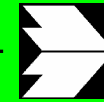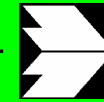# Modelling PMx-Emissions and – Concentrations of Streets for Environmental Impact Assessments and Action Plans

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(ingo.duering@lohmeyer.de)

1. **Modelling PM10, PM2.5 or ultra fine particles (UFP)?**

2. **Problems in the case of modelling particles**

3. **Exhaust and non-exhaust particle emissions**

4. **PMx emission data**

5. **Dispersion modelling in the case of environmental impact assessments and action plans**

6. **Open questions**
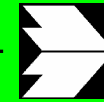
22. BImSchV (2007):

Presently limit values exist for PM10 only
(not for PM2.5 or UFP)
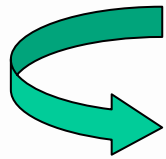
PM10- emissions and -concentrations are needed

CAFE position paper for future assessment:

- PM2.5 will be the important particle size
- Coarse mode (PM2.5-10) ditto relevant for human health
- Presently not enough knowledge to limit PM1 or UFP

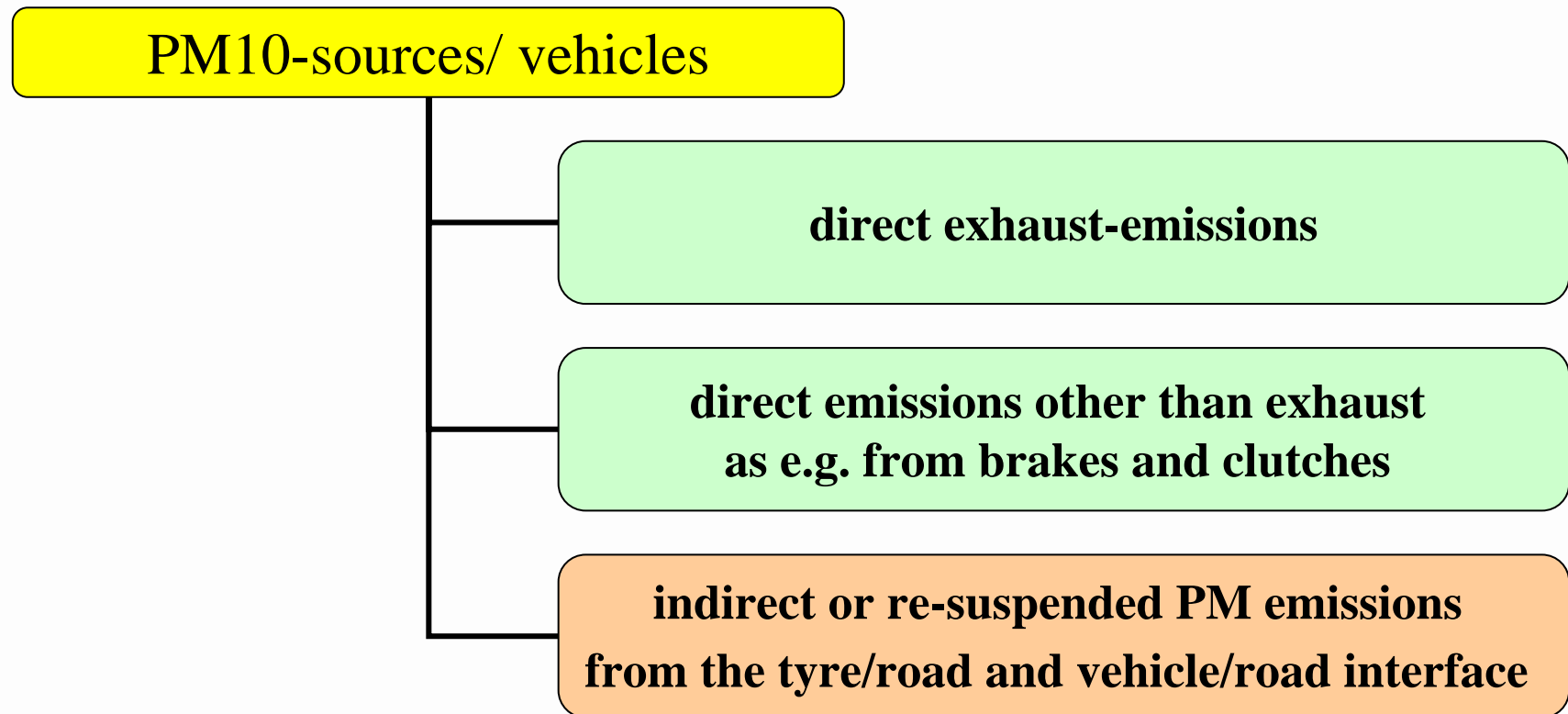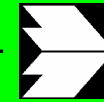In the case of atmospheric aerosols there is a lack of knowledge concerning

