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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "High spatiotemporal resolution pollutant measurements of on-board vehicle emissions using ultra-fast response gas analyzers" *by* Martin Irwin et al.

**Anonymous Referee #1**

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The researchers present an interesting setup in which NOx emissions of cars can be monitored under real driving conditions with a high temporal resolution. Their technique detects short but very strong emission peaks which can't be detected with conventional methods (having a slow and delayed response time). In their driving experiments they detect strong variations of emissions related to acceleration/gear shifting at e.g. speed bumps, traffic lights, motor way access lanes.

I recommend publication after minor changes, although I feel that the paper could gain further scientific relevance with a more in-depth data analysis of the driving experiments. Apparently, both research vehicles comply emission standards when averaged



over time, but exceed emission standards for short time periods. The high spatio-temporal measurements are very relevant for e.g. detecting traffic emission hot spots in an urban areas and assessing possible air quality gain by promoting a steady traffic flow. Although the authors wish to "keep the focus on the technique and the instrumentation" (page 3, line 6), a better data analysis will lead to more interesting conclusions or recommendations (e.g. for reducing traffic emissions by changing driving styles or adapting urban infrastructure), and would give more direction to follow-up research.

Minor comments:

In Section 2 (page 4, line 5) it is explained that the emissions from the gasoline car are sampled "pre-muffler but post 3-way catalyst", which is in conflict with the description in Section 2.2 (page 5, line 1-3) which state that NO is sampled both upstream and downstream of the catalyst. In the latter case: can the authors present some numbers about their measured efficiency of the catalyst? Is this as expected? How does it react under transient driving conditions?

Page 2, line 11: abbreviation RDE is used, while only explained at page 5 (line 19) for the first time.

Page 4, line 13-15: maybe it should be remarked that the diesel vehicle is not equipped with a catalyst.

Page 4, line 32-33: "(. . .) as it was anticipated that the NOx emissions would be relatively low (NOx being mainly a byproduct of diesel-powered internal combustion engines)". I presume that the authors mean NO2 instead of NOx (and that therefore there was no need to use an NO2 converter).

Page 5, line 27: "Figure 3 shows (. . .) increasing from 20 mg/s baseline when stationary". From the figure I would estimate 2 instead of 20 mg/s.

Page 5, line 27-32: The authors are measuring both NO and NOx, so I would expect some words about their findings in the NO/NOx ratio. Is the NO2/NOx ratio approximately stable (also during the acceleration phases)? If so, is it relevant to keep measuring NO2 in future experiments?

Section 3.2, page 6, line 9-11: "Using much slower conventional PEMS equipment (. . .), this highly time-resolved event would be significantly delayed, and smoothed out over a longer period making its location difficult to place." I would also remark that the duration is so short (∼2s) that its magnitude would be missed by PEMS, having a response time of about 1 second.

Section 3.2, page 6, line 12-13: To put things into perspective, I would include a remark that the current Euro emission standards are 60 mg/km (petrol) and 80 mg/km (diesel).

Section 3.3, page 6, line 19-20: From Figure 2b I learn that also the petrol car has been driven over these speed bumps. Why not include a comparison between the petrol and diesel vehicle emissions regarding speed bumps, as more or less promised on page 4, line 26: "(. . .) used for comparison of diesel and gasoline vehicle emissions."?

Page 6, line 30: "illustrating that acceleration (. . .) alone is not a suitable proxy for emissions.". Why not? If I look at Figure 6a, I see two different velocity gradients (roughly 2216.0-2217.5s and 2218.5-2220.0s), corresponding to different emission peaks. If the sampling rate of the speed permits, it would be insightful to overplot this graph with the vehicle's acceleration.

Section 4, page 7, line 4-5: "the analyser's sampling rate of 100 Hz captures emission transients that would be lost or smeared when using conventional PEMS equipment or other slower analysers". I would include this important statement also in the abstract.

Figure 1: Consider to include arrow heads on the dotted lines to indicate direction of data flow.

Figure 3b: Missing legend/color bar. It would also be interesting to see the location of all traffic lights along the driving path.

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