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

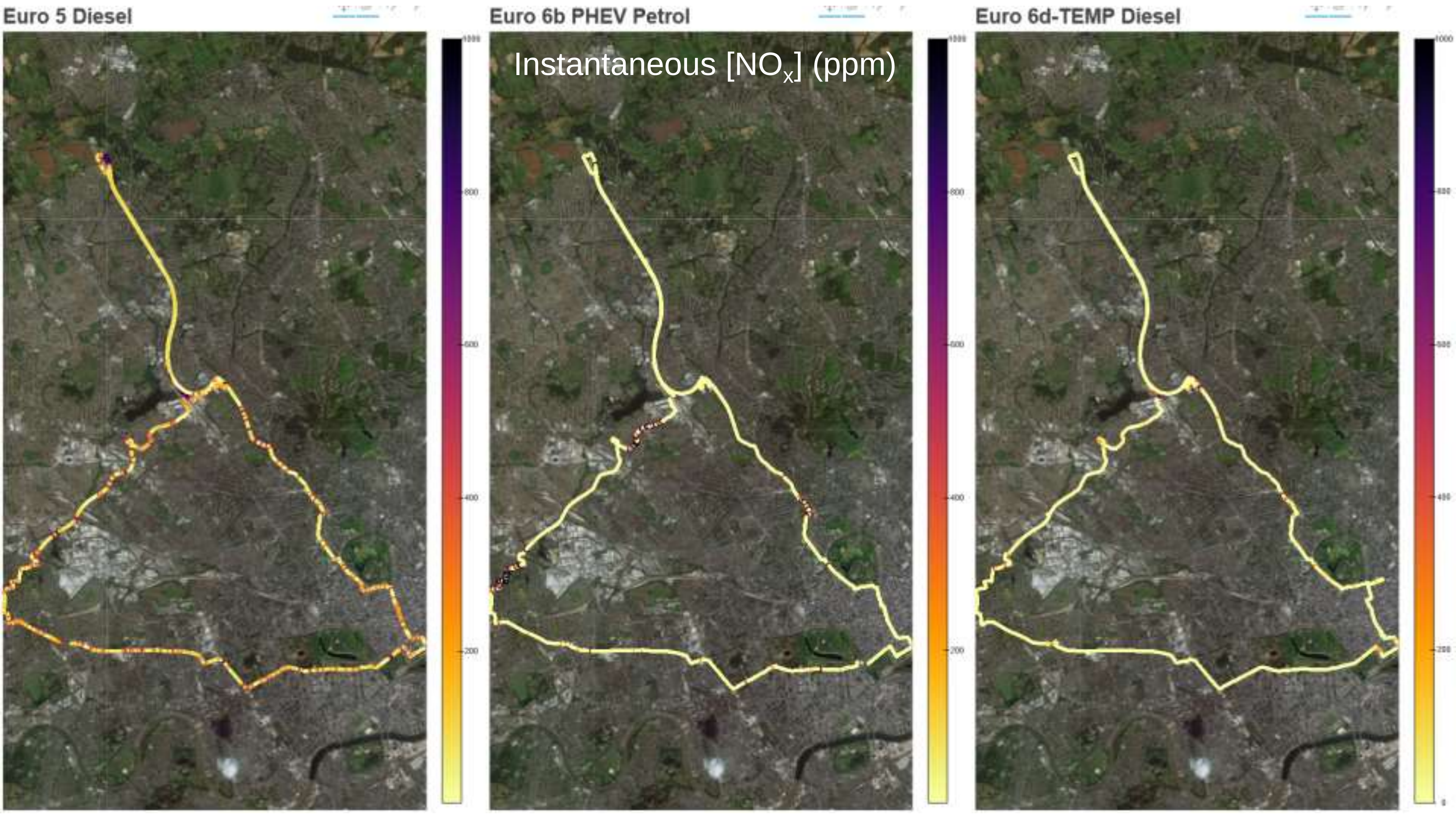
Dr. Mark Peckham

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)*

NO_x tailpipe ppm comparisons – newer cars better!



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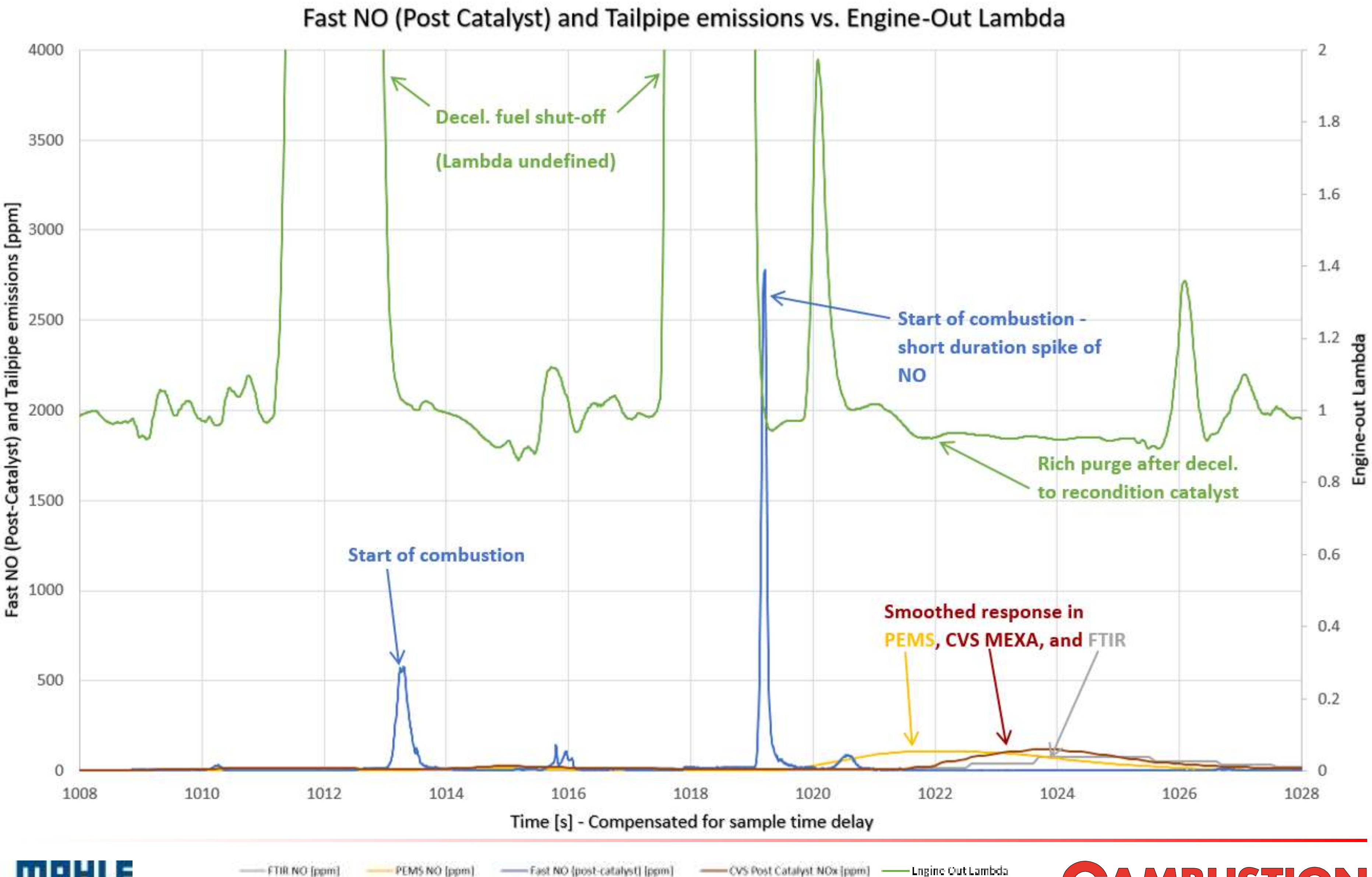
Fast Response RDE

