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NO_x pollution “hot spots” measured on-board a variety of passenger vehicles

Copy including working videos, available on request to
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Dr. Mark Peckham

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 a response time of a few *milliseconds (…a thousand times faster)*

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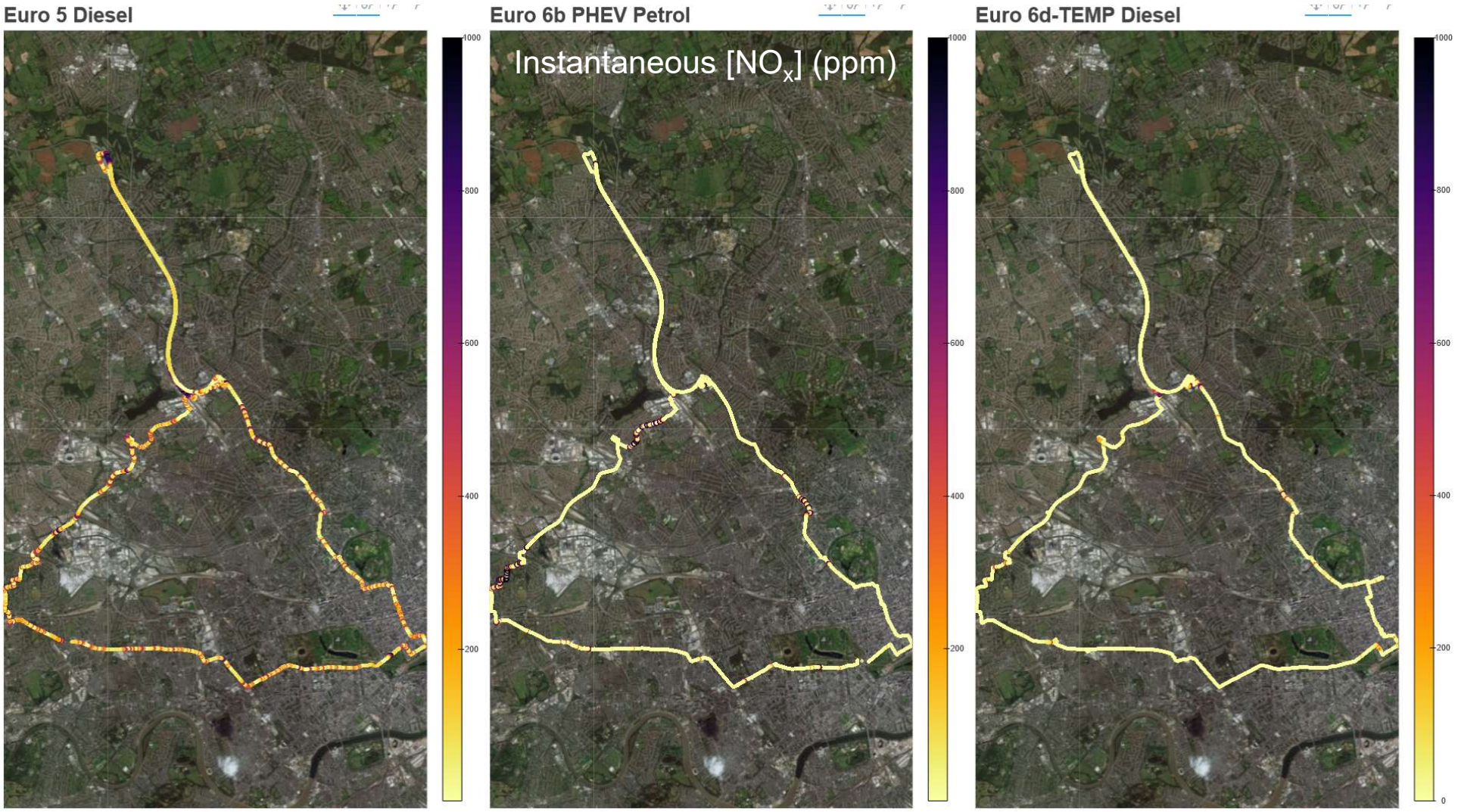
NO_x tailpipe ppm comparisons – newer cars better!



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Fast Response RDE

- <10 millisecond response time
- Specifically developed for transients
- Integration with vehicle data and GPS
- Helps identify vehicle “problem” conditions
- Urban pollution “hot spots”

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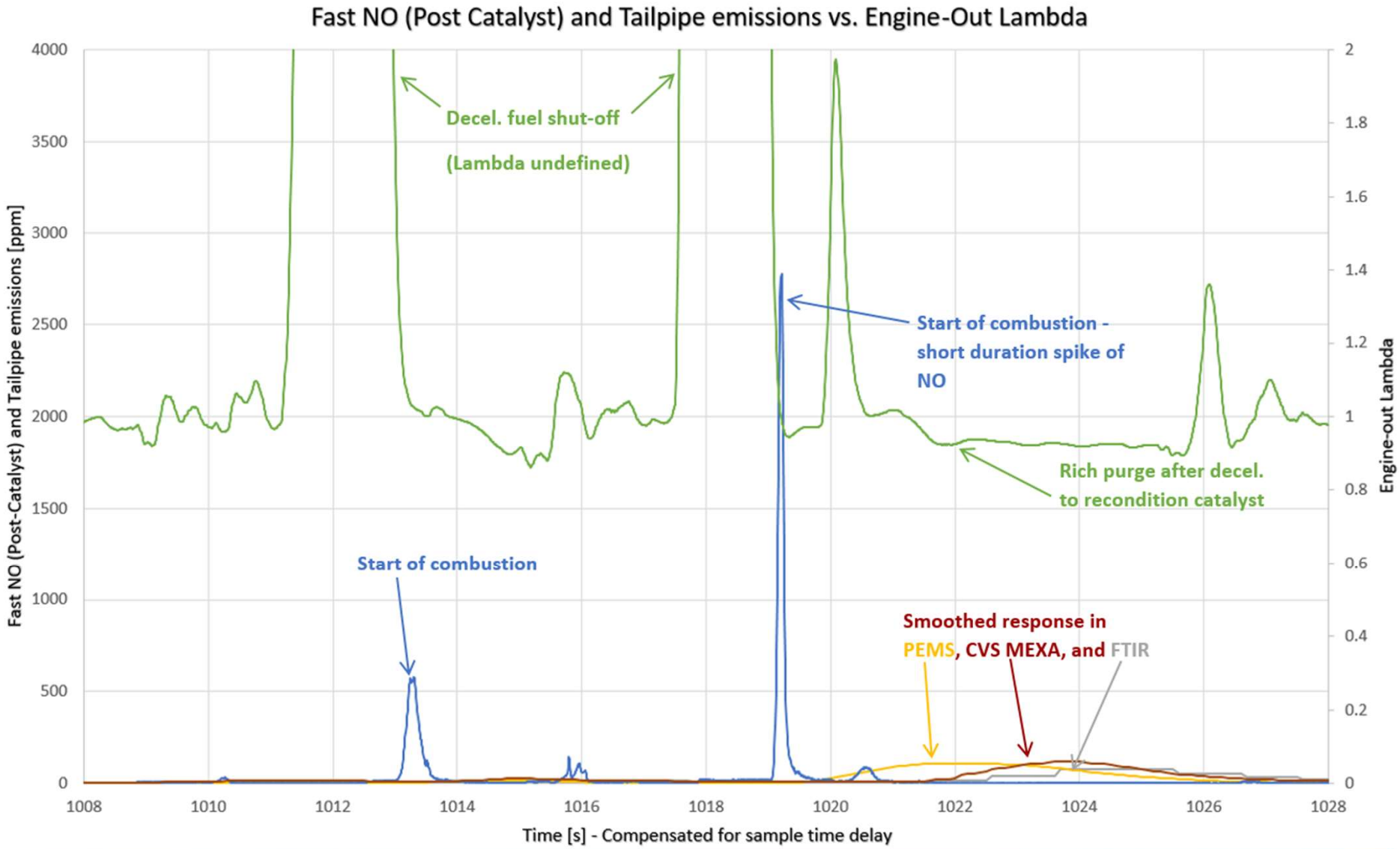
Comparison of standard PEMS with fast RDE



