MOVES
Motor Vehicle Emission Simulator

Updates to Onroad Vehicle Population and Activity Data in MOVES2014

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MOVES2014

- EPA's mobile source air pollution emission model
- Estimates emissions and energy use from onroad sources at the national, county, and project scales
- Adds nonroad emissions by incorporating of NONROAD2008
- Contains new rules, emission rates and activity data for onroad vehicles
- Updates onroad fuel effects and other correction factors
- Replaces MOVES2010b

Major Updates to Onroad Vehicle Population and Activity

- Updated *historical* vehicle populations and miles (VMT)
- Updated *projected* vehicle populations and VMT
- Better described vehicle mix and heavy truck characteristics
- Improved default speed distributions and driving cycles
- Improved default activity for long-haul truck hotelling
- Accounted for multi-day parking

Historical VMT and Population from FHWA

- MOVES relies on FHWA for historical VMT and vehicle population defaults
- In 2011, FHWA changed their vehicle categories
  - Based on updated vehicle classification approach
  - Intended to improve VMT estimates for light-duty vehicles
- This methodology change
  - No longer separates light-duty cars and trucks
  - Conserved total VMT
    - decreased light-duty VMT *slightly*;
    - increased heavy-duty VMT *substantially*

Old Classifications

ANNUAL VEHICLE DISTANCE TRAVELED IN MILES AND RELATED DATA - 2006 1/
BY HIGHWAY CATEGORY AND VEHICLE TYPE

January 2011 TABLE VM-1

YEAR	ITEM	PASSENGER CARS	MOTOR-CYCLES /3	BUSES	OTHER 2-AXLE 4-TIRE VEHICLES 4/	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE TRUCKS 5/	COMBINATION TRUCKS	SUBTOTALS: PASSENGER CARS AND OTHER 2-AXLE 4-TIRE VEHICLES	SUBTOTALS: SINGLE-UNIT 2-AXLE 6-TIRE OR MORE AND COMBINATION TRUCKS	ALL MOTOR VEHICLES 2/
	Motor-Vehicle Travel: (millions of vehicle-miles)									
2006	Interstate Rural	123,847	1,367	950	81,548	7,125	43,079	205,395	50,204	257,915
2006	Other Arterial Rural	207,029	1,602	959	145,716	13,847	25,430	352,744	39,277	394,582
2006	Other Rural	206,732	1,666	1,612	145,773	15,154	13,711	352,505	28,865	384,649
2006	All Rural	537,607	4,635	3,521	373,036	36,125	82,221	910,644	118,346	1,037,146
2006	Interstate Urban	267,106	2,379	1,024	166,660	10,033	30,085	433,766	40,118	477,287
2006	Other Urban	885,821	5,035	2,239	542,794	34,186	29,863	1,428,615	64,049	1,499,938
2006	All Urban	1,152,927	7,414	3,263	709,454	44,219	59,948	1,862,381	104,167	1,977,225
2006	Total Rural and Urban	1,690,534	12,049	6,783	1,082,490	80,344	142,169	2,773,025	222,513	3,014,371
2006	Number of motor vehicles registered 6/	135,399,945	6,678,958	821,959	99,124,775	6,649,337	2,169,670	234,524,720	8,819,007	250,844,644
2006	Average miles traveled per vehicle	12,485	1,804	8,253	10,920	12,083	65,526	11,824	25,231	12,017
2006	Person-miles of travel 7/ (millions)	2,671,044	15,303	143,816	1,876,690	80,344	142,169	4,547,734	222,513	4,929,366
2006	Fuel consumed 8/ (thousand gallons)	75,008,950	221,030	1,148,409	60,685,249	9,852,378	28,106,544	135,694,199	37,958,921	175,022,559
2006	Average fuel consumption per vehicle (gallons) 8/	554	33	1,397	612	1,482	12,954	579	4,304	698
2006	Average miles traveled per gallon of fuel consumed 8/	22.5	54.5	5.9	17.8	8.2	5.1	20.4	5.9	17.2

