2.06 EXPERIENCES WHEN MODELLING ROADSIDE PM10 CONCENTRATIONS

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INTRODUCTION

Field measurements in the vicinity of roads and in streets canyons in Germany show at some locations an exceedance of the limit values of the EU Directive 1999/30/EU. Therefore action plans are needed. However, PM10 pollution modelling for action plans in the vicinity of paved roads shows to be deficient mainly because the determination of the PM10 emissions resulting from abrasion of the road surface and dust re-suspension is not understood.

It is one of the problems, that these emissions can not be measured directly as the exhaust pipe emissions, but need to be determined for example by inverse dispersion modelling from roadside concentration measurements or tracer methods. Another problem is the lack of data sets, containing all parameters, needed to determine the emissions. The emission model, frequently used in Germany, was presented on the 8th Harmonisation Conference in Sofia (Düring et al., 2002). The contribution for the 9th Conference introduces some of the new findings since then and presents the basis for the amendments of the model, presently executed for the non exhaust pipe PM10 emission modelling of motorways and arterial roads.

OUR FINDINGS SINCE THE 8TH HARMONIZATION CONFERENCE

Conclusions from measurements in Goettinger Strasse, Hanover

The Goettinger Strasse validation data monitoring site is described in Mueller et al. (2001). Measurements of the silt load of Goettinger Strasse were executed, as the silt load is needed for the application of the PM10 emission model of the US-EPA (Düring et al., 2002). The values in table 1 were obtained and compared to other measurements. It can be seen that the good quality street surface Göttinger Strasse unexpectedly has nearly the same silt load as the bad quality Lützner Strasse whereas the good quality Schildhornstrasse has a low silt load. We thus conclude, that the silt load of a street surface can not be estimated reasonably on the basis of just the quality of the street surface.

Table 1. Results of silt load measurements on surfaces of traffic lanes

Name of street	Goettinger, Hanover	Schildhorn, Berlin	Luetzner, Leipzig
Quality of surface	good	good	very poor
Silt load in g/m^2	0,30	0,09	0,21

The silt load of Goettinger Strasse consists to max. 2/3 of abrasion from the material of the road surface. The rest is material from tires, clutch and brakes and materials as dirt carried in by tires, material lost from vehicles etc.

The study confirms, that the non exhaust pipe contribution of the PM10 emission of a road must be taken into account when doing emission modelling for emission inventories for cities, dispersion modelling and/or action plans in the frame of the EU Directives. It means for action plans, that the percentage of the reduction of the PM10 emission of a road is less than the percentage of the reduction of the PM10 emission from the exhaust pipe.

For the full report of the Lower Saxony State Agency for Ecology (NLOE) about the basis of the Goettinger Strasse action plan see Baechlin et al. (2003).

Conclusions from roadside Regular German State Monitoring Stations

A research project, financed by the Ministry of Environment and Traffic of the German State of Baden-Wuerttemberg, made use of the results of 16 out of more than 40 of the longterm roadside regular German State Monitoring Stations.The measurements were used to deduct PM10 emission factors at these roads and to compare them to the results of the PM10 emission modell for roads. The model, often used in Germany, is a modified US-EPA model, described in Duering et al. (2002). The results of the project mostly concerned roads inside cities as most of the monitoring stations are located in cities. Although only 3 of these 16 stations are located at motorways or arterial roads the project gave an indication, that there are significant overpredictions of the modelled non exhaust pipe emissions for this kind of roads. Therefore, during the next step of our research a focus was set on these kind of roads.

For the full report about this comparison see Lohmeyer et al. (2003).

Preliminary conclusions from leeward/windward measurements at the arterial road B10, Karlsruhe

