution**
- **The “VMT conversion” calculation is not the cause of the flip**
- **The purpose of the calculation is to allocate VMT by source type and by vehicle age**
- **The calculation is done internally for inventory MOVES or externally for SMOKE-MOVES (for FF10) in EPA practice**

# Discussion

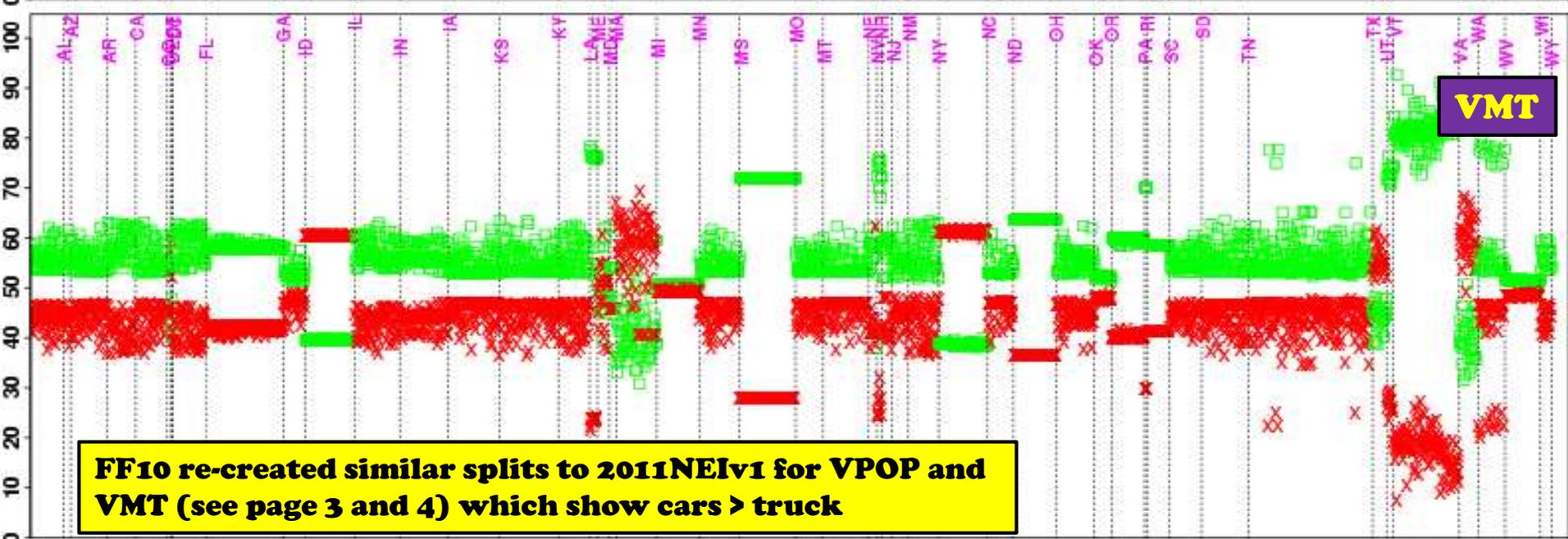
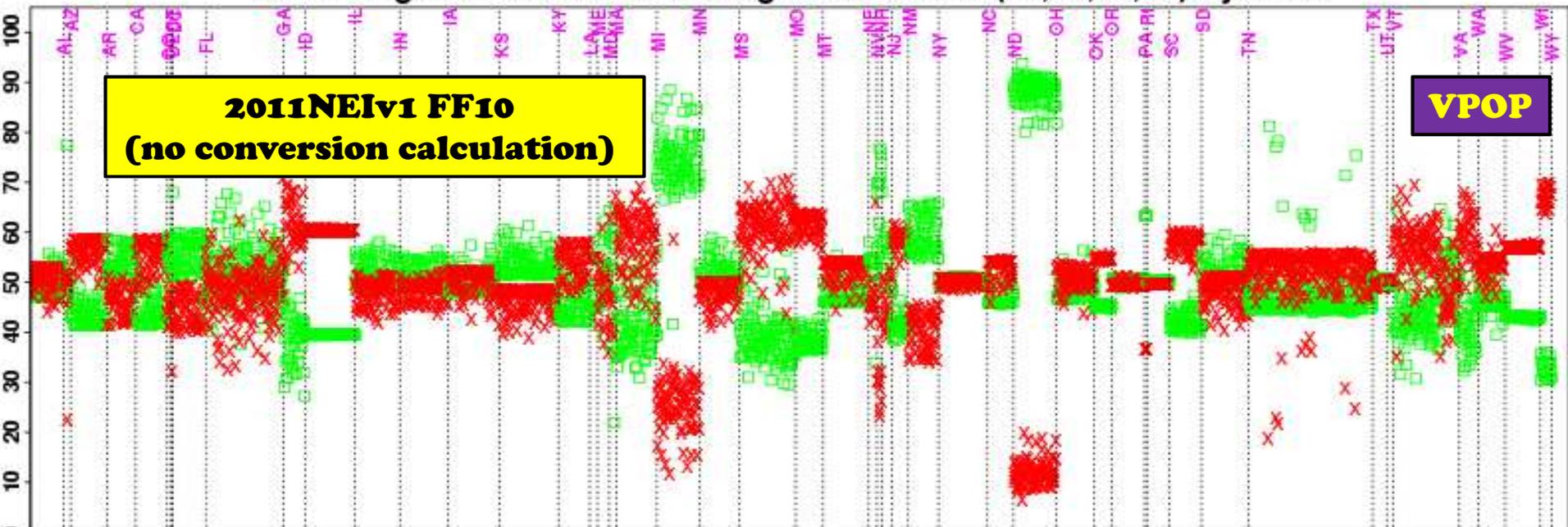
# 2011NEIv1

