MOVES Project Level Sensitivity Analysis Update

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History of MOVES Sensitivity Analysis

- MOVES Project Level Analysis Began in November 2012
  - Is a complement analysis to the Regional Level Sensitivity Analysis – Report released in December 2012

- Focused on three variables associated with the Project Level Domain
  - Age Distribution
  - Fleet Mixture (Link Source Type)
  - MOVES Drive Schedules
    - Average Speed, Link Drive Schedule, and Operating Mode Distribution

Age Distribution Analysis

- The Project Level applied more meaningful variations
  - Reached out to the Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (MWCOG)
  - Provided Age Distribution data for each MOVES source type
  - For each source type analyzed, divided the Age Distribution into age groups based upon the trends observed from the TPB of MWCOG data.

- Analyzed the effects of vehicle aging on Passenger Cars, Transit Buses, Single Unit Trucks and Combination Trucks

Age Distribution Passenger Car

Passenger Car						
Vehicle Age Range	Baseline Age Fraction	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
0-3 years	0.32	-5%	-10%	-20%	-30%	-45%
4-7 years	0.22	-2%	-5%	-7.50%	-10%	-20%
8-12 years	0.26	5%	10%	20%	30%	50%
13-17 years	0.14	4%	8%	15%	20%	30%
18-30 years	0.06	2.50%	5%	7.50%	10%	25%
Average Vehicle Age	***7.48***	***7.68***	***7.86***	***8.21***	***8.53***	***9.24***

Source Type	Pollutant	Case	Average Age	Emission Rate (gram/vehicle-mile)	Percent Change
Passenger Car	NOX	Baseline	7.48	0.2929	-
		Scenario 1	7.68	0.3017	2.91%
		Scenario 2	7.86	0.3104	5.63%
		Scenario 3	8.21	0.3246	9.76%
		Scenario 4	8.53	0.3367	12.99%
		Scenario 5	9.24	0.37	20.84%

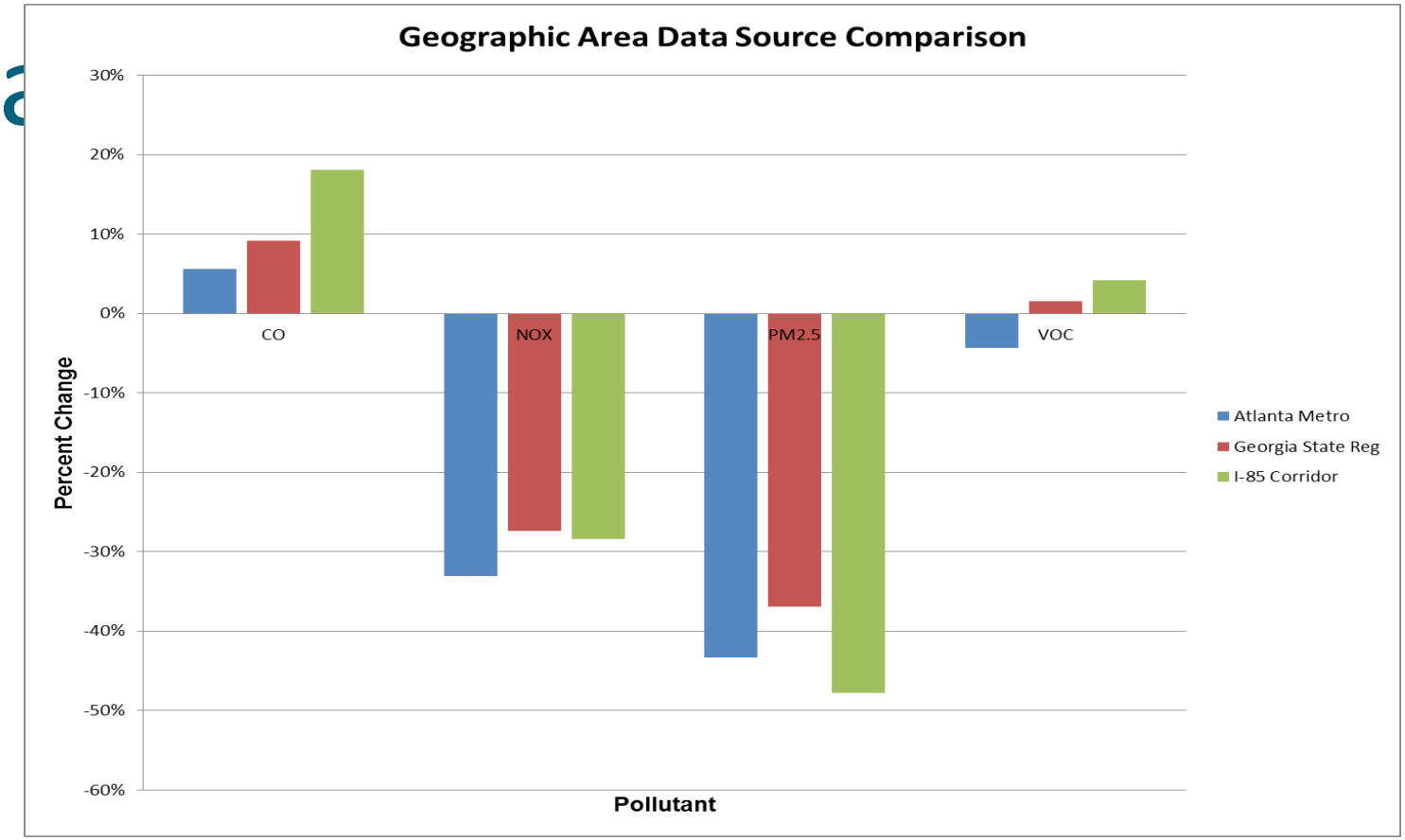
Fleet Mix (Link Source Type)

- Conduct Fleet Mix Sensitivity Analysis for multiple cases
  - Geographic Area Data Source
  - Passenger Car to Passenger Truck Ratio
  - Heavy Duty Truck Mix
  - Heavy Duty Truck Type Mix
  - Transit Bus Mix

- Utilized Fleet Mix data provided by Georgia Tech

- Compared composite emissions rates to the 'Baseline Case' specific to the scenario/cases that were analyzed

Fleet Mix Geographic Area Da



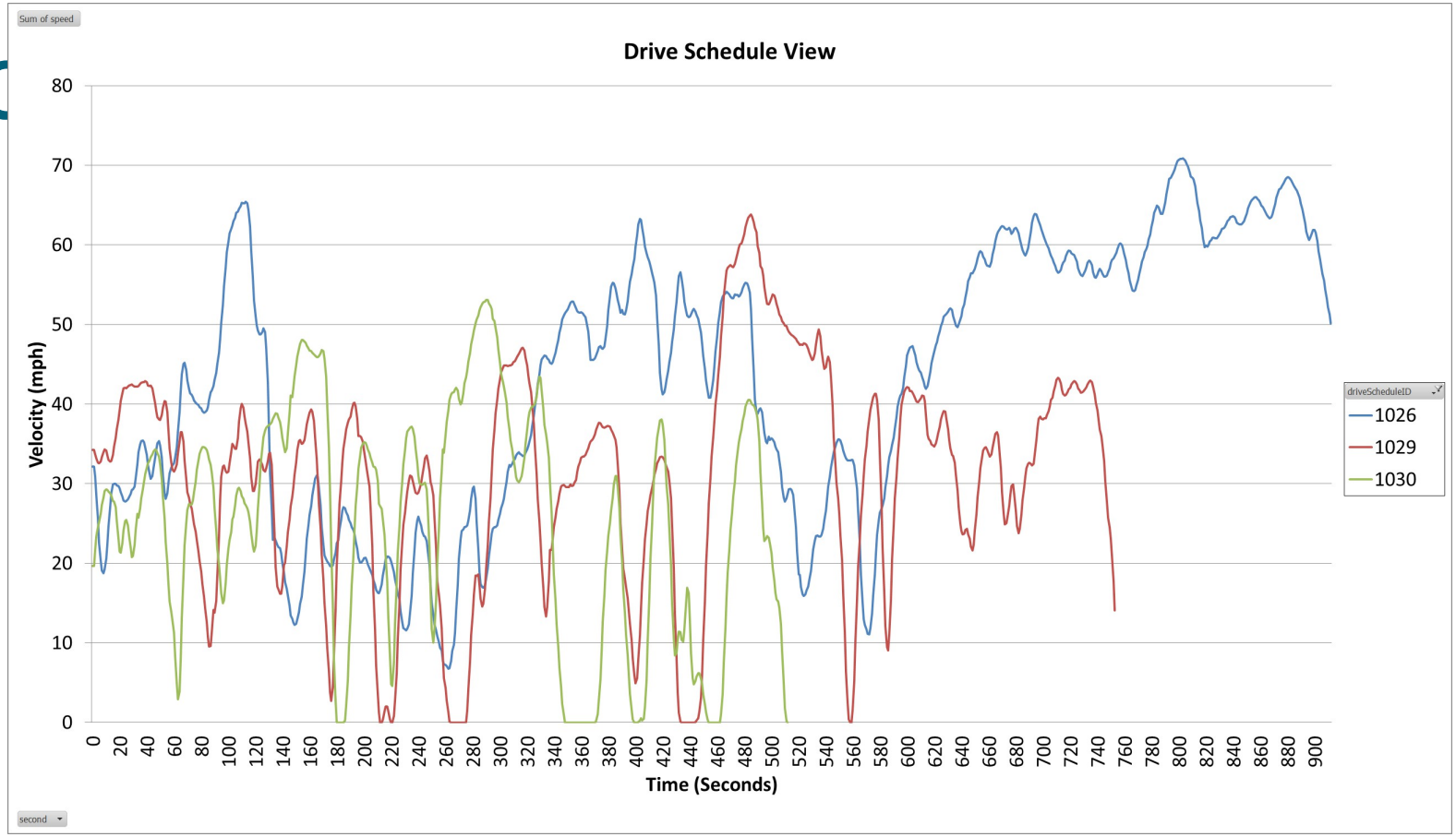
Average Speed compared to Drive Schedule and Operating Mode Distribution