http://www.fhwa.dot.gov/policy/ohim/hs06/htm/vm1.htm

New Classifications

ANNUAL VEHICLE DISTANCE TRAVELED IN MILES AND RELATED DATA - 2006 1/
BY HIGHWAY CATEGORY AND VEHICLE TYPE

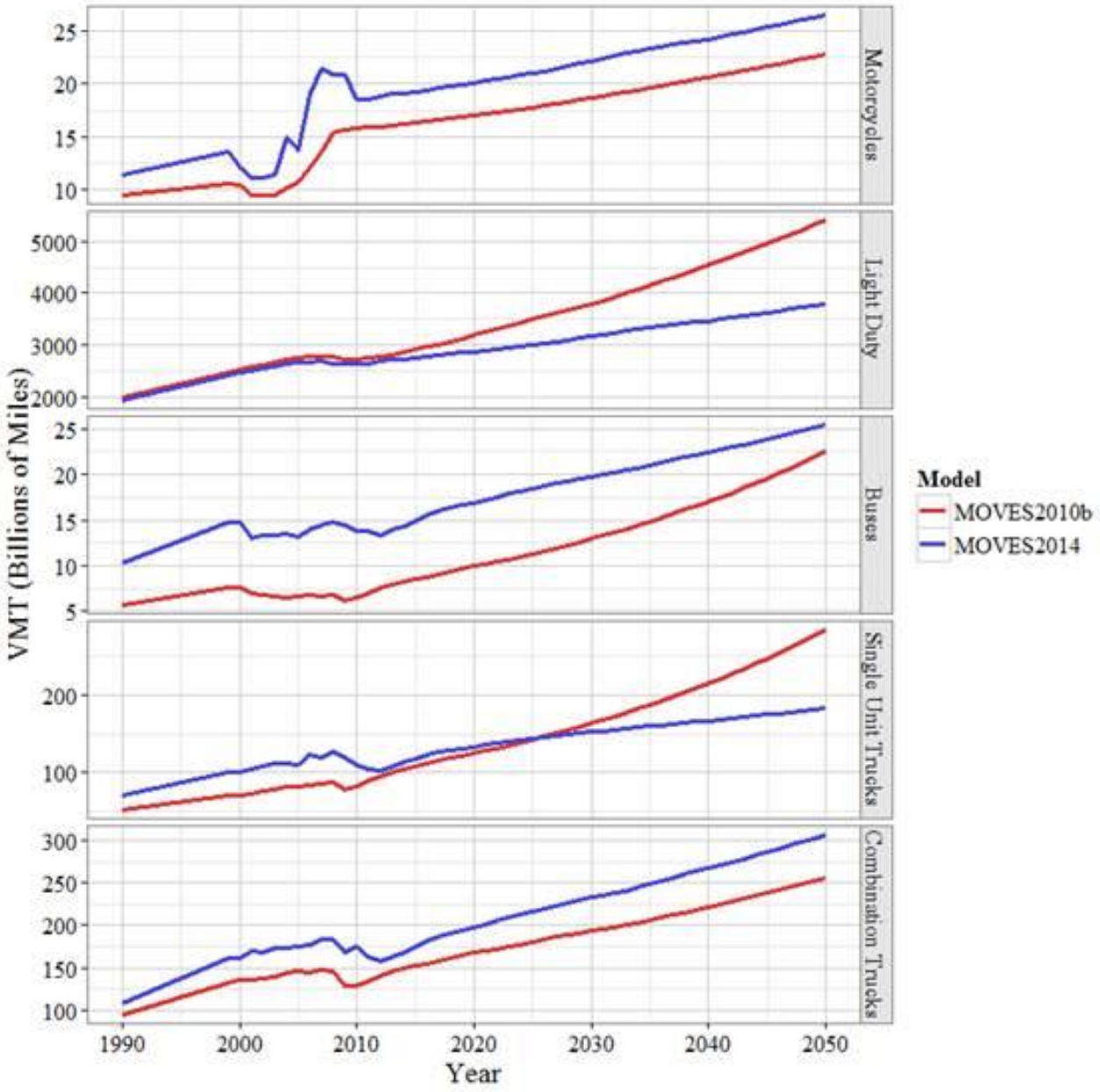
Published: April 2011 UPDATED VM-1*

YEAR	ITEM	LIGHT DUTY VEHICLES SHORT WB 2/	MOTOR-CYCLES	BUSES	LIGHT DUTY VEHICLES LONG WB 2/	SINGLE-UNIT TRUCKS 3/	COMBINATION TRUCKS	SUBTOTALS		ALL MOTOR VEHICLES
								ALL LIGHT DUTY VEHICLES /2	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE AND COMBINATION TRUCKS	
	Motor-Vehicle Travel: (millions of vehicle-miles)									
2006	Interstate Rural	145,528	1,399	1,410	45,217	10,201	54,161	190,745	64,361	257,915
2006	Other Arterial Rural	244,948	2,881	1,982	93,525	19,999	31,247	338,473	51,246	394,582
2006	Other Rural	237,099	2,721	1,933	105,356	20,530	17,010	342,455	37,540	384,649
2006	All Rural	627,575	7,001	5,324	244,098	50,730	102,418	871,672	153,148	1,037,146
2006	Interstate Urban	334,898	2,150	1,812	84,682	17,004	36,741	419,580	53,745	477,287
2006	Other Urban	1,085,472	10,005	6,902	303,813	55,584	38,162	1,389,285	93,746	1,499,938
2006	All Urban	1,420,370	12,155	8,714	388,495	72,588	74,903	1,808,865	147,491	1,977,225
2006	Total Rural and Urban 5/	2,047,945	19,157	14,038	632,593	123,318	177,321	2,680,537	300,639	3,014,371
2006	Number of motor vehicles registered 2/	194,294,855	6,678,958	821,959	38,714,951	7,755,933	2,577,988	233,009,805	10,333,922	250,844,644
2006	Average miles traveled per vehicle	10,540	2,868	17,079	16,340	15,900	68,783	11,504	29,092	12,017
2006	Person-miles of travel 4/ (millions)	3,235,752	24,329	297,631	1,096,712	123,318	177,321	4,332,465	300,639	4,955,063
2006	Fuel consumed (thousand gallons)	88,590,016	445,987	1,975,536	36,974,459	16,761,174	29,613,306	125,564,475	46,374,480	174,930,342
2006	Average fuel consumption per vehicle (gallons)	456	67	2,403	955	2,161	11,487	539	4,488	697
2006	Average miles traveled per gallon of fuel consumed	23.1	43.0	7.1	17.1	7.4	6.0	21.3	6.5	17.2

Future Year Projections from DOE

- MOVES2014 uses DOE's Annual Energy Outlook 2014 projections for 2012-and-later
  - Vehicle miles traveled
  - Vehicle population
  - Fuel consumption
- MOVES sales projections are based on relative annual VMT growth