MAHLE Powertrain

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Typical engine transients

- Cold start
- Accelerations
- Decelerations (decel fuel shut-off)
- Gear changes

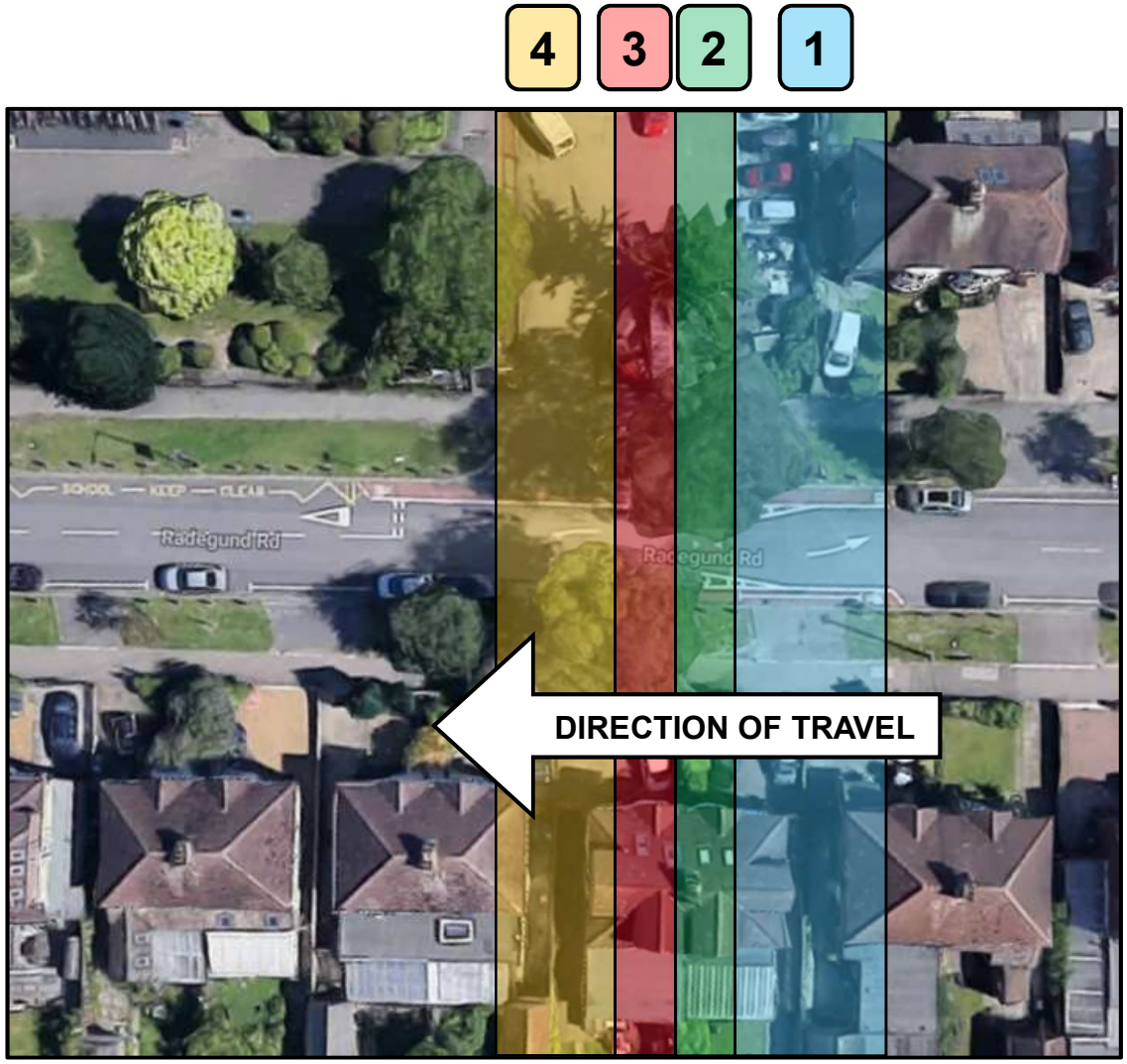
Negotiating the humble speed bump!

