



Ingenieurbüro Lohmeyer
GmbH & Co. KG
Karlsruhe und Dresden

Experiences when modelling Roadside PM10 concentrations

*Achim Lohmeyer¹, Ingo Duering¹, Wolfgang
Baechlin³, Rainer Boesinger³ and
Wolfgang J. Mueller²*

**1 Ingenieurbüro Lohmeyer GmbH & Co. KG, 01445
Radebeul, Germany**

**2 Lower Saxony State Agency for Ecology, 30449
Hannover, Germany**

**3 Ingenieurbüro Lohmeyer GmbH & Co. KG, 76229
Karlsruhe, Germany**





- 1. Problem of non exhaust PM10**
- 2. Additional measurements at a motorway**
- 3. Overview of available datasets**
- 4. Proposal Motorway Emission Factor**
- 5. Outlook**





PM10 concentration levels in 2002

Traffic site	Annual Mean $\mu\text{g}/\text{m}^3$	Number of exceedance >50 $\mu\text{g}/\text{m}^3$ in daily mean
Göttinger Street, Hannover	43	102
Lützner Street, Leipzig	36	63
Stadtautobahn motorway, Berlin	40	91

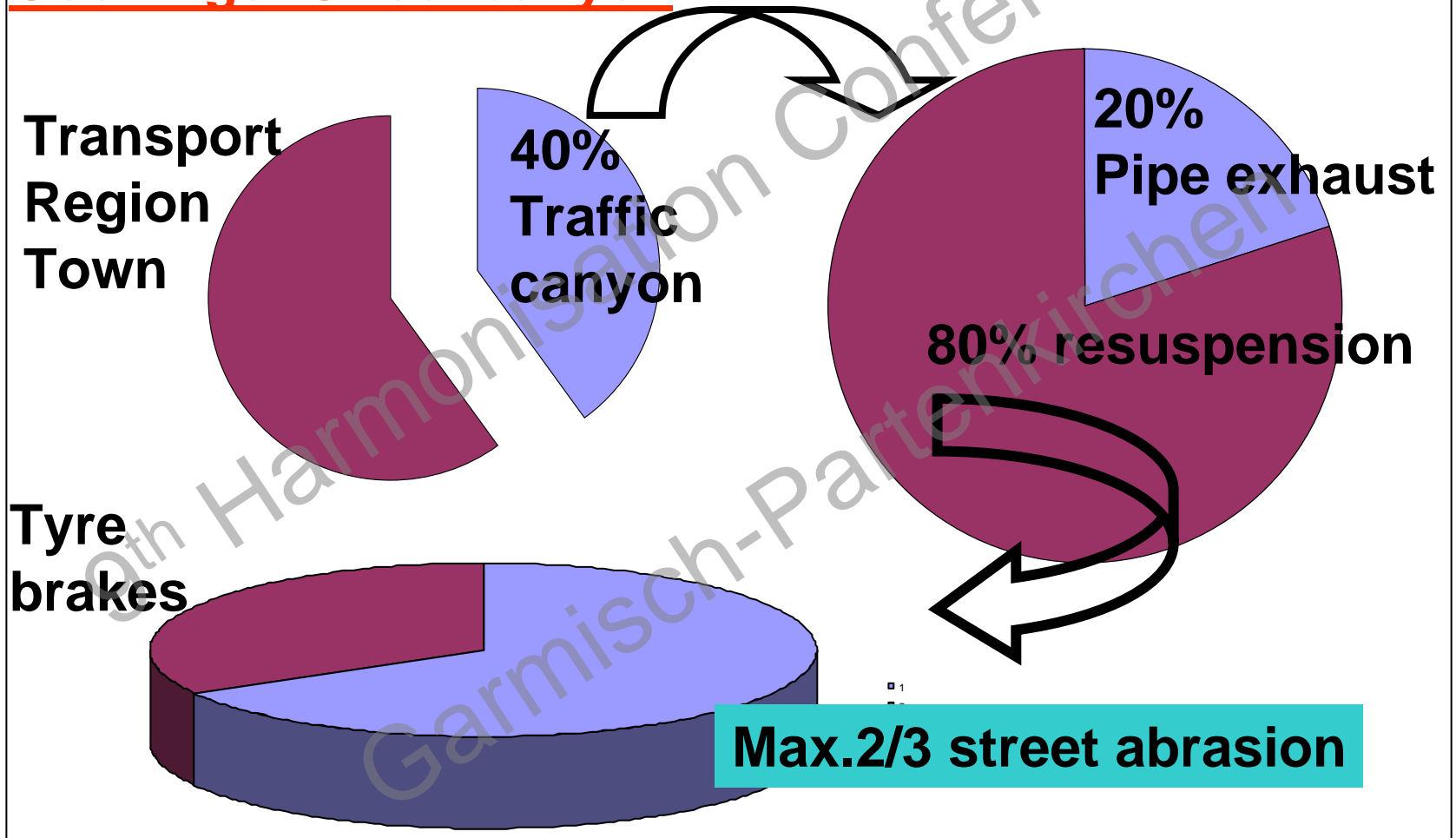
**→ exceedance of the limit values of the EU Directive 1999/30/EU.
Abatement plans, action plans are needed.**



