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Impacts of Modifying Exhaust Temperature and Event Duration Limits on Not-To-Exceed Compliance for In-Use NOX Emissions from 2010-Technology Heavy-Duty Diesel Vehicles

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California Air Resources Board

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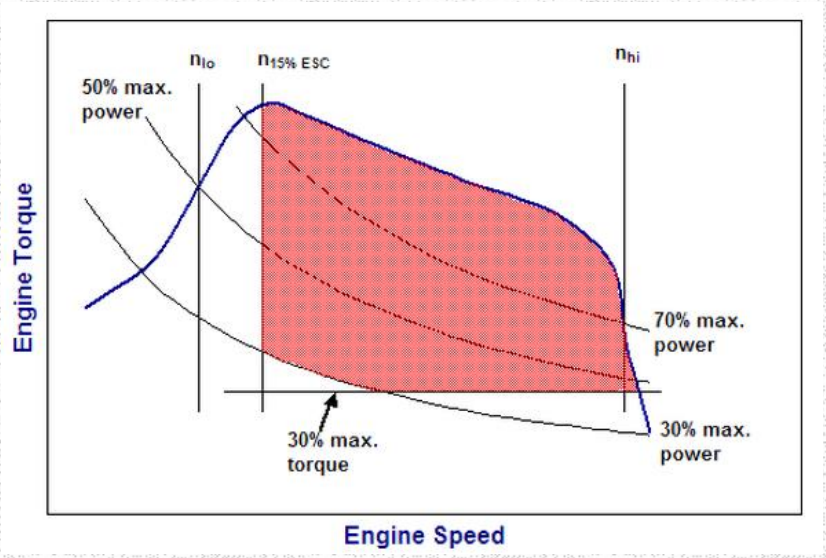
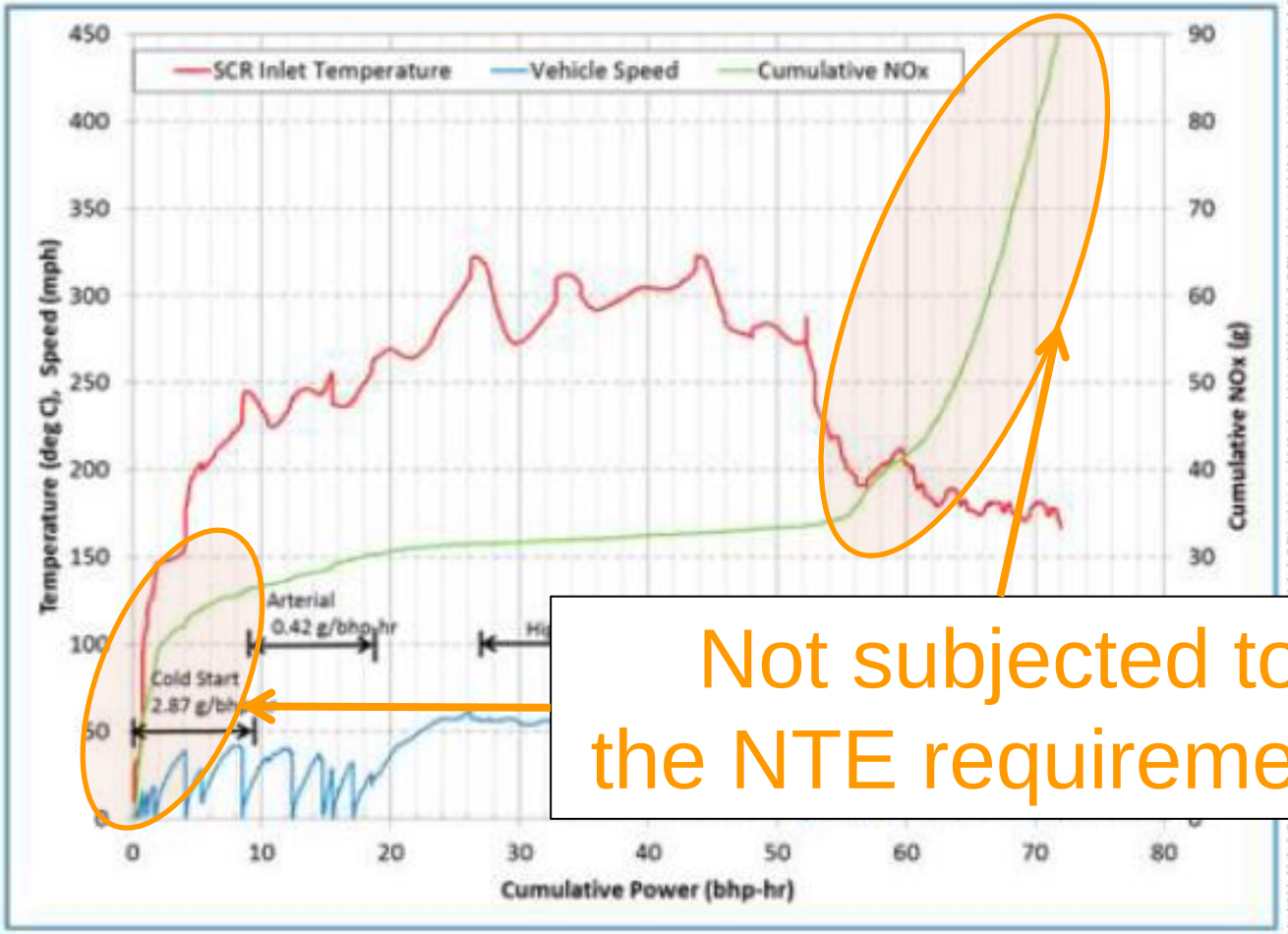
Not-To-Exceed (NTE) Requirements

- As part of the 1998 Consent Decrees, not-to-exceed (NTE) emission limits were introduced to ensure heavy-duty engine emissions controlled over the full range of speed and load combinations commonly experienced in use
- NTE zone definition
  - Above 30% max engine power
  - Above 30% max engine torque
  - Above 15% ESC RPM
- Temperature and duration limits
  1. Longer than or equal to 30 consecutive seconds
  2. Higher than or equal to 250 °C exhaust temperature (SCR-equipped diesel trucks)



Exhaust Temperature Matters to NOX Emissions from SCR-Equipped Diesel Trucks



1b: Veh-2 (EGR+SCR)

Misra et al. Environ. Sci. Technol. 2013, 47, 7892−7898

Objectives

- Investigate the effectiveness of NTE requirements in control of in-use NOX emissions from 2010 technology (DPF+SCR) heavy-duty trucks
- Evaluate impacts of lowering the SCR-out exhaust temperature limit or of shortening the NTE duration limit on NTE activity and NOX emissions