1. Decelerate, combustion stops

2. Clutch in and engine starts (idle)

3. Accelerate away from speed bump

4. Change up gear and head for speed limit



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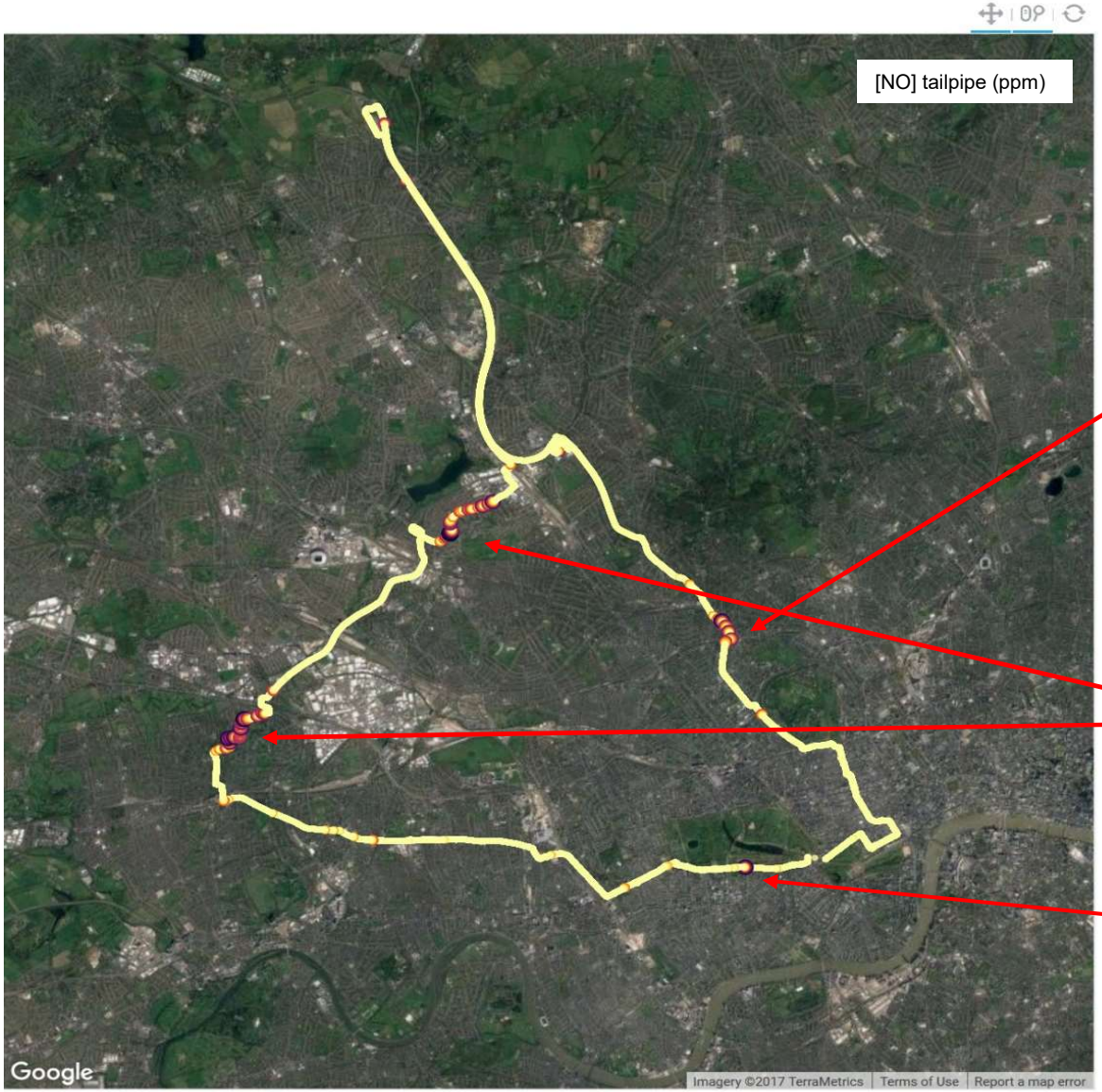
Speed bump – Euro 4 gasoline

TfL West London Route with PHEV vehicle



Generally very good for NOx emissions, but…

Trouble at Swiss Cottage

…and in West London over speed bumps

Bus lane convergence

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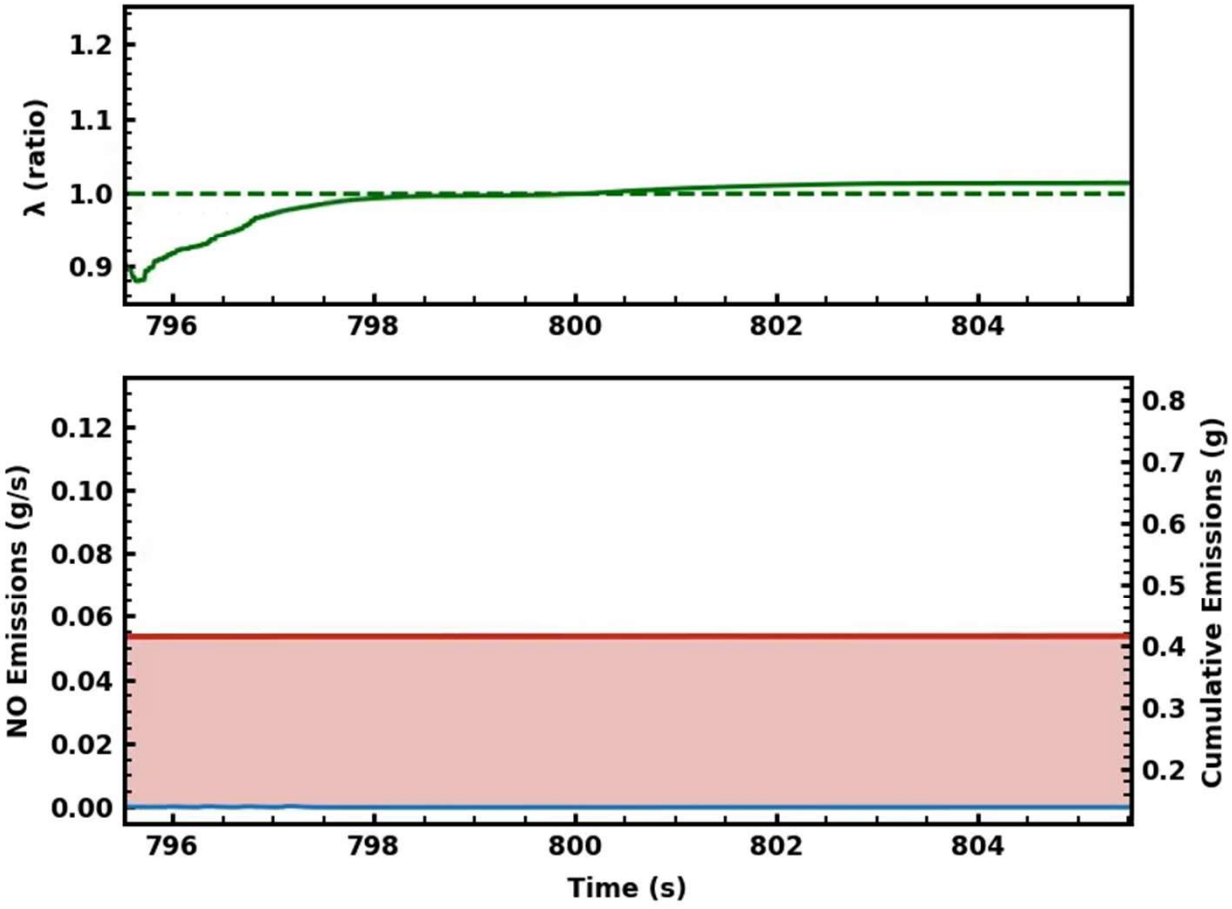
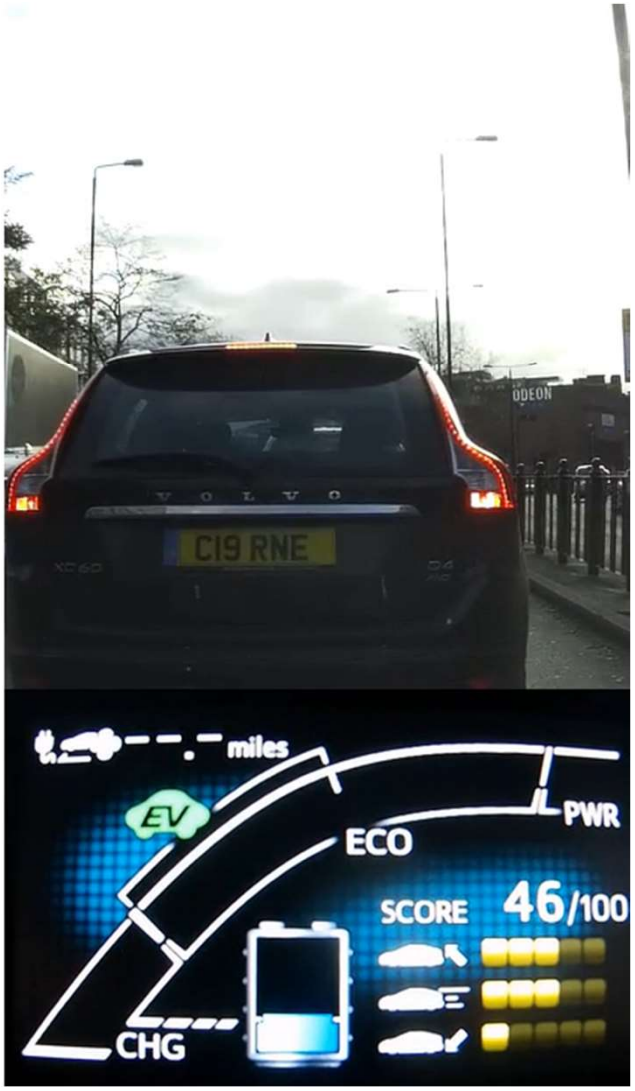
Swiss Cottage PHEV manoeuvres NO_x emissions