Relevance of concentration level

PM10 origin

Goettinger Street canyon





PM10 emission model is needed for

- Action plans, abatement planning

Problems

- **Quantifying the PM10 emission processes resulting from abrasion of the road surface and dust re-suspension**
- **PM10 emissions can not be measured directly as the exhaust pipe emissions, inverse dispersion modelling from roadside concentration measurements or tracer methods**
- **there is a lack of data sets, containing all parameters, to validate PM10 emission calculation**





Only **modified EPA model** is available

$$E \sim sL^a, W^b, R$$

with

- **E** = emission of PM10
- **sL** = PM75 silt load g/m²
- **W** = weight of average vehicle of fleet
- **R** = share of rainy days per year
(precipitation > 0.1 mm per day)
- **a,b** = exponent





silt load of a street surface can not be estimated reasonably on the basis of the quality of the street surface.

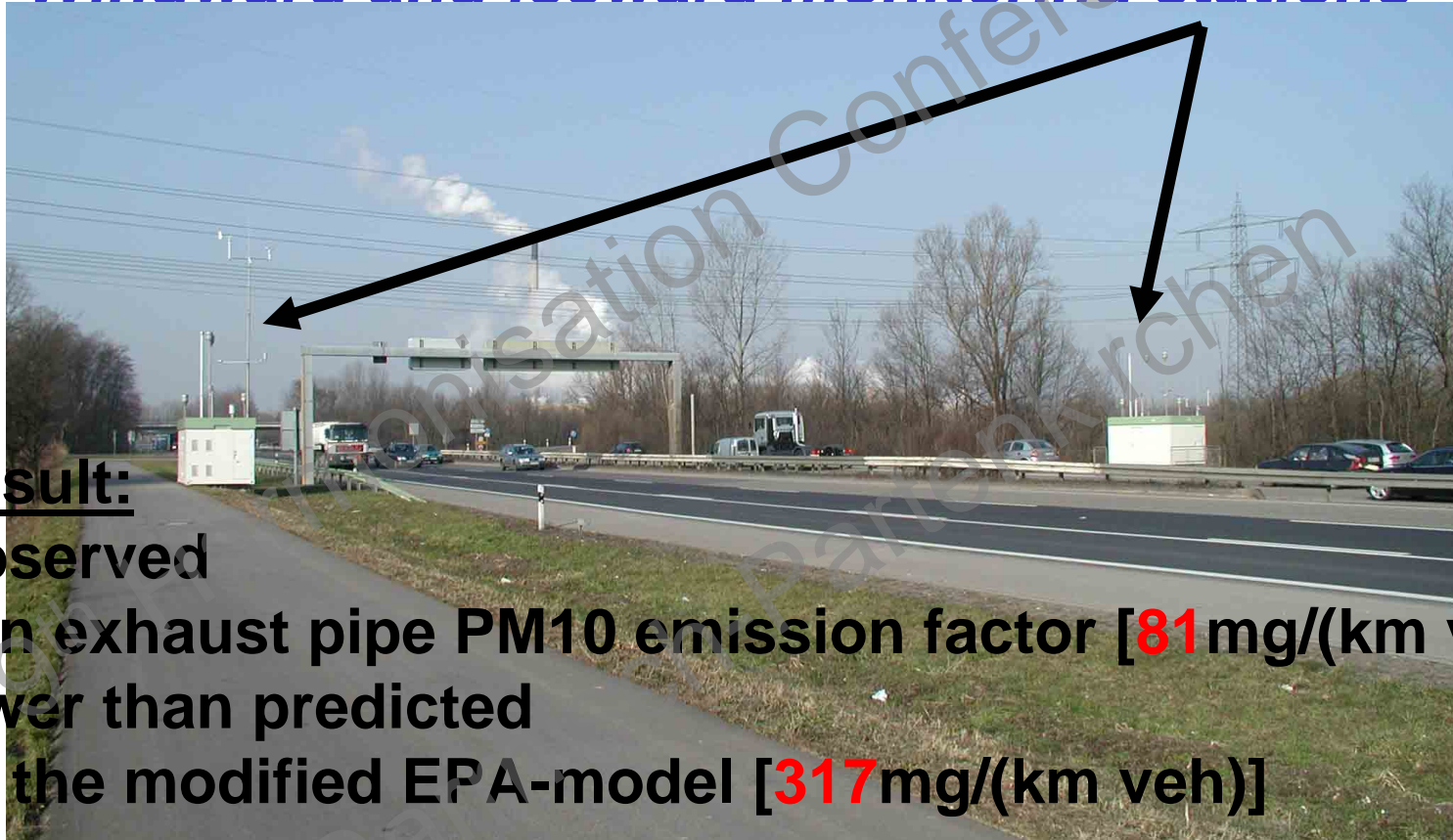
Results of silt load measurements on surfaces of traffic lanes