Trucks Tested with PEMS

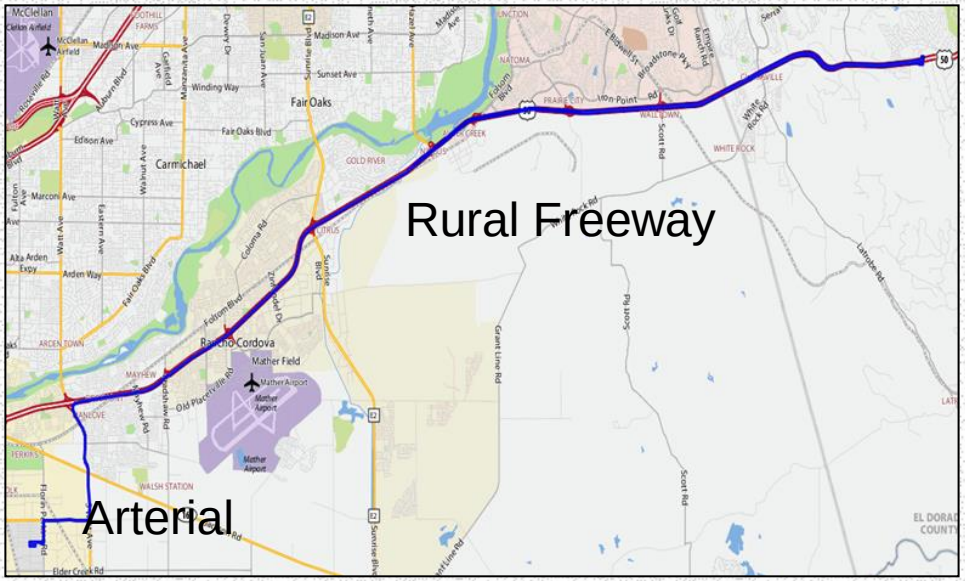
Truck		Engine		NOX	
ID	Odometer (miles)	Model	MY	Control	Cert Value (g/bhp-hr)
Veh-1	70,000	Maxxforce 13	2011	EGR-only	0.46
Veh-2	13,500	Cummins ISX	2010	EGR+SCR	0.25
Veh-3	23,000	Detroit Diesel DD-13	2010	EGR+SCR	0.13
Veh-4	68,000	Volvo D13	2010	EGR+SCR	0.11

Misra et al. Environ. Sci. Technol. 2013, 47, 7892−7898

Test Routes

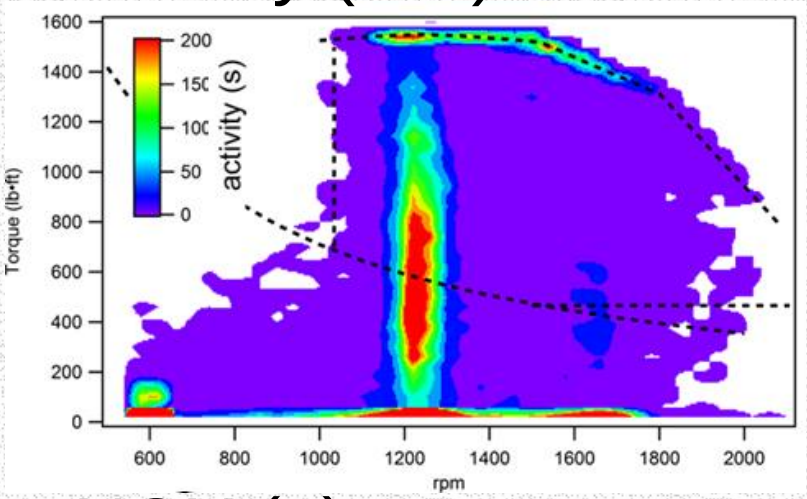
- Placerville Route
  - Distance: 34mi
  - Avg. speed: 40mph
  - Altitude gain: 1,360ft
  - Test load: empty, medium, and high

- West Sac Route
  - Distance: 24mi
  - Avg. speed: 26mph
  - Altitude gain: -27ft
  - Test load: empty, medium, and high

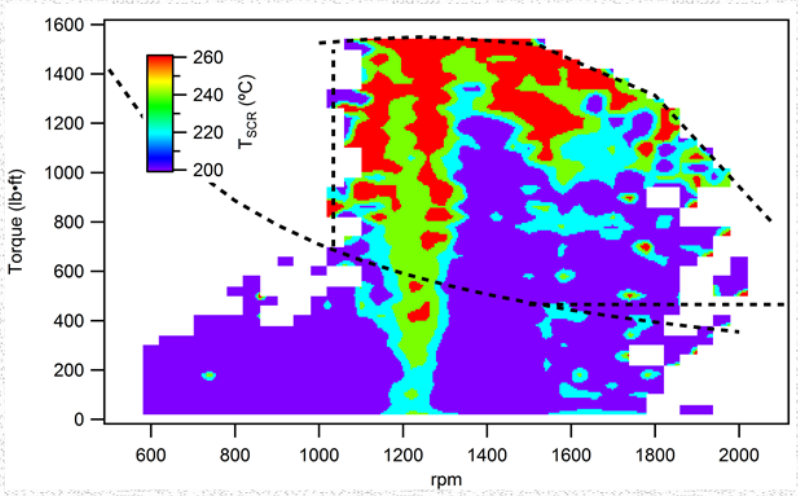


DDC Activity and NOX Emissions on Placerville Route

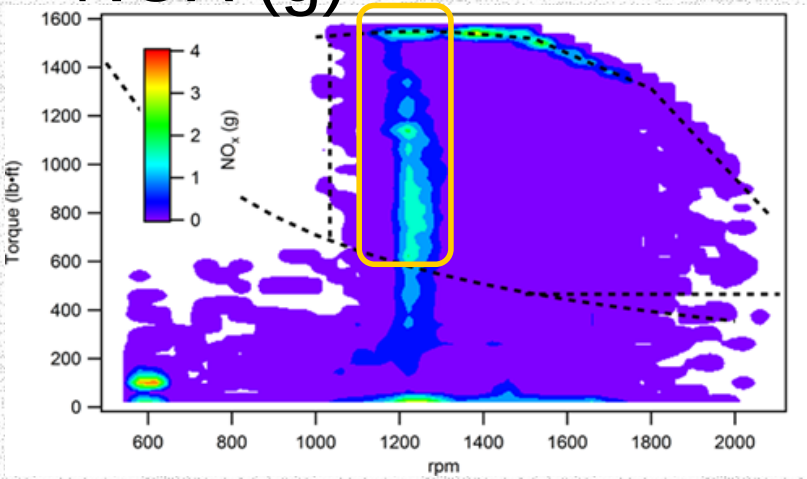
Activity (sec)