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

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

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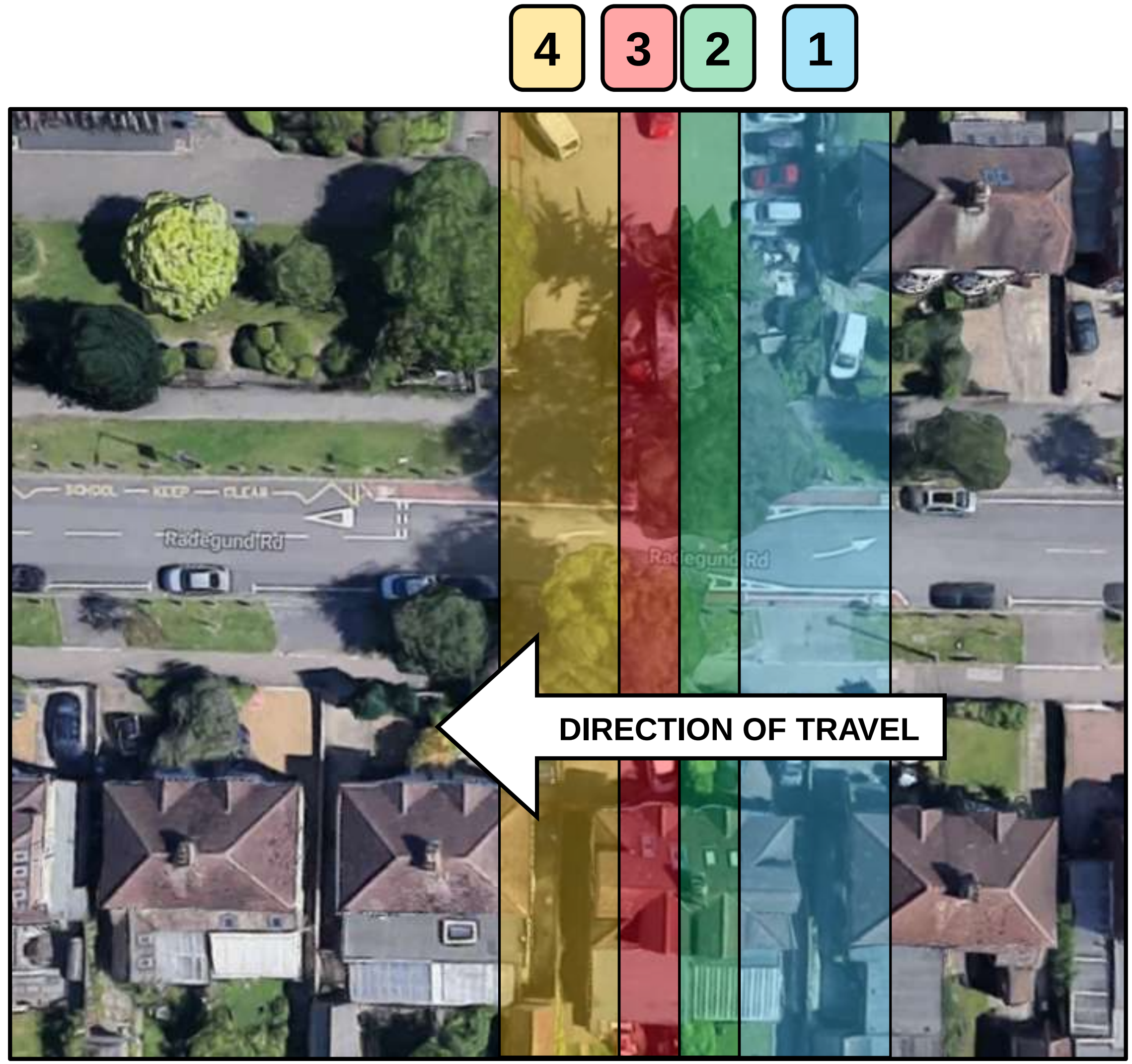
Negotiating the humble speed bump!