- emissions (sources)
- dispersion (transmissions)
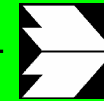- convertion (chemical, physical)
- elimination (sinks)
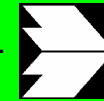
Various PM-sources are not or only insufficiently known:

- Agricultural activities, construction activities, vehicle induced re-suspension
- Wind induced re-suspension over natural open country or in urban areas
- Biological particles

Quantity and composition of PM-emissions, arising from combustion, are less known, as the classic pollutants

PM10-sources/ vehicles

direct exhaust-emissions

**direct emissions other than exhaust
as e.g. from brakes and clutches**

**indirect or re-suspended PM emissions
from the tyre/road and vehicle/road interface**

Exhaust emissions (refer to mass):

- Emission factor handbook HBEFa2.1 (UBA, 2004)
- 100% in PM1
- Depends on so called ,,traffic situations"
- differentiates vehicle classes, vehicle engine concept etc.

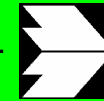No emission factors for speed limit 30 km/h available
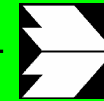
An official databank is not available

There exist emission-factors for abraision (tyres, brakes, cluches, road surface) in different international databanks:
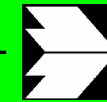
- e.g. CORINAIR (EMEP)
- e.g. RAINS (IIASA)

but ....

Uncertainties and scattering are large, emission-factors often differ significantly from databank to databank

Re-suspension lacks completely

PM10-emission-factors

Annual mean

(good road surface conditions)

| Traffic situation (according to [2])	Speed-limit [km/h]	Percentage constant speed driving (acc. to [2]) [%]	Percentage no traffic flow (acc. to [2]) [%]	Emission factor [mg/km veh]	
				Pass. car incl. vans	trucks
AB>120	---			22	200
AB_120	120			22	200
AB_100	100			22	200
AB_80	80			22	200
AB_60	60			22	200
AB_StGo	---			22	200
AO1	100	60	1	22	200
AO2	100	53	1	22	200
AO3	100	28	1	22	200
IO_HVS>50	60	46	1	22	200
Tunnel AB_100	100			10	200
Tunnel AB_80	80			10	200
Tunnel AB_60	60			10	200
Tunnel IO_HVS>50	60	46	1	10	200
HVS1	50	46	1	22	200
HVS2	50	52	1	30	300
HVS3	50	44	7	40	380
LSA1	50	44	7	40	380
HVS4	50	37	14	50	450
LSA2	50	32	20	60	600
LSA3	50	28	26	90	800
IO_Kern	50	23	33	90	800
IO_NS_dicht	50	32	5	90	800