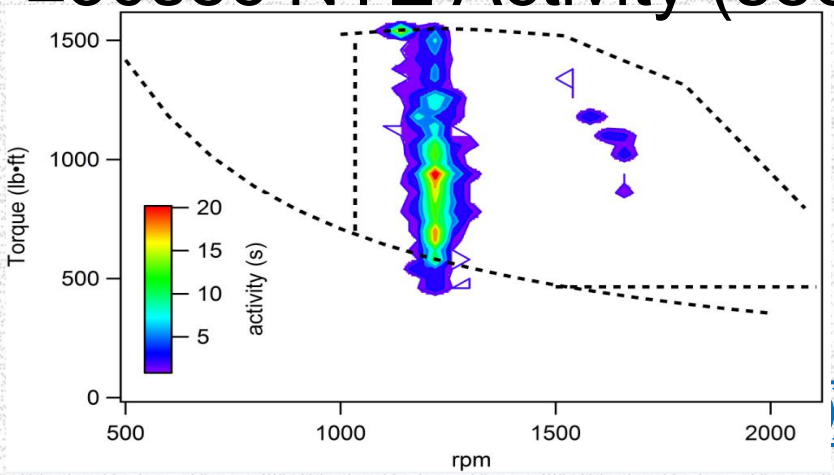
Temperature (°C)



NOX (g)

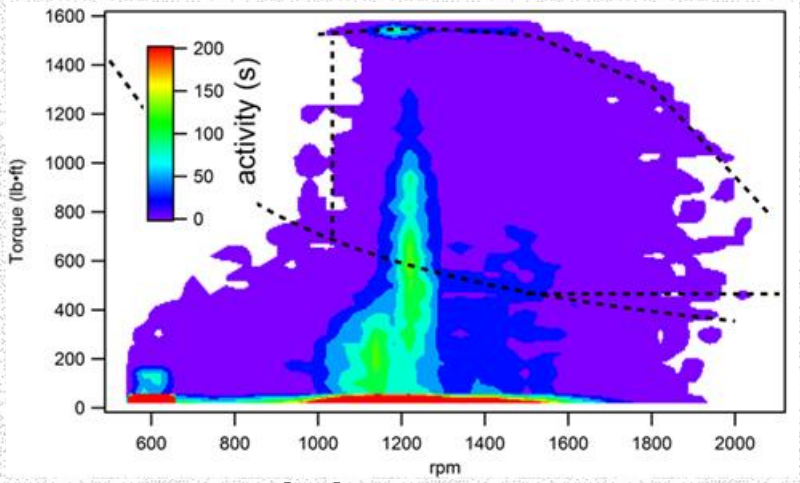


≥30sec NTE Activity (sec)

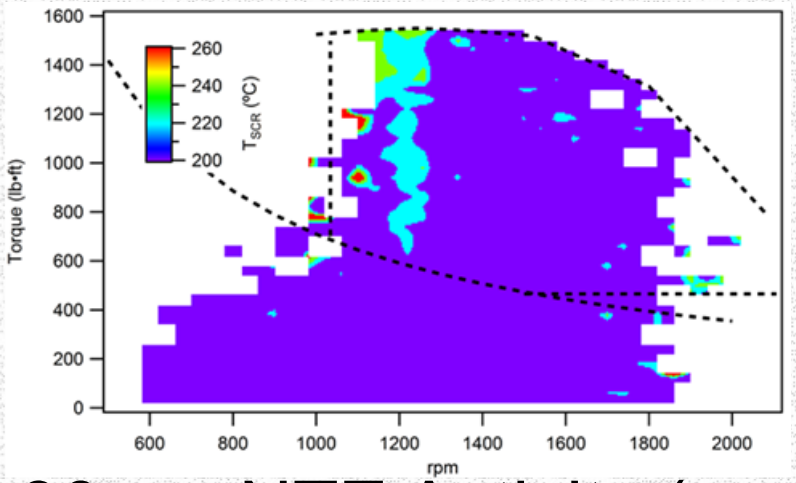


DDC Activity and NOX Emissions on West Sac Route

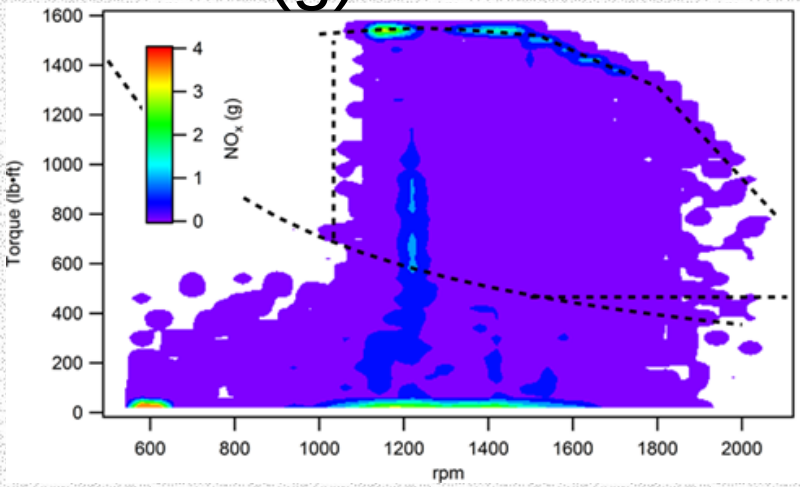
Activity (sec)



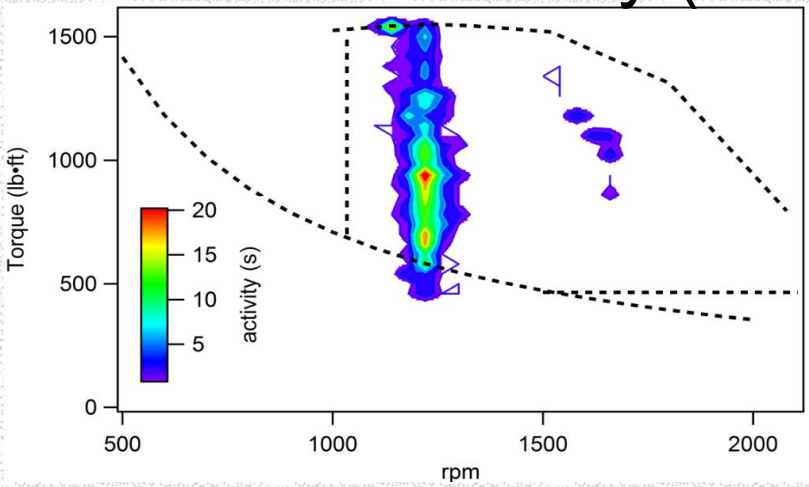
Temperature (°C)



NOX (g)



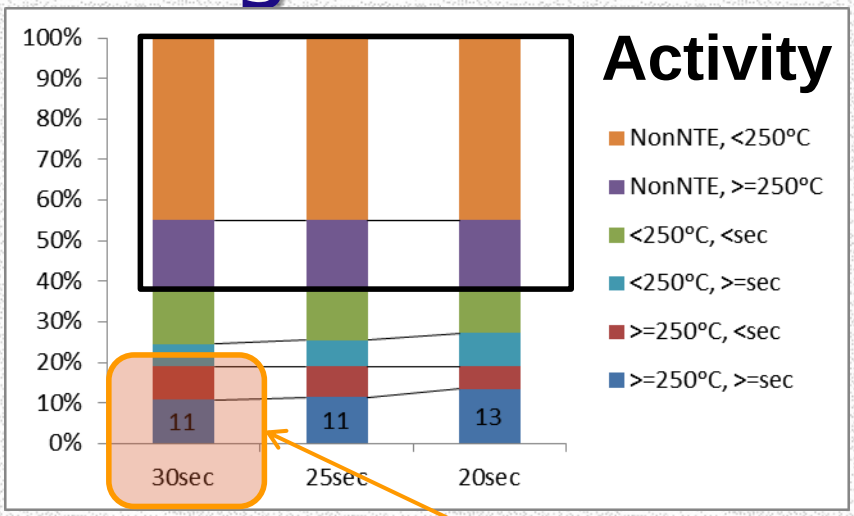
≥30sec NTE Activity (sec)

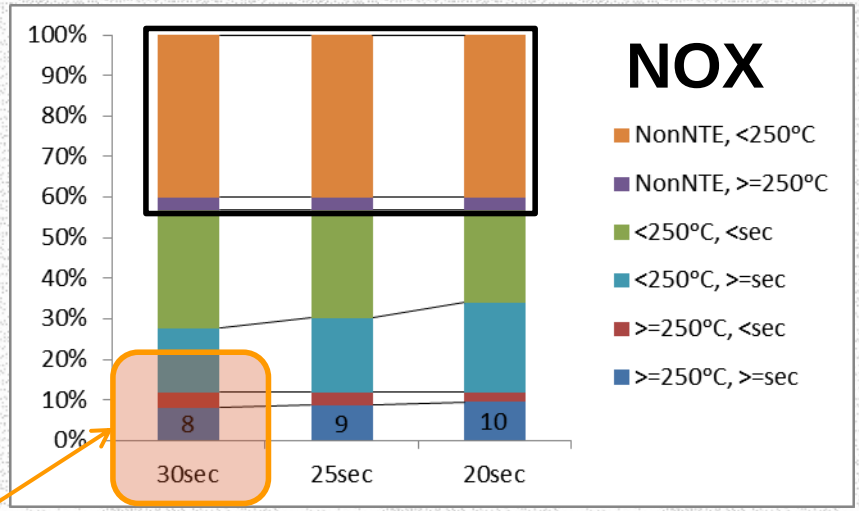


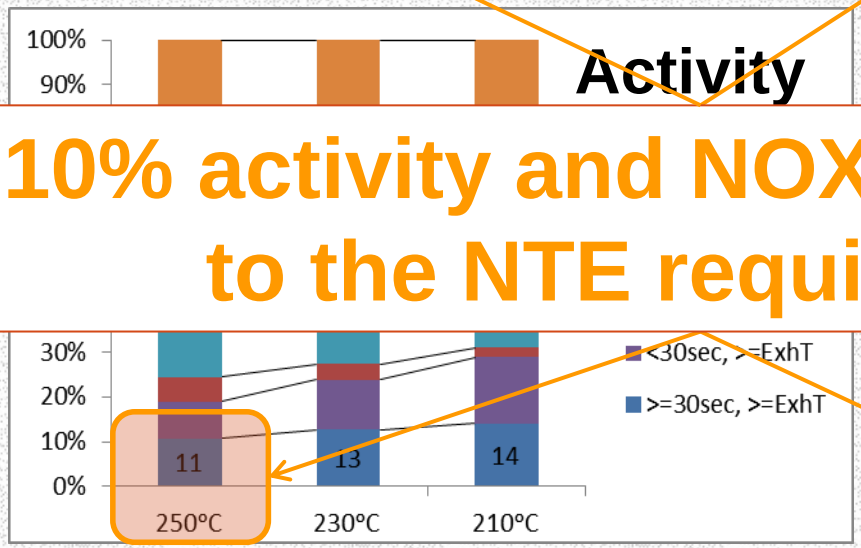
Change SCR-Out Exhaust Temperature and NTE Duration Limits

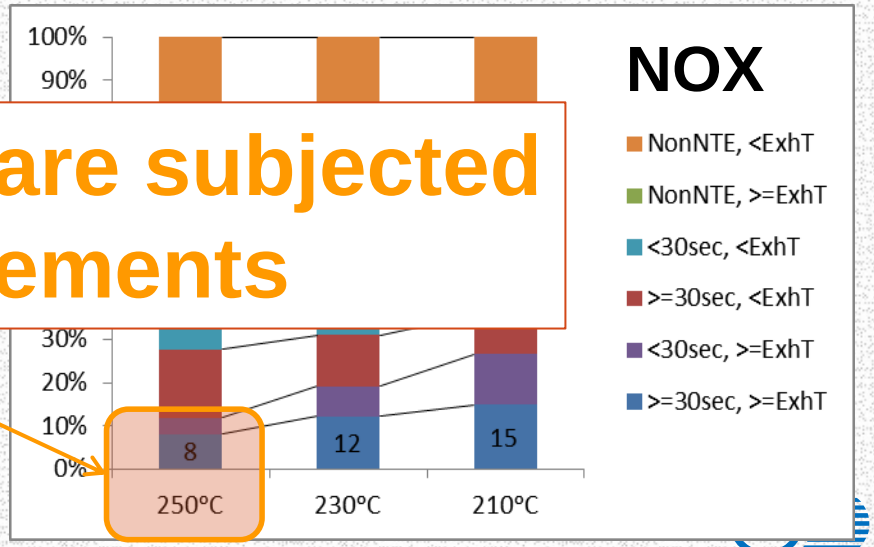
- Lower the SCR-out exhaust temperature limit from 250 °C to 230°C or 210 °C
- Shorten the NTE duration limit from 30 sec to 25 sec or 20 sec