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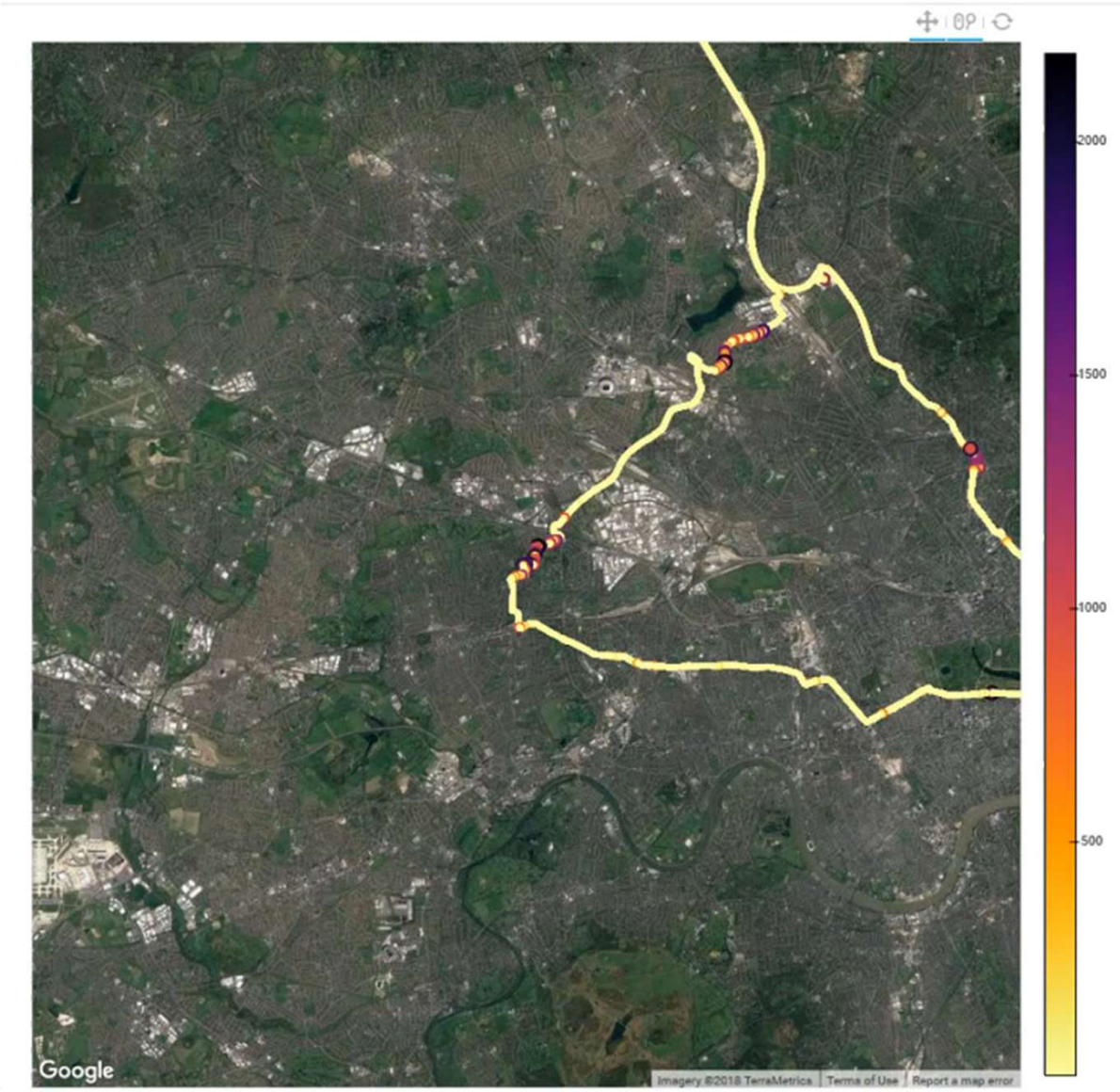
Accurate NO_x concentration location measurements



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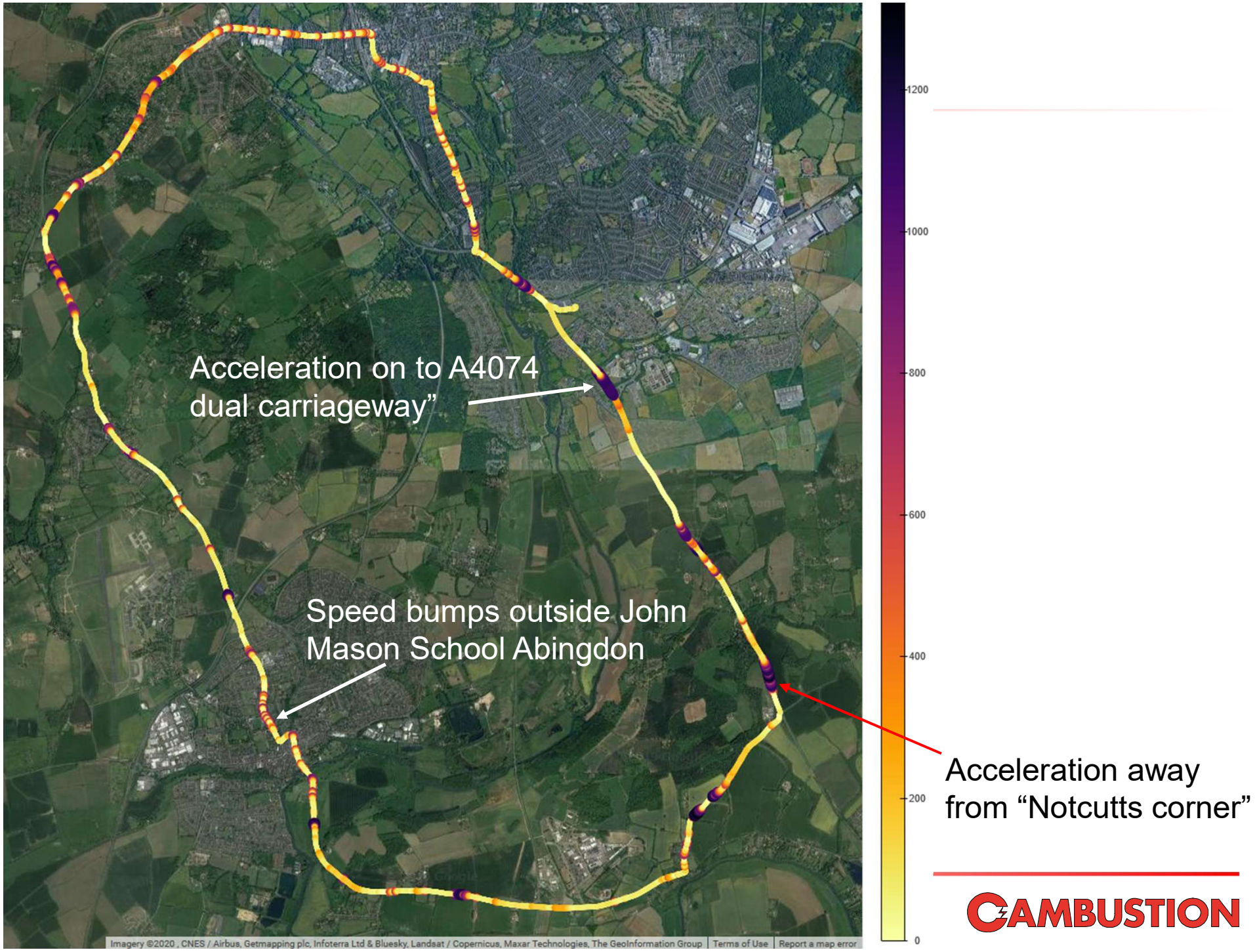
Acceleration on to A4074 dual carriageway”
Speed bumps outside John Mason School Abingdon
Acceleration away from “Notcutts corner”
1200
1000
800
600
400
200
0
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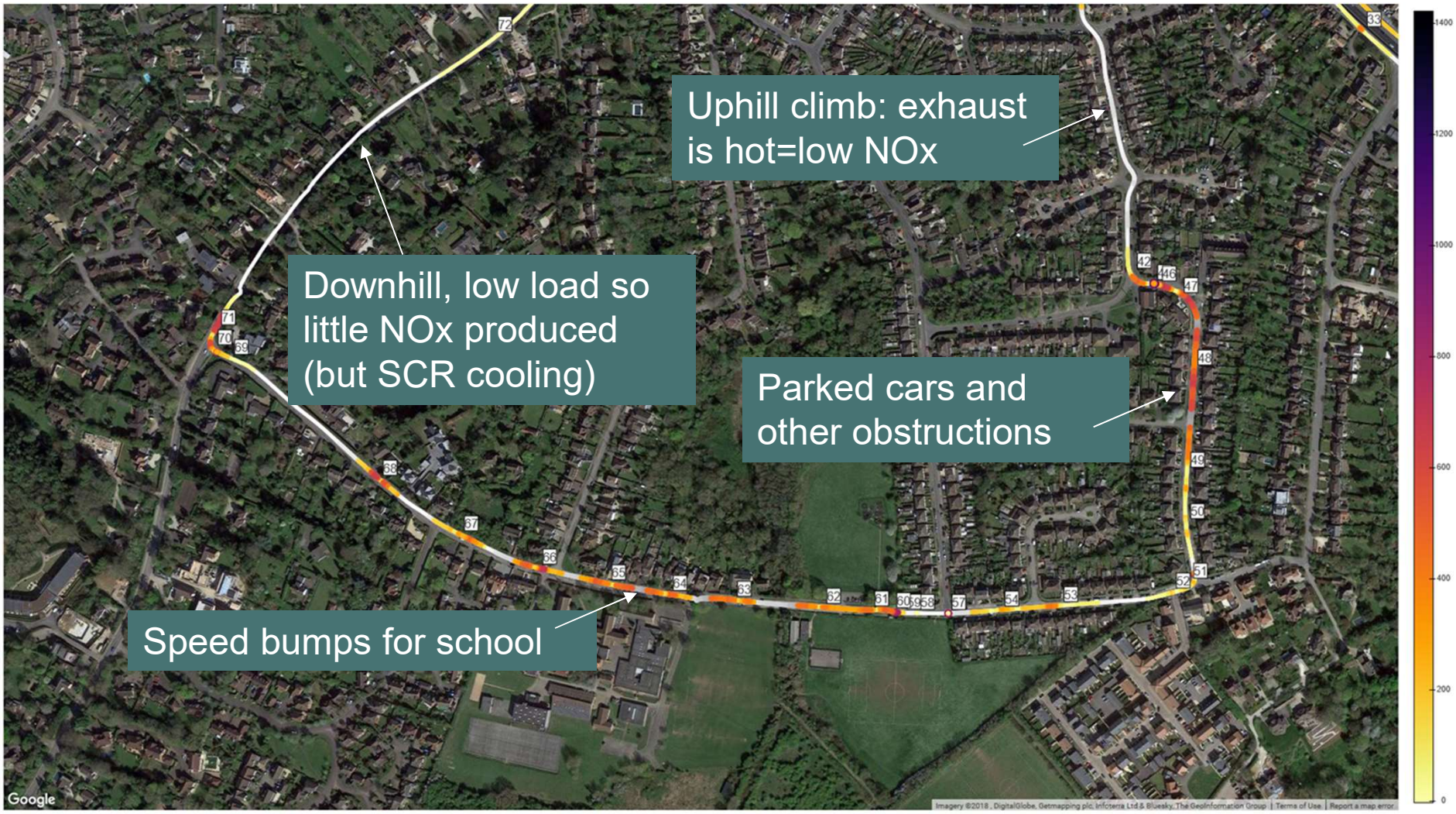
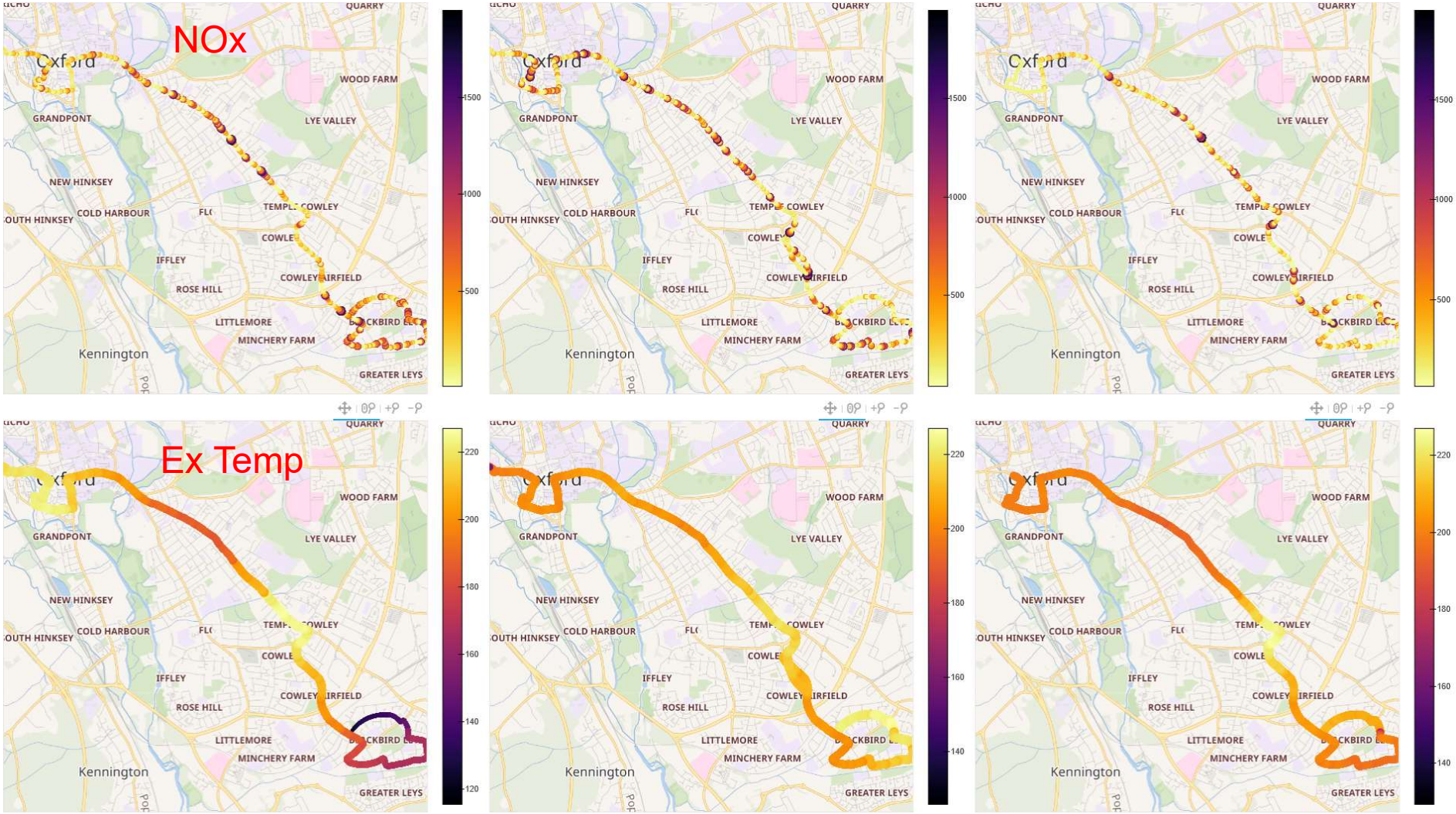
In-service bus transient NOx emissions