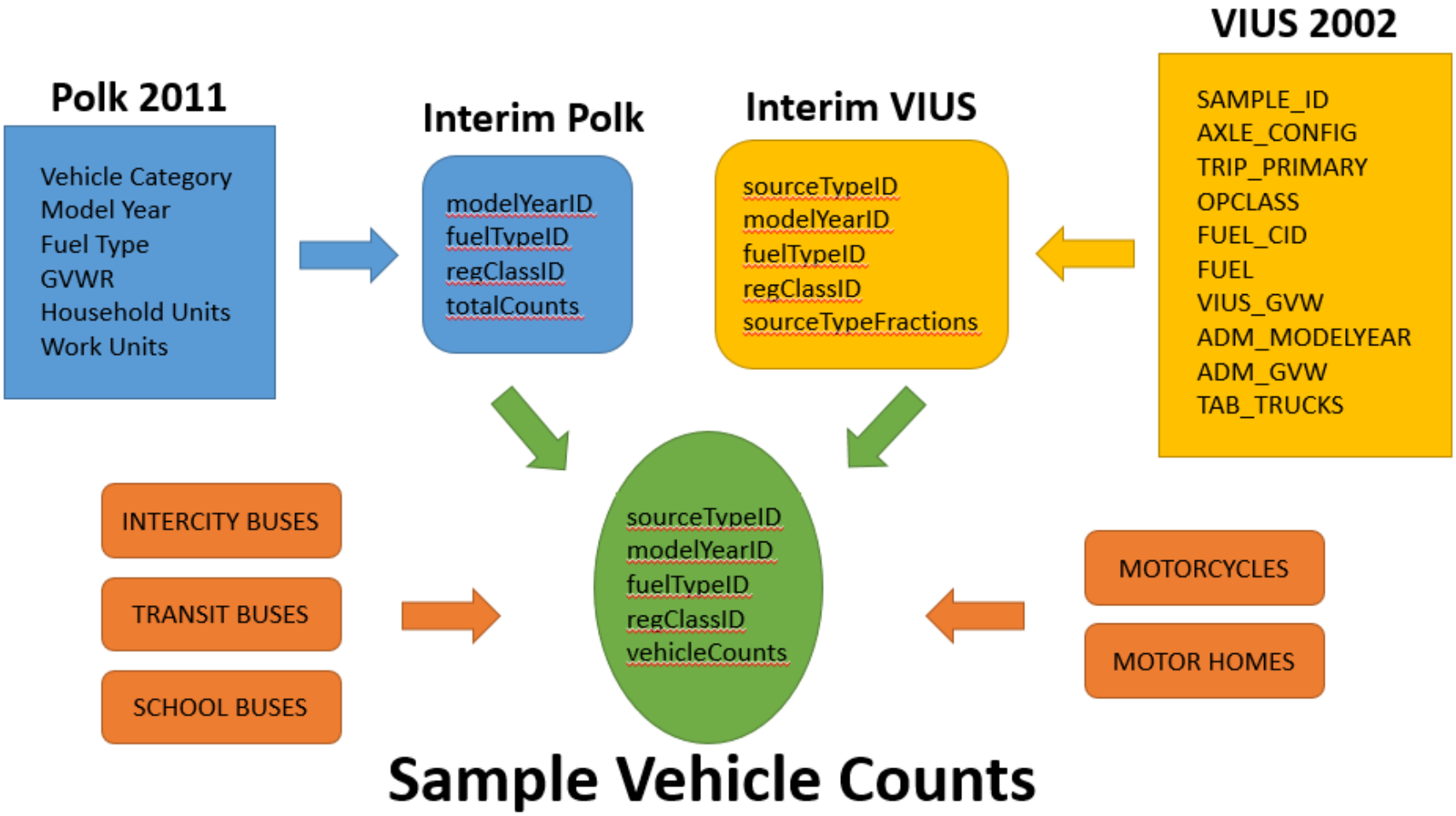
VMT Growth in MOVES 2010b and MOVES 2014



Vehicle Mix

- Vehicle mix is important for emissions:
  - Fuel Types
    - Fraction of Gasoline & Diesel
    - Availability of Flexible Fueled (E85) Vehicles
  - Regulatory Classes
    - Emission standards depend mostly on vehicle weight ratings (GVWR) and model year
  - Age Distributions
    - Model-year distribution
    - Deterioration of controls
    - Activity varies with age