1. Decelerate, combustion stops

2. Clutch in and engine starts (idle)

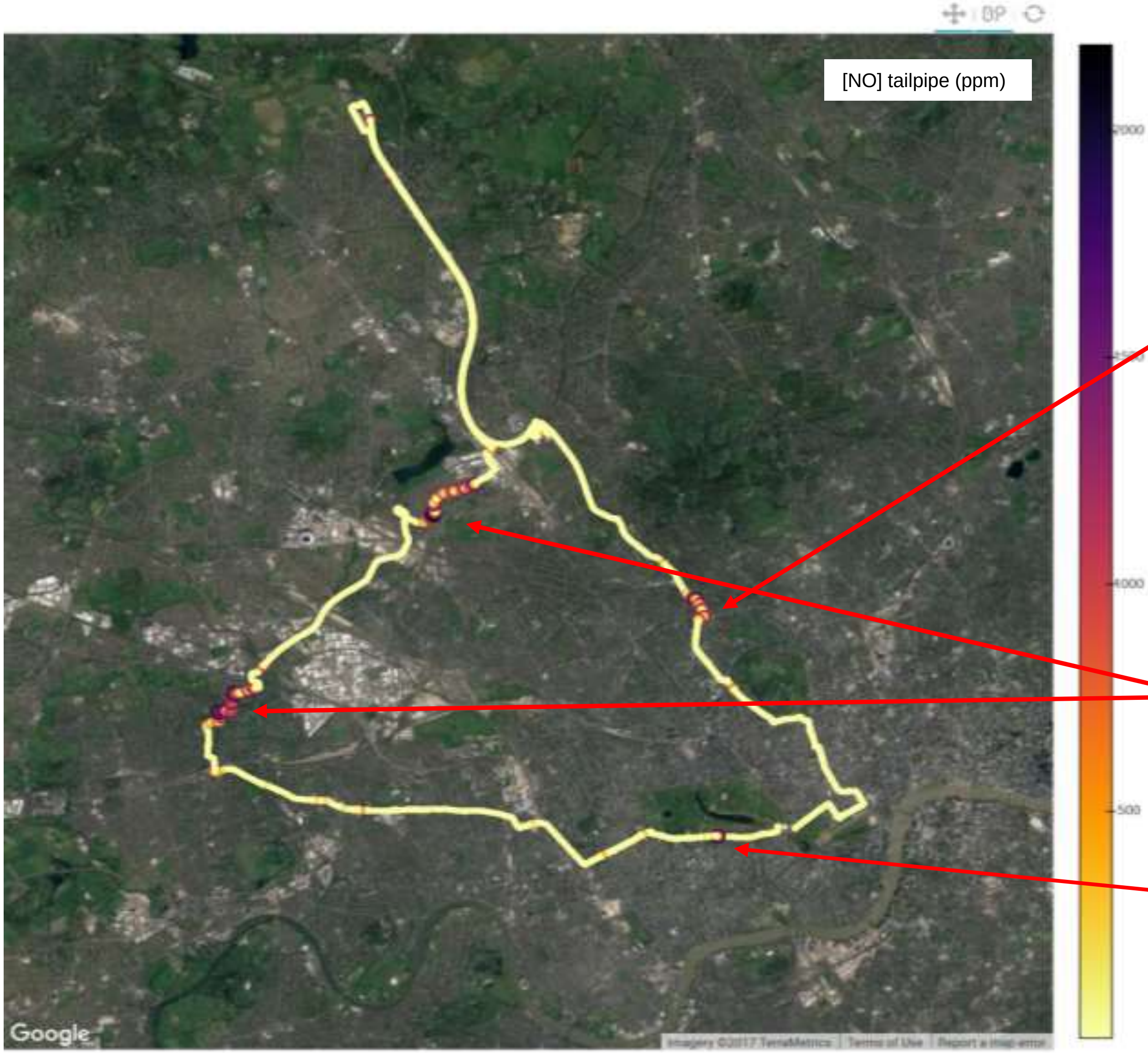
3. Accelerate away from speed bump

4. Change up gear and head for speed limit



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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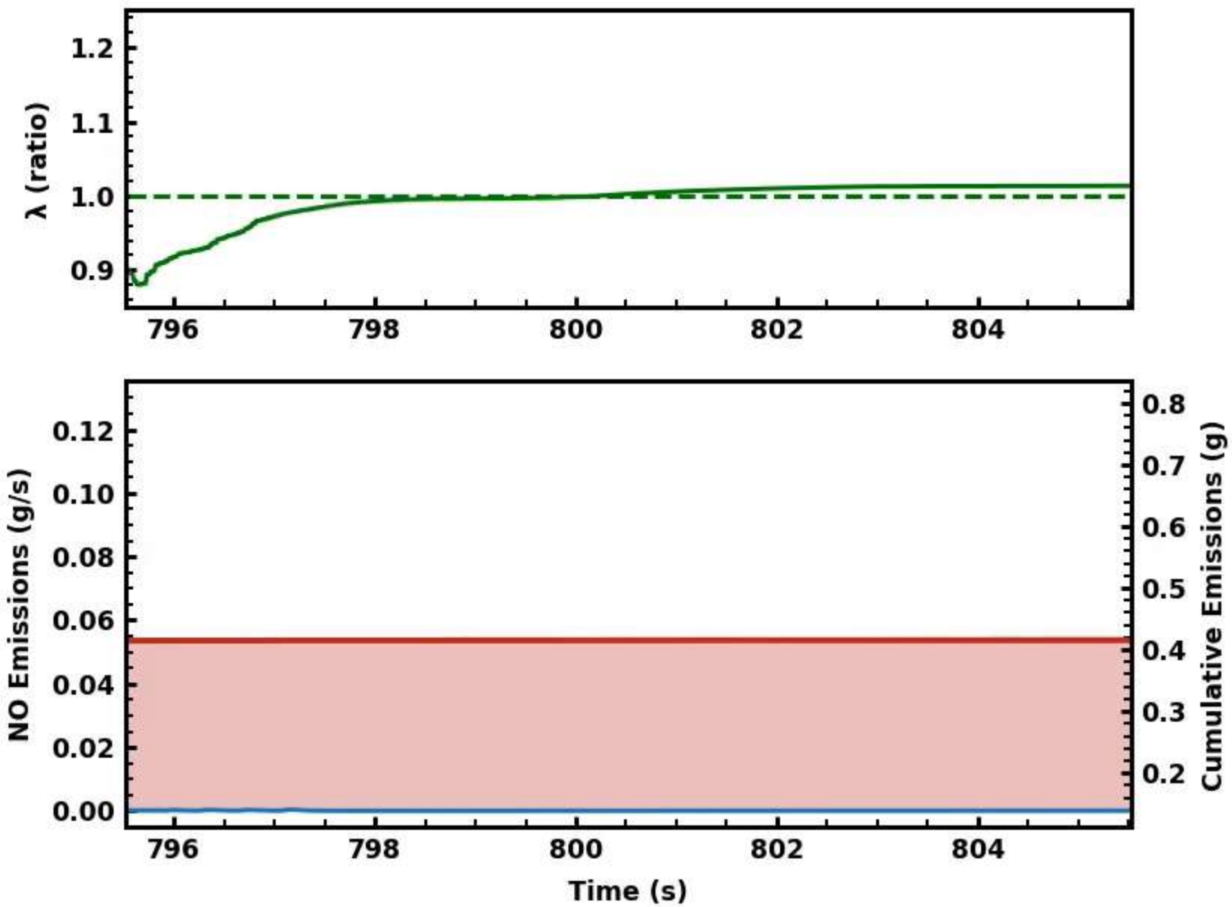
Swiss Cottage PHEV manoeuvres NO_x emissions