- **strong influence of trucks (ca. factor 10)**

- **no significant influence of vehicle speed**

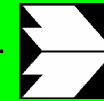- **strong influence of traffic situation (traffic flow)**
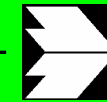
year 2007, 10% trucks
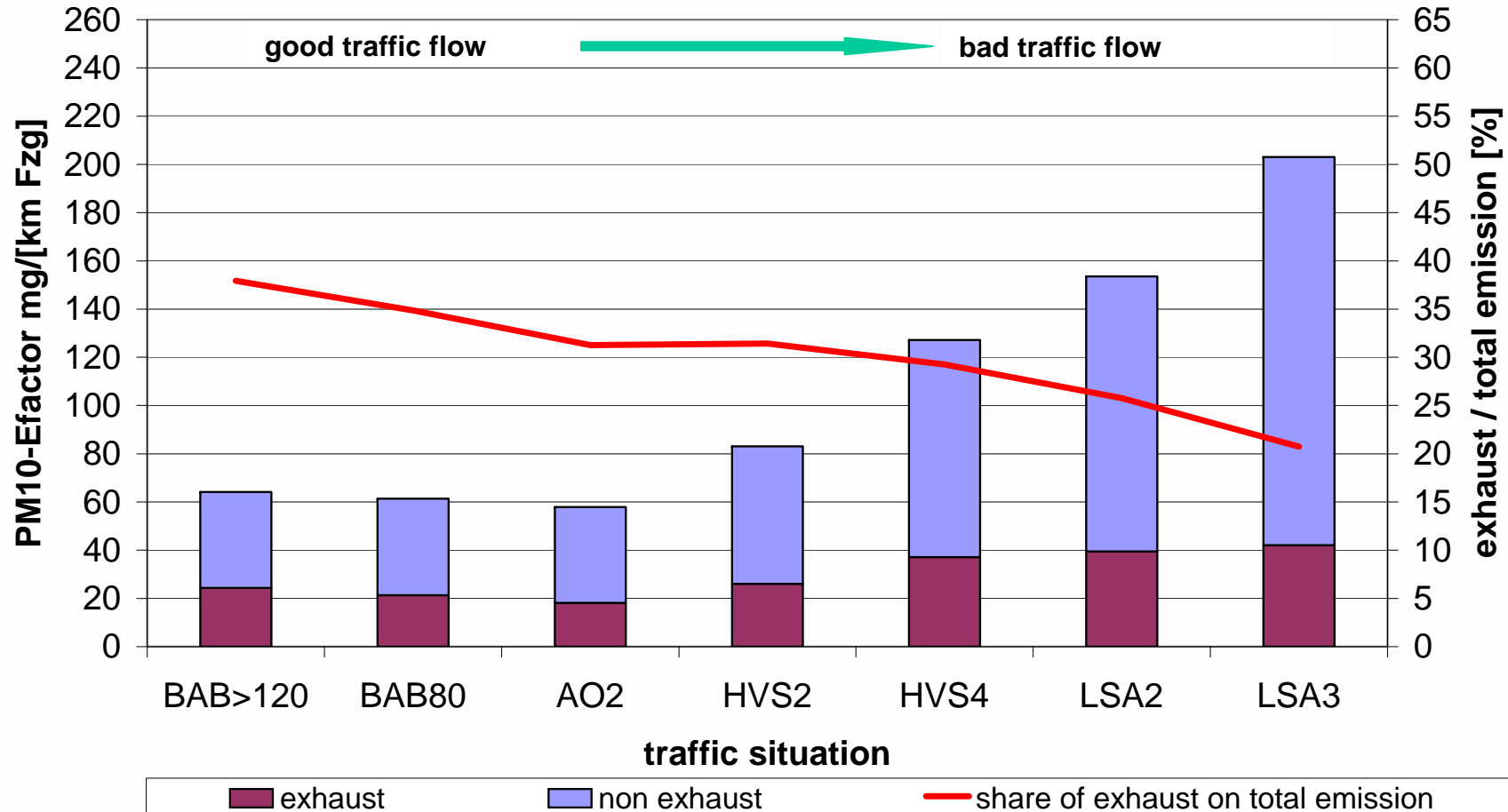
Strong influence of traffic flow ⟹ **Exact determination important!**

Special cases:

Speed limit (SL) of 30km/h in the case of regular traffic flow adapted from LfU Bayern (2003, WIME-Project):
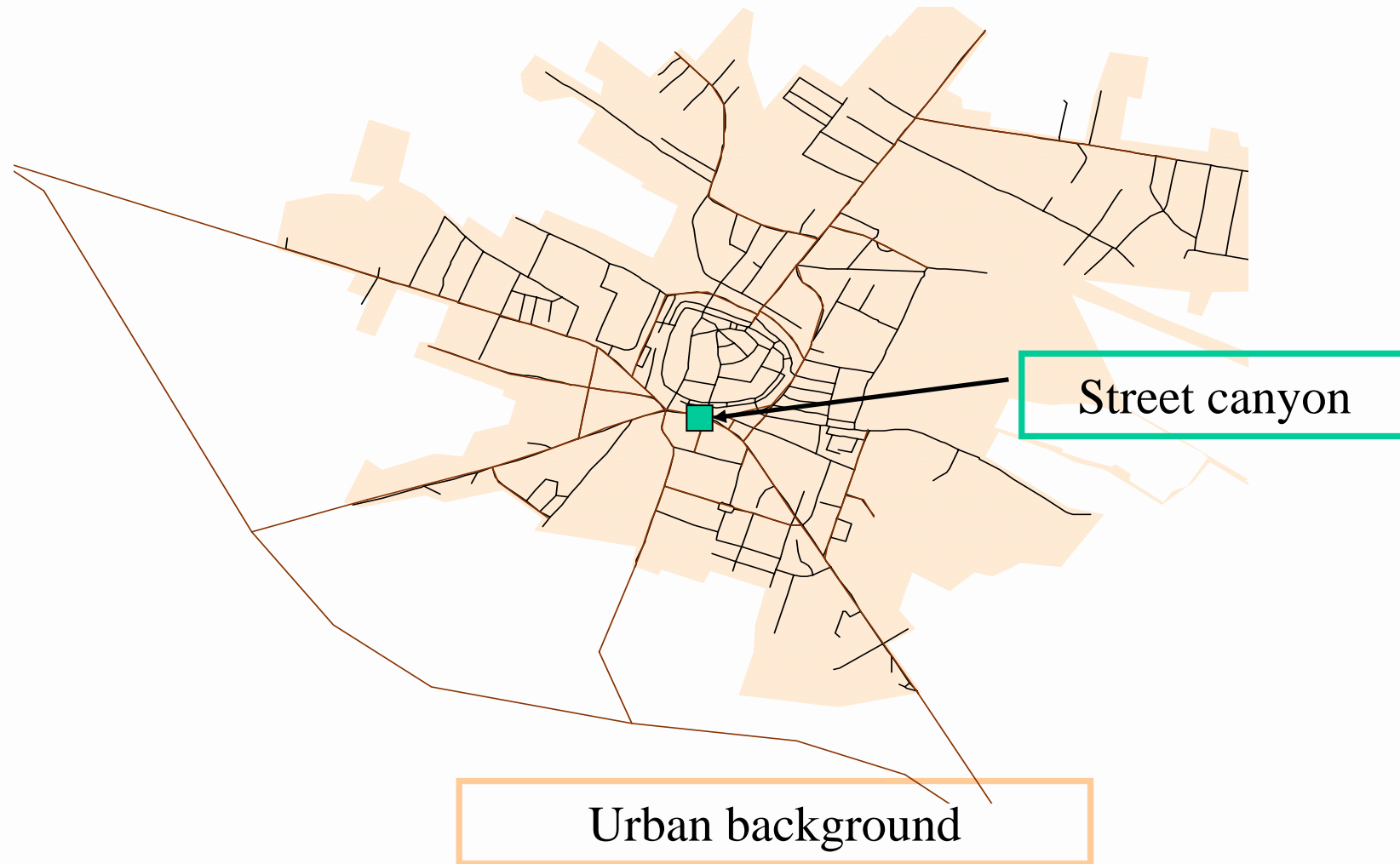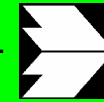
EFact (exhaust) for SL30 = 0.5 * EFact (exhaust) für SL50
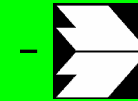
EFact (non-exhaust) unmodified

Bad road surface conditions (RSC)

EFact (exhaust) unmodified

EFact (non-exhaust) bad RSC = 3.6 * EFact (non-exhaust) good RSC

Street canyon

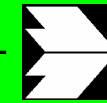Urban background

Regional background

Common (cost reduced) procedure:

- Regional background from measured data

- Urban background from measured data

- Determination of hot-spots by means of screening

- Detailed calculation of the hot-spot additional concentration by means of microscale flow- and dispersion modell

- use of PM10 (because of limit values)