UMEG, Centre for Environmental Monitoring, Karlsruhe, operated a leeward and a windward air pollutant monitoring station at an arterial road in Karlsruhe called B10. Measurements included heights of 3 and 6 m above ground, PM2.5 and PM10 concentrations (daily means by gravimetry and hourly values by ß-meter), traffic, meteorology and analysis of the content of selected PM2.5 and PM10 filters. For the availability of the data contact www.umeg.de. Figure 1 shows the monitoring site, figure 2 as an example for the raw data the difference of the daily mean PM concentrations at the two stations, indicating the contribution of the street. The grey bars indicate the difference of the PM2.5 concentrations, the black of the PM(10-2.5) concentrations. Reading example: The first bar from the left indicats a monitored PM2.5 difference of 7 $\mu g/m^3$, PM10 difference of 23 $\mu g/m^3$, thus the PM(10-2.5) difference is 16 $\mu g/m^3$. As well the PM10 as the PM2.5 differences are positiv, that means the northern monitoring station showed higher concentrations than the southern station for both PM2.5 and PM10. That is expected, but there are unreasonable results. There is a day where the PM2.5 concentration difference is +22 $\mu g/m^3$. At this day the PM10 concentration difference was monitored to be -3 $\mu g/m^3$, thus the PM(10-2.5) concentration difference is displayed to be –25 $\mu g/m^3$. Of course this is unreasonable and no such cases were used for evaluation.

The evaluation is presently going on, the preliminary results indicate:

- Here again, at this arterial road, the non exhaust pipe PM10 emissions are lower than predicted by the modified EPA-model, described in Duering et al. (2002).
- Only for 5 days (3 working days, 2 sundays) with a minimum of 0.1 mm of precipitation, pronounced leeward/windward conditions were given for the whole day. At these working days the PM10-emissions were reduced by nearly 30%, compared to dry days. At these sundays no reduction was observed. The analysis of the dust filters for 38 days, selected for pronounced leeward/windward conditions indicated the composition of the PM10, emitted by the B10 at the special case of dry working days to consist of about 50% exhaust pipe emission, tire wear was about 20%, brake lining wear less than 1%, rest (road abrasion, dirt carried in, re-suspension) about 30%.

- The values of the INFRAS Handbook of exhaust pipe emission factors were in the same range as the values, deducted from the analysis of the dust filters.

The full report is under preparation, it is supposed to be acknowledged for publication in June 2004.

Figure 1. Windward and leeward monitoring station at B10 in Karlsruhe.

