

## ***Interactive comment on “Modelling street level PM<sub>10</sub> concentrations across Europe: source apportionment and possible futures” by G. Kiesewetter et al.***

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General comments: This paper helps closing a scale gap in the integrated assessment modelling activities underpinning the multi-pollutant emissions control policy development of the EU and the UN-ECE Convention on long-range transboundary air pollution (CLRTAP). More than a decade ago acidification, eutrophication and tropospheric ozone abatement was in the focus, when the NEC Directive and the Gothenburg Protocol was developed. When assessing compliance of control scenarios with the objectives, e.g. excess of critical loads for acidification and exceedances of certain ozone concentration levels, a simulation of pollution concentrations at a small scale,

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like a street canyon, was not necessary. Both, exceedances of critical loads and ozone mostly occurred outside of urban areas. Now, the situation is different with a growing emphasis on pollutants like NO<sub>2</sub> and particulate matter (PM10 and PM2.5), which are characterized by urban sources, especially road traffic. So, concentrations culminate in urban areas, almost entirely along busy roads as traffic contributes significantly to PM and NO<sub>2</sub> pollution. For the same reason, compliance with the policy objectives, i.e. with the limit values for NO<sub>2</sub>, PM10 and PM2.5, needs to be checked at road side spots, where, according to the siting criteria for monitoring stations set out in the EU Air Quality Directive, the highest concentrations are likely to occur and where people are exposed not only for a short time. Given that PM10 road-side levels are typically 15–40% higher than urban background concentrations, modelling down to urban background scale with a resolution of a few km<sup>2</sup> (like is has been done in CityDelta for the CAFE program mid of the last decade) is not sufficient. As a consequence, modelling tools used for analyzing emission control scenarios to tackle PM and NO<sub>2</sub> problems need to resolve somehow also the street canyon scale, so that the essential question could be answered, to what extent scenarios lead to compliance with the legally binding limit values for PM and NO<sub>2</sub>. In that respect, the paper (together with the one on NO<sub>2</sub> published recently) is an extremely important milestone in the development of integrated assessment modeling approaches supporting the development of international cost-effective air pollution control policies.

Specific comments: Page 3, para 2: It might be useful to also mention the AQ objectives based on the AEI, i.e. the national exposure reduction target and obligation, which is based on the urban background PM2.5 levels averaged over all larger cities for every EU Member State. During the development of the CAFE (Clean Air for Europe)-strategy and the AQ Directive a decade ago, the national exposure reduction target was considered as the pollution reduction objective, which should correspond to the emission reduction stipulated by a revised NEC-Directive. While the revision of the NEC was not brought forward, these standards are now in force anyway. The modelling approach presented here could be used also for estimating the AEI and thus for

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assessing compliance with a revised national exposure reduction objective, which will most likely be part of the forth-coming review of the AQ Directive.

Page 3, para 3: I think the value of the paper could be better reflected in the introductory section by elaborating a bit more the context as described above. In particular the fact should be added, that the AQ Directive requires compliance at (traffic) hot spots and that, therefore, the roadside increment needs to be resolved when measuring the success of a emission control scenario in terms of attainment with the limit values for PM (and NO<sub>2</sub>). That could best be inserted at the end of the 3rd paragraph.

Page 3 line 17 and Page 27, line 29: There is now a 2013 version of EEA's report available. Hence, I'd suggest citing that, including the web URL. Here's the reference: EEA: Air quality in Europe – 2013 report, Report No. 9/2013, European Environment Agency, Copenhagen, DK, 2013, available at <http://www.eea.europa.eu/publications/air-quality-in-europe-2013/>

Page 3, line 20: Better use the term "reduction commitments", instead of emission ceilings, because the latter is less self-explaining and formally correct anyway.

Page 5, line 20: It would be good to provide an uncertainty range for the 30  $\mu\text{g}$  surrogate, or at least a number for the probability for more than 35 excess days in the event that the annual average is 30  $\mu\text{g}$ .

Fig. 2: It would facilitate understanding the figure if you added a horizontal line indicating the margin between "regional/Rural" and "urban" background. These terms are both being used in the text, and in Figure 5, which could then be better understood, too. Such a differentiation is especially relevant for PM, given the higher regional background contribution to total PM levels than for NO<sub>2</sub>.

Page 8, line 4: add "...to derive an urban concentration increment..."