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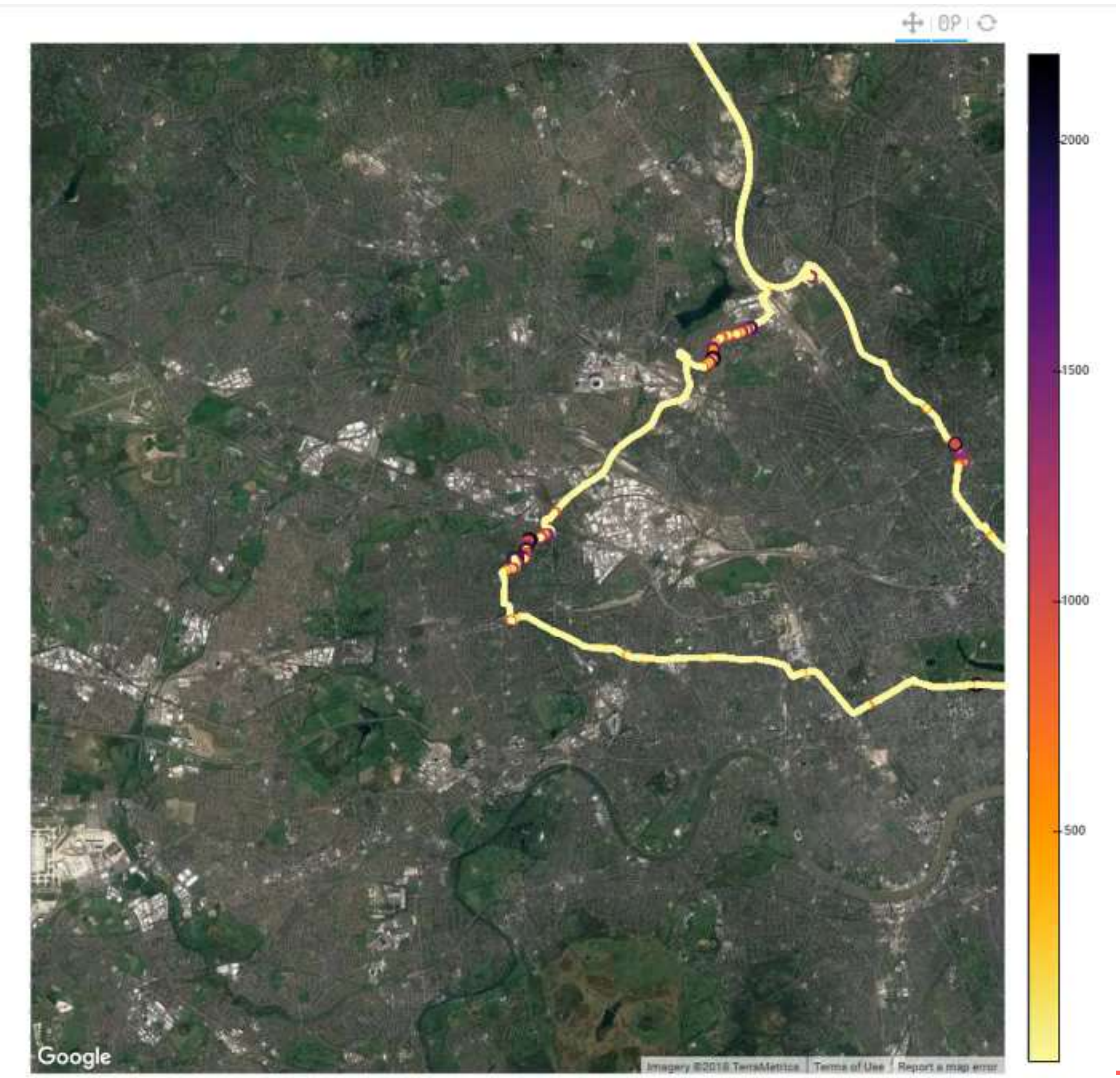
Accurate NO_x concentration location measurements