- particle conversion in local (street canyon) contribution is neglected

- secondary particle formation in local contribution is neglected
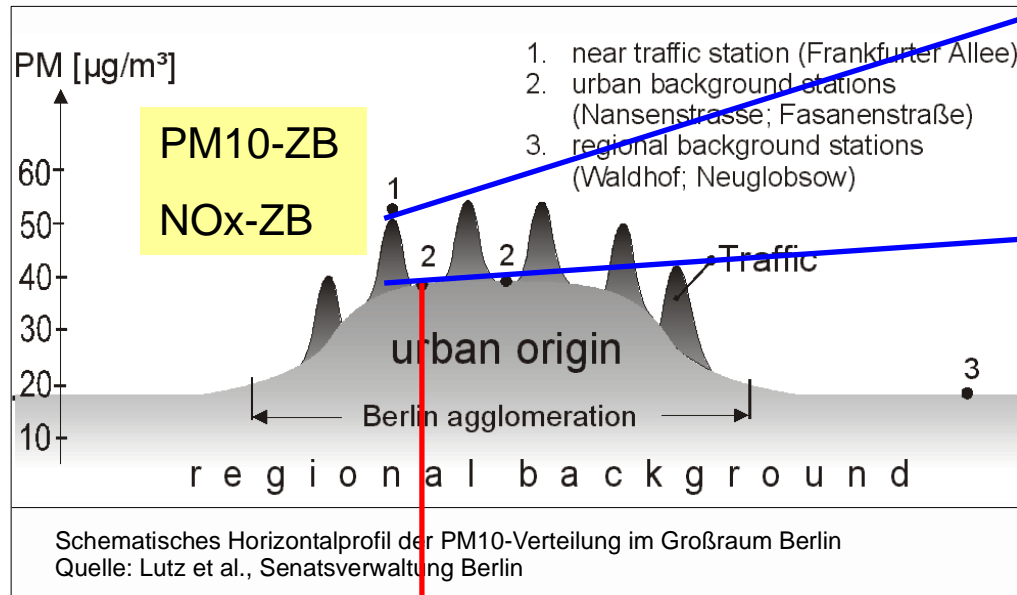
- deposition in local contribution is neglected

Modelling of local contribution particle concentration like a gas
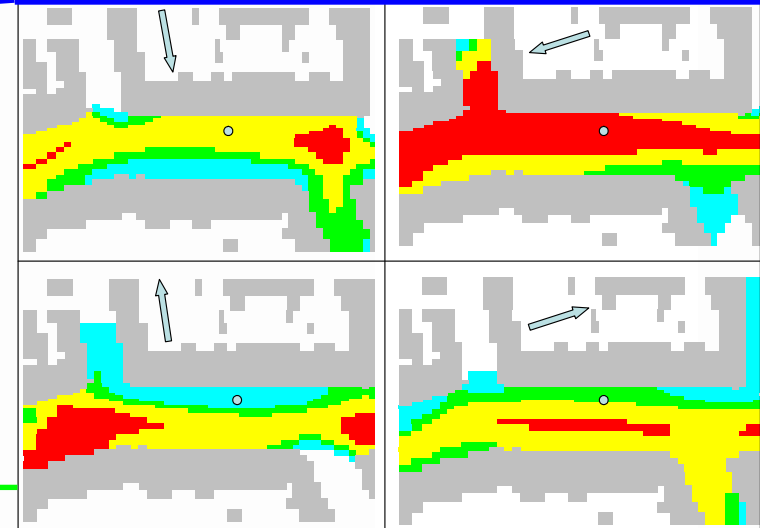
Common (low cost) procedure

e.g. MISKAM or PROKAS-B

Local contribution depends mainly on buildings, vehicle fleet, traffic situation and wind

PM [µg/m³]

PM10-ZB

NOx-ZB

1. near traffic station (Frankfurter Allee)
2. urban background stations (Nansenstrasse; Fasanenstraße)
3. regional background stations (Waldhof; Neuglobsow)

60
50
40
30
20
10

1
2 2
Traffic

urban origin

Berlin agglomeration

3

r e g i o n a l   b a c k g r o u n d

Schematisches Horizontalprofil der PM10-Verteilung im Großraum Berlin
Quelle: Lutz et al., Senatsverwaltung Berlin

Urban background from measurement

Total concentration

Ingenieurbüro Lohmeