# Transient NOx emissions from in-service UK buses

*Note: the original presentation contained many embedded videos. If you would like a copy of the original presentation, please e-mail the author at msp@cambustion.com*

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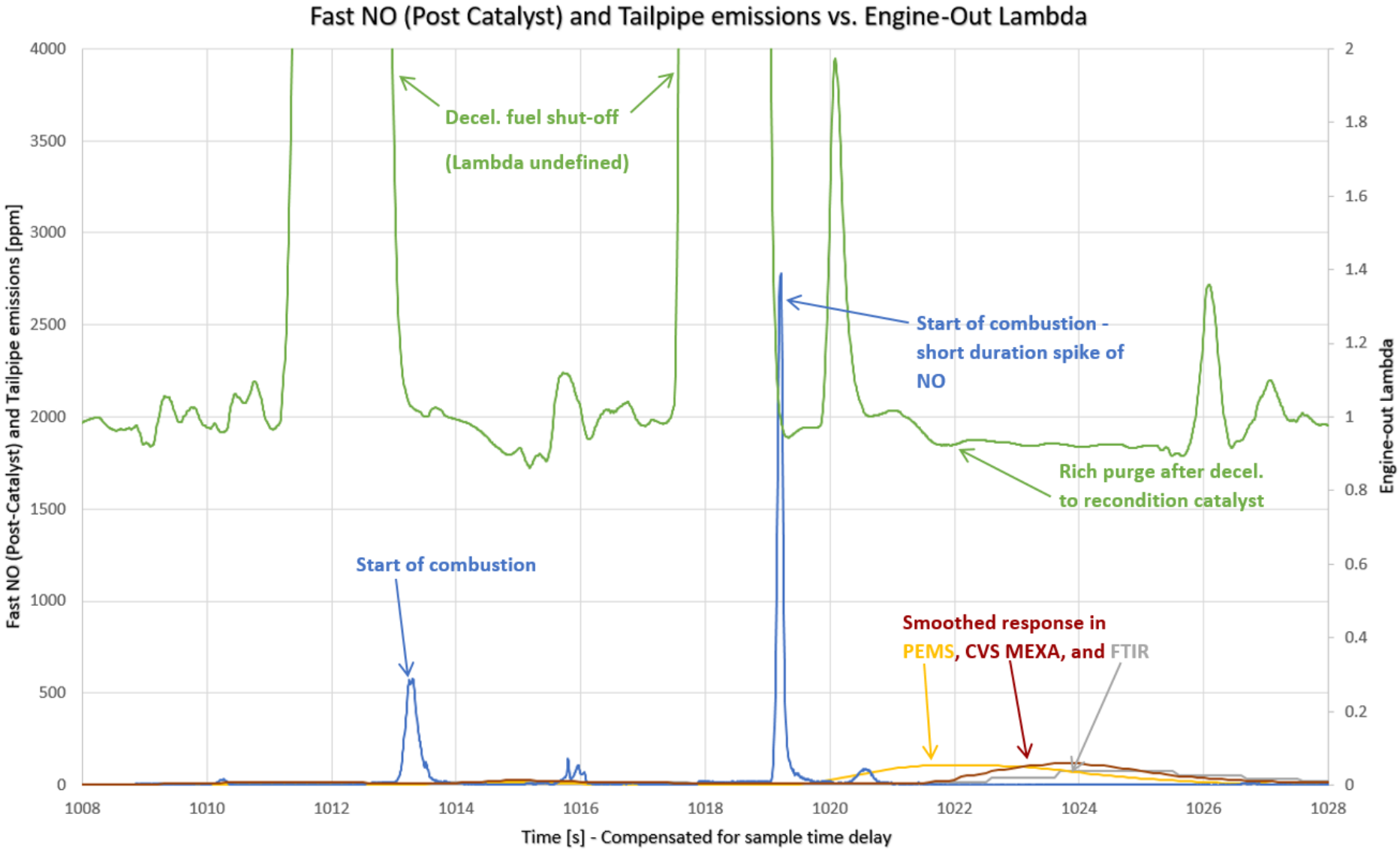
# Real world Driving Emissions (RDE)

- Main challenge is transients (start, accel, decel & “unsmooth” driving), often <<1 second duration
- If a short-duration “spike” of emissions is produced, you need an instrument with a fast response time to measure it accurately
- Portable Emissions Measurement Systems (PEMS) have a response time of a few seconds