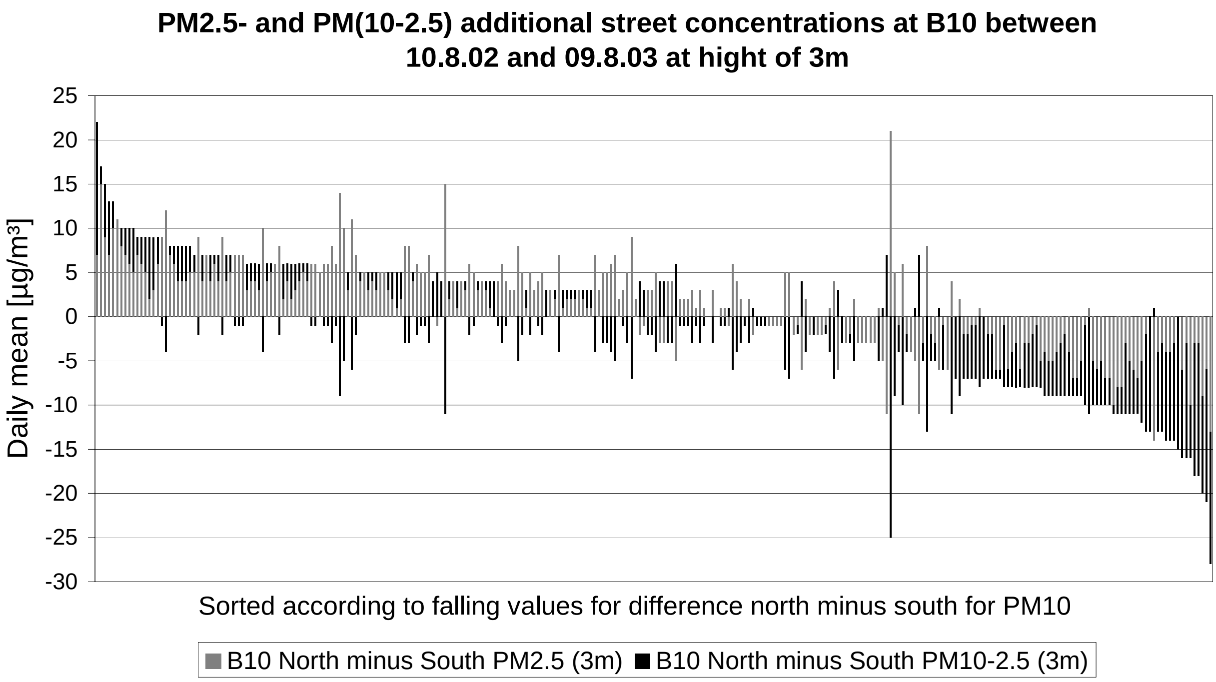

Figure 2. Differences of the daily means of the PM2.5 and the coarse particle (PM10-2.5) concentrations at the two stations. Values of station at north side of road minus values at south side. Results determined by gravimetry. See text for further explanation.

The special case of motorways and arterial roads. Collection of and conclusions from newly available measurements

Since the last harmonization conference, quite some results of PM10 concentration measurements at motorways and arterial roads became available. Table 2 displays them, the autors would be grateful to get hints about additional measurements.

Table 2. Collection of data for motorways and major arterial roads, presently available to the authors. Column quality estimation: A indicates the data set is more complete. s.u. means: Information about trucks comes from fact that one of the tubes is not allowed for trucks.*

Autor	Name of monitoring station	Quality Estim.	Veh. speed [km/h]	Truck content [%]	PM10-Total Emission g/(km*veh)	Quotient: Total Emiss./ Exh. Pipe Emiss.	PM10-non-exhaust g/(km*veh)	PM10-non exh. g/(km*veh) pass.cars	trucks
Lohmeyer (2003)	A5/Kenzingen	B	130	13.1	0.06	1.1	0.01		
Lohmeyer (2003)	A5/Holzhausen	C	130	12.9	0.06	1.1	0.01		
unpublished	A4/BASt	C	130	8.8	0.09	2.5	0.04		
Gehrig (2003)	A1/Birrhard	B	120	10.6	0.08	2.5	0.05	0.05	0.07
Keuken (1999)	N201/Netherl.	B	120	10.0	0.10	1.8	0.04	0.01	0.35
Gehrig (2003)	A4/Humlikon	B	110	12.5	0.07	2.1	0.04	0.02	0.14
unpublished	B10/Karlsruhe	A	90	14.4	0.09	2.9	0.06	0.02	0.31
Israel (1994)	Berlin/ Lerchpfad	C	80	8.0	0.22	4.1	0.16	0.07	1.19
unpublished	Berlin Lerchpfad	B	80	5.8	0.14	4.1	0.11		
Gehrig (2003)	Aahltal	B	50	6.1	0.07	2.9	0.04	0.03	0.21
Keuken (1999)	Netherlands/ Drechttunnel	B	100	s.u.*				0.02	0.51
Keuken (1997)	Netherlands/ Drechttunnel	B	100	s.u.*				0.03	0.63
Israel (1994)	Berlin/ Tunnel Tegel	B	80	6.0	0.07	1.6	0.03	0.02	0.19
Rauterberg-Wulff (1998)	Berlin/ Tunnel Tegel	B	80	7.0	0.09	4.2	0.07	0.02	0.54
Sternbeck (2002)	Tunnel Tingstad	B	60	10.0	0.04	1.3	0.01		
Schmid (2001)	Tauerntunnel	B	75	15.0	0.08	1.5	0.03	0.02	0.08
Palme (2004)	Brudermühl-tunnel	A	58	8.0	0.03	1.5	0.01	0.00	0.08

Based on the few data available in table 2, the major conclusions from this collection for the non exhaust pipe emission factors are:

- No significant differences between the emissions in tunnels and in open roads can be detected.
- No significant dependence of the vehicle speed can be detected for these motorways and major arterial roads.
- The mean of the quotient total emission factor / exhaust pipe emission factor is larger than 2, indicating that in the mean, the non exhaust pipe contribution is more important than the exhaust pipe contribution.

- The mean of the quotient between truck non exhaust pipe emission factor in table 2 and passenger car emission factor is 14, compared to a factor of 15 for the exhaust pipe.
- The values given in table 2 provide an indication for the range of the non exhaust pipe emission factors for passenger cars and trucks. A reliable emission model still needs to be developed.

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