New Data on Vehicle Mix



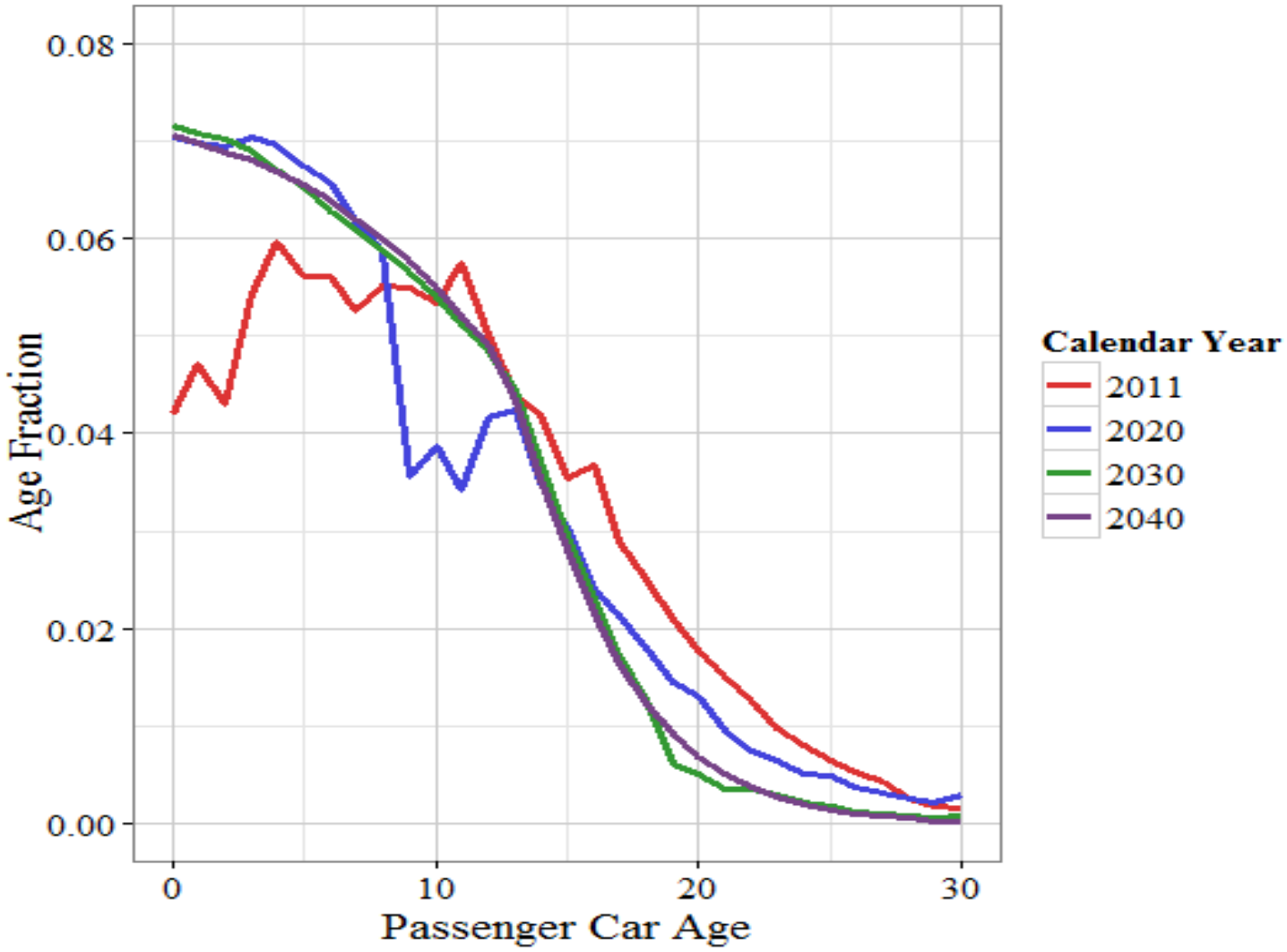
Vehicle Characteristics

- Weight and aerodynamic characteristics of vehicles determine power needed at different speeds
- We used Weigh-in-Motion data to update mass characteristics of heavy-duty trucks
- HD GHG rule requires changes in HD truck characteristics– MOVES now reflects thsi.

Age Distributions

- Base year age distributions from Polk & VIUS data
- Projected to future using sales and scrappage assumptions
  - MOVES2010 used single scrappage curve
  - MOVES2014 uses a dynamic scrappage rate