- Cambustion emissions analyzers have two-channels a response time of a few *milliseconds (…a thousand times faster)*

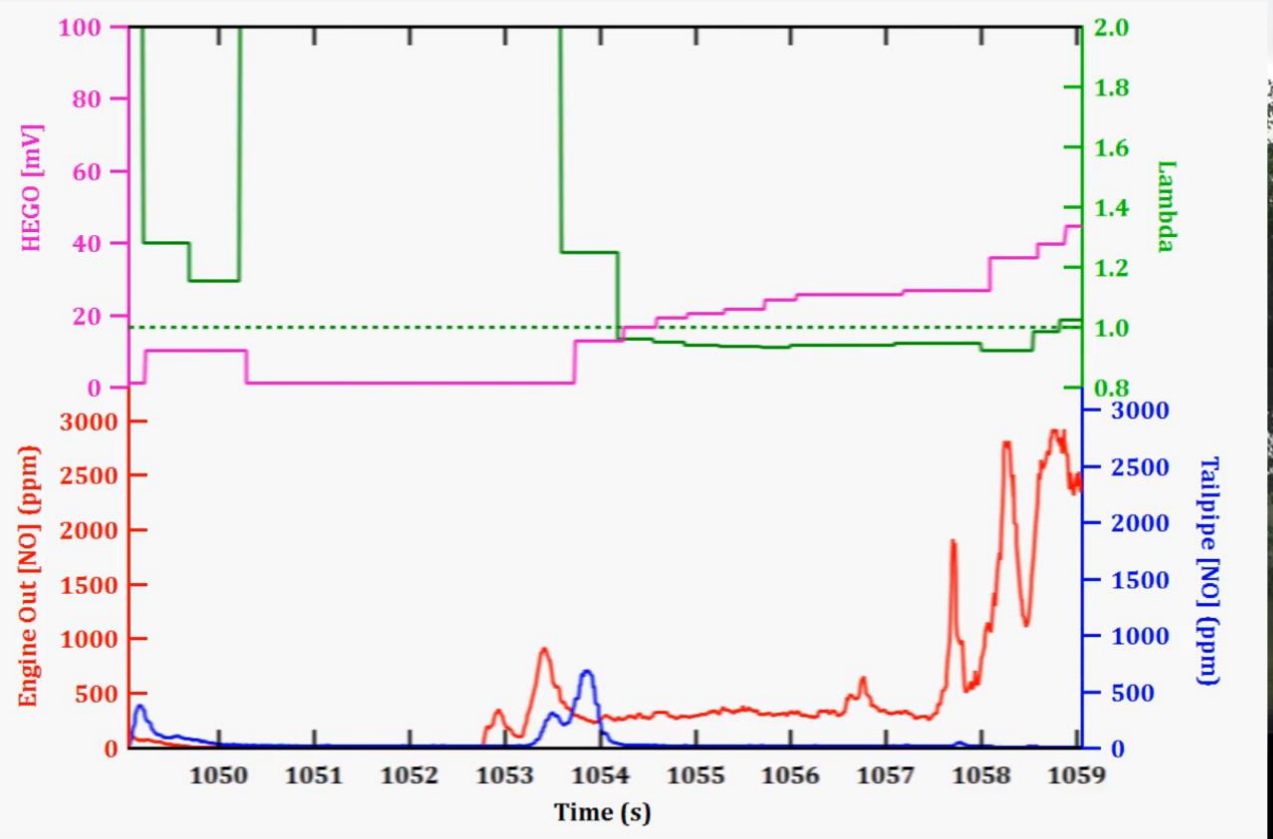
# Comparison of standard PEMS with fast RDE




MAHLE Powertrain

CAMBUSTION

# Fast engine-out & tailpipe [NO] from Euro 4 gasoline



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# In-service bus transient NOx emissions

# Vehicles tested

2012 Euro V hybrid with OEM SCR
(251,000 miles)

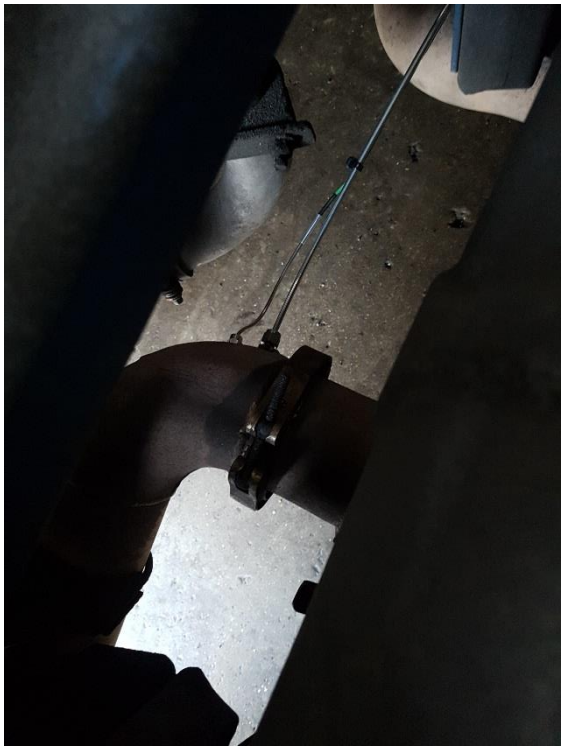
2015 Euro VI with OEM SCR
(119,000 miles)

Neither had any fault light indicators illuminated, were regularly in service and in good repair

# Sampling arrangements near rear seats


# Sampling arrangements

- Fast NOx measured immediately post aftertreatment in both buses

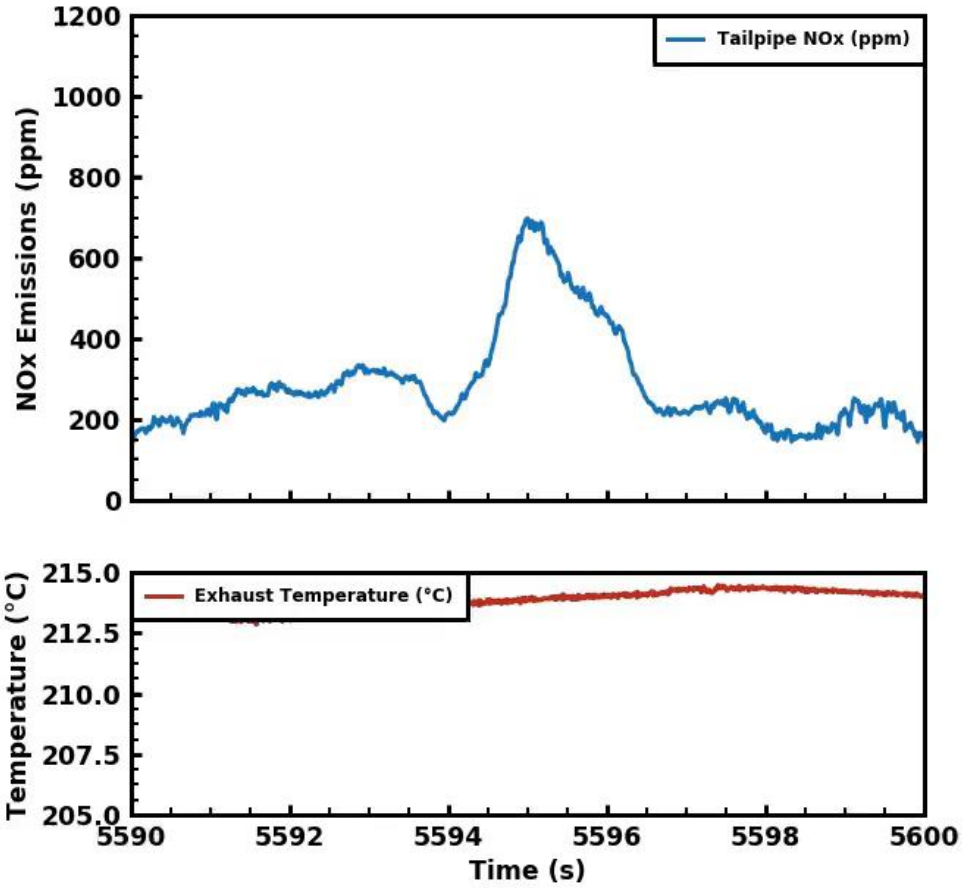



- Euro VI bus with additional exhaust temperature measurement
- GPS, dashcam and emissions also logged simultaneously – no ECU!

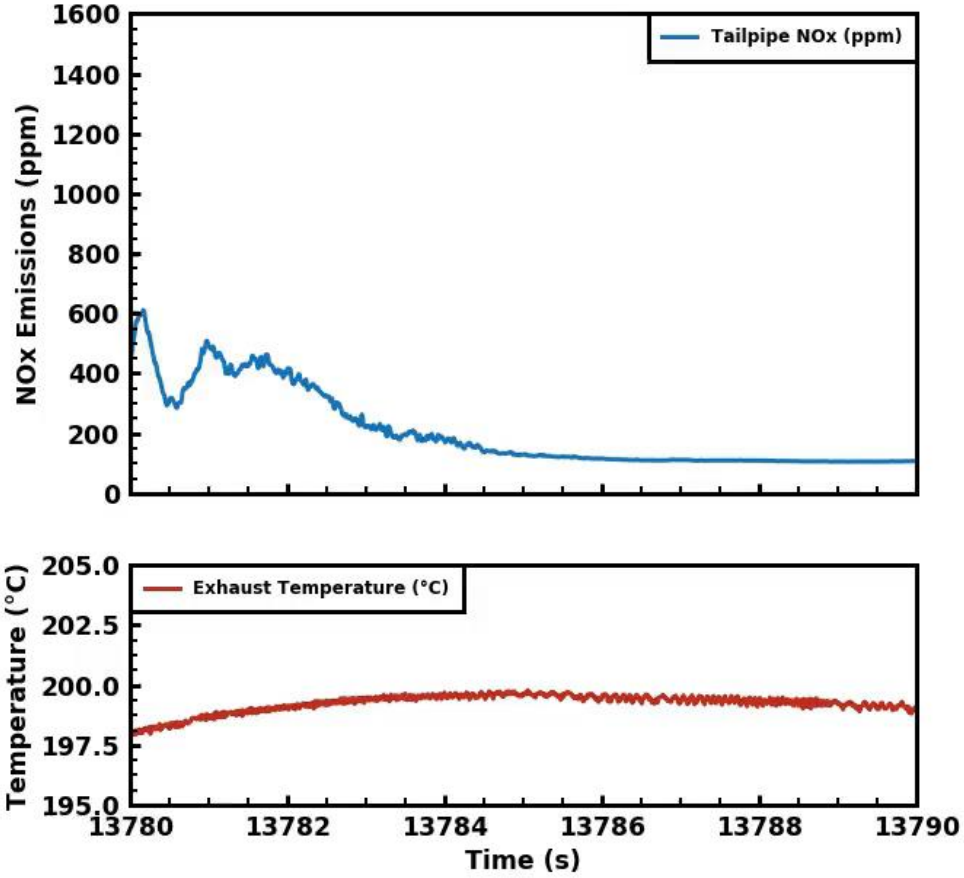
# Accuracy of GPS bus NOx emissions

- Differential GPS measurements accurate to 0.1 cm
- Gives accuracy on emissions ~14 cm @ 30 mph

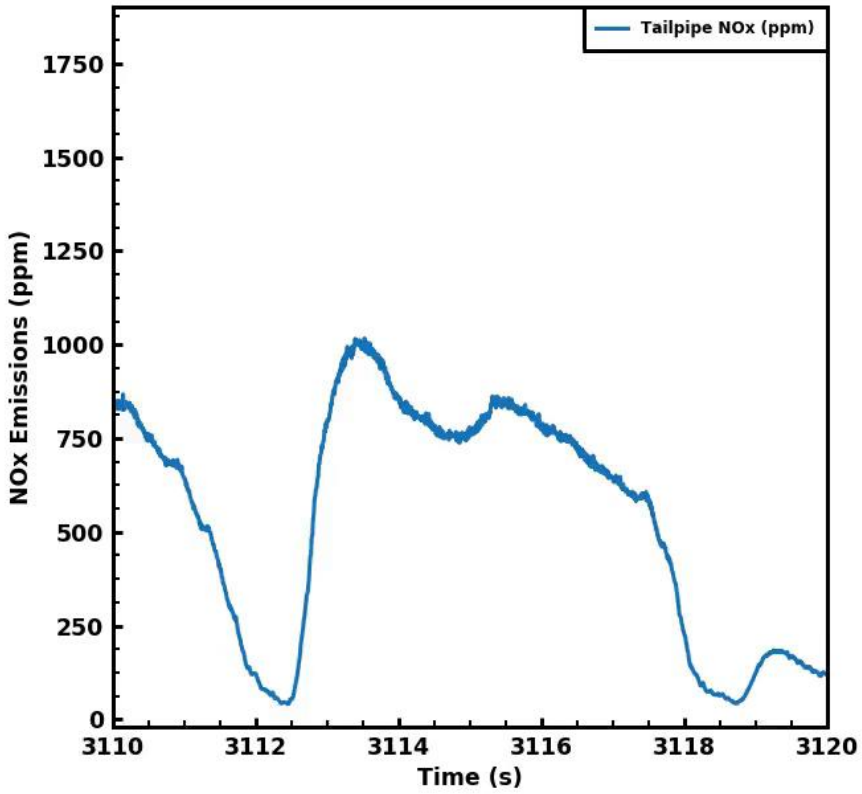
# Euro VI bus: bus stop manoeuvre



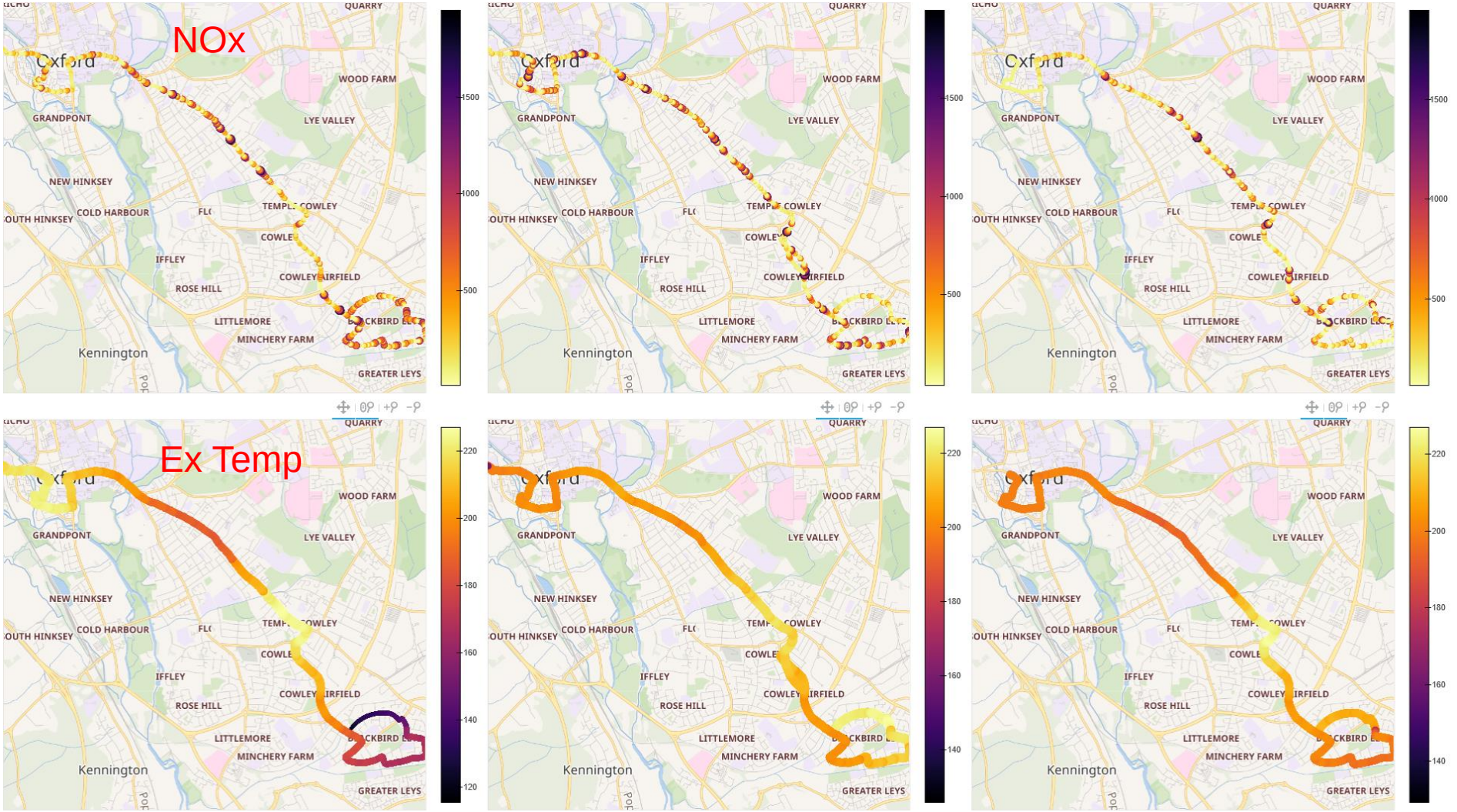

# Euro VI bus: roundabout




# Euro V hybrid bus over speed bumps




# Comparison of 3 x Eu VI north runs

