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Constraining Variabilities Of On-Road Portable Emission Measurement Testing For Light Duty Vehicles

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Background

- Portable Emissions Measurement Systems (PEMS) testing represents the real world driving patterns and emissions
- PEMS have drastically evolved, improved, and are becoming the way of the future
- PEMS testing is subject to many explainable real world testing variabilities that have different effects on emission results
- This presentation will focus on the variabilities faced in on-road PEMS testing

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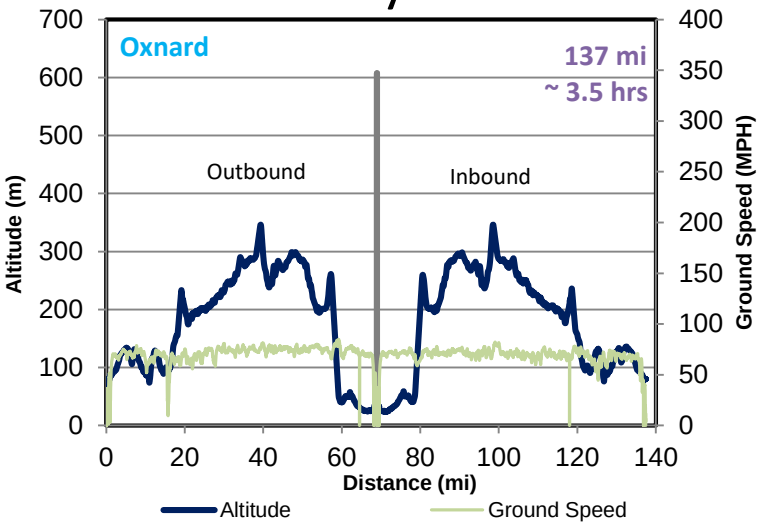
Some Variabilities Faced During On-Road PEMS Testing

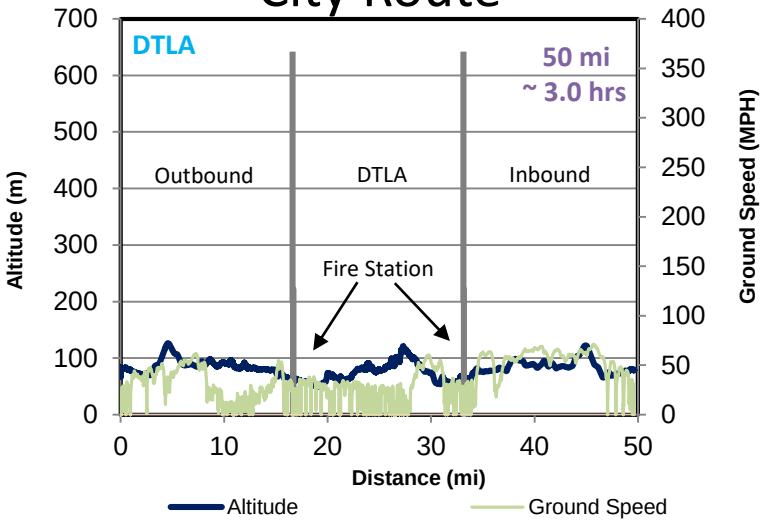
- Vehicle test weight
- Usage of climate control
- Driver behavior

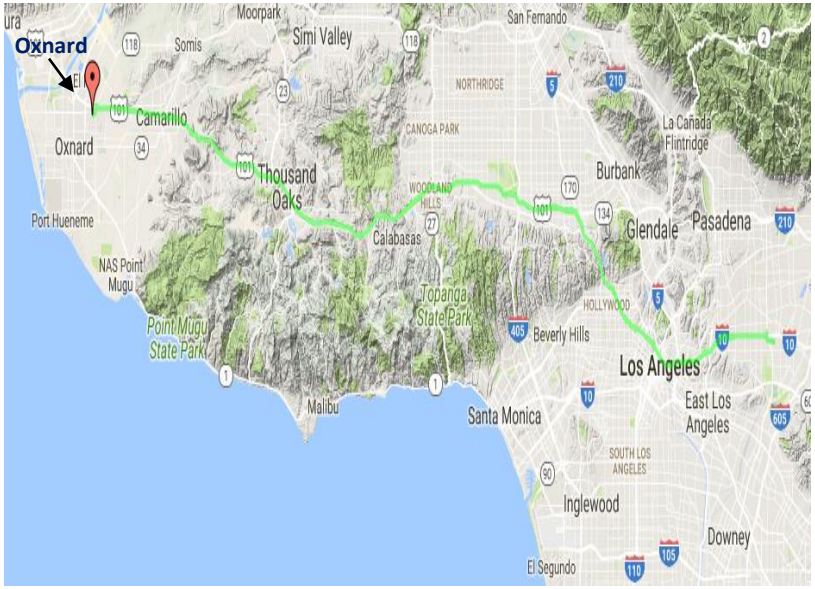
PEMS Routes

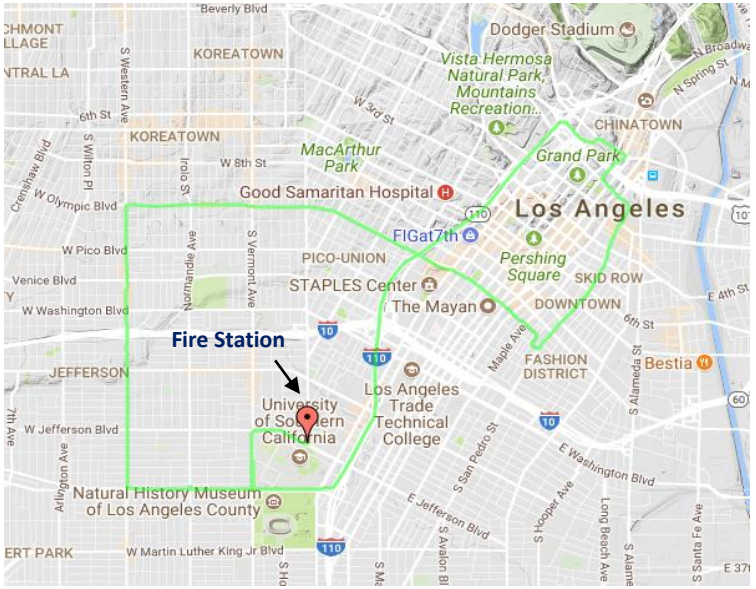
Freeway Route



City Route







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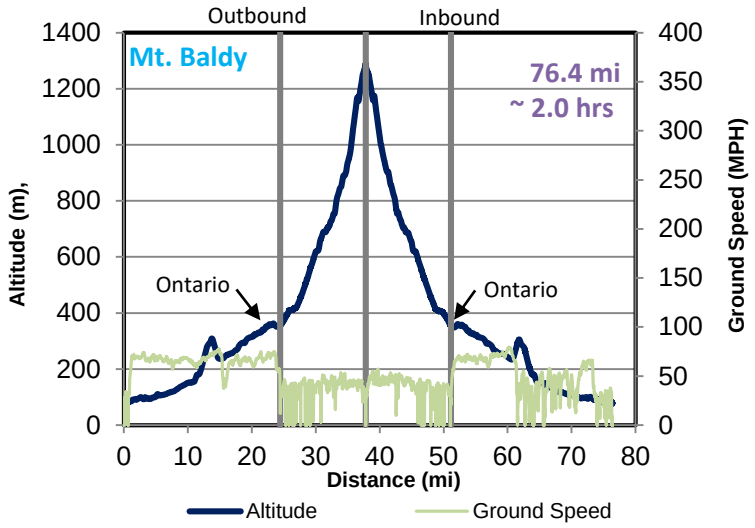
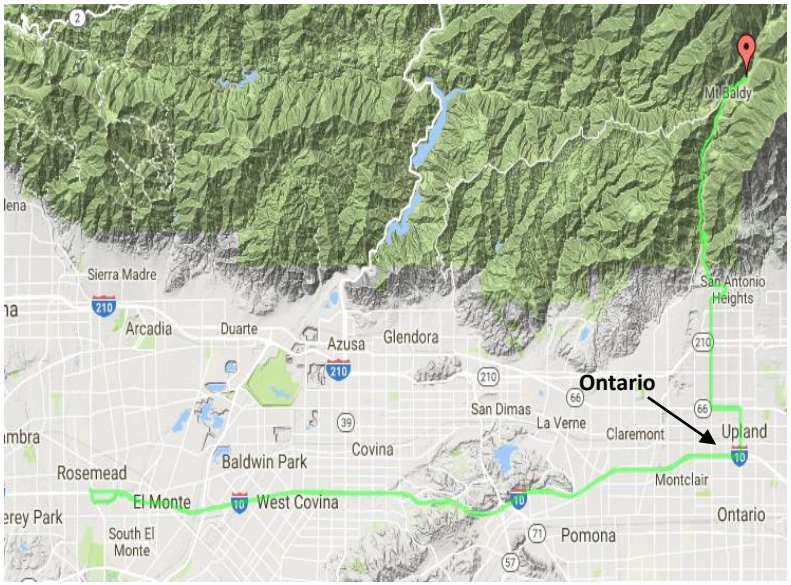
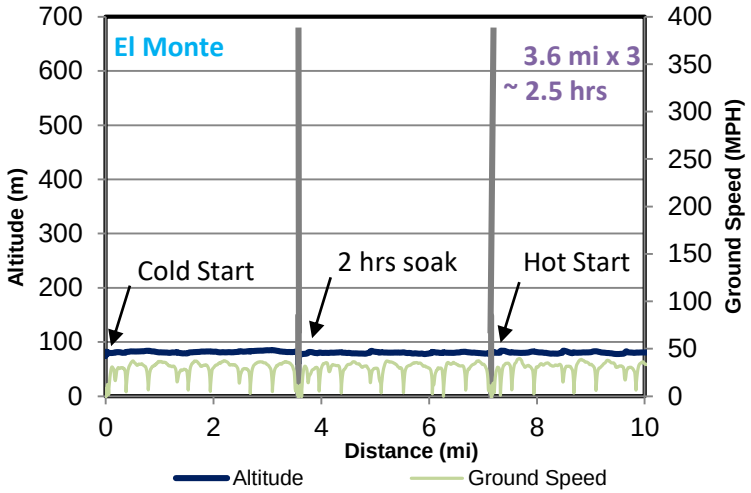
PEMS Routes

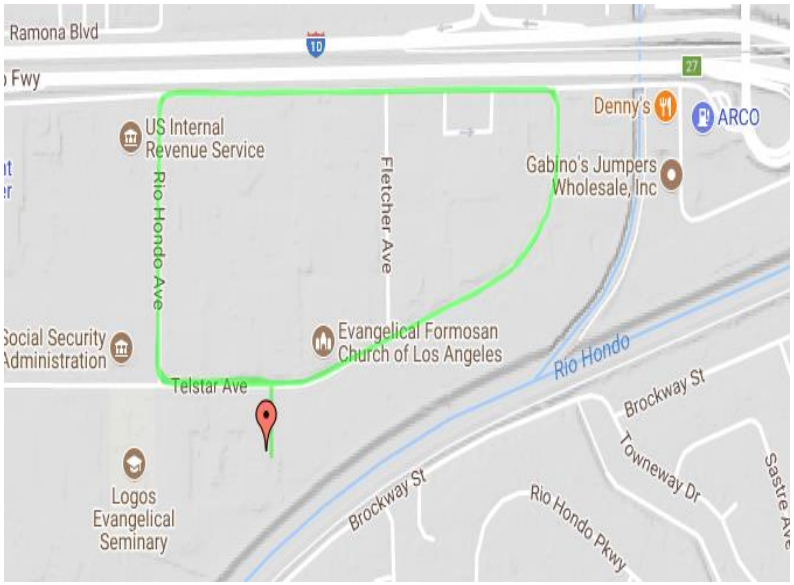
Mountain Route





10 Minutes Route





Variabilities Faced During On-Road PEMS Testing

- **Vehicle test weight**
- Usage of climate control
- Driver behavior

Reduced Weight Effect Example

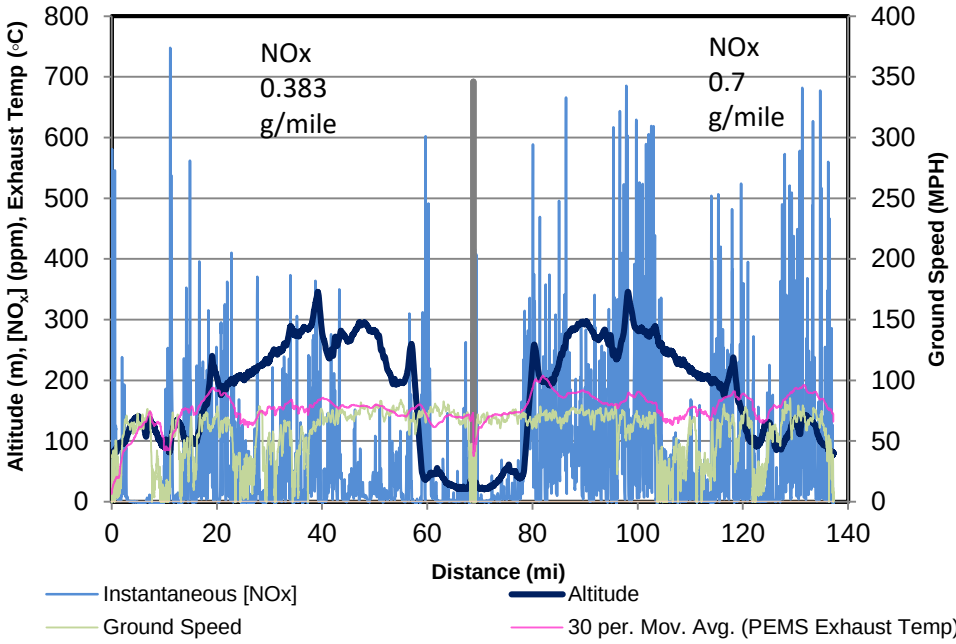
PEMS Weight

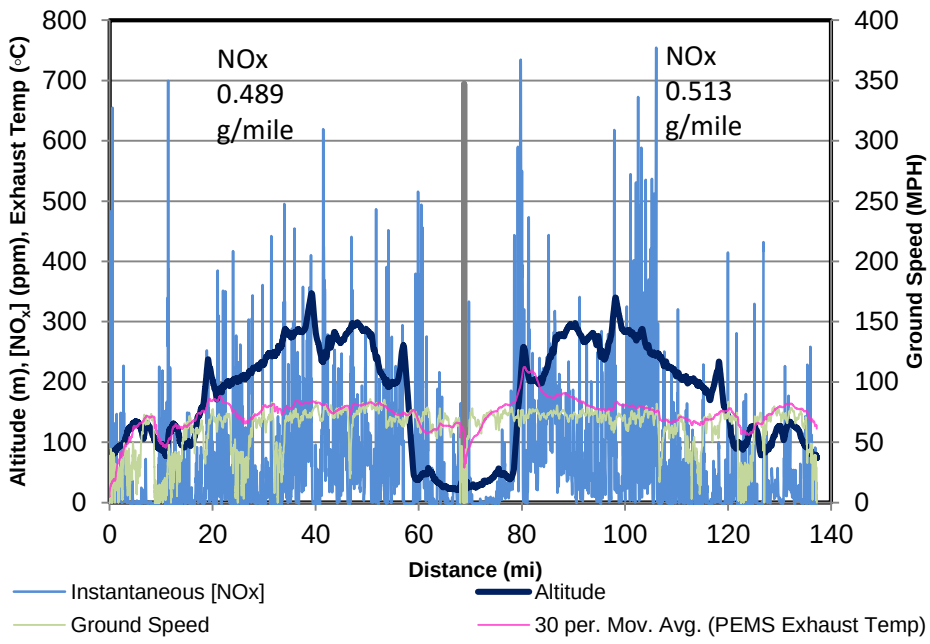
5,760 lbs

-220 lbs

Reduced Weight

5,540 lbs





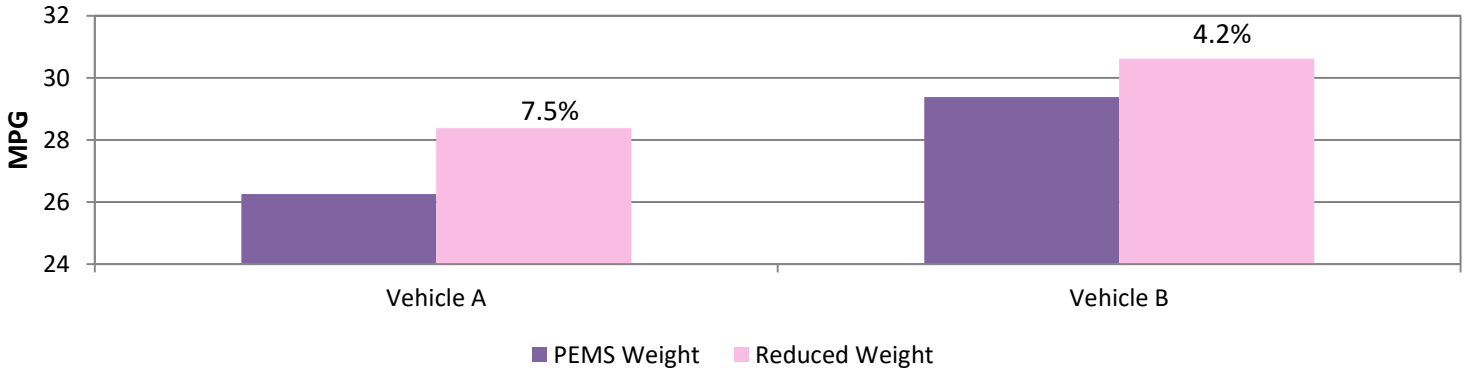
Vehicle A 11/21/2017 AC ON Oxnard PEMS Weight	Whole Trip 1→2→1*	Outbound 1→2	Inbound 2→1*
Total Distance (mi)	137.2	68.8	68.4
Fuel Economy (mpg)	26.3	25.9	26.7
Average Speed (mph)	39.9	35.7	45.1
CO_2 (g/mi)	385.9	391.9	379.9
CO (g/mi)	0.016	0.032	0.000
NO_x (g/mi)	0.541	0.383	0.700
THC (g/mi)	0.000	0.006	0.000

Vehicle A

Vehicle A 11/29/2017 AC ON Oxnard FTP Weight	Whole Trip 1→2→1*	Outbound 1→2	Inbound 2→1*
Total Distance (mi)	137.2	68.8	68.4
Fuel Economy (mpg)	28.4	27.9	28.9
Average Speed (mph)	46.1	39.2	56.0
CO_2 (g/mi)	357.1	362.9	351.4
CO (g/mi)	0.000	0.000	0.000
NO_x (g/mi)	0.501	0.489	0.513
THC (g/mi)	0.000	0.003	0.000

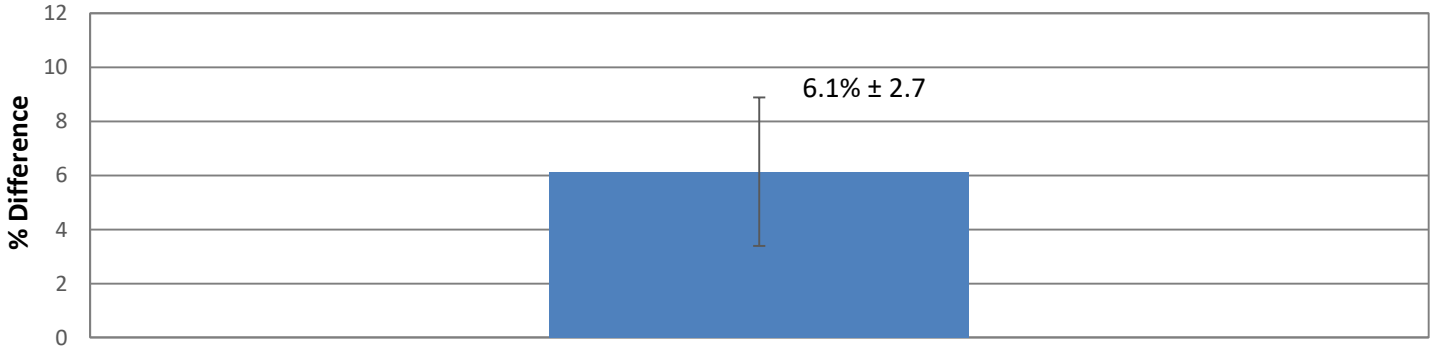
1 = ARB 2 = Oxnard

PEMS Vs. Reduced Weight Fuel Economy Comparison



Fuel Economy %Difference

Vehicle A and B Average % Difference

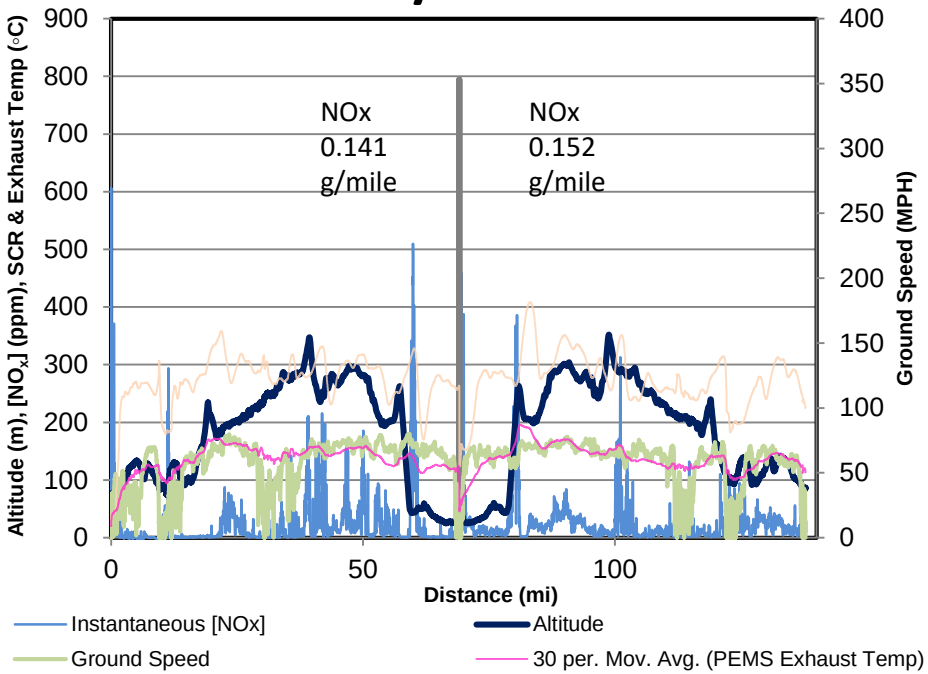


Variabilities Faced During On-Road PEMS Testing

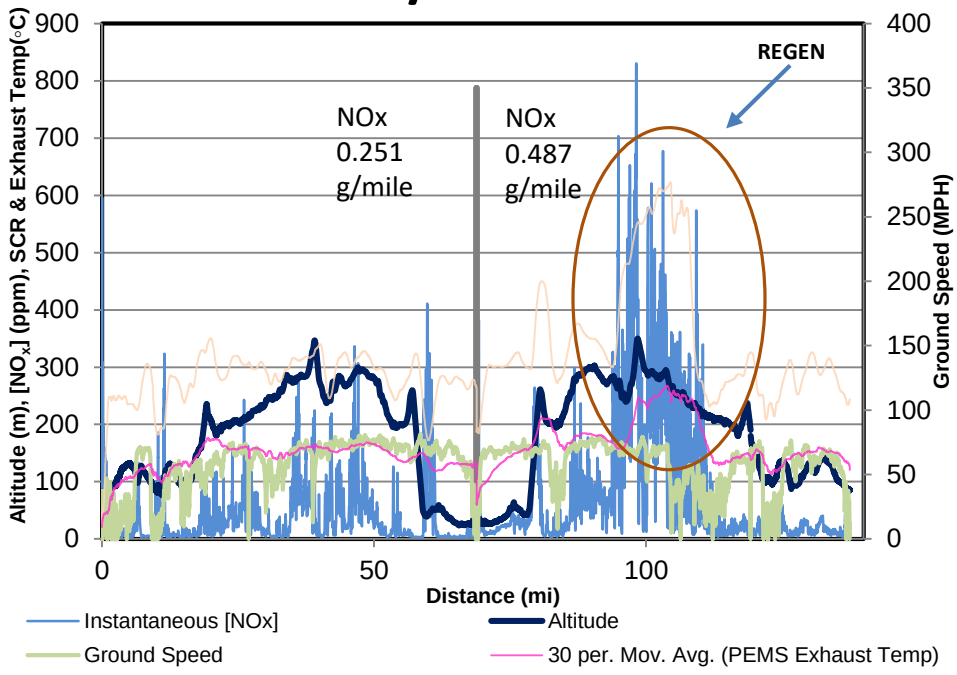
- Vehicle test weight
- **Usage of climate control**
- Driver behavior

Climate Control Effect Example

A/C OFF



A/C ON



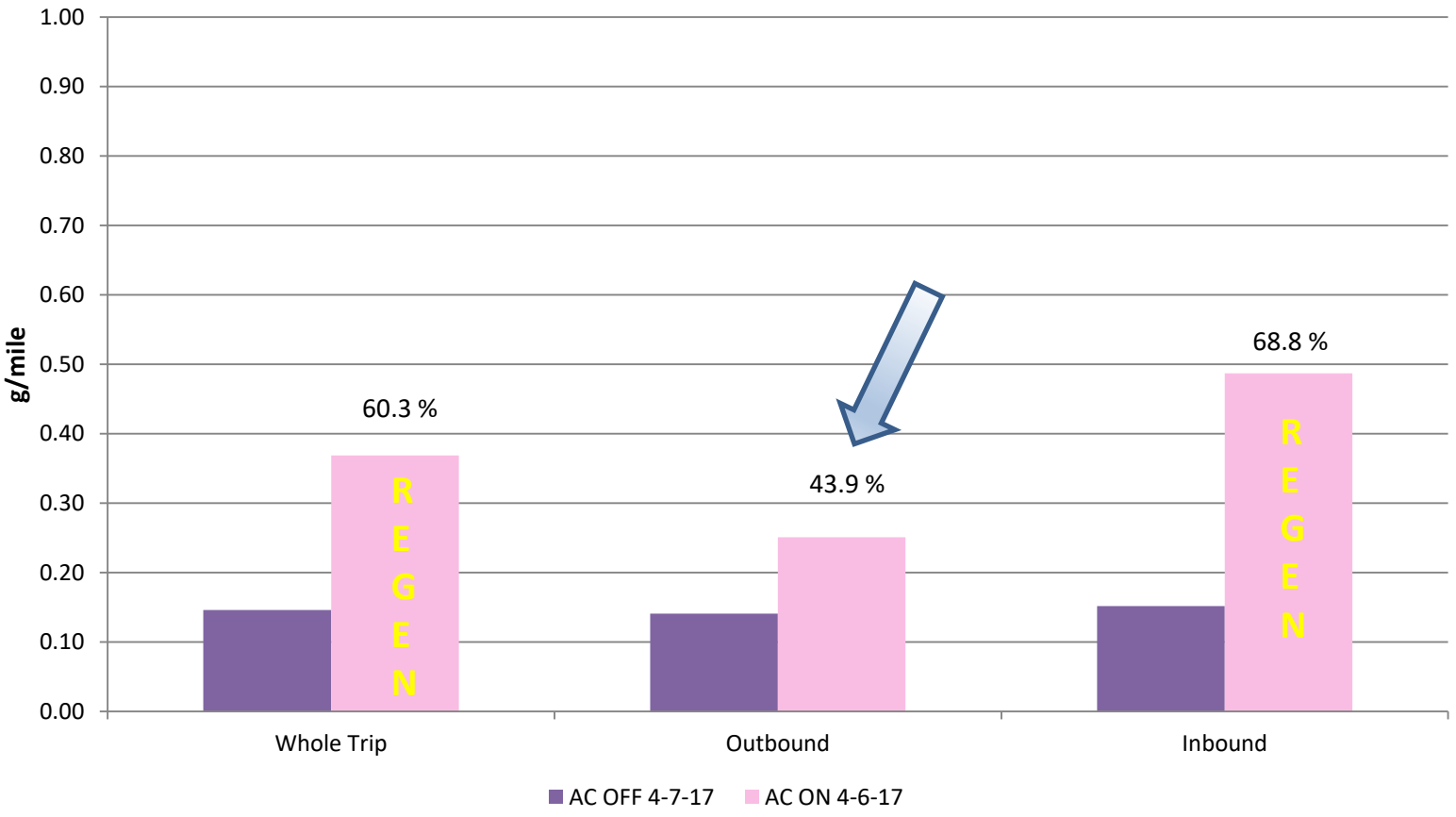
Vehicle C

Vehicle C 4/7/2017 AC OFF Oxnard	Whole Trip 1→2→1*	Outbound 1→2	Inbound 2→1*
Total Operation Time (s)	10961	5813	5148
Total Distance (mi)	137.8	69.1	68.7
Fuel Economy (mpg)	31.7	30.1	33.4
Average Speed (mph)	45.3	42.8	48.0
CO_2 (g/mi)	320.0	336.4	303.6
CO (g/mi)	0.001	0.005	0.000
NO_x (g/mi)	0.146	0.141	0.152
THC (g/mi)	0.007	0.008	0.006

Vehicle C 4/6/2017 AC ON Oxnard	Whole Trip 1→2→1*	Outbound 1→2	Inbound REGEN 2→1*
Total Operation Time (s)	11275	6008	5267
Total Distance (mi)	137.4	68.8	68.6
Fuel Economy (mpg)	28.6	29.0	28.2
Average Speed (mph)	43.9	41.3	46.9
CO_2 (g/mi)	355.0	350.1	360.0
CO (g/mi)	0.000	0.000	0.000
NO_x (g/mi)	0.368	0.251	0.487
THC (g/mi)	0.007	0.007	0.006

1 = ARB 2 = Oxnard

AC On vs. AC Off NOx Comparison

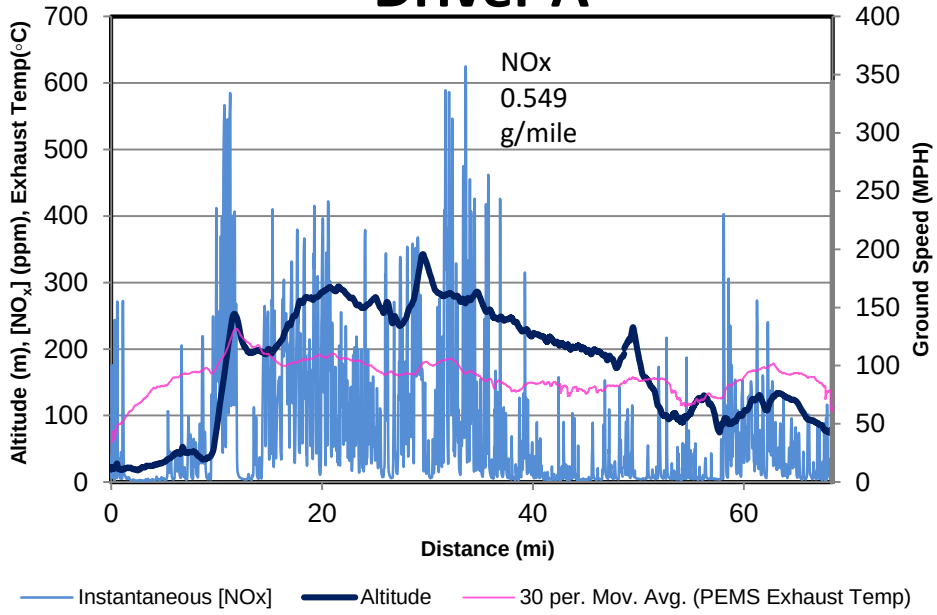


Variabilities Faced During On-Road PEMS Testing

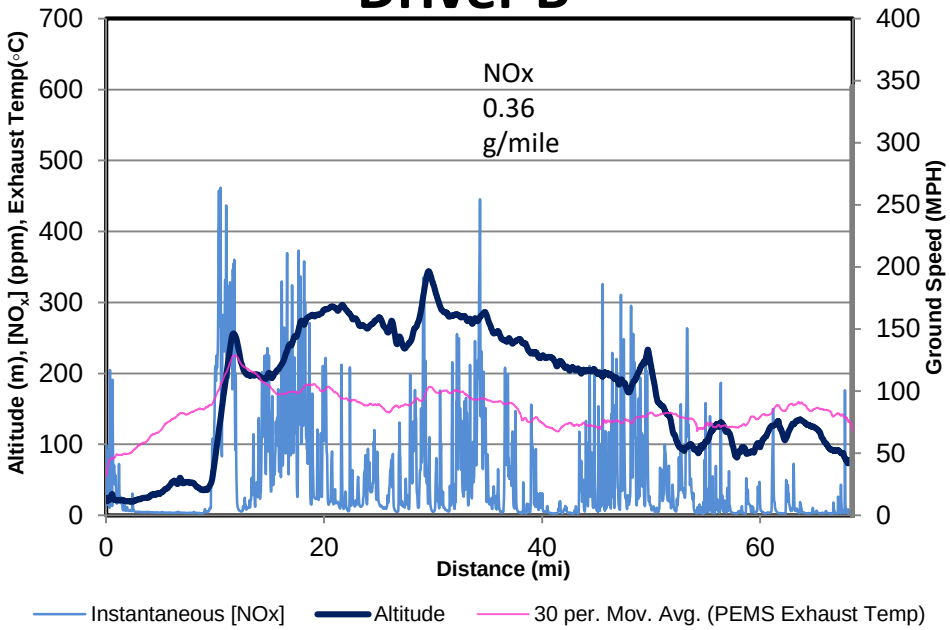
- Vehicle test weight
- Usage of climate control
- **Driver behavior**

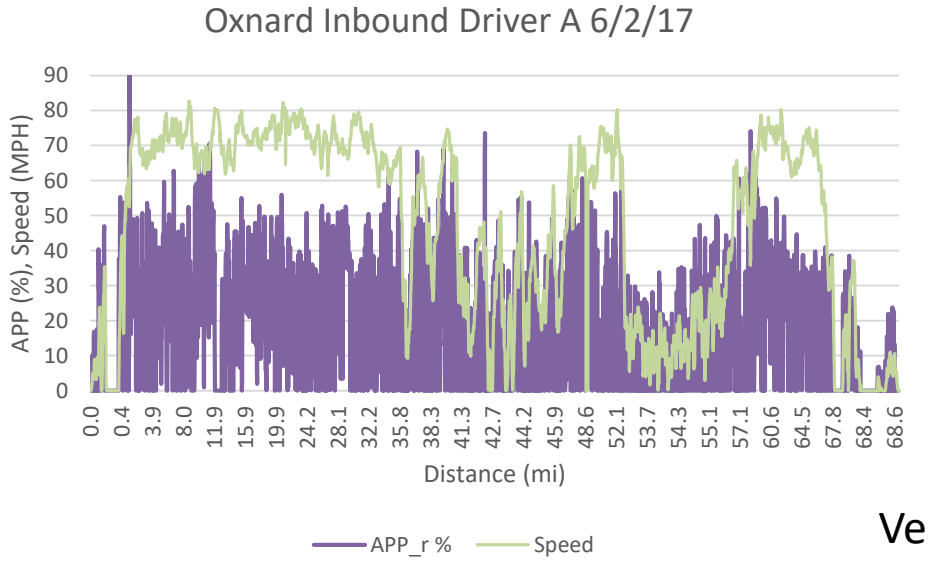
Driver Behavior Example

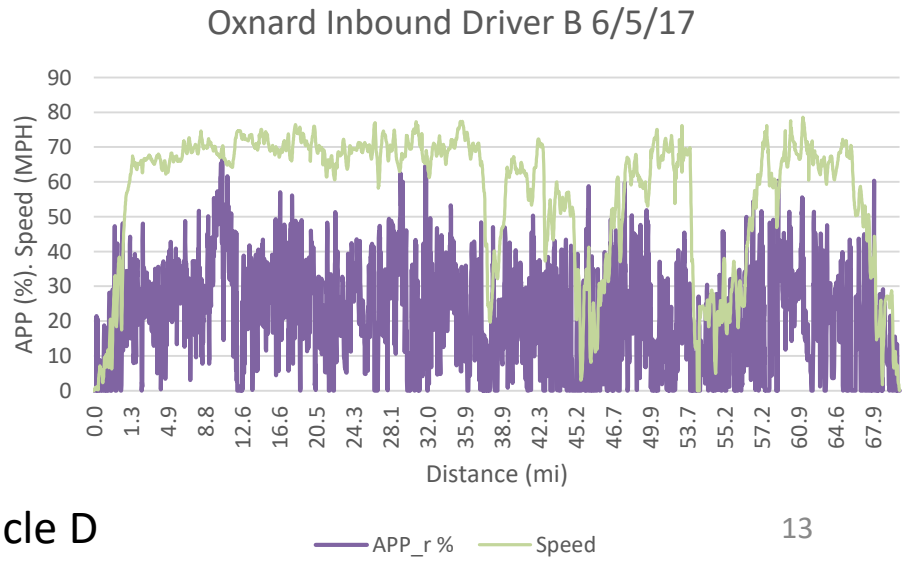
Driver A



Driver B

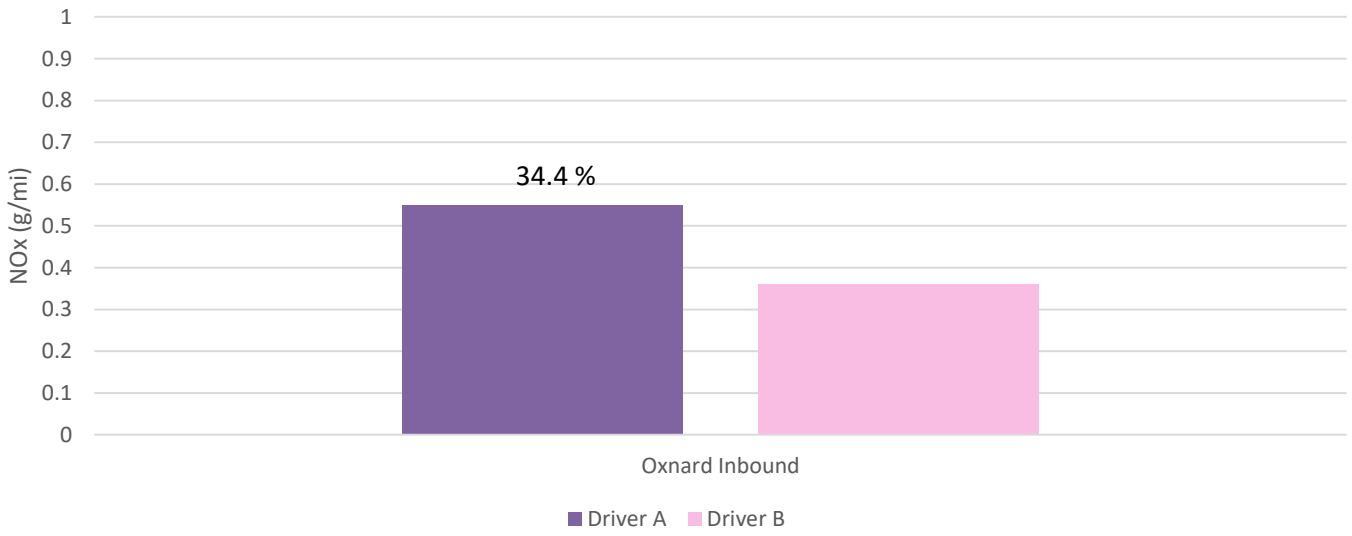






Vehicle D

Driver Effect NOx Comparison



Vehicle D Driver A 6/2/2017 AC OFF Oxnard Inbound	Inbound $2 \rightarrow 1^*$
Total Operation Time (s)	5231
Total Distance (mi)	68.4
Fuel Economy (mpg)	23.6
Average Speed (mph)	47.1
CO_2 (g/mi)	400.6
CO (g/mi)	0.007
NO_x (g/mi)	0.550
THC (g/mi)	0.005

Vehicle D Driver B 6/5/2017 AC OFF Oxnard Inbound	Inbound $2 \rightarrow 1^*$
Total Operation Time (s)	4346
Total Distance (mi)	68.5
Fuel Economy (mpg)	24.4
Average Speed (mph)	56.7
CO_2 (g/mi)	366.5
CO (g/mi)	0.005
NO_x (g/mi)	0.360
THC (g/mi)	0.003

1 = ARB 2 = Oxnard

Summary

- The role of PEMS is expected to grow
- The test weight effect has shown to be minimal while other effects like climate control usage, driver behavior, and varying traffic conditions might have a more significant effect
- Future ARB programs will continue to explore the effect of variabilities during on road testing for each vehicle
- PEMS data is being used to evaluate the emission impact in modeling and inventory
- **A bigger sample size is needed and should better explain how PEMS testing variables effect emissions**

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