Source Apportionment for PM Lenschow, PMF and the Potenital Source Region Contribution Function

Source Apportionment for PM

Lenschow, PMF and the Potential Source Region Contribution Function

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Institute for Energy and Environmental Technology

Air Quality & Sustainable Nanotechnology

Airborne Particles: Origins, compositions and effects
AAMG and NPL Xmas Conference
- London, UK - December 16th-17th 2008

Content

- Source apportionment methods
- Lenschow Approach
- PMF - Approach
- Comparability of Methods
- Potential Source Region Contribution Function
- Needs

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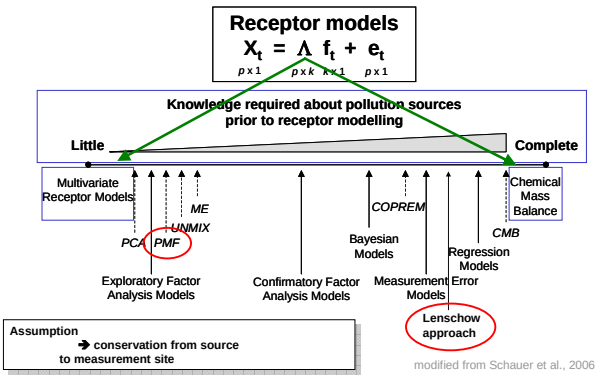
Receptor modelling



modified from Schauer et al., 2006

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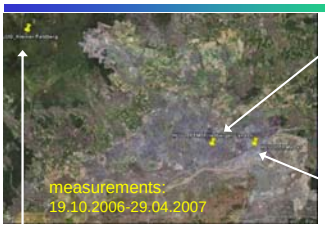
3 Measurement sites / area of Frankfurt/Main



every day:
PM10

every 3rd day:
OC, EC,
SO_4^{2-}, NO_3^-, NH_4^+, Cl^-,
Sb, Cu, Ca, Na, K, Al, Mg, Fe, Zn

background: „Kleiner Feldberg"

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Mean PM10 concentrations

PM10 [µg/m³]	Mean value 06/07	analytical data pool (52 days)
Traffic	30.0	33.3
urban&rural background	26.0	24.7
reg. background	11.5	9.4

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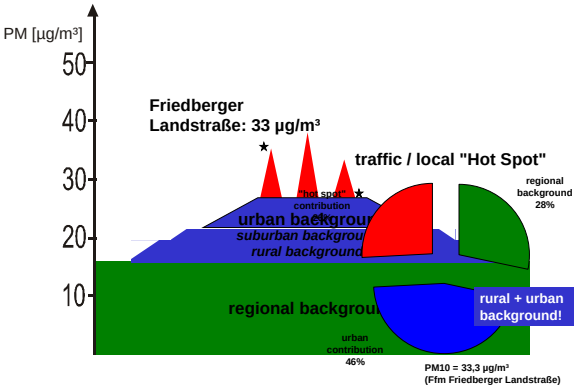
Lenschow approach



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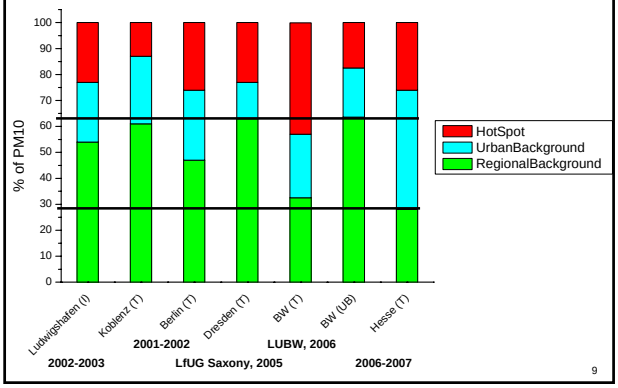
Lenschow: Comparability to other studies in Germany



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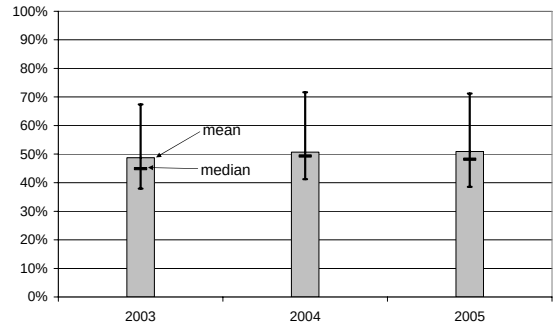
Reg. backg. contribution to traffic site



TFMM Report 2007

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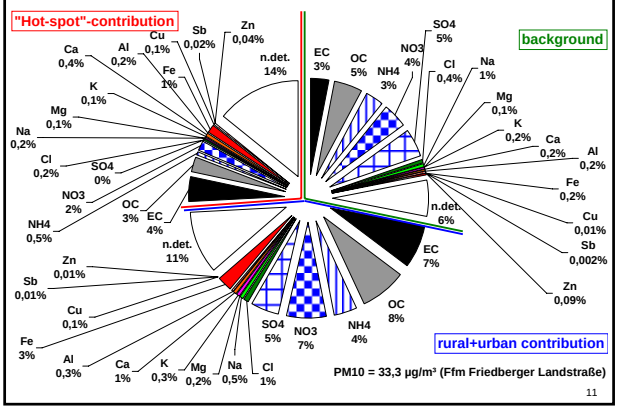
Chemical characterization



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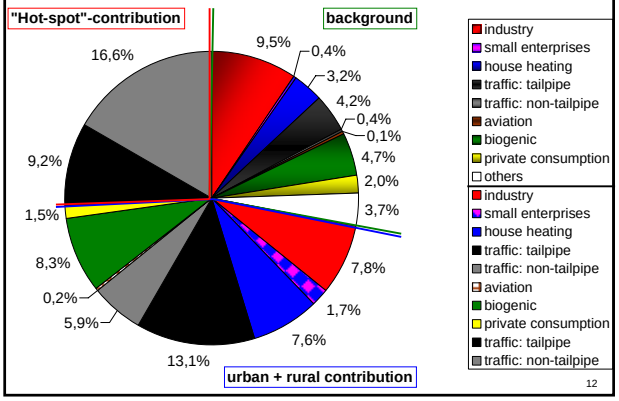
Source apportionment: source regions and source groups



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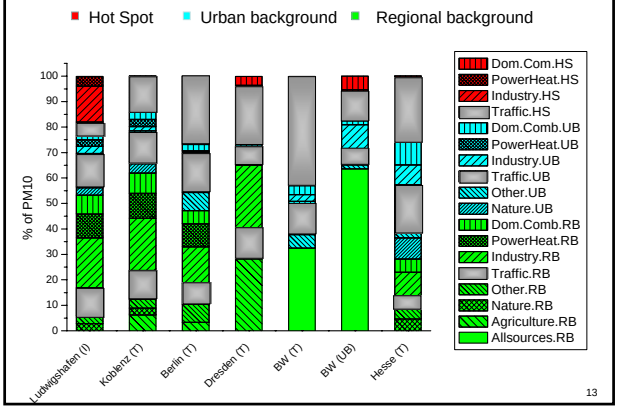
Lenschow: Comparability to other studies in Germany



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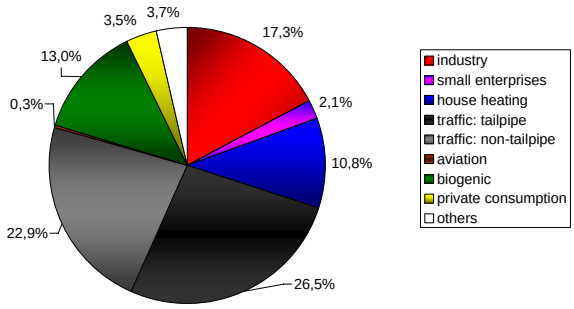
Source apportionment: summary source groups



PM10 = 33,3 µg/m³ (Ffm Friedberger Landstraße)

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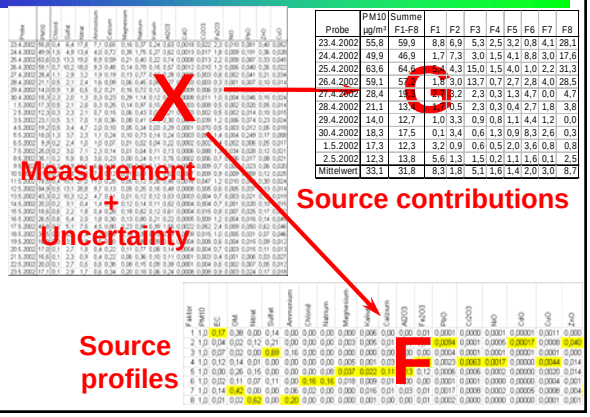
Positive Matrix Factorization (PMF)



Probe	PM10 µg/m³	Summe F1-F8	F1	F2	F3	F4	F5	F6	F7	F8
23.4.2002	55,8	59,9	8,8	6,9	5,3	2,5	3,2	0,8	4,1	28,1
24.4.2002	49,9	46,9	1,7	7,3	3,0	1,5	4,1	8,8	3,0	17,6
25.4.2002	63,6	64,6	2,4	4,3	15,0	1,5	4,0	1,0	2,2	31,3
26.4.2002	59,1	57,6	1,9	3,0	13,7	0,7	2,7	2,8	4,0	28,5
27.4.2002	28,4	19,2	0,6	3,2	2,3	0,3	1,3	4,7	0,0	4,7
28.4.2002	21,1	13,7	0,5	2,3	0,3	0,4	2,7	1,8	3,8	
29.4.2002	14,0	12,7	1,0	3,3	0,9	0,8	1,1	4,4	1,2	0,0
30.4.2002	18,3	17,5	0,1	3,4	0,6	1,3	0,9	8,3	2,6	0,3
1.5.2002	17,3	12,3	3,2	0,9	0,6	0,5	2,0	3,6	0,8	0,8
2.5.2002	12,3	13,8	5,6	1,3	1,5	0,2	1,1	1,6	0,1	2,5
Mittelwert	33,1	31,8	8,3	1,8	5,1	1,6	1,4	2,0	3,0	8,7

Positive Matrix Factorization (PMF): approach

- Screening of 4-8 factors for every measurement site
- Screening of „pooled“ data set

→ Most plausible results for 6 factors:

- **„combustion/fossil“**
- **„combustion/biogenic“**
- **„secondary“**
- **„salt“**
- **„earth crust / aluminium“**
- **„traffic“**

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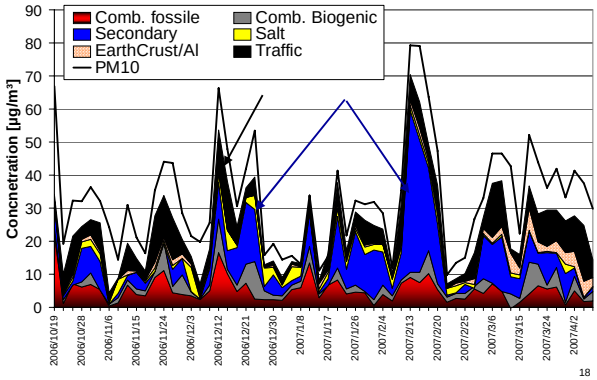
PMF Analysis G-Matrix: Factor time series (traffic site)



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PMF-Lenschow: Factor Contributions by Site (µg/m³)

Factor	regional bg		rural&urban bg		hot spot	
	mean	span	mean	span	mean	span
Comb./fossil	1.2	0.9 - 1.6	2.7	2.7 - 2.8	1.0	0.7 - 1.3
Comb./biogenic	2.0	1.9 - 2.1	1.2	1.1 - 1.3	-0.1	-0.2 - 0.0
secondary	2.6	2.5 - 2.7	4.2	4.2 - 4.3	0.2	0.2 - 0.2
salt	0.5	0.4 - 0.5	1.1	0.9 - 1.3	0.3	0.3 - 0.4
earth crust/Al	0.6	0.4 - 0.9	1.0	0.8 - 1.1	0.3	0.2 - 0.4
traffic coarse	-0.1	-0.1 - -0.1	3.9	2.6 - 5.2	4.9	3.4 - 6.4
residuals	2.6	2.5 - 2.6	1.2	-0.5 - 2.9	2.0	0.0 - 3.9
Sum	9.4	9.0 - 10.2	15.3	11.8 - 18.9	8.6	4.6 - 12.6

Secondary aerosols/ (sea-)salt:
Increase from reg. Bg to urban despite large scale transport!

➔ **Regional bg site partly above mixing layer?**

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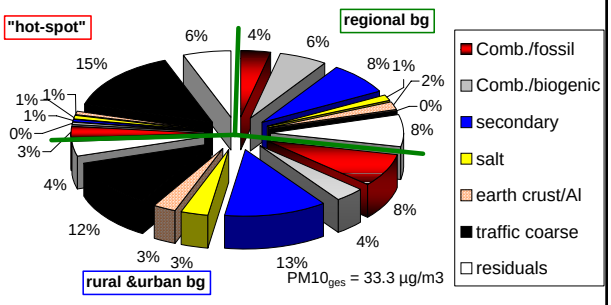
„Lenschow"-chart for average of factors



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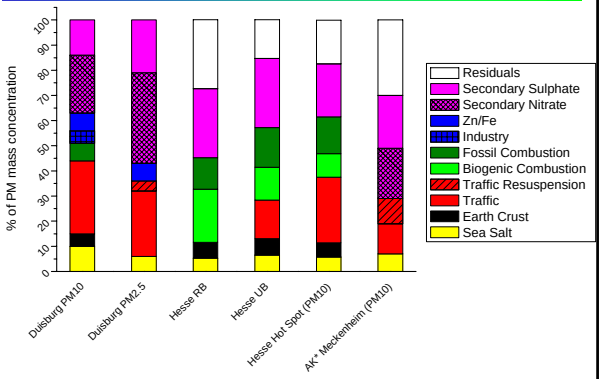
PMF: Comparison of results in Germany



*AK = Autobahn upwind side

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Comparability – PMF/Lenschow

- Comparison Lenschow / PMF
  traffic tailpipe + non-tailpipe 49% /
  traffic coarse + comb./fossil 42%
  other factors not directly comparable
- Lenschow approach:
  direct link to emission sources
  ➔ good for environmental management
  depends on completeness and accuracy of emission inventory
  ➔ natural sources (e.g. sea-salt not assessable)
- PMF:
  groups source and environmental processes rather than sources
  ➔ allows identification of long-range influences
  depends only on measured concentrations
  ➔ local contribution can be split into factors

➔➔ complementary information provided by combination!

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Do factors have their origin in different regions/areas?

Potential Source Contribution Function (PSCF)

Introduced by Ashbaugh et al, 1985
Modified and amended by several groups,
reviewed by A. Stohl
Atmospheric Environment Vol. 32, No. 6, pp. 947-966, 1998

Basic approach:
Probability analysis of backwards trajectory
regional residence time for selected groups of days
(e.g. high PM or factor concentration)

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