

PEMS Testing Studies at UCR CE-CERT

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Introduction

- PhD student in the emissions and fuels research group
- Ran multiple PEMS projects
 - Heavy Duty and light duty vehicles
- Presenting 2 of the PEMS projects that we have ran
 - GPF on-road emissions study
 - Heavy-duty PEMS study

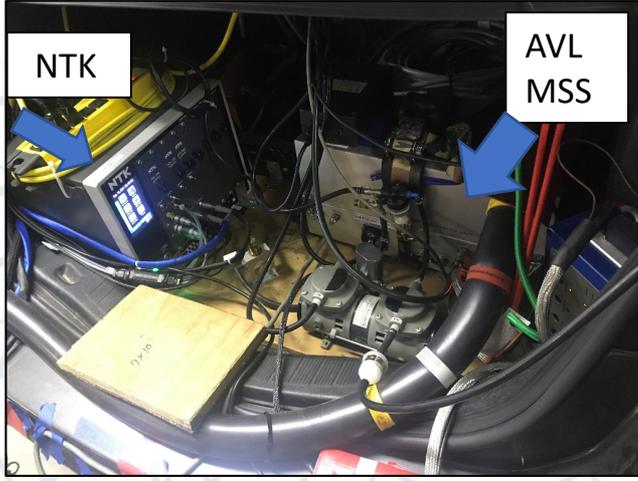
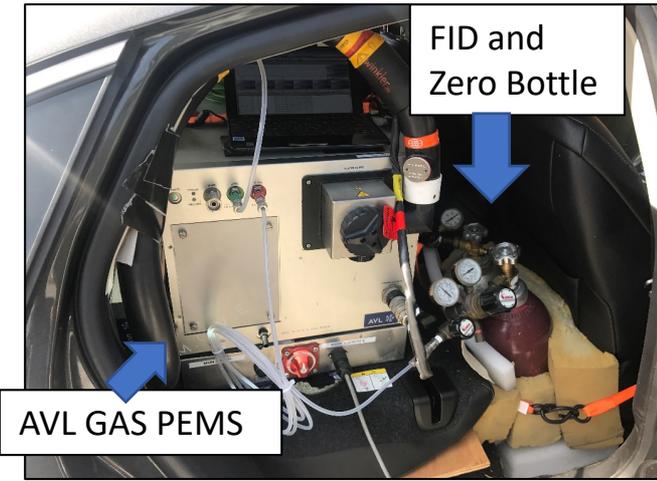
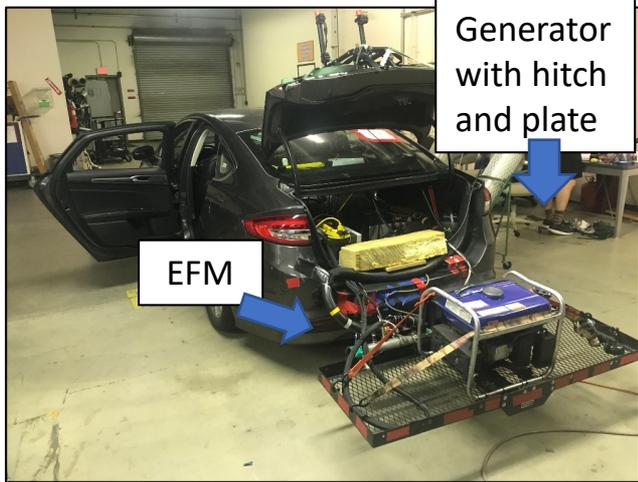
Gas and PM/PN Emissions from GDI Vehicles with and without Catalyzed GPFs Using PEMS



Test Vehicles

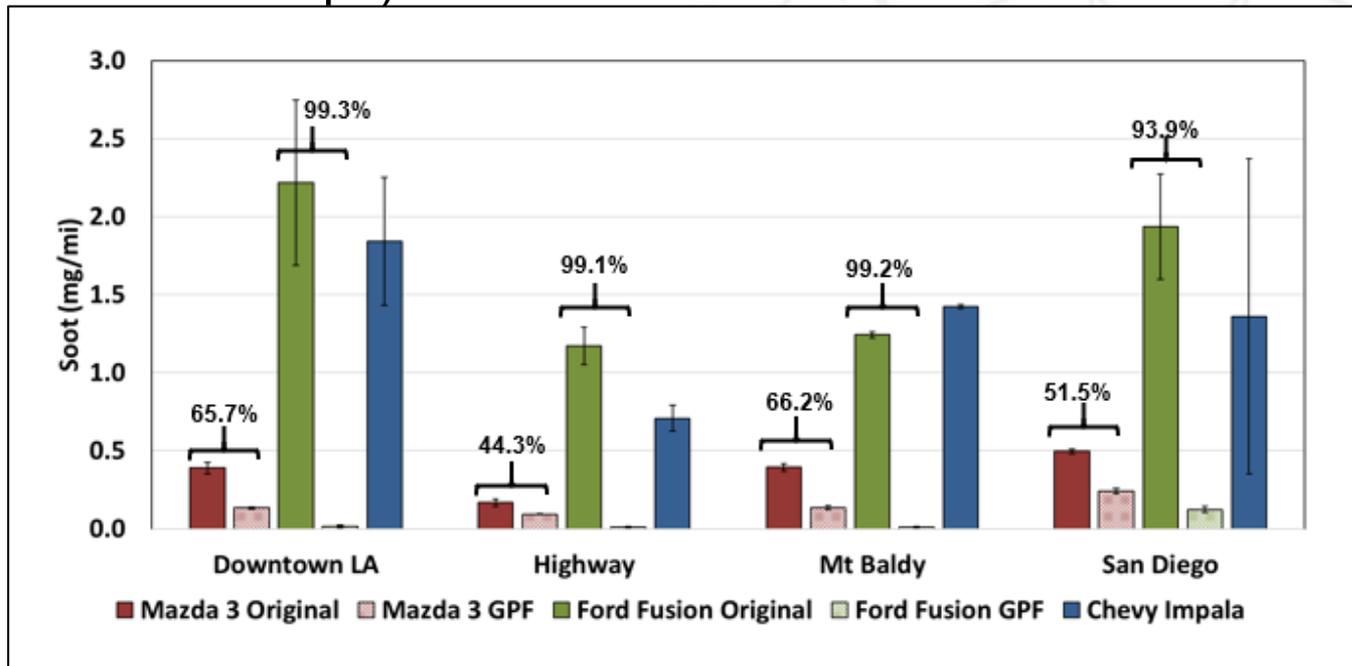
Vehicle Model	2017 Ford Fusion	2017 Mazda 3	2018 Chevy Impala
Cylinder Number	4, Inline	4, Inline	V6
Displacement	1.5 L Turbocharged	2.0 L	3.6 L
Horsepower	181 at 6000 rpm	155 @ 6000 rpm	305 @ 6800 rpm
Torque	185 lb-ft at 4320 rpm	150 ft-lb @4000 rpm	264 lb-ft @ 5200 rpm
Compression Ratio	10.0:1	13.0:1	11.5:1
Air Intake	Turbocharged	Naturally Aspirated	Naturally Aspirated
Fuel Injection	Centrally-Mounted	Wall-Guided	Wall-Guided
Emissions Standards	USEPA:T3B30, CA: SULEV 30 PZEV	US EPA: IT3B30 LDV, CA:SULEV 30 PZEV	US EPA: T3 LDV, CA:SULEV 30

Setup

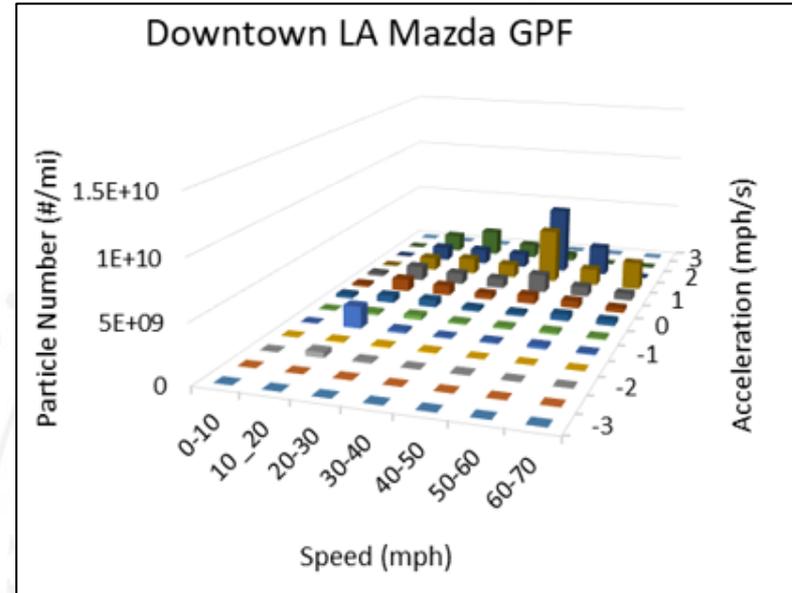
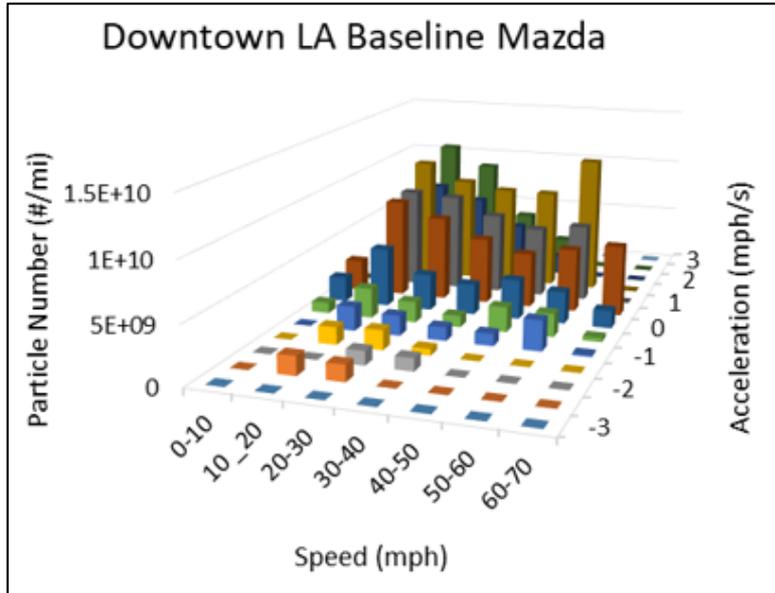


Soot Mass Emissions

- Catalyzed GPF resulted in reductions in soot emissions for all routes
- Soot mass emissions were higher during urban driving conditions (frequent start and stops)

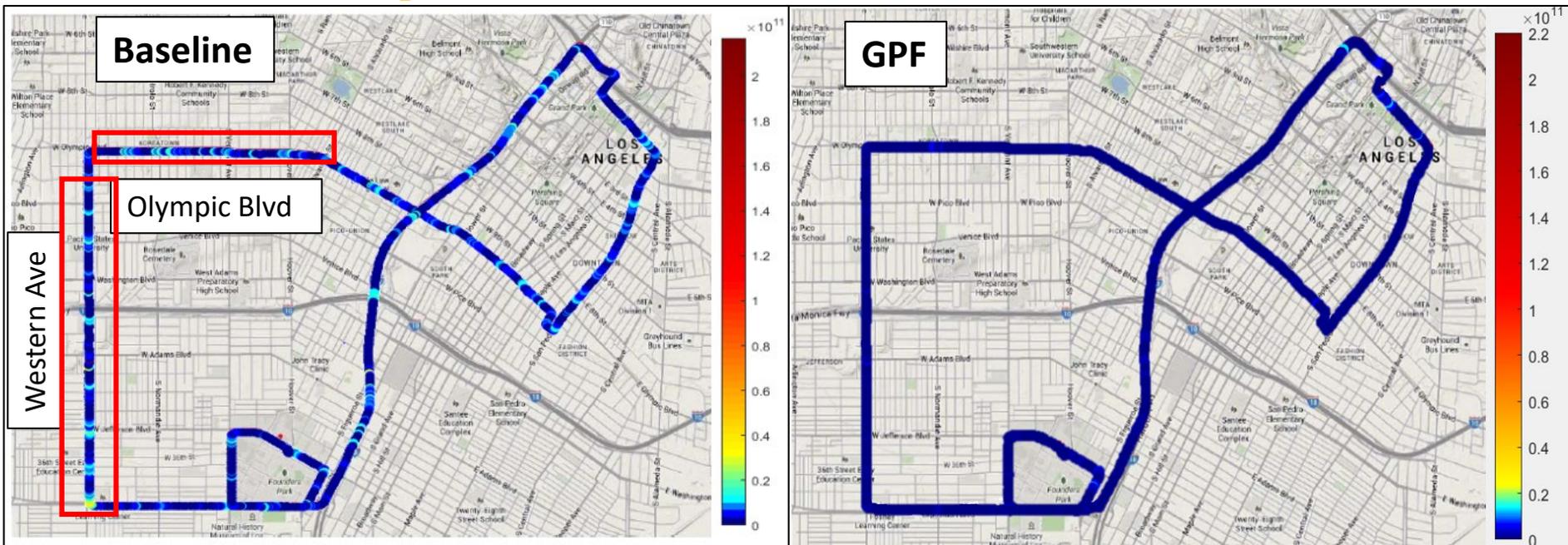


Emission Bins



- Particles generally forming at low speeds and high accelerations
 - Indicative of stop and go driving
- GPF Provides reductions in all of these areas
 - Very important in terms of human health in densely populated areas

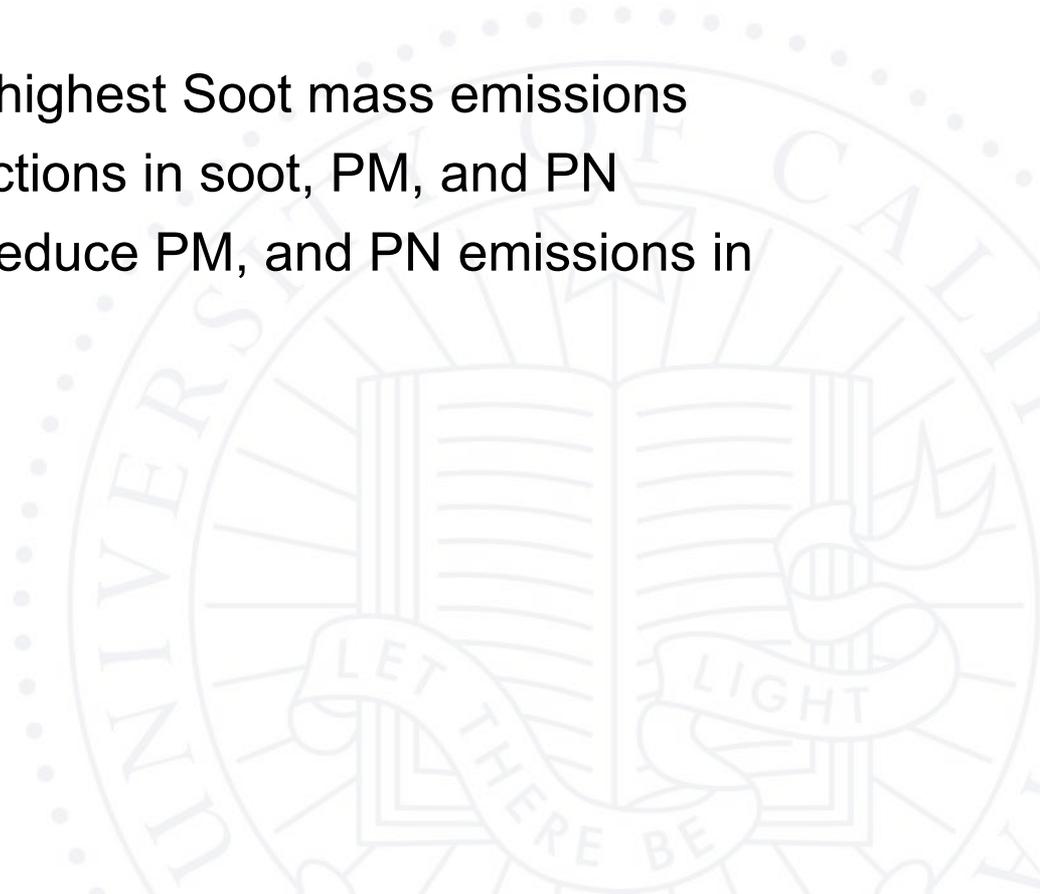
Heat Maps



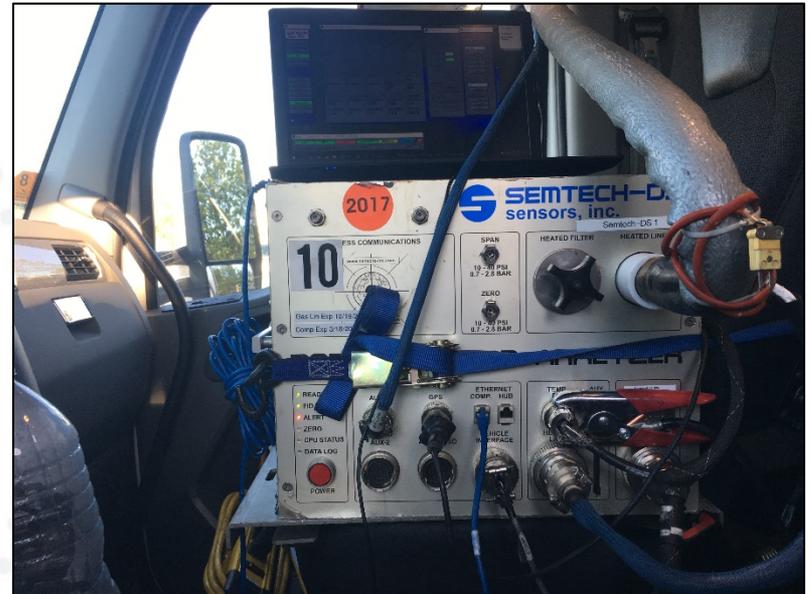
- Plotted maps to look at peaks in PN, Soot, NOx, and Acceleration
- GPFs provide PN reductions in densely populated areas

Conclusions

- Urban driving routes showed highest Soot mass emissions
- GPF provided important reductions in soot, PM, and PN
- GPF has potential to greatly reduce PM, and PN emissions in densely populated areas



In-Use Emissions Testing of On-Road Heavy-Duty Engines



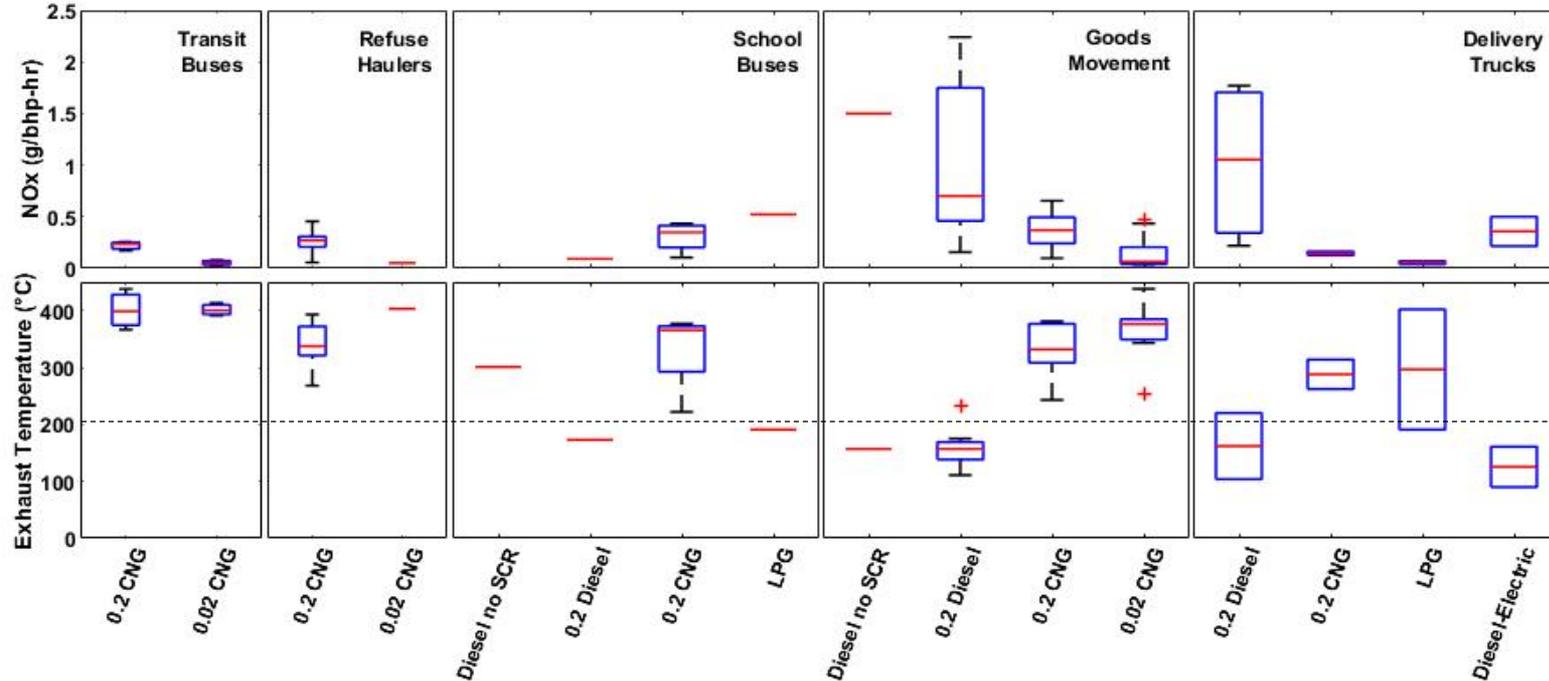
Project Overview

- **Semtech DS for PEMS measurements of 50 Heavy Duty Vehicles**
- **Vehicles from five vocations were tested**
 - Transit buses, school buses, refuse haulers, delivery trucks, goods movement trucks
- **Alternative fuels, conventional diesel fuel, and Hybrid Technology**
- **Tested over a normal daily route**
 - Asked to make no changes to routine

Test Vehicles

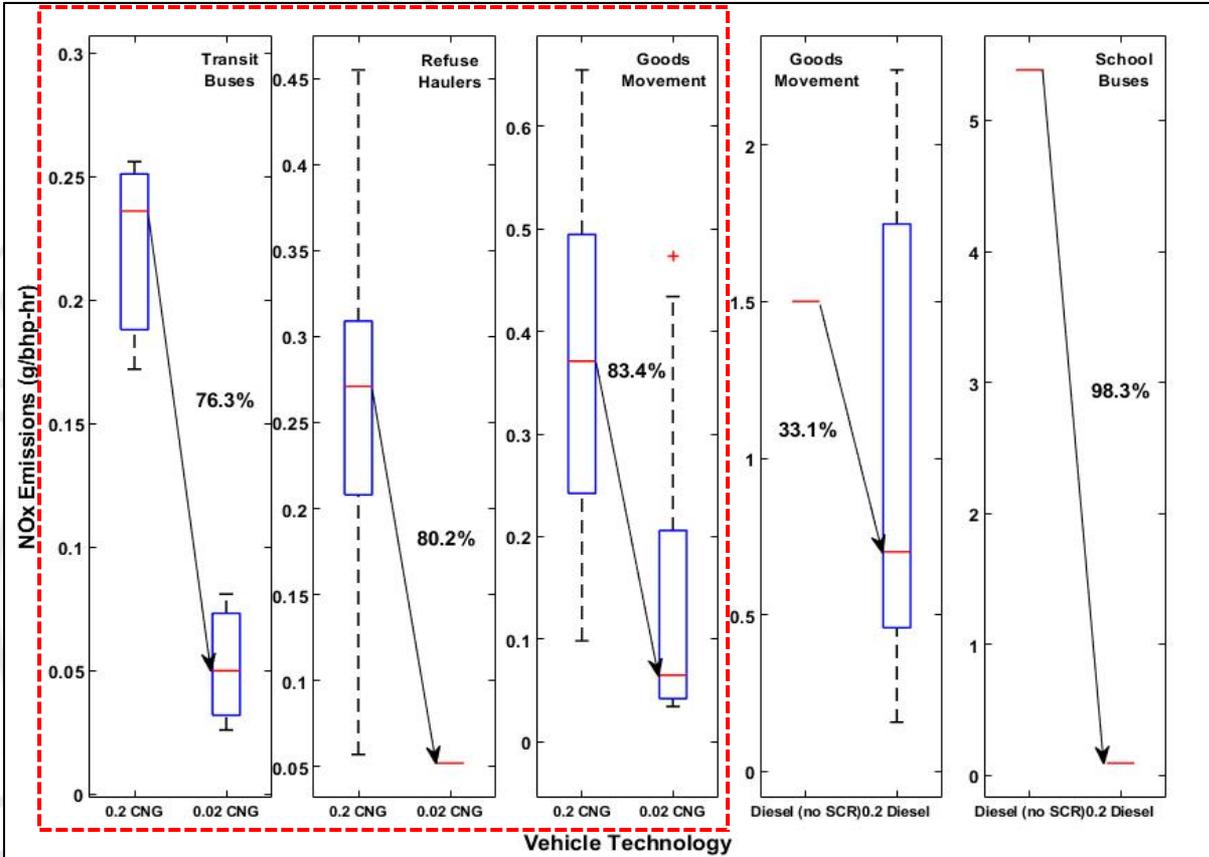
Vocation	Transit	School Bus	Refuse	Delivery	Goods Movement
Number of PEMS Vehicles	6	7	7	10	20
CNG 0.20g	3	4	5	2	4
CNG 0.02g	3	0	2	0	6
Diesel 0.20g	0	1	0	4	9
Diesel (No SCR)	0	1	0	0	1
Diesel-Electric Hybrid	0	0	0	2	0
Propane (0.2g)	0	1	0	1	0
Propane (0.02g)	0	0	0	1	0

NOx Results



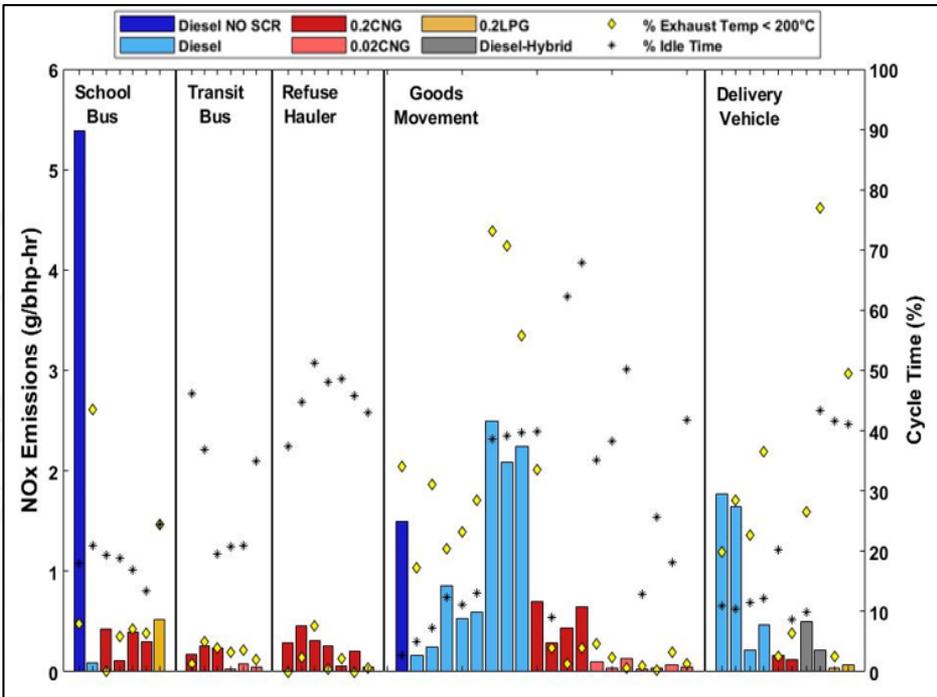
- Diesel vehicles with SCR (0.2 g) showed highest NOx emissions other than the diesel vehicles with no SCR
 - Goods Movement and Delivery vocation showed SCR temperatures were near or below 200°C greatly effecting total NOx emission rates
- CNG vehicles were generally lower than diesel vehicles with emission rates near certification levels

NOx Reductions



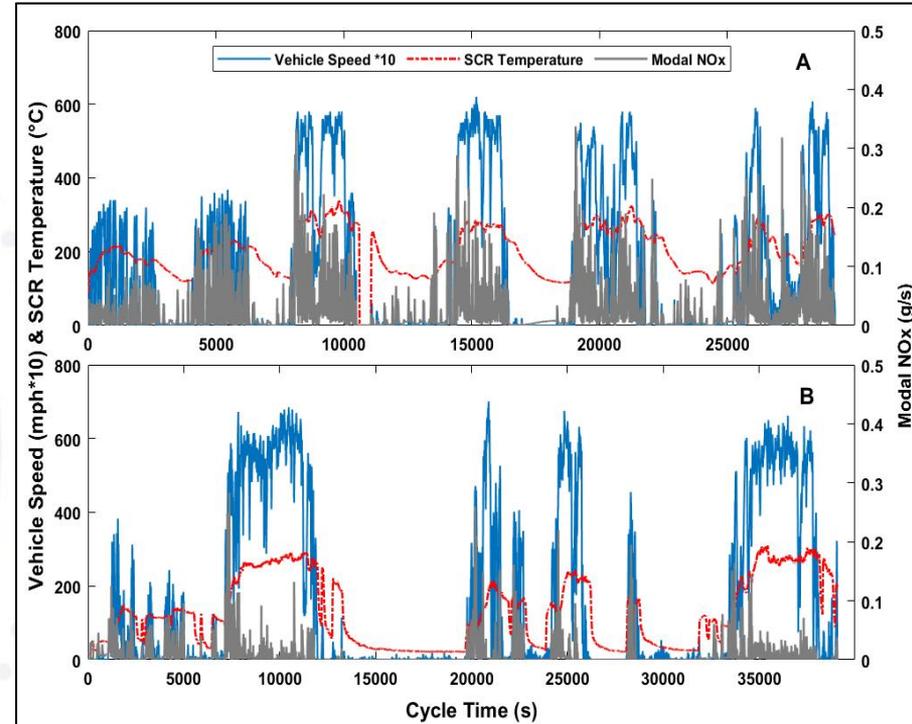
- **0.02 CNG technology provided 76.3%-83.4% reduction efficiencies compared to 0.2g CNG**
- **Diesel with SCR only showed 33.1% reduction efficiency for Goods Movement**
 - 3 vehicles tested showed NOx emissions higher than 2 g/bhp-hr

Outlier Tests

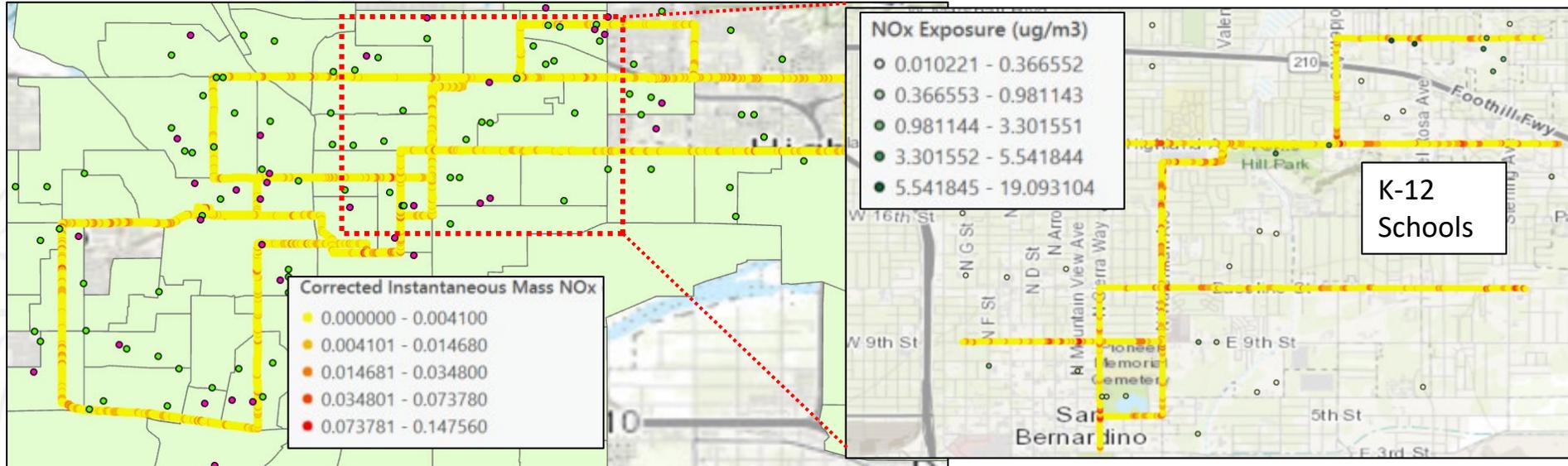


- Some SCRs were not functioning correct even at high temps
- Others showed issues with hot start events

- 0.2g Diesel with high emission rates spent more time idling and lower exh. temps
- Delivery category spent much of the route turned off



NOx Exposure



- Plotted NOx emission rates throughout the route
- NOx exposure of populated areas (Focused on EJ Communities)
- Points of interested are schools and parks
- Next step is to compare different vocations and engine technologies

Summary

- **Diesel Vehicles showed highest NOx emissions, specifically in the Delivery and Goods Movements vocations, as well as diesel no-SCR vehicles**
 - Average exhaust temperatures of diesel vehicles were on average well below 200°C
- **CNG vehicles generally showed lower NOx emissions compared to SCR vehicles**
 - Emission rates near certification levels
- **0.02 g CNG vehicles showed lower NOx emissions compared to 0.2g CNG vehicles**
 - Next generation technology effective in NOx reductions
- **New technology trucks can provide important reductions in exposure effects**
 - Important for Environmental Justice communities

Thank You

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