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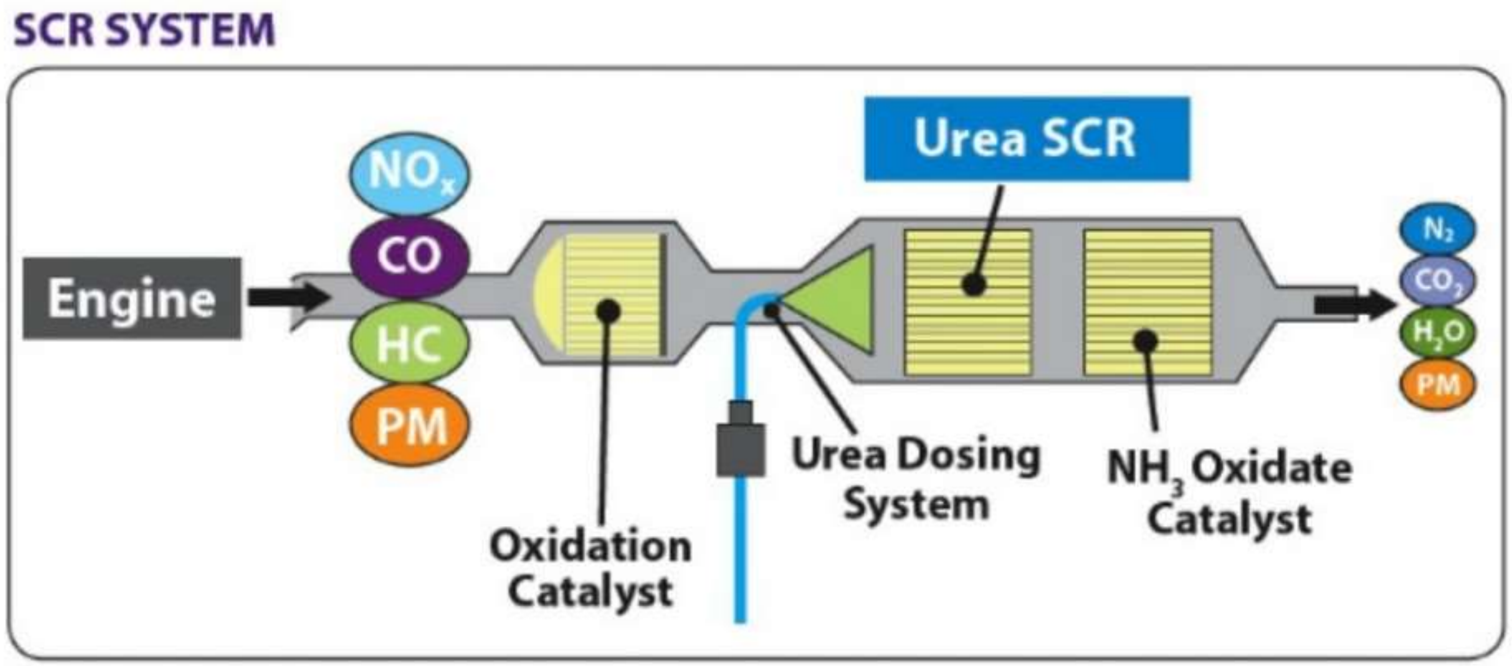
In-service bus transient NOx emissions

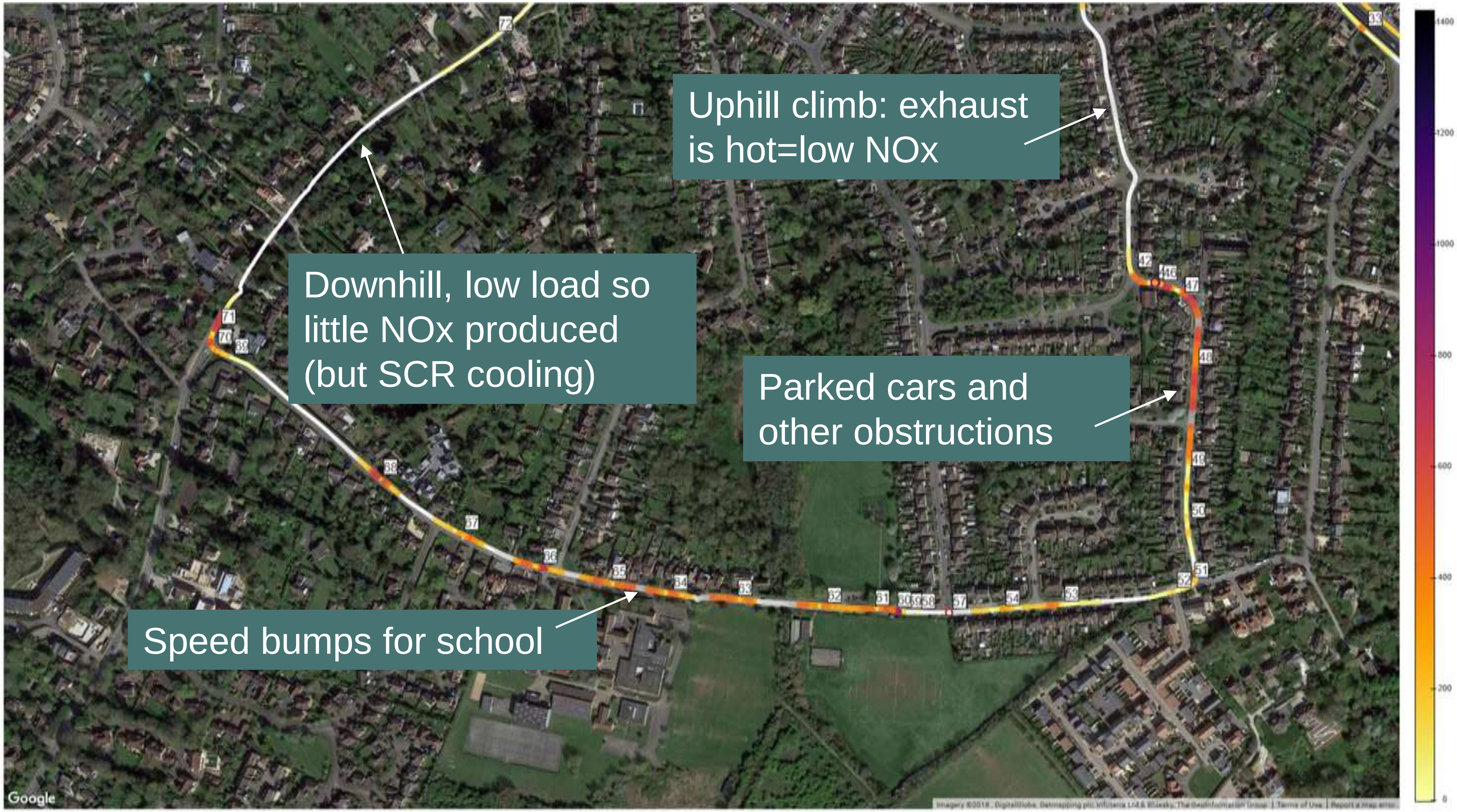
SCR NOx aftertreatment for modern diesels