NOx around school, SCR temperature dependency



Comparison of 3 x Eu VI north runs



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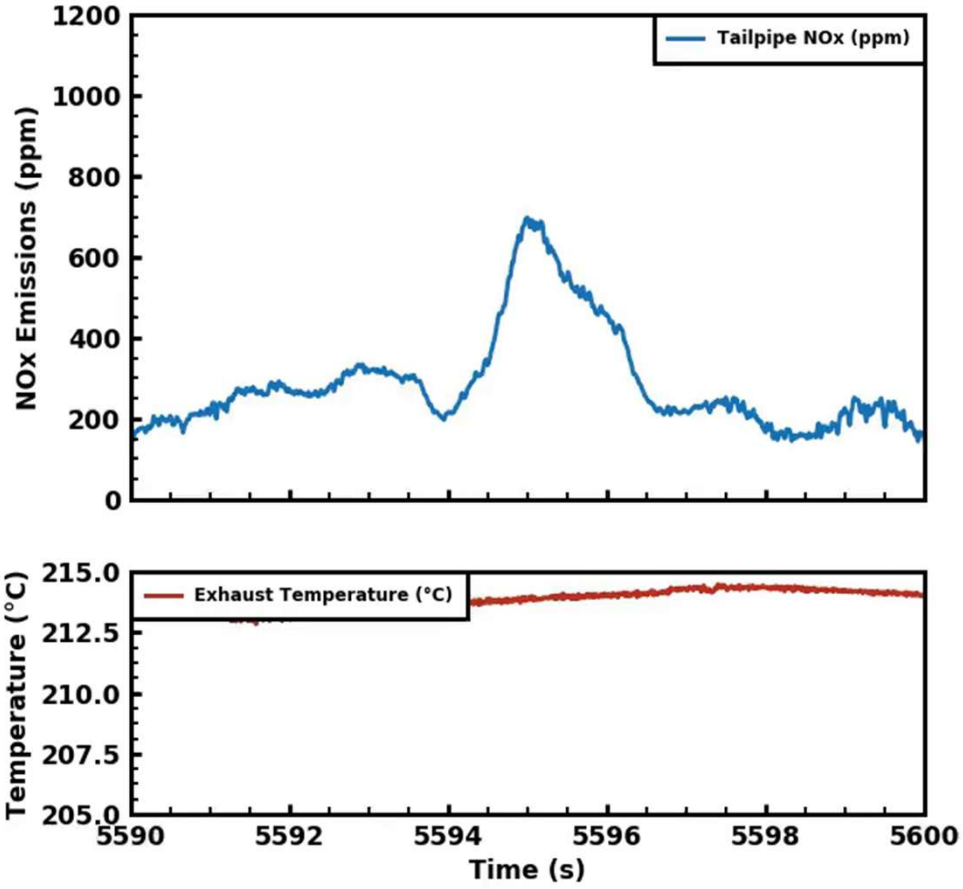
Euro VI bus: bus stop manoeuvre



Switch off engine – really?

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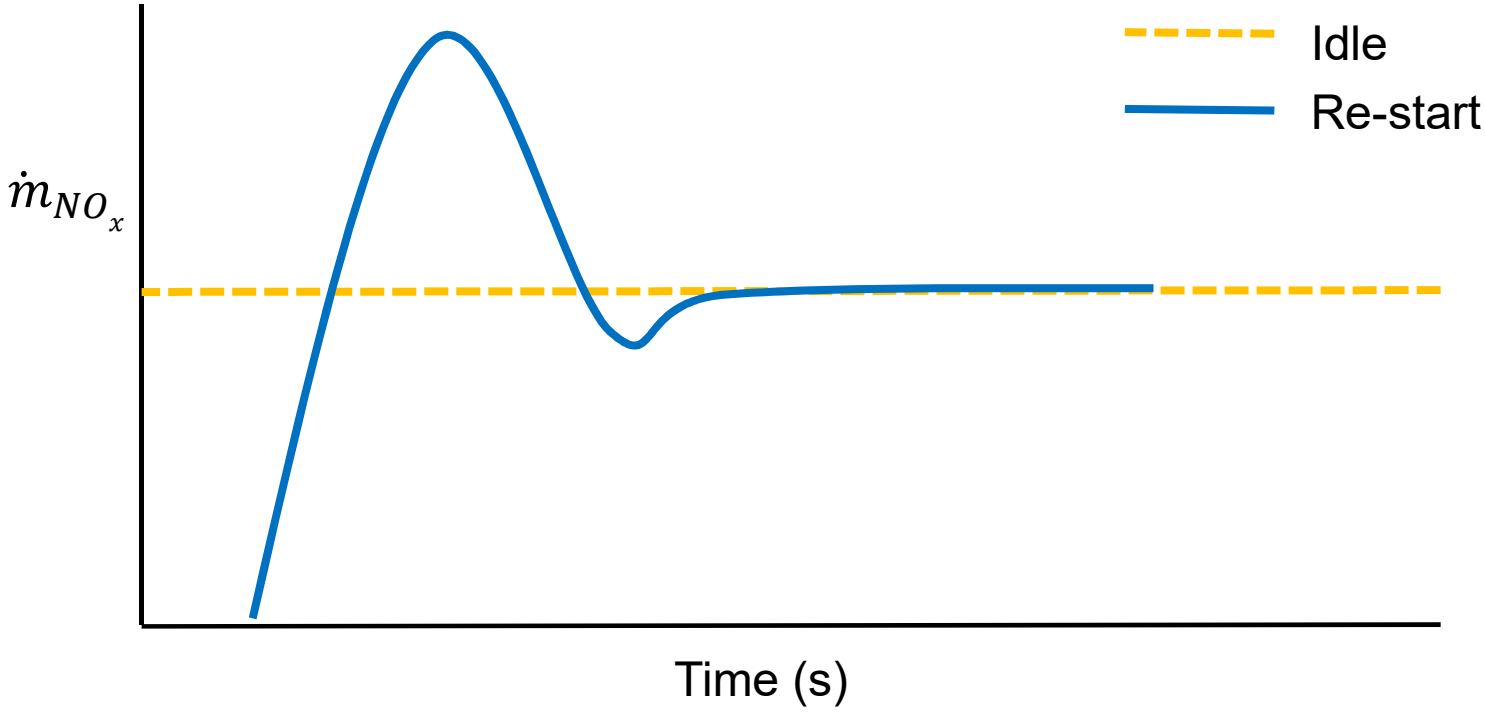
Re-start emissions

- Remember!: here we're only considering NO_x (don't forget particles, CO_2, ammonia, HC etc etc)
- What do we mean by "idling"? It's not necessarily a stable condition!
- What do we mean by re-start emissions? The ideal shown below:..



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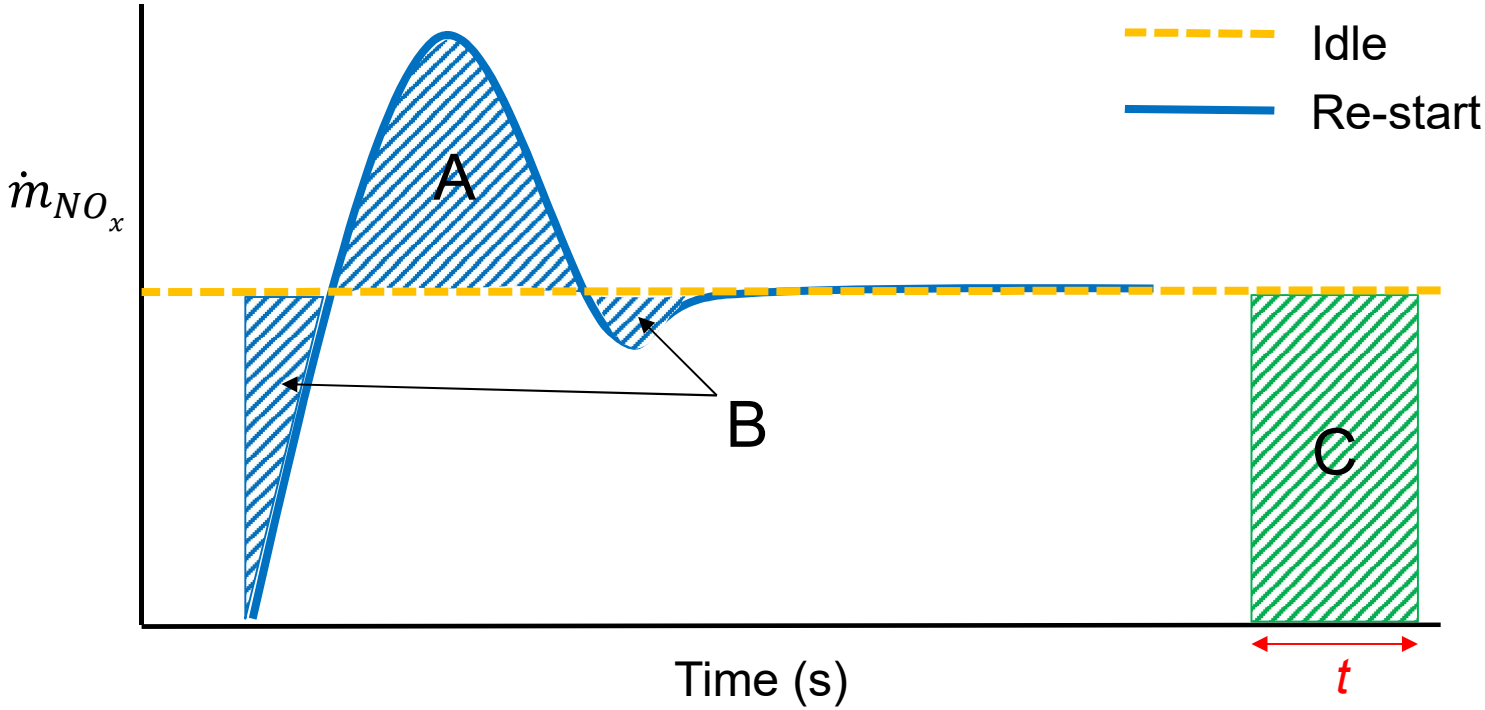
Worthwhile switch-off time calculation…

C = A-B where *t* is “Worthwhile switch-off time”



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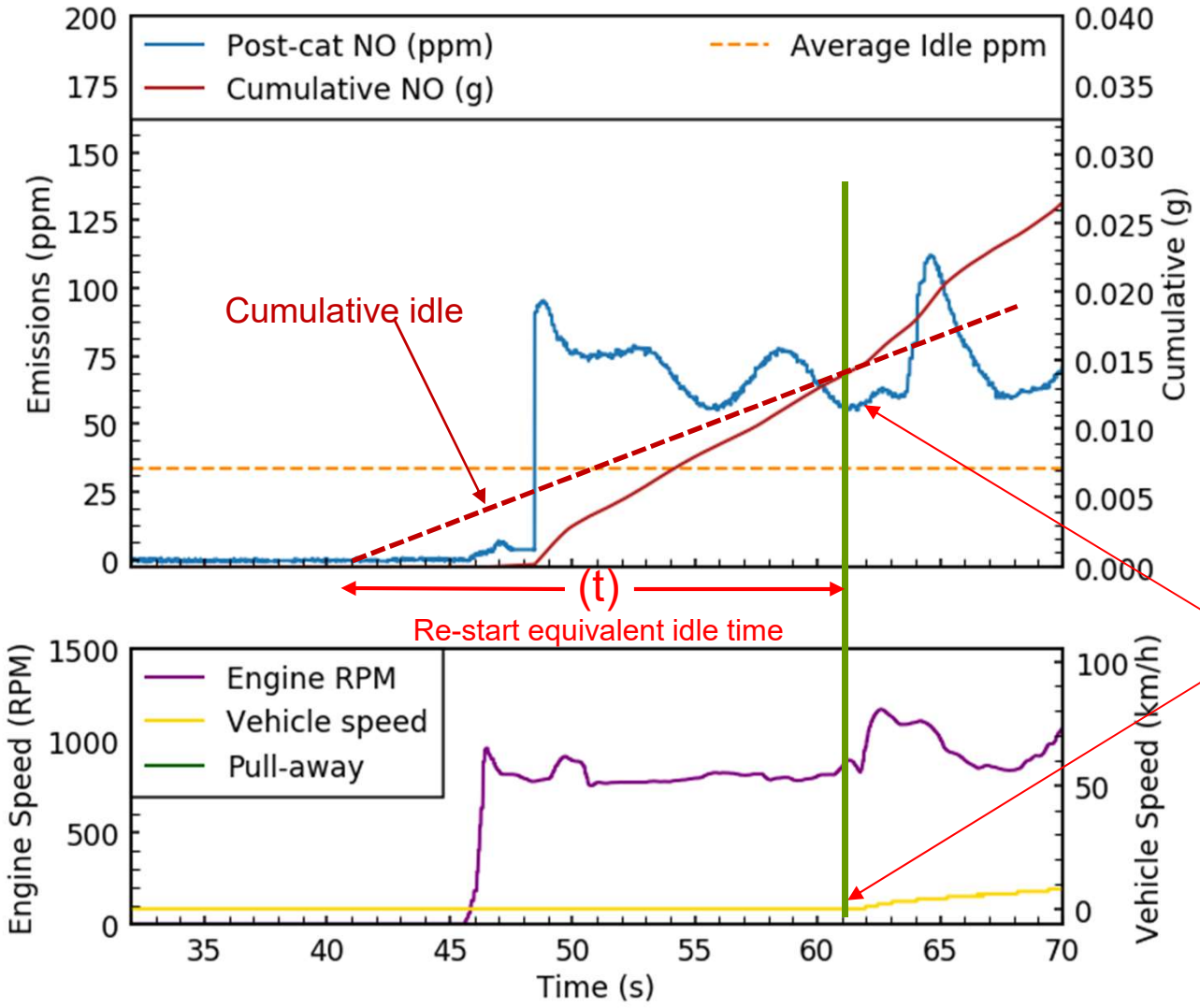
Real Euro 5 diesel car data



Vehicle pulls away before steady idle emissions is reached

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Trade-off between cumulative idle and restart spike

Euro 5 passenger car **diesel**: **~20s**

But at a different part of the drive*, the same* **Euro 5** passenger car **diesel**: *idle = 0.47mg/s; start = 14mg*
Therefore, start = 14 / 0.47 = **29.8s of idle**

Euro 6b passenger car **diesel with auto-stop/start**: *idle = 0.06mg/s; start = 0.19mg*
Therefore, start = 0.19 / 0.06 = **3.2s of idle** (or 2.7s, 2.1s, 2.7s…)

Euro 6d-TEMP passenger car **diesel**: *virtually no NO_x at idle nor at restart, so why not always switch off? Yet, the vehicle activates auto-stop-start relatively infrequently! Many parameters are checked before deployment: battery state of charge, assumed ammonia storage, catalyst temperature, etc etc…*

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Please contact me if you would like a copy of this presentation including the videos (large file)