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





Windward and leeward monitoring stations



Result:

**Observed
non exhaust pipe PM10 emission factor [81 mg/(km veh)]
lower than predicted
by the modified EPA-model [317 mg/(km veh)]**

8 lanes, 75500 Veh./d, 14.4% trucks, speed ~100km/h



CONCLUSIONS FROM LEEWARD/WINDWARD MEASUREMENTS at the B10 MOTORWAY



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- At the analysed rainy working days the **PM10-emissions** were reduced by about 40%, compared to dry days
- At rainy sundays no reduction was observed



Results of analysis the gravimetric data incl. the content of selected PM2.5 and PM10 filters



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	PM10-Total [mg/ (km · veh)]	Exhaust [mg/ (km · veh)]	Tyre wear [mg/ (km · veh)]	Brake lining wear [mg/ (km · veh)]	Road abrasion plus dust resuspension [mg/(km · veh)]
Dry Workdays n = 14	92	46 (44)*	19 to 26	< 1	22 to 30

()* = emission factor calculated by means of HBEFa2.1

n = number of days with stabile met. conditions and complete data sets.

• **PM10 at dry working days:**

50% exhaust pipe emission

20% tyre wear

30% road abrasion, re-suspension

} **non
exhaust**



Emission data of motorways

→ 18 datasets with various quality



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Autor	Name of monitoring station	Quality Estim	Vehicle speed [km/h]	Truck content [%]	PM10-Total Emission g/(km*veh)	Quotient: Total Emiss./ Exhaust P. Emiss.	PM10-non-exhaust g/(km*veh)	PM10-non exhaust g/(km*veh) pass.cars trucks	
Lohmeyer (2003)	A5/Kenzingen	C	130	13.1	0.06	1.12	0.01		
Lohmeyer (2003)	A5/Holzhausen	C	130	12.9	0.06	1.12	0.01		
unpublished	A4/BASt	C	130	8.8	0.09	2.50	0.06		
Rabl (2003)	A8/Zusmarshausen	B	130	15.0					
Gehrig (2003)	A1/Birrhards	B	120	10.6	0.08	2.52	0.05	0.05	0.07
Keuken (1999)	N201/Holland	B-C	120	10.0	0.10	1.75	0.04	0.01	0.35
unpublished	A4/Jena	C	110	15.0					
Gehrig (2003)	A4/Humlikon	B	110	12.5	0.07	2.09	0.04	0.02	0.14
unpublished	B10/Karlsruhe	A	90	14.4	0.08	1.88	0.04	0.01	0.21
Israel (1994)	Berlin/Lerchpfad	C	80	8.0	0.22	4.60	0.17	0.07	1.27
Lohmeyer (2003)	Berlin/Lerchpfad	C	80	5.8	0.14	4.12	0.11		
Gehrig (2003)	Aahltal	B	50	6.1	0.07	2.92	0.04	0.03	0.21
Israel (1994)	Berlin/Tunnel Tegel	B	80	6.0	0.07	1.82	0.03	0.02	0.29
Rauterberg Wulff (1998)	Berlin/Tunnel Tegel	B	80	7.0	0.09	2.44	0.05	0.01	0.58
Laschober (2004)	Kaisermühl-Tunnel	B	80	12.6	0.05	1.04	0.00	0.00	0.00
Sternbeck (2002)	Tunnel Tingstad	B-C	60	10.0	0.04	1.38	0.01		
Schmidt (2001)	Tauerntunnel	B	75	15.0	0.08	1.73	0.04	0.02	0.14
Palme (2004)	Brudermühl-tunnel	B	58	8.0	0.03	1.48	0.01	0.00	0.08





the major conclusions from this collection
(**quality A and B**) for the non exhaust pipe
emission factors are:

- **Significant differences between the emissions in tunnels and in open roads can be detected only for passenger cars.**
- **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 about **2**, indicating that in the mean, the non exhaust pipe contribution is in the same order than the exhaust pipe contribution.
- The mean of the quotient between truck non exhaust pipe emission factor and passenger car emission factor is **11**, compared to a factor of **12 for the exhaust pipe**.





Based on measurements we propose to calculate the non exhaust PM10 emission in the case of motorways

MEF=Motorway Emission Factor

→ this is not a new emission model, but a better fit to measured data than the mEPA-model

- $E_{Veh} = MEF * N_{Veh}$





$$E_{\text{Veh}} = \text{MEF} * N_{\text{Veh}}$$

MEF Pass. cars incl. LDV:

inside Tunnel 0,010g/(km veh)

outside Tunnel 0,022g/(km veh)

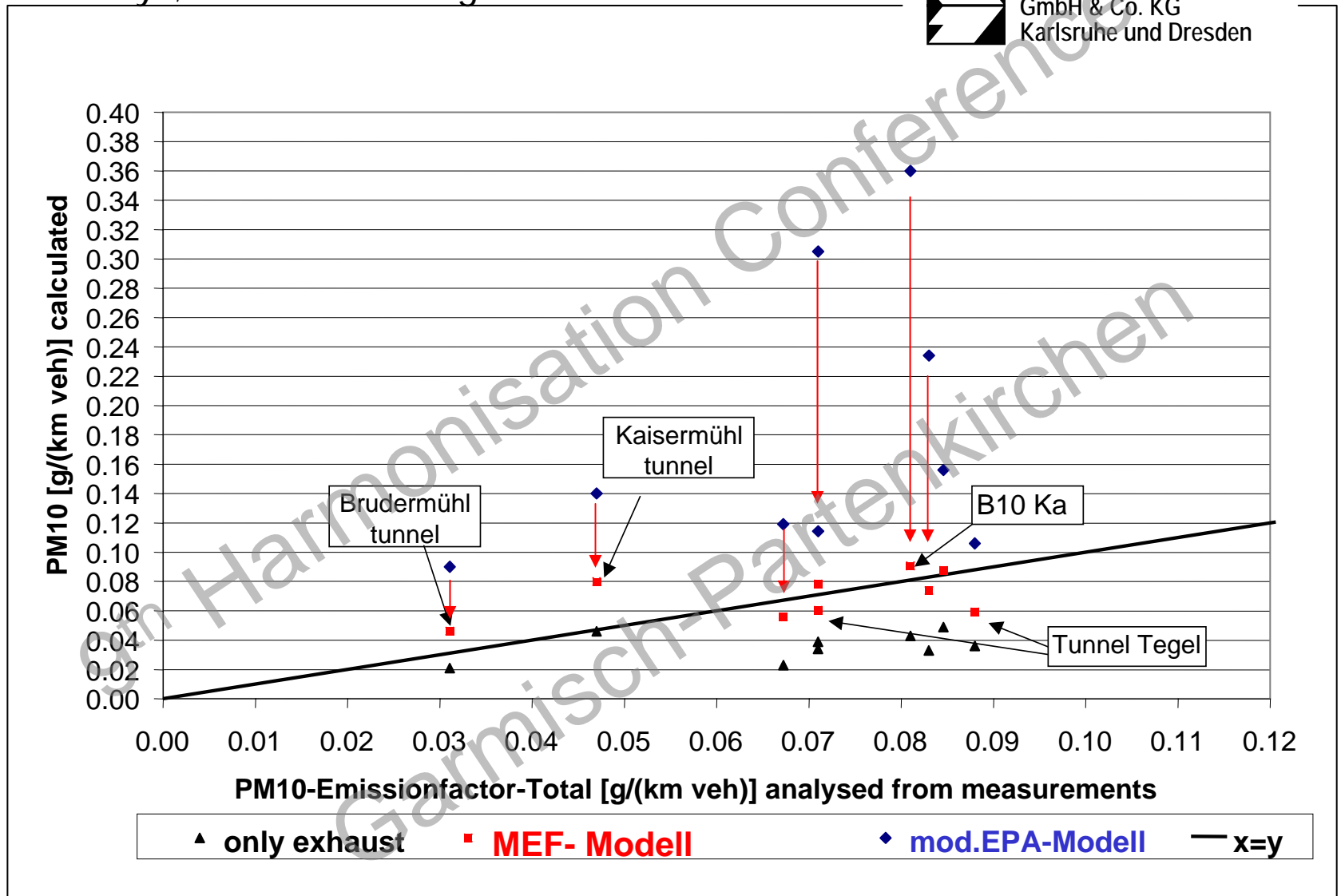
MEF Trucks:

inside Tunnel 0,200g/(km veh)

outside Tunnel 0,200g/(km veh)



Emission factors (quality A and B) in the case of motorways; Performance regression





- **Development of PM10 non exhaust Town Emission Factor „TEF“ for urban streets**
 - ➔ **fit to datasets like Göttinger Straße, Lützner Straße ...**
- **Differentiate the Emissionfactors in the same traffic situations like for the exhaust emissions in the HBEFa**





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9th Harmonisation Conference
Garmisch-Partenkirchen

Thanks for your attention