The temperature of SCR catalyst systems is crucial (T > ~200C)

Other important features are oxidation catalyst performance and urea dosing levels

NOx around school, SCR temperature dependency



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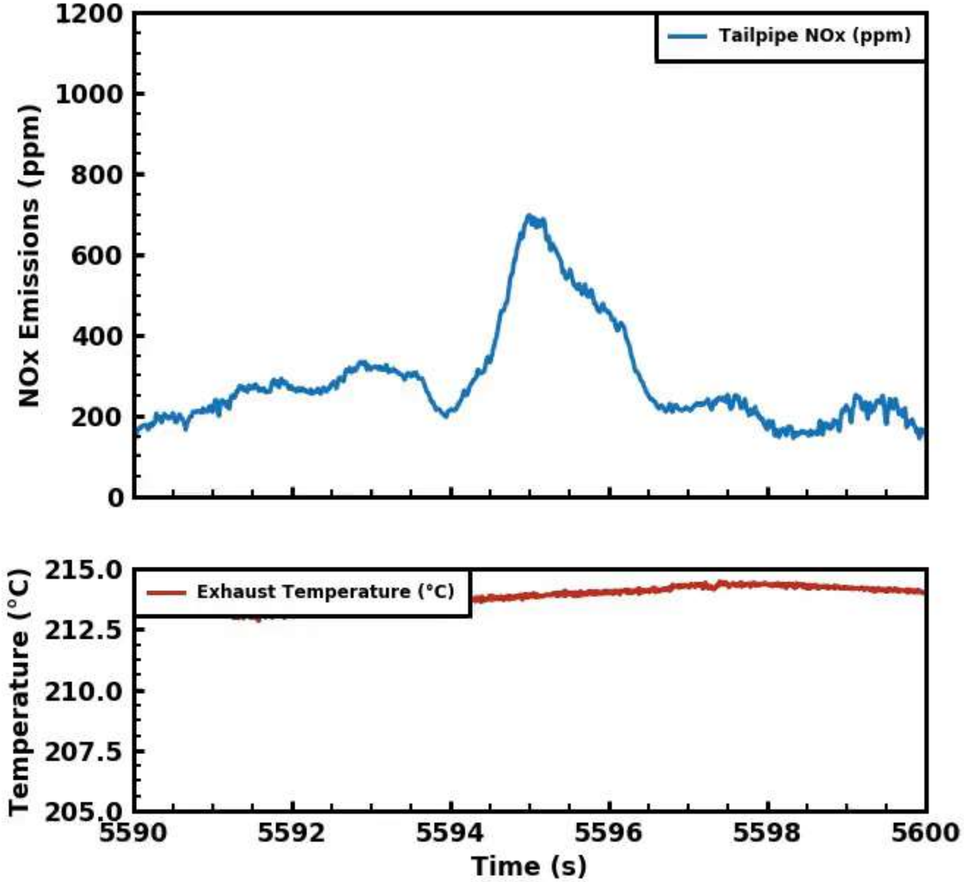
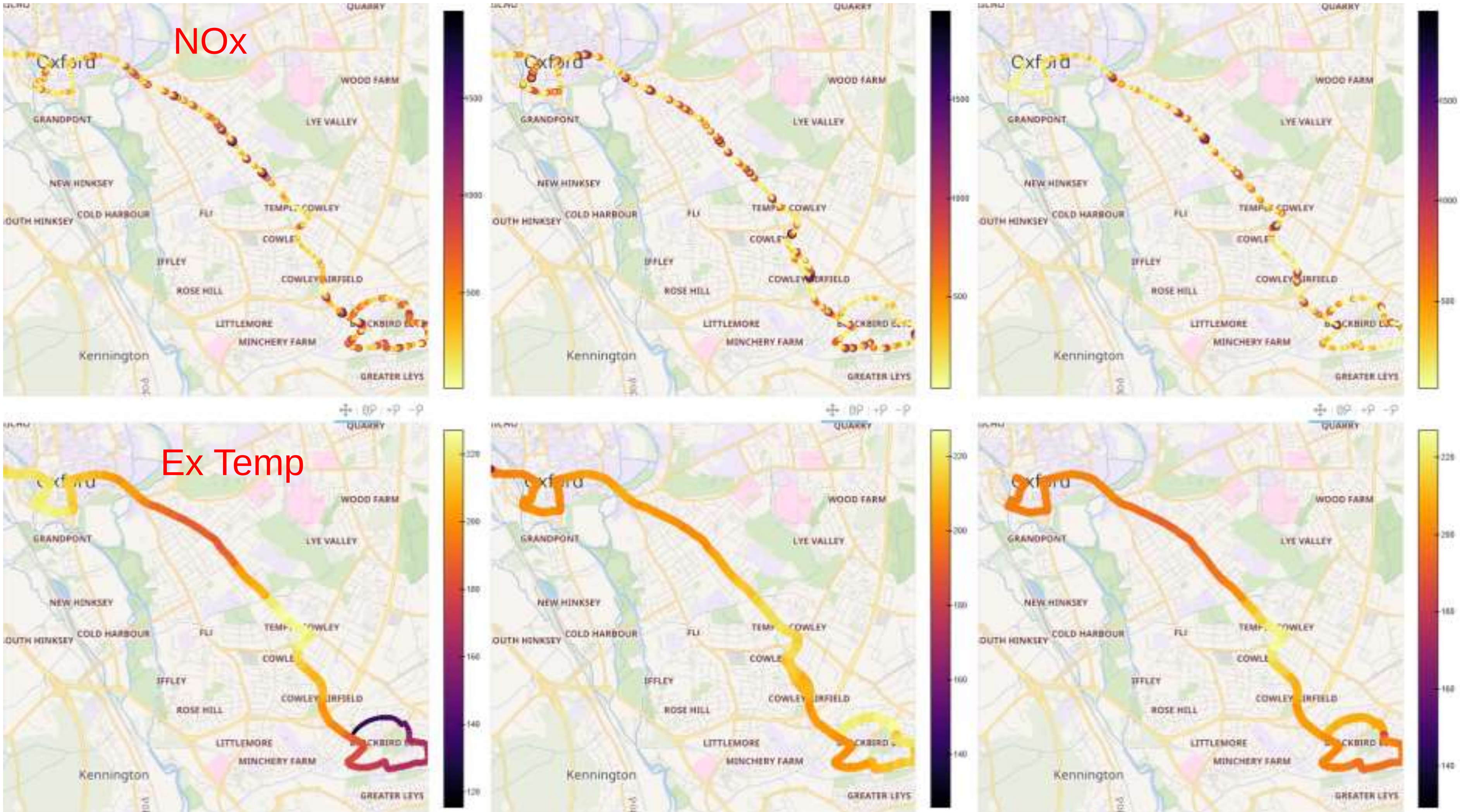
Euro VI bus: bus stop manoeuvre