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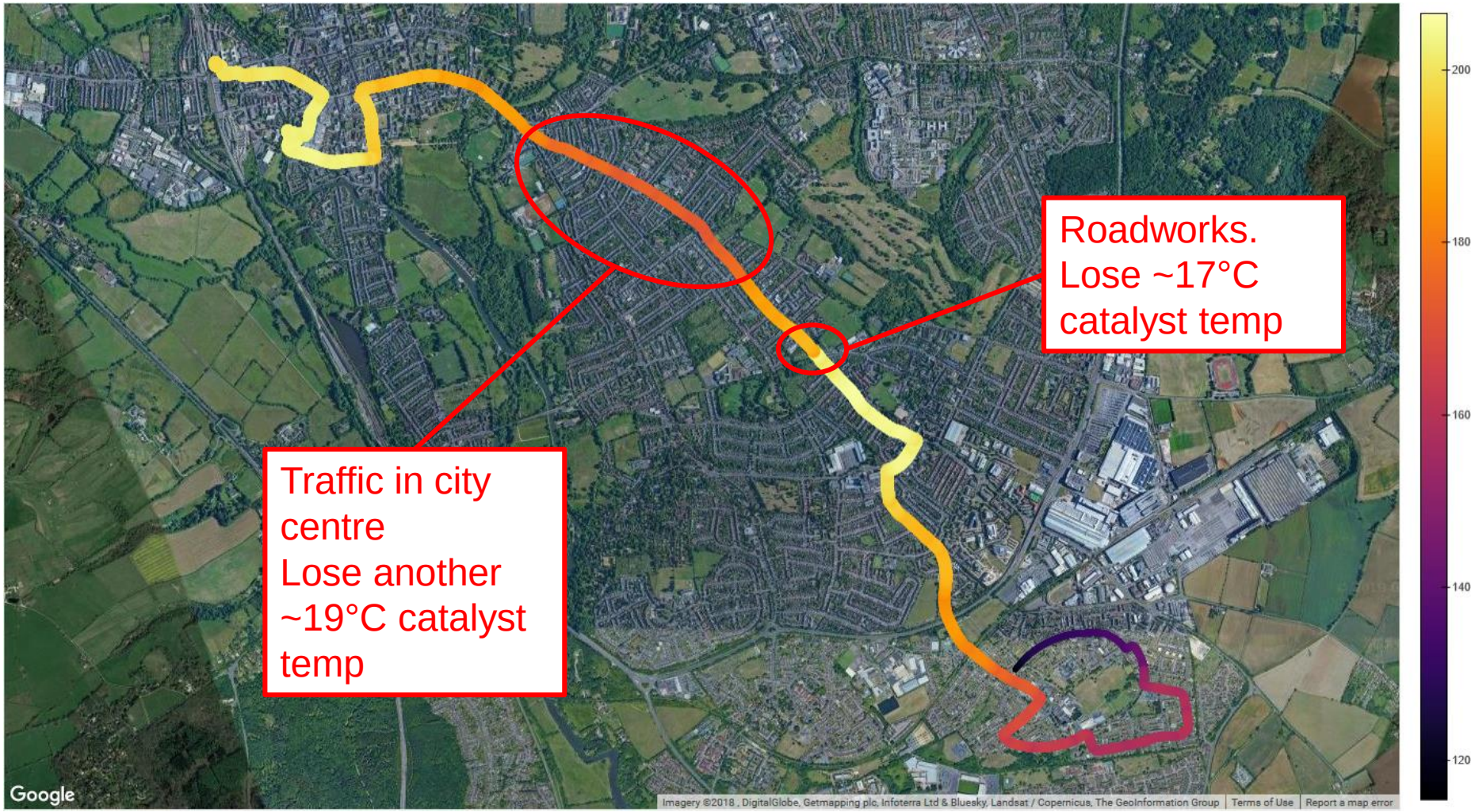
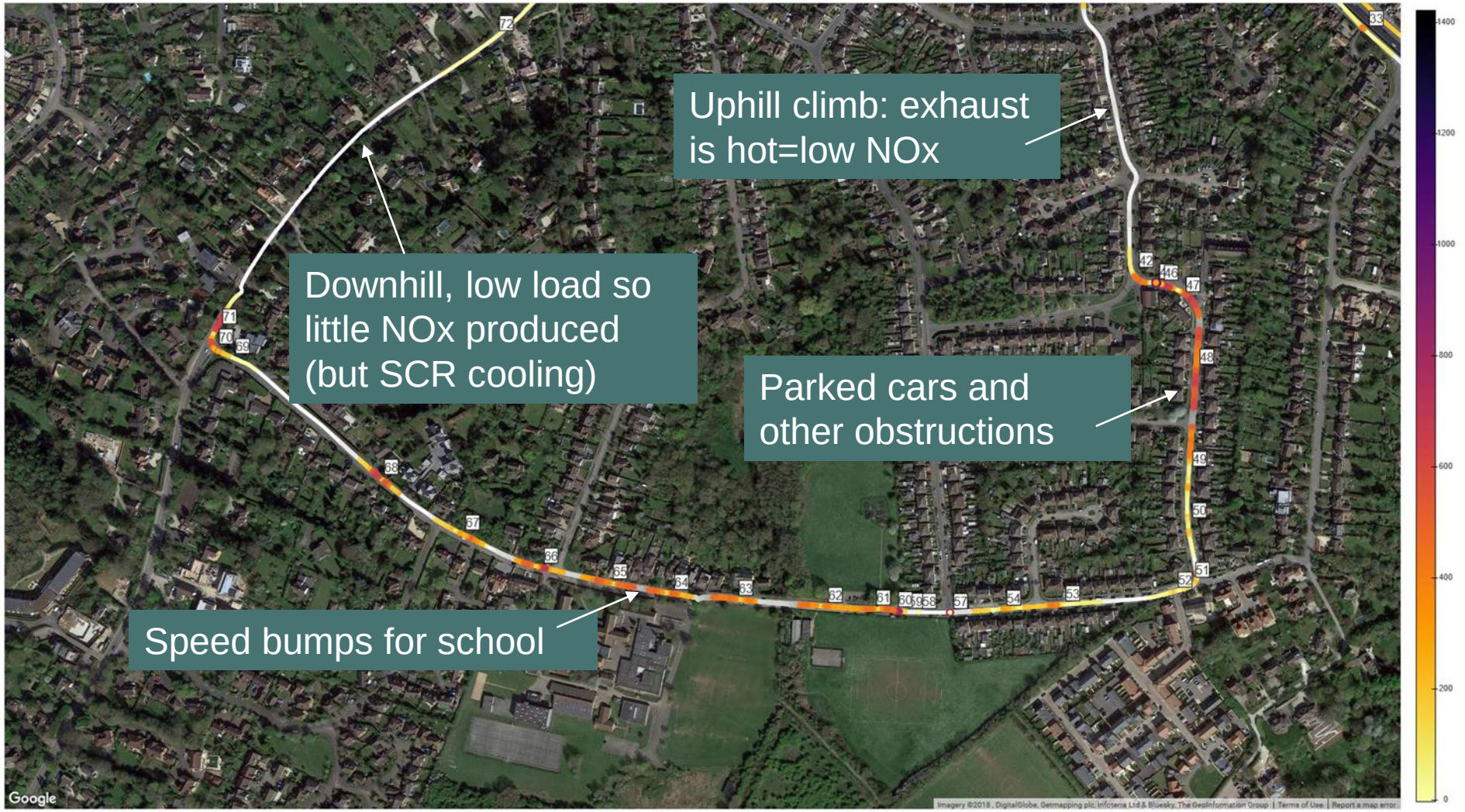
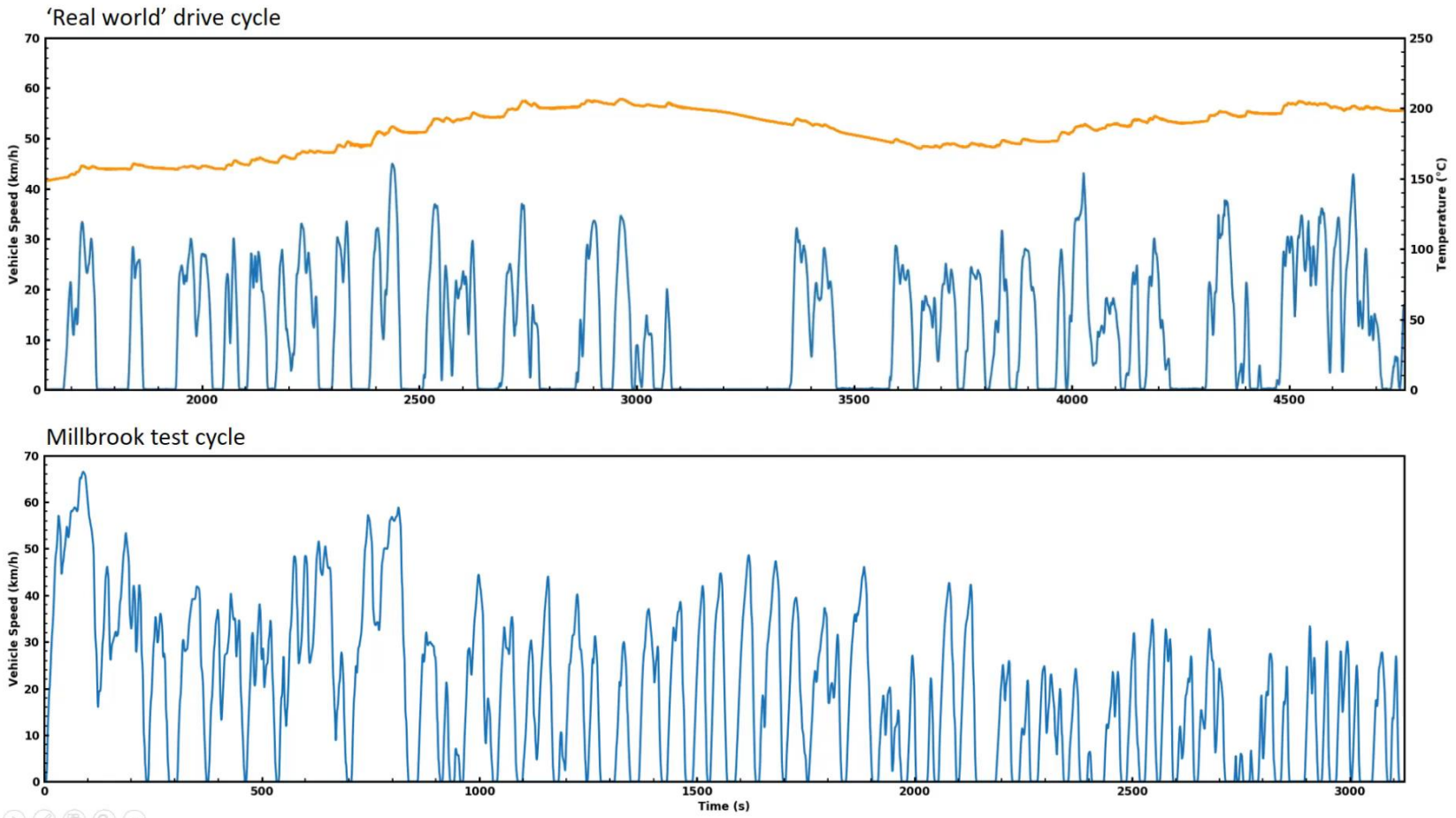
# Exhaust temperature variation



# NOx around school, SCR temperature dependency



# “Millbrook” certification cycle compared to real world



# Conclusions

- Transients are an important aspect of the vehicles' emissions performance
- The chosen routes were more gentle than the certification cycle
- Obstructions such as roadworks, traffic lights and speed bumps provoke transient NOx emissions
- Decelerations cooling the aftertreatment system appear to cause a spike of NOx when pulling away from bus stops
- Sub-optimal gear change speed/load settings can also cause spikes of NOx

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