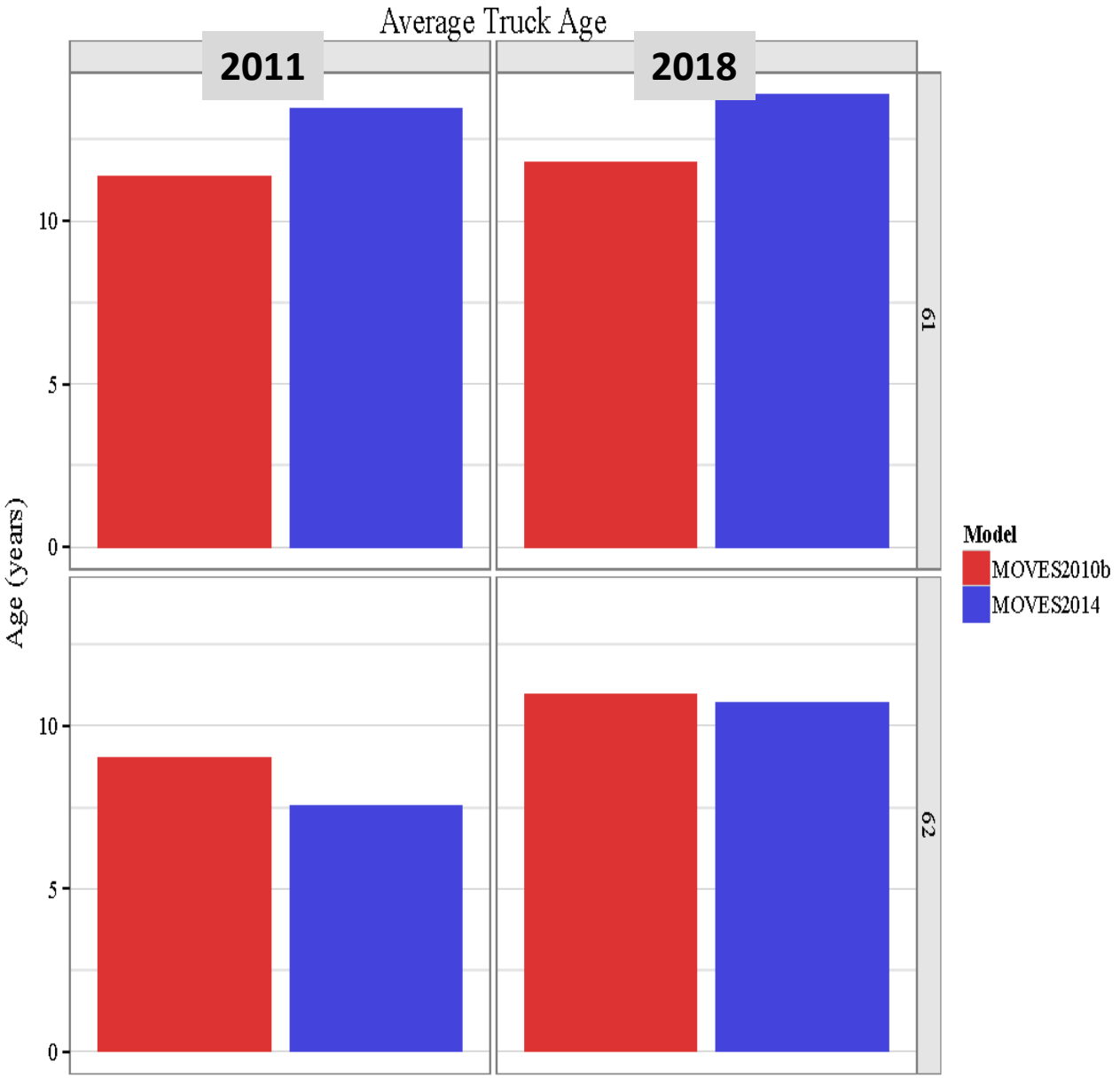
Passenger Car Age Distributions



Average Combination Truck Age

Short Haul

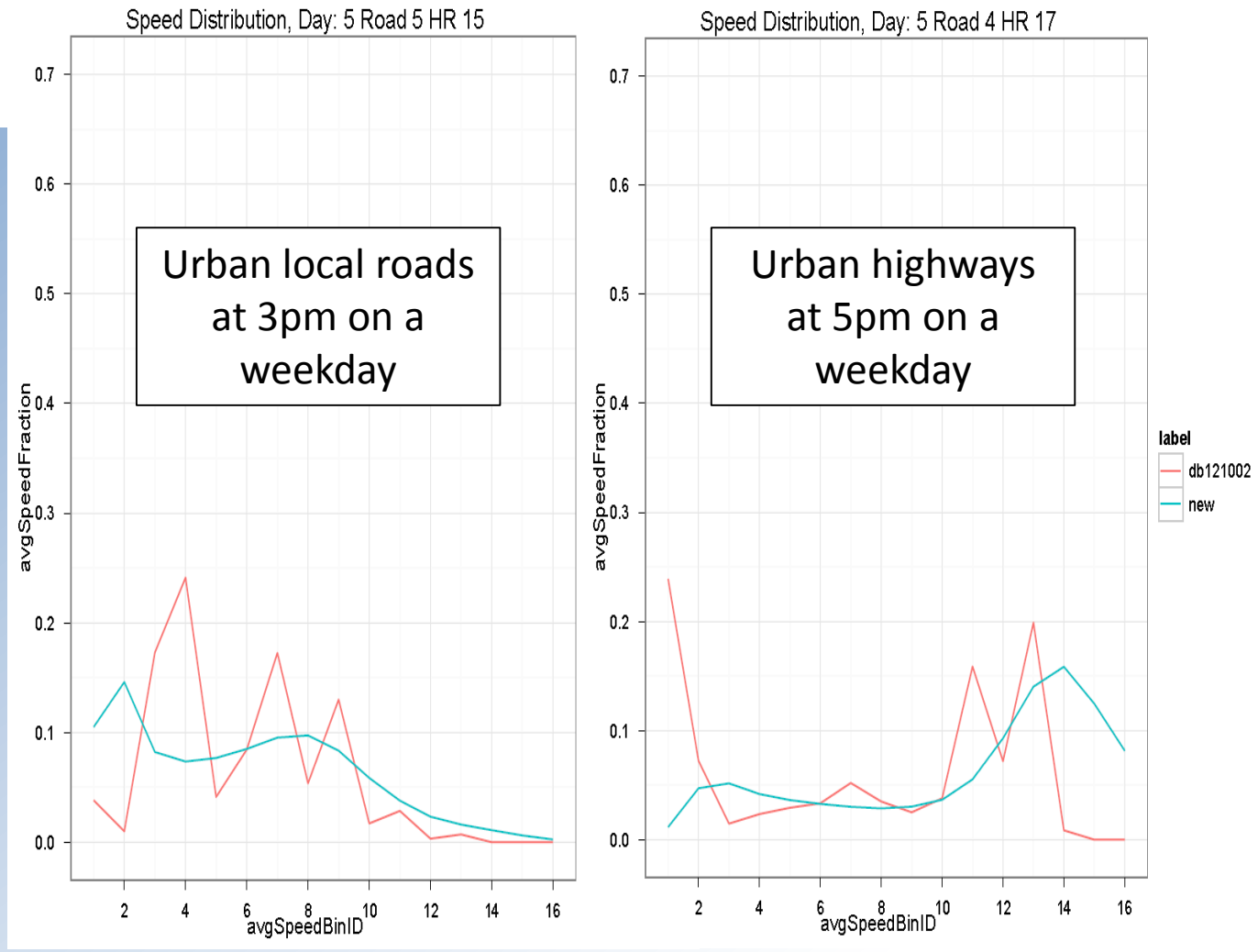
Long Haul