- The Project Level Sensitivity Analysis compared using Average Speed for defining a link to:
  - Highway Capacity Manual (HCM) derived Drive Schedule/Operating Mode Distributions

- Trip based Empirical Data provided by Georgia Tech

- Link Types analyzed
  - Cruise Conditions
    - Arterial
    - Freeway
  - Intersection Links
    - Approach

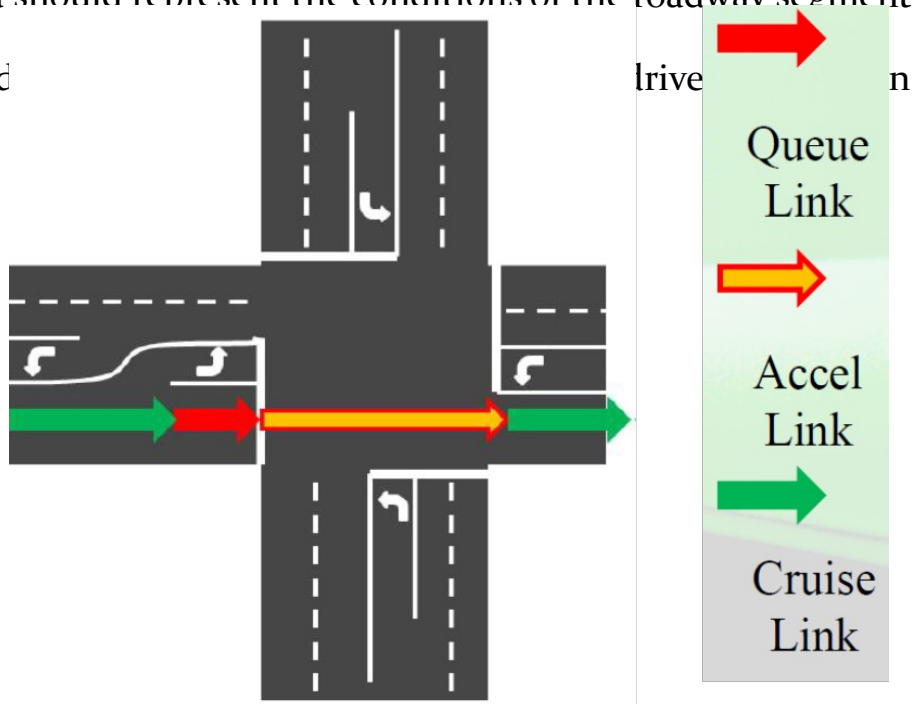
Example: MOVES Default Drive Sc



driveScheduleID	AverageSpeed (mph)	driveScheduleName
1026	43.2662	Final FC12LOSE Cycle (C15R10-00782)
1029	31.0232	Final FC14LOSB Cycle (C15R07-00177)
1030	25.379	Final FC14LOSC Cycle (C10R04-00104)

Average Speed

- The user will specify an average speed for a link
  - The average speed and distance assigned to the link determines the Source Operating Hours spent of the link.
  - The average speed should represent the conditions of the roadway segment being analyzed
  - The Average Speed [illegible] drive [illegible] n the Default Database



Average Speed compared to constant approach speed Drive Schedule

Road Type	Link Type	Scenario	CO Emissions Rates (gram/veh-mile)	Percent Change Compared to Average Speed	PM2.5 Emissions Rates (gram/veh-mile)	Percent Change Compared to Average Speed
Urban Unrestricted Access	Approach	25 mph Average Speed	3.6880	-27.12%	0.0504	-36.64%
		Constant 25 mph Drive Schedule	2.6876		0.0320	
Urban Unrestricted Access	Approach	35 mph Average Speed	3.1387	-24.33%	0.0374	-38.41%
		Constant 35 mph Drive Schedule	2.3752		0.0230	
Urban Unrestricted Access	Approach	45 mph Average Speed	2.7569	-19.77%	0.0314	-35.52%
		Constant 45 mph Drive Schedule	2.2118		0.0203	

Project Level Sensitivity Results Summary

- Variations in Age Distribution can have a significant effect on emissions rates
  - An older average age does not always equate to higher emissions rates (Transit Bus Scenario)
  - For passenger cars when the average age increases by a year then the emissions rates increase was in the 10% percent range for CO, VOC, and NOX. The emissions rate increase in PM2.5 was approximately 5%.

- Getting the fleet mix accurate for your project is important
  - The ratio between passenger cars and passenger trucks is important primarily for CO
  - Getting the ratios between single unit and combination trucks are important
  - However there is very little change in emissions rates between the short

Sensitivity Questions – Drive Schedule

- What is the difference in emissions rates between using average speed versus user provided link drive schedule/operating mode distribution?
  - The default drive schedules utilized when using average speed might not represent the exact profile you want to model
    - Link might only have deceleration and idle
    - Link might only have cruise with no deceleration or acceleration
- How detailed do you have to be?
  - Individual drive schedules for each vehicle on the link?
  - Does it matter if you are more detailed?