## Vehicle source type mapping between NEIv1 and NEIv2

- EPA also posted 2011NEIv1 activity in FF10 format
- FF10 contains activity data based on old SCC classification
- Conduct similar split analysis by summarizing activity by source type (**no** VMT conversion calculation) :

SCC2	01	20	40	70
SCCVtypeID	LDGV	LDGT1	LDGT2	HDGV
Surrogate source type	Passenger car	Passenger truck	Passenger truck	Passenger truck
Mapping assumed in sensitivity 3	21	31	31	32

Percentage for Gasoline Passenger Cars/Truck (01,20,40,70) by State



□ Passenger Cars (01)    X Passenger Trucks (20, 40, 70)

top: VPOP; bottom: VMT

# CRC Data

- **CRC project goal was to improve the default inputs used in EPA MOVES modeling**
- **Have CRC data been incorporated into 2011NEIv2?**
- **CRC data resolution:**

**CRC Vehicle Source Types for age distribution:**

**20, Passenger Car**

**30, Passenger Truck and Light Commercial Truck**

**CRC Vehicle Source Types for vehicle population:**

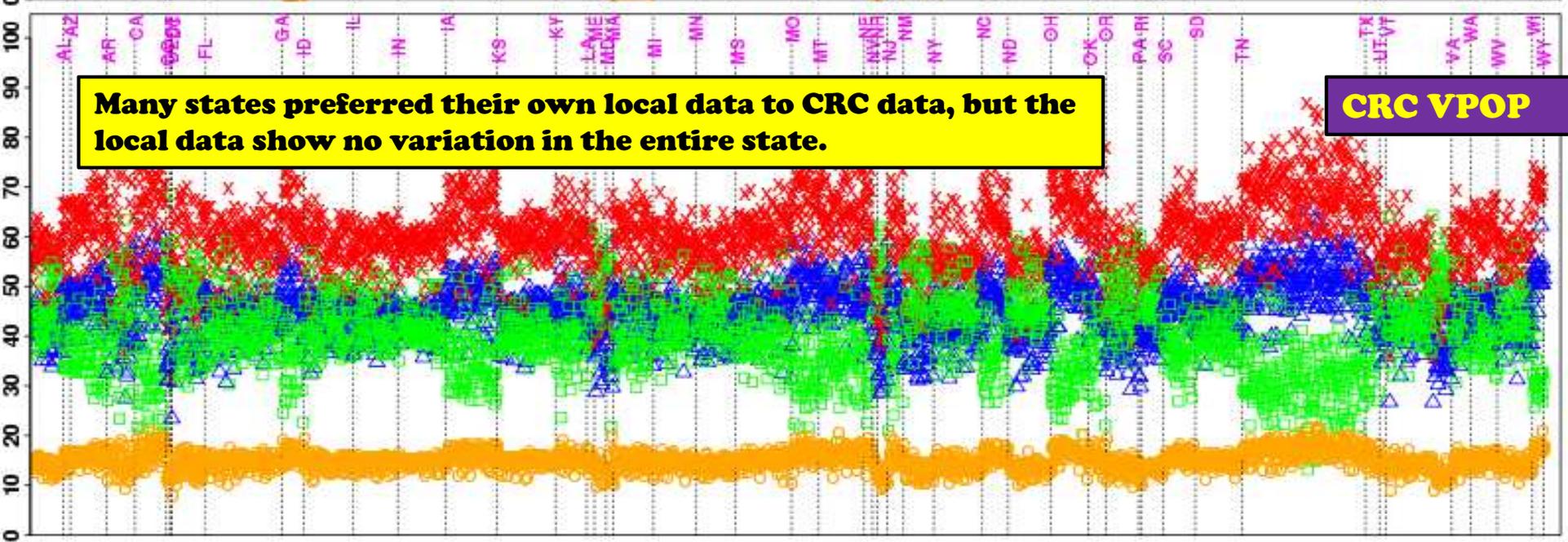
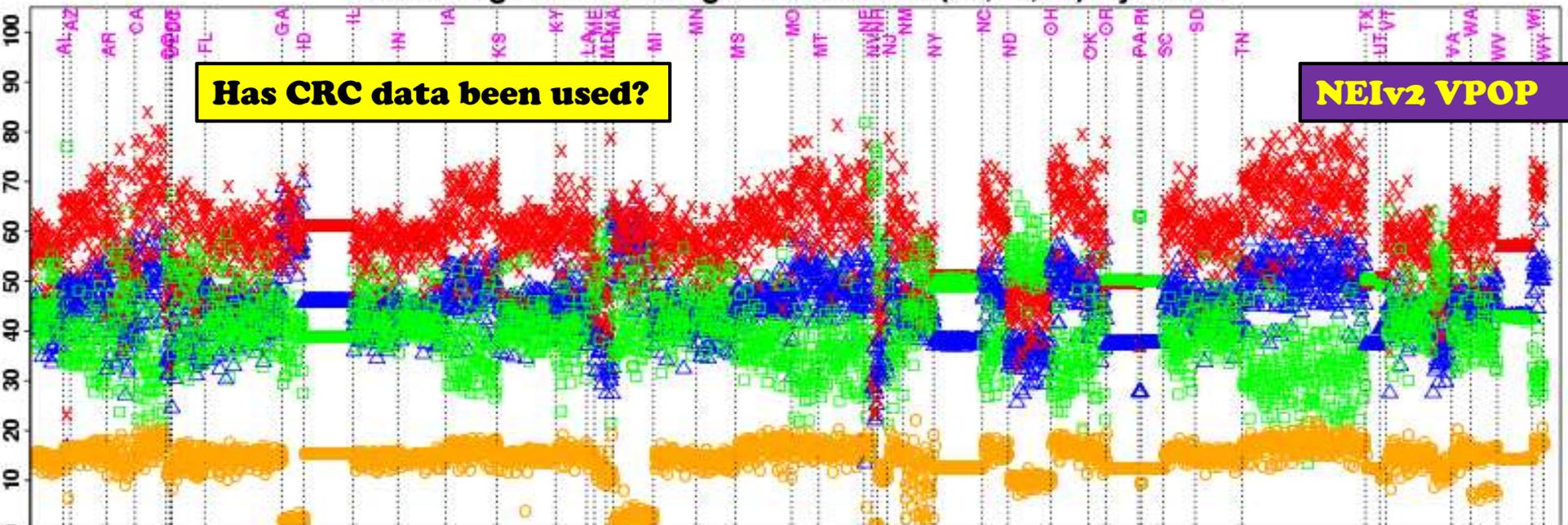
**21, Passenger Car**

**31, Passenger Truck**

**32, Light Commercial Truck**

**CRC VPOP is provided by MOVES source type (21, 31, 32) (i.e. the split among the three source types has already been determined)**

Percentage for Passenger Cars/Truck (21,31,32) by State



■ Passenger Cars (21)   
 ▲ Passenger Trucks (31)   
 ○ Light Commercial Truck (32)   
 X Sum of Two Trucks (31+32)   
 top: 2011NEIv2; bottom: CRC

# Overall Summary

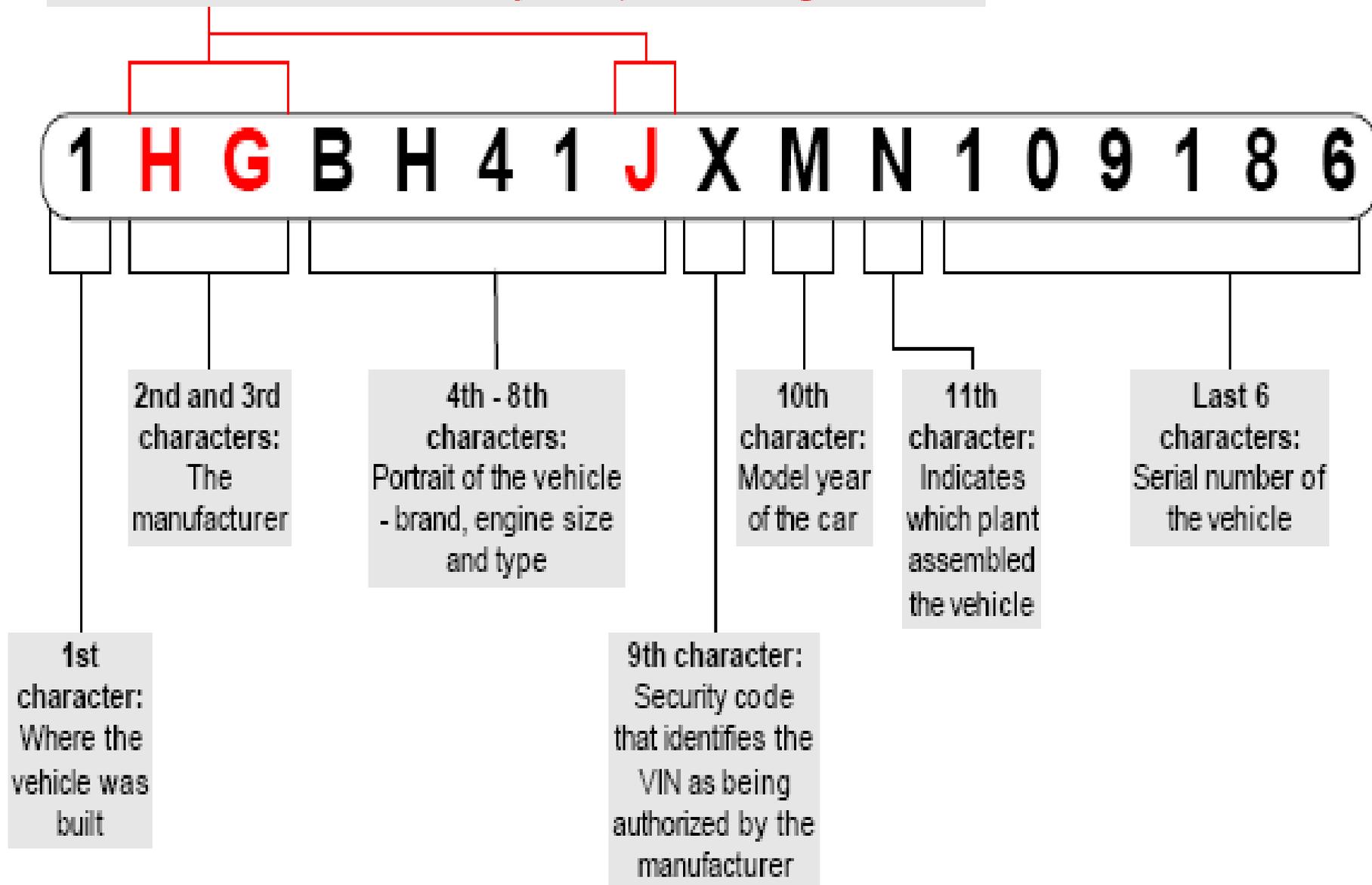
- **VPOP comparison indicates that CRC data is incorporated into 2011NEIv2**
- **Some states opted out of using CRC data, but the data replaced are homogeneous with no variation in the entire state**
- **CRC VPOP was provided at the MOVES source type level (21, 31, 32)**
- **As demonstrated in this study, VPOP distribution determines VMT distribution**
- **CRC VPOP for light-duty trucks (31+32) is higher than passenger cars (21) for most counties**
- **The change in VMT distribution (trucks > cars) in 2011NEIv2 is therefore attributed to CRC VPOP**

# Next Steps

# Vehicle Identification Number (VIN)

- **Each vehicle worldwide has a unique 17 digit code assigned when it is manufactured**
- **State vehicle registration databases include this code for every vehicle**
- **These 17 digits can be used to sort vehicles into broad vehicle types needed by the MOVES model**
- **Five of these digits (positions 4 to 8) indicate general characteristics of the vehicle like body type, model, engine type, series**
- **However, these 17 digits cannot distinguish between passenger trucks (31) and light commercial trucks (32) or between short-haul and long-haul vehicles.**

Flexible Fuel Vehicles can be identified by the 2nd, 3rd and 8th digits of the VIN



# Next Steps

- **What ratio or assumptions did CRC use to create vehicle population split between passenger cars, passenger trucks and light commercial trucks? Should states also use this method? Any documentation?**
- **Some states use fractions provided by EPA to convert MOBILE6 to MOVES vehicle types (see MOVES2010 technical guidance, Appendix A). Will EPA provide similar fractions for MOVES2014?**
- **How can states create VPOP inputs for passenger car, passenger truck, and light commercial trucks? Currently no standard method is available.**
- **Should all states be asked to use a VIN decoding process (commercial software or in-house method) to create VPOP input?**
- **Are there established methods to convert VINs directly to MOVES vehicle types?**
- **How can a consistent approach be derived to guide states in development of MOVES vehicle population inputs?**

**EPA please comment**