Better Data on Speed

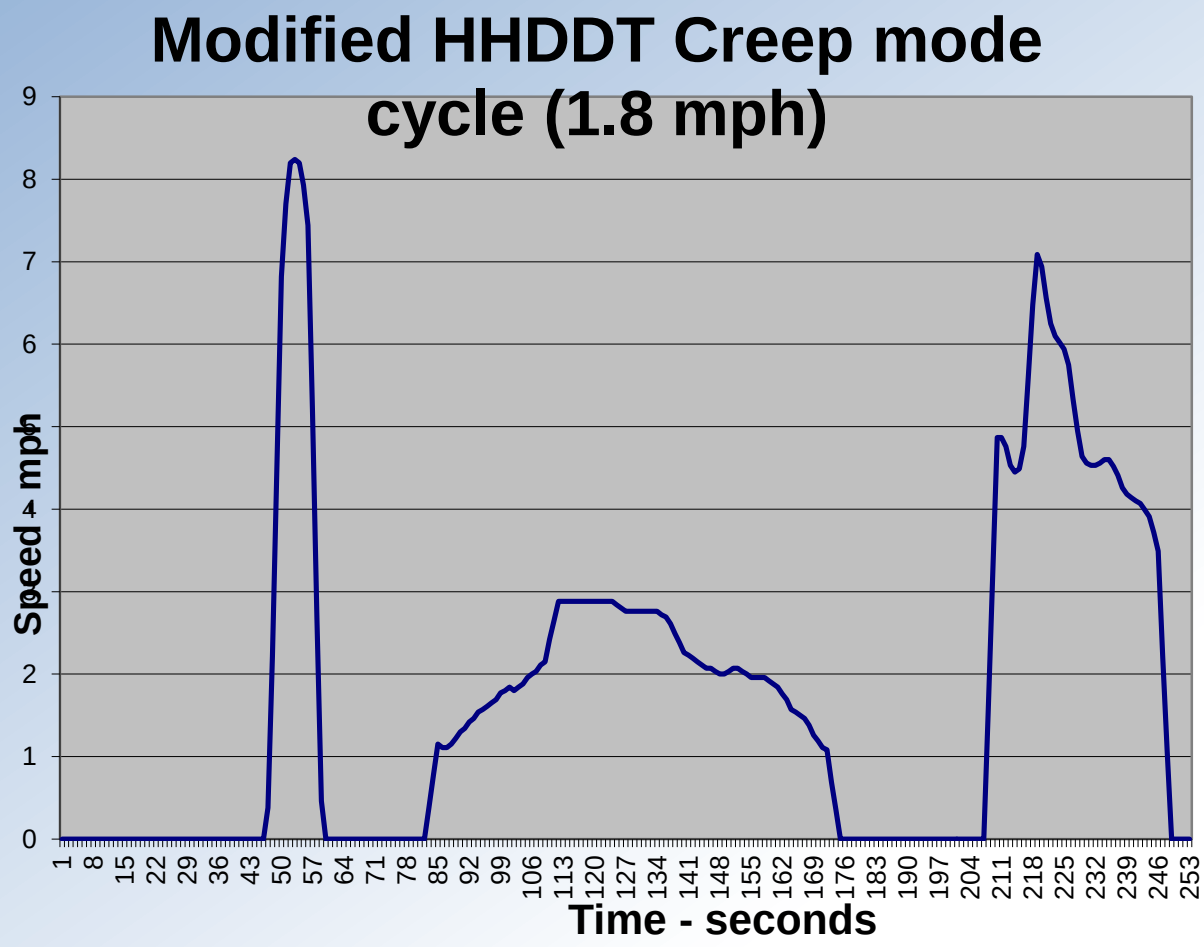
- MOVES2010b average speed distributions were based on travel demand models from a 1999 analysis
- Instrumented vehicles provided more up-to-date and detailed vehicle behavior
- New speed distributions based on TomTom summary GPS information with detail by:
  - road type
  - hour of the day
  - day of the week