Page 8, line 5-7: At least for larger urban areas, there is NO<sub>3</sub> formation even within the urban domain. In the example of Berlin and Paris, 5% and 3%, respectively, of the

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total road-side PM<sub>2.5</sub> is NO<sub>3</sub>, generated in the city area. While I think that omitting this factor does not compromise the approach, it would be good to mention it in the discussion of the uncertainties. Perhaps it could be considered (for any future update of the approach) taking this aspect into account by adding a term in Equation (3) dependent on NO<sub>x</sub> emissions in the subgrid m ?

Page 8, line 26: I'd also add orography as a factor influencing the Beta-values and thus the dispersion in the boundary layer (see Map in Fig. 3, looking especially at the UK, AT and SW-Germany, where mountainous regions correspond well with elevated beta-numbers.)

Page 9, line 10: It would be helpful for the reader to know the resolution also in Km x Km

Page 10, line 21: add "... national total tailpipe emissions of ..."'

Page 11, line 15: How do you calculate the changes in primary emissions? Based on national mean traffic volume changes?

Page 11/12, Section 2.3: It could helpful to refer to Fig. 2 (and the colours of the bars in there) when explaining the different steps here. To my opinion, Fig 2 really helped understanding the whole approach. So, linking the description closer to that figure would make it easier for the reader to follow what is being done to model the total roadside pollution.

Page 15, line 15: The systematic difference between the gravimetric reference method and automatic techniques is not limited to TEOM instruments. Also Beta-attenuation monitors show lower values and need to be corrected by a factor of about 20% depending on the local environment.

Page 15, line 9: Well, there is a uniform methodology ("Guidance on how to demonstrate equivalence with the reference method", see Commission AQ-website), but it hasn't been always applied yet.

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Page 15, line 22: When referring to “successful local measures” I suggest not to limit it to reducing “dust suspension”, as the dust binding mentioned here isn’t very (cost-)effective, especially in heavily trafficked roads. I’d rather point to measures like LEZ, traffic management and economic measures to promote clean transport modes, some of which have proven beneficial impact both on tailpipe and non-exhaust emissions (due to a shift in transport modes away from car traffic like in Berlin, where car traffic volumes decreased by 10% within a decade thanks to some sort of sustainable transport policy)

Page 18, end of Section 4: I suggest adding a sentence like “... and to estimate the remaining compliance gap left by future EU policy scenarios, which is supposed to be closed by additional measures on national level and local level, such as economic incentives for clean technology, traffic management, access restrictions, etc.” This further highlight the advantage of being able (thanks to the presented methodology) to express the resulting improvement from emission control scenarios (also) in the form of compliance with the limit values

Page 19: I don’t know whether the chosen station from Paris is the same as “Boulevard périphérique”, which was part of AIRPARIF’s source apportionment study, lasting from Sept. 09 to Sept 10. The station name suggests that it might be identical and that, in any case, “A1, St. Denis” seems to be at a heavily trafficked city motorway (like Boulevard périphérique, which isn’t really representative for a typical inner-city road-side station). So, the large coarse part calculated there might be overestimated, because (as rightly stated on page 11, line 12 ...) the resuspension per vehicle decreases with growing traffic volume numbers, and NOx emissions (used for the parametrisation of the coarse fraction) per vehicle tend to be higher there because of the higher speed driven on motorways. This would explain the higher share of PM coarse in the modelled traffic increment (almost 50%) in comparison to what was measured during AIRPARIF’s campaign (38%, comparing Fig. 26 with Fig. 53 in their report). You might want to briefly discuss that on page 19. At least add Paris on line 3-5 on page

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20. It might be of interest to add somewhere here or in the following section 5.2 that the AQ Directives allows to neglect the contribution from winter traction sanding when assessing compliance with the PM10 limit values.

Fig 7: Substitute in the legend above the first bar the term “domestic” by “national”, so that it’s consistent with the naming of the legend on the right side

Page 25, line 27/28: I’d suggest adding road and tire abrasion. Concerning the last sentence of the paragraph (“targeted measures ...”) I don’t think that it merits mentioning dust binding and enhanced road cleaning as generally useful. Investigations in Stuttgart showed that the dust binder is very quickly removed in roads with intensive traffic. Hence, it would be required to distribute it over and over again after a few hours in order to maintain its dust binding impact. Given its high costs, it is questionable, whether applying dust binders is a promising recipe. Studies in Berlin did not show any visible effect of enhanced street cleaning on PM10 levels. Hence, I’d suggest pointing (also) to traffic management and planning measures as a means to shift motor traffic to cleaner transport modes, following the logic that less road traffic produces less PM emissions.

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