DDC %Activity and %NOX Emission Changes on Placerville Route



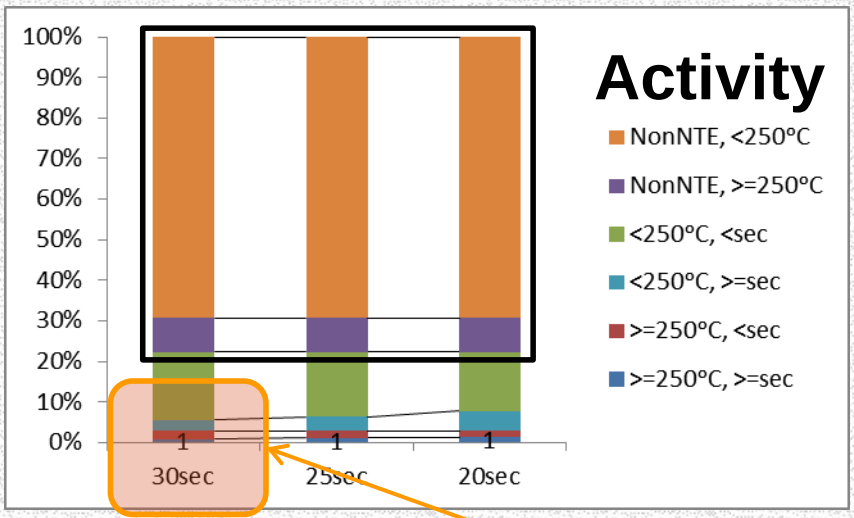


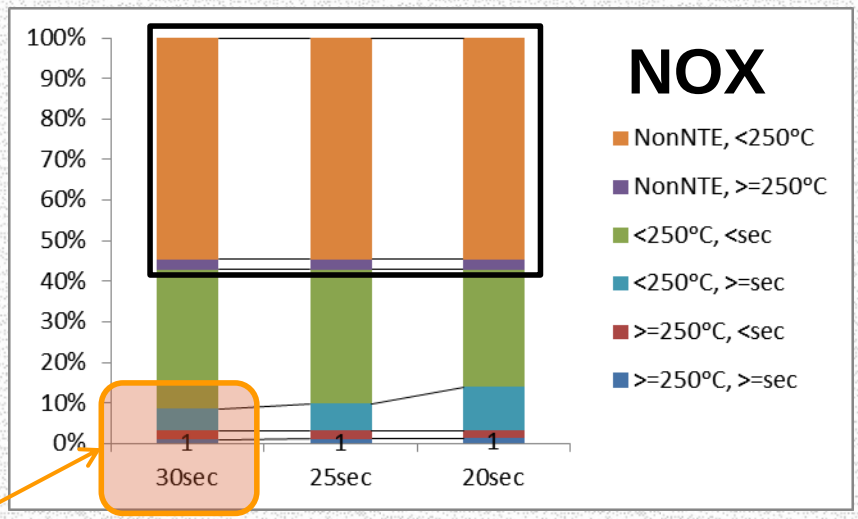


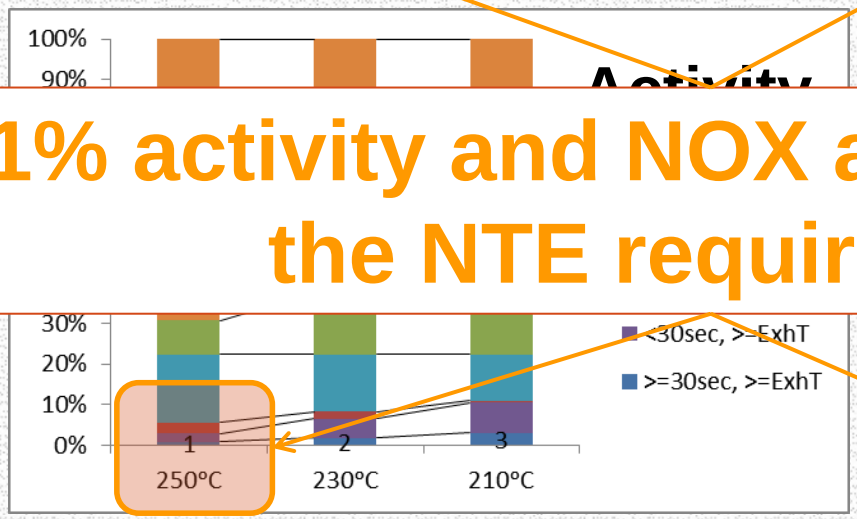


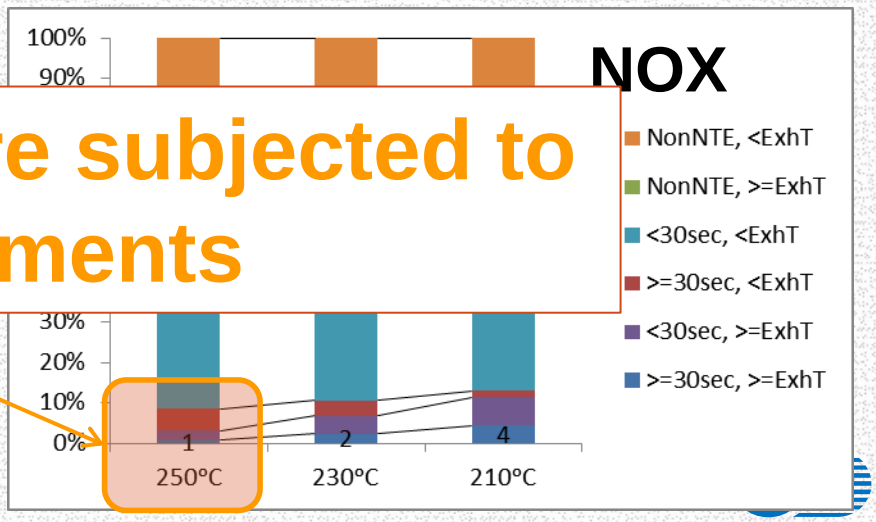
~10% activity and NOX are subjected to the NTE requirements

DDC %Activity and %NOX Emission Changes on West Sac Route



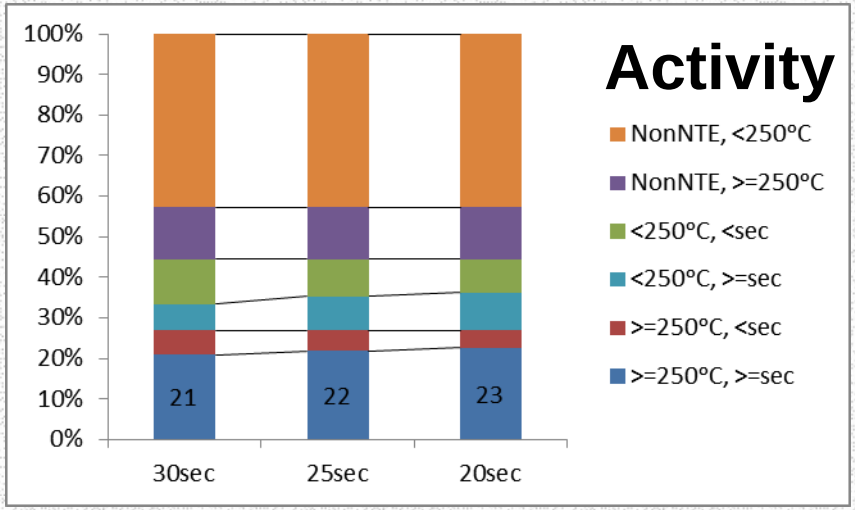


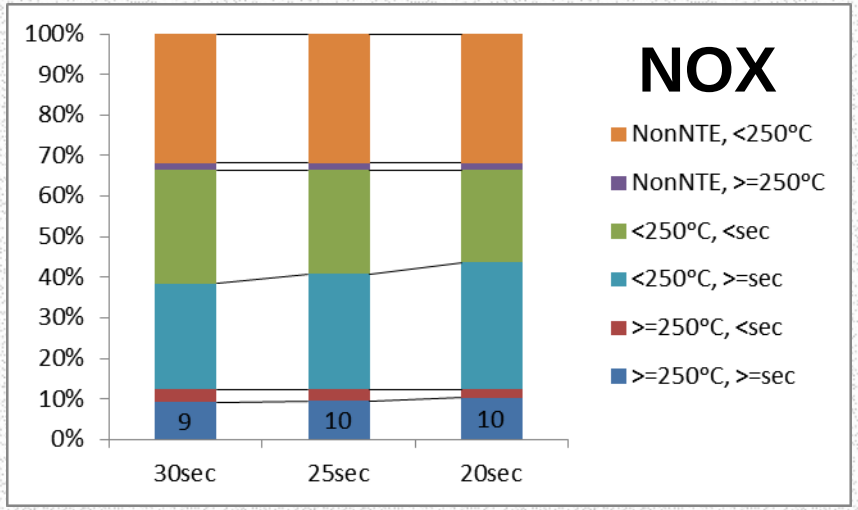


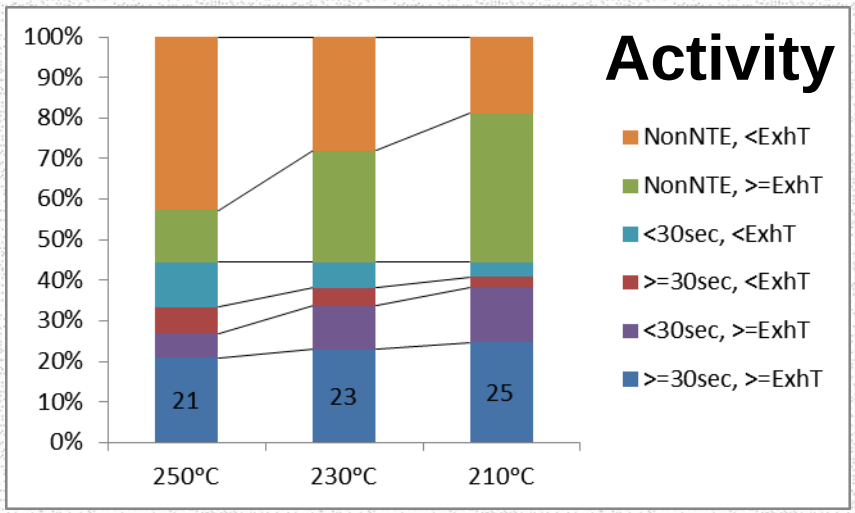


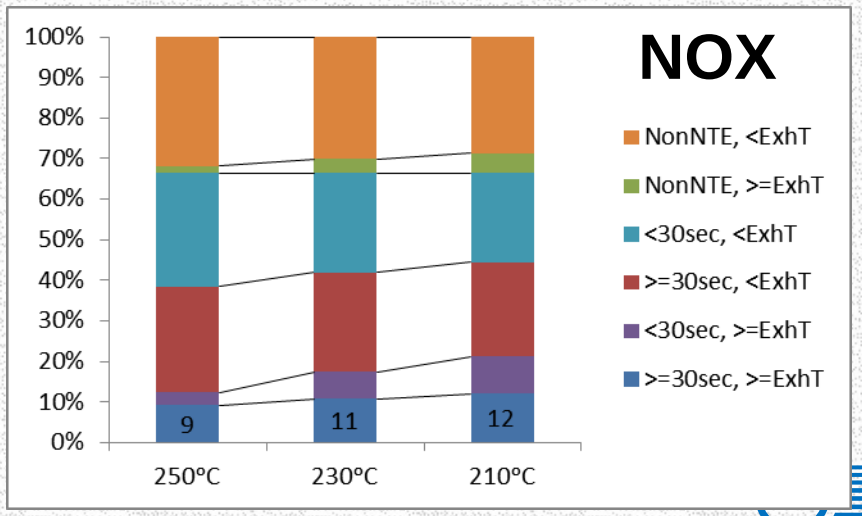
~1% activity and NOX are subjected to the NTE requirements

Volvo %Activity and %NOX Emissions on Placerville Route

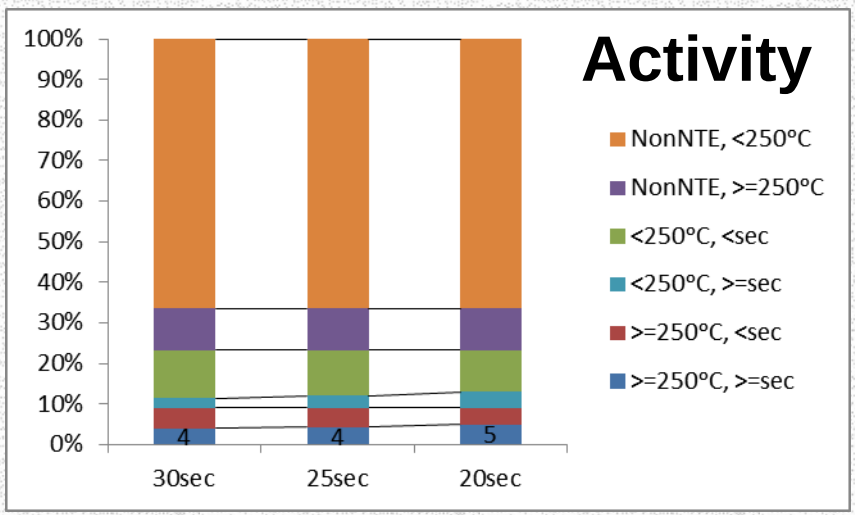


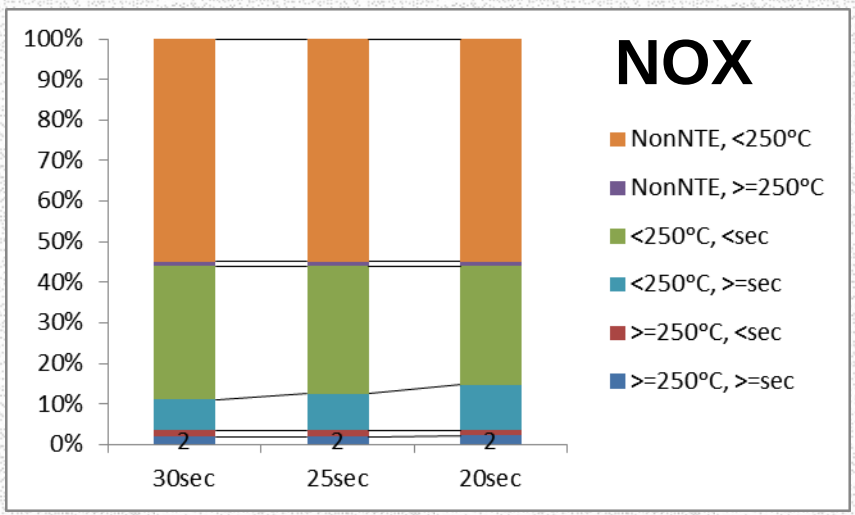


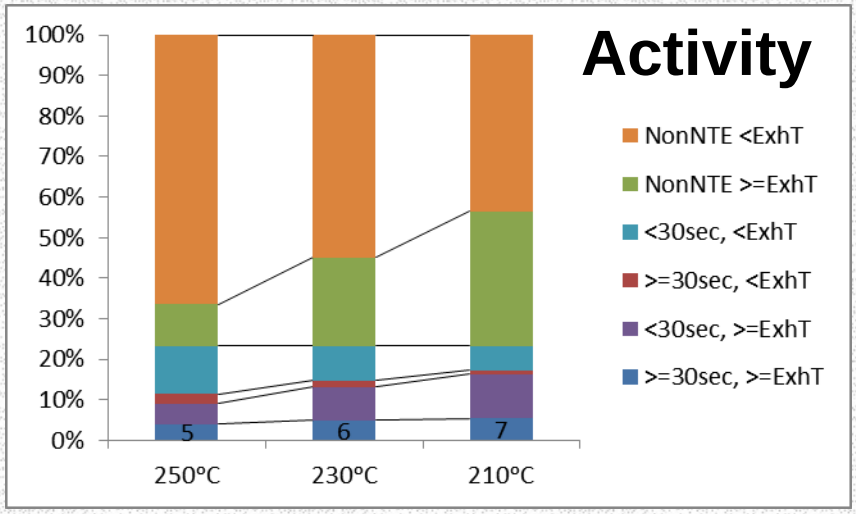


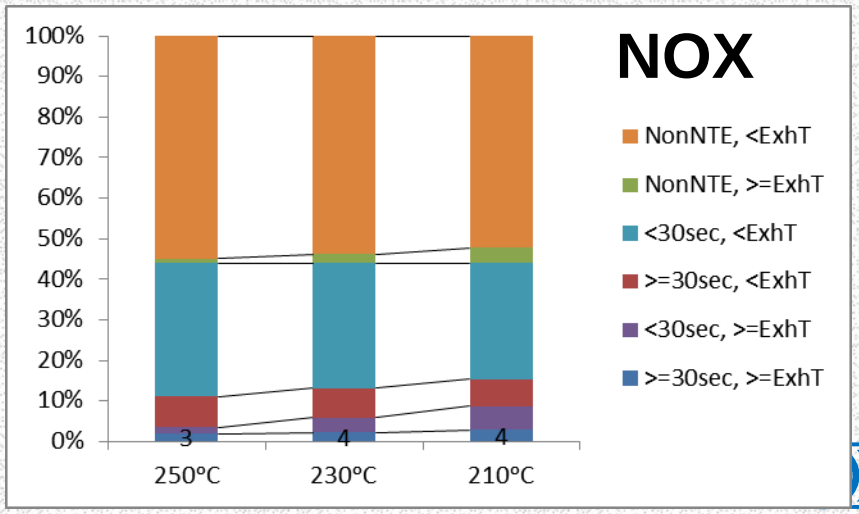


Volvo %Activity and %NOX Emissions on West Sac Route









Summary of Findings

- Majority of truck activity occurred outside of NTE zones while majority of NOX emission occurred inside of NTE zones
- About 10% to 20% of activity and NOX from 2010 technology Volvo and DDC trucks on Placerville route are subjected to the NTE requirements
- About 1% to 5% of activity and NOX from 2010 technology Volvo and DDC trucks on West Sac route are subjected to the NTE requirements
- Lowering the SCR-out exhaust temperature limit and shortening the NTE duration limit add only a few percent of activity and NOX to the NTE control boundaries

Implications and Discussions

- Current NTE requirements are not effectively controlling in-use NOX emissions over short-haul routes
- Do we need to redefine the NTE zone?
  - Lowering engine torque, power, and RPM limits
- Do we need supplemental NTE requirements?

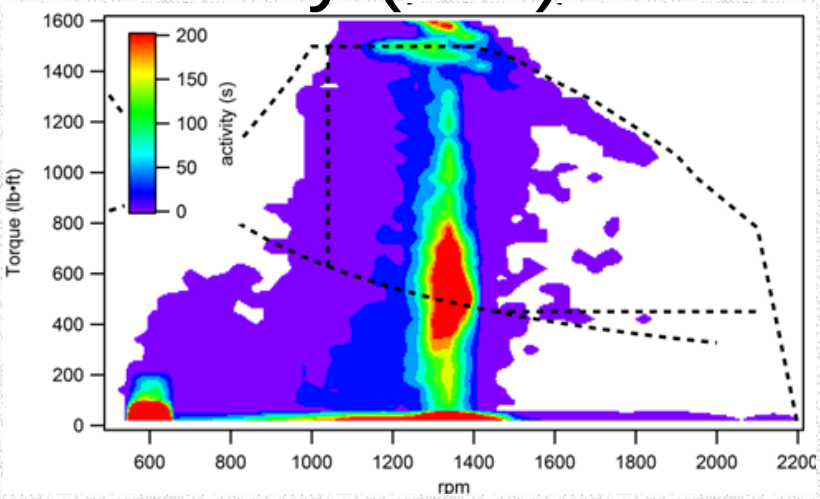
Next Step

- A research plan is in development to better understand the effectiveness of NTE requirements for control of in-use NOX emissions from 2010 or newer HDDVs
  - Measure engine operations and emissions with PEMS over various on-road driving conditions
  - Compare the effectiveness of current NTE requirements to other approaches for controlling in-use NOx emissions from HDDVs

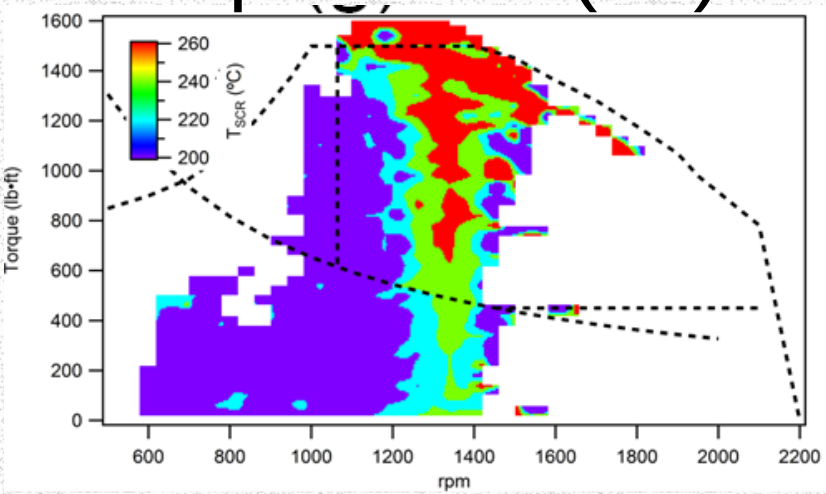
Supplemental Information

Volvo Activity and NOX Emissions on Placerville Route

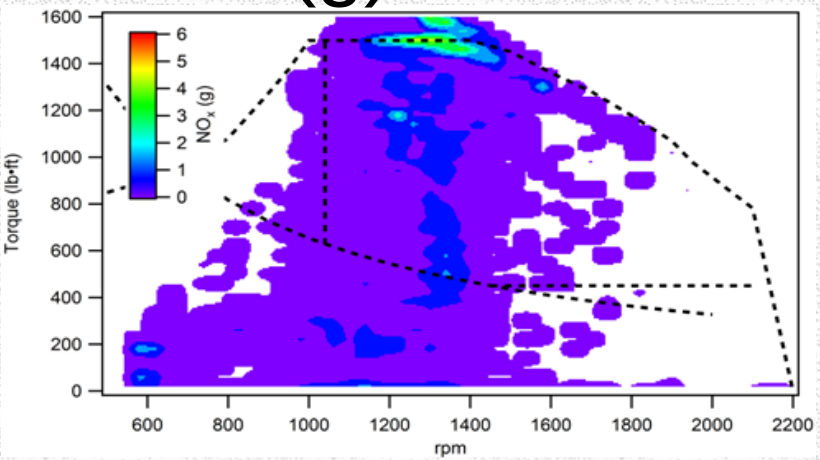
Activity (sec)



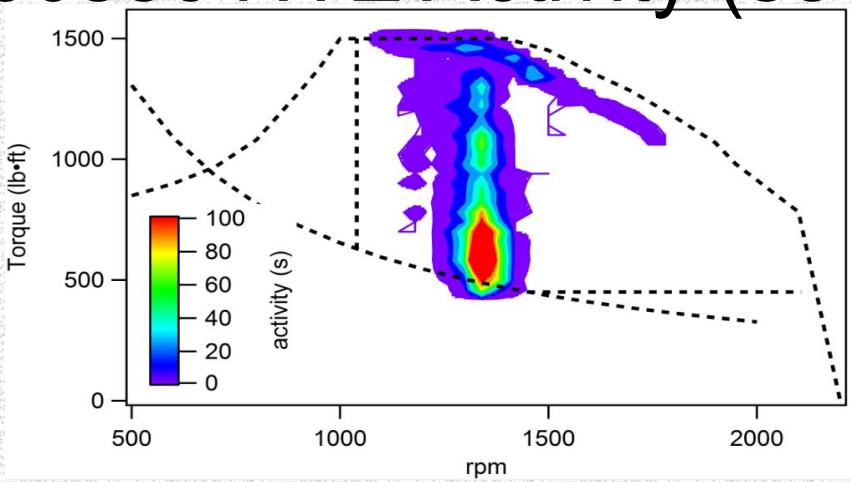
Temperature (°C)



NOX (g)

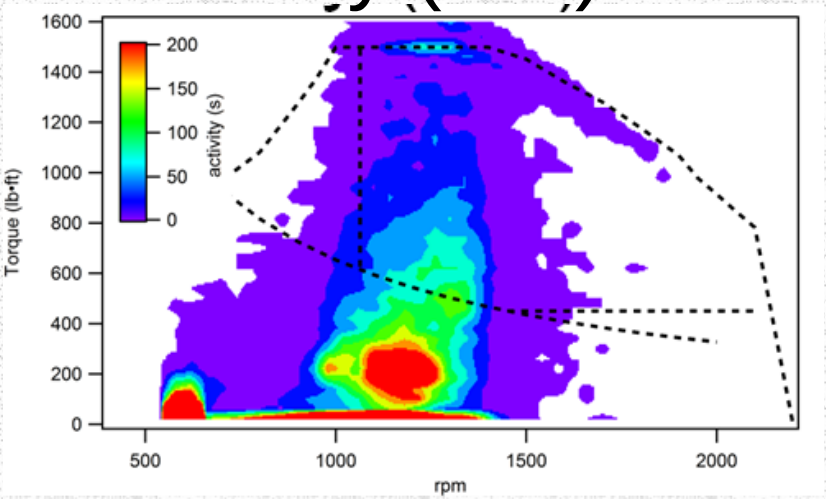


≥30sec NTE Activity (sec)

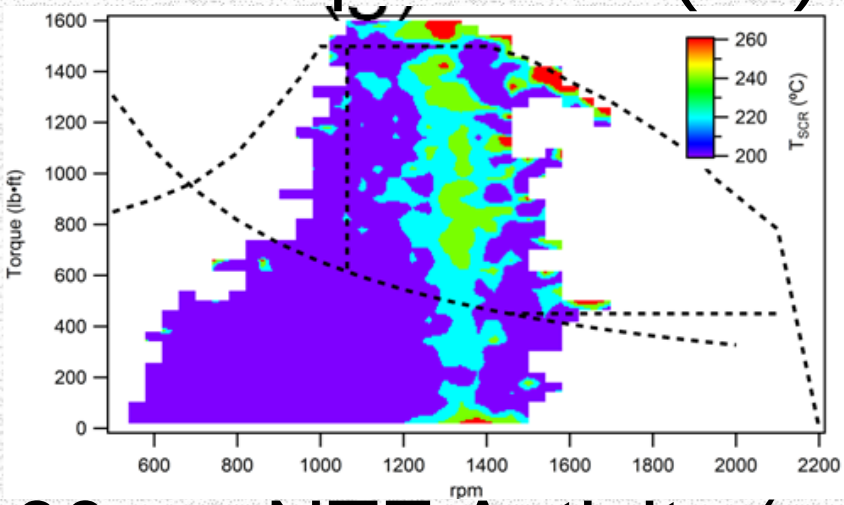


Volvo Activity and NOX Emissions on West Sac Route

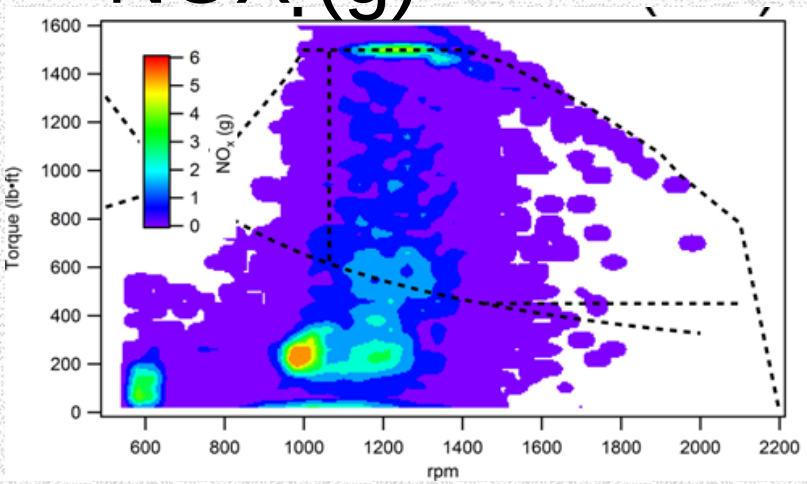
Activity (sec)



Temperature (°C)



NOX (g)



≥30sec NTE Activity (sec)