Comparison of Example Average Speed



GPS data provides much smoother transitions between speed bins than previous defaults

New driving cycles for high and low speeds



Driving Schedule Map

Source Type		Min Speed (mph) / Max Speed (mph)	0 – 2.5	2.5 – 5	5 – 10	10 – 15	15 – 20	20 – 25	25 – 30	30 – 35	35 – 40	40 – 45	45 – 50	50 – 55	55 – 60	60 – 65	65 – 70	70 – 75	75 – 100
11	Motorcycle																		
21	Passenger Car																		
31	Passenger Truck																		
32	Light Commercial Truck																		
41	Intercity Bus																		
42	Transit Bus																		
43	School Bus																		
51	Refuse Truck																		
52	Single Unit Short-haul Truck																		NEW!
53	Single Unit Long-haul Truck																		
54	Motor Home																		
61	Combination Short-haul Truck	NEW!	NEW!																
62	Combination Long-haul Truck																		

Hotelling

- Long-haul combination trucks often operate even when they are not driving (hotelling).
- MOVES2014 can model two methods of hotelling on long-haul combination trucks:
  - Idling the main engine (Extended Idle)
  - Running an auxiliary power unit (APU)
    - National default APU penetration rate
      - MY <2010: 0%
      - MY ≥2010: 30%
    - APU mission rates are modelled as a small (6 hp) Tier IV nonroad diesel engine
- MOVES2014 defaults allocate hotelling activity to rural highways

Light Duty Parking/Trip Data

- Evaporative emissions are more likely to "break-through" canister when vehicles park more than three days
- Updated MOVES trip data adding information on multi-day parking episodes
- This also affected MOVES2014 default trip-per-day calculations.

NOTES FOR MODELERS

Use Local Data!!!

- MOVES default population and VMT are based on national data
- Local areas often have better local data:
  - VMT
  - Vehicle populations
  - Age distributions
  - Gas/diesel mix
  - Speed distributions
  - Information on starts, hotelling
  - Etc.

MOVES2014 Technical Guidance

Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity

http://www.epa.gov/otaq/models/moves/documents/420b15007.pdf

Tools to make local inputs easier

- MOVES County Data Manager
  - Assists user in entering data at the county scale
- MOVES Project Data Manager
  - Assists user in entering data at the project scale
- AADVMT converter
  - Converts Average Annual Daily VMT to total annual VMT for use in MOVES
- Age Distribution Projection Tool
  - Creates projections of future age year distributions based on current local age distributions.

Questions?

Email the MOVES team at mobile@epa.gov

Read the technical report to be posted soon at

http://www.epa.gov/otaq/models/moves/moves-reports.htm

Acknowledgements

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