Comparison of 3 x Eu VI north runs



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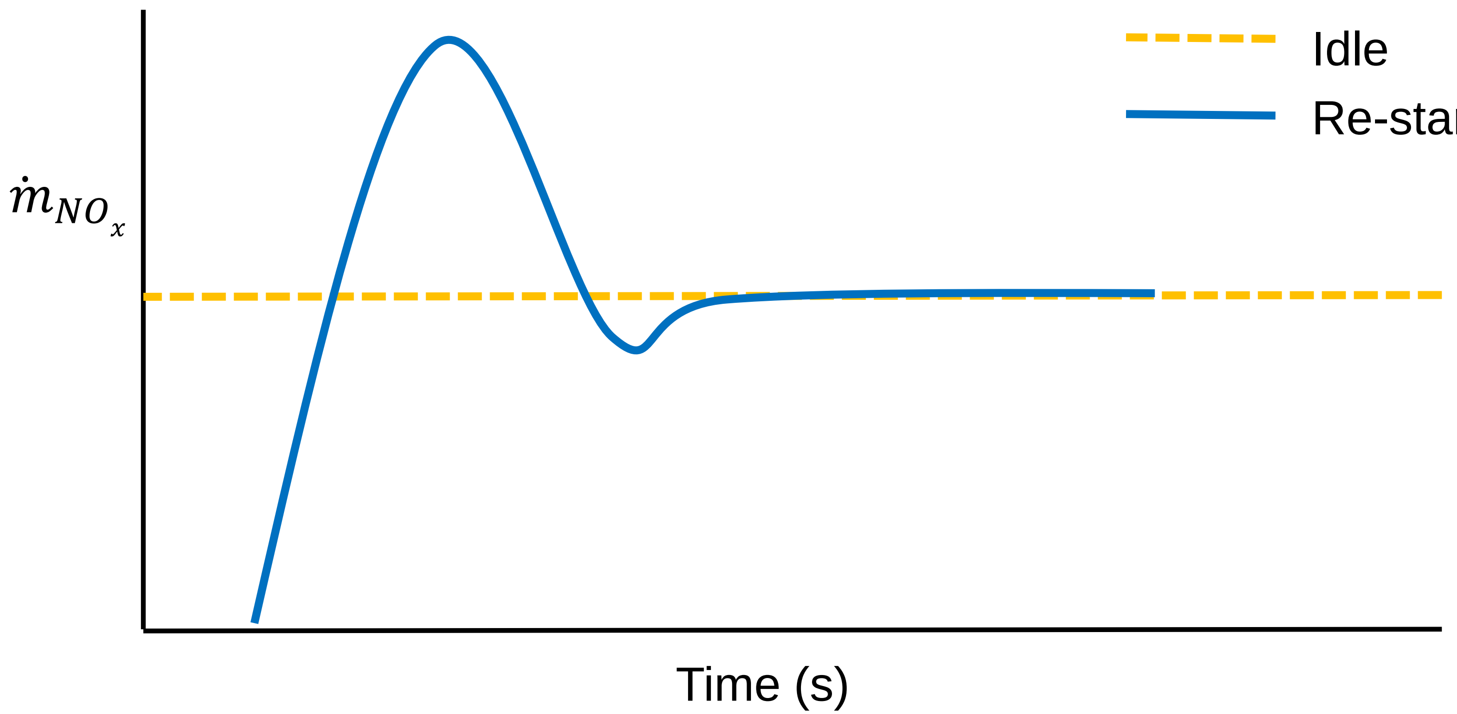
Switch off engine – really?

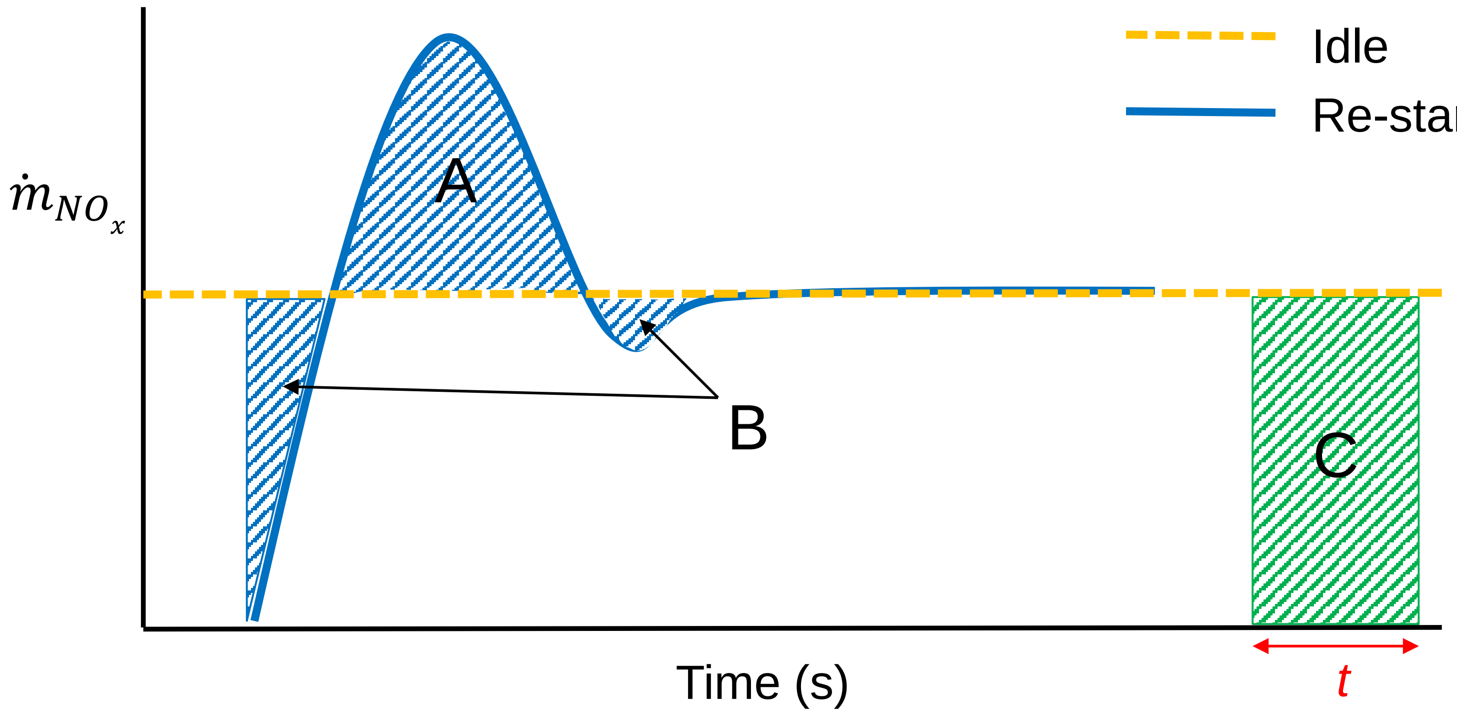
Re-start emissions

- 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:..



Worthwhile switch-off time calculation…

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



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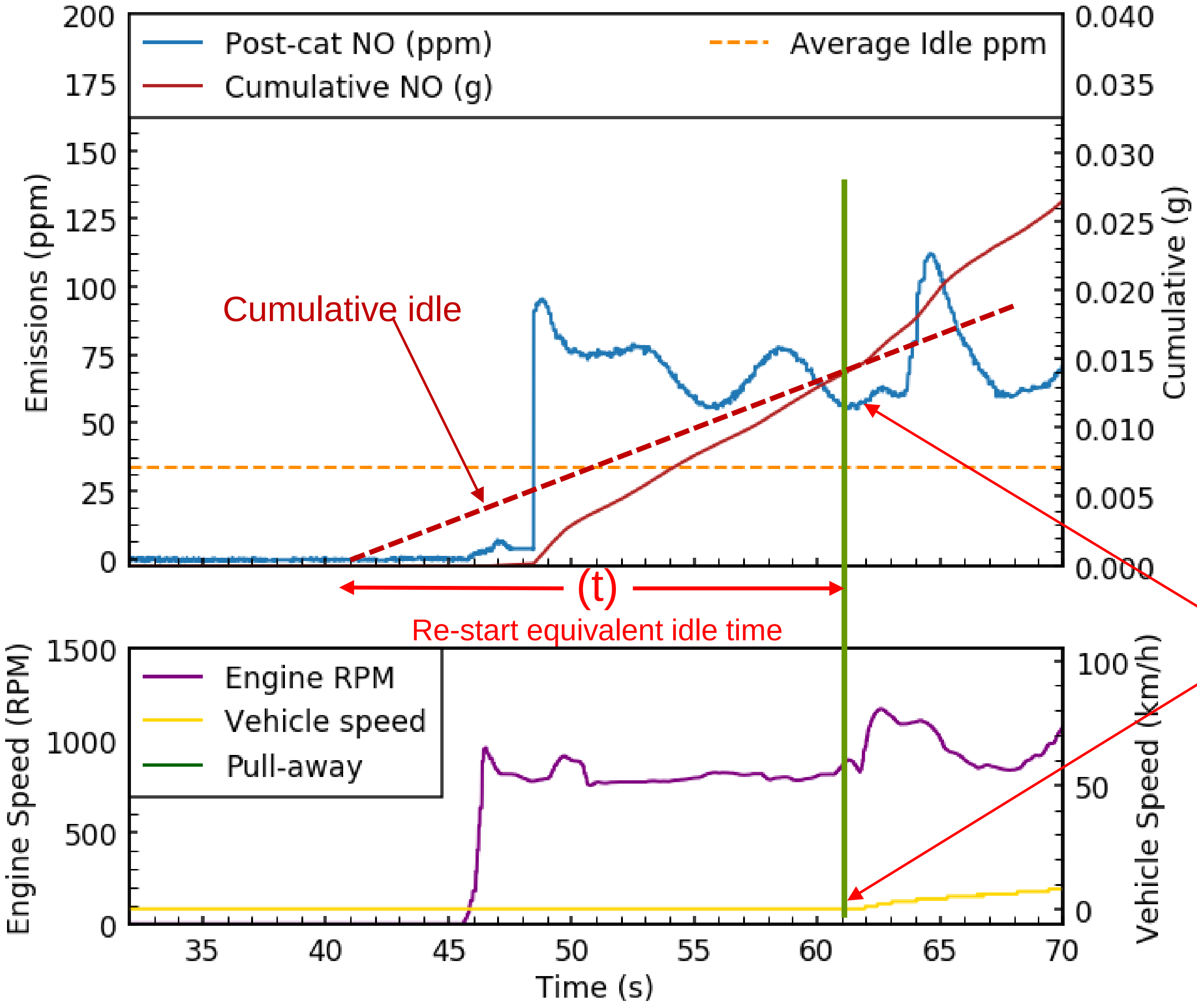
Real Euro 5 diesel car data



Vehicle pulls away before steady idle emissions is reached

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…*

Contact details

Dr. Mark Peckham
Cambustion Ltd
J6 The Paddocks
347 Cherry Hinton Road
Cambridge CB1 8DH
United Kingdom

msp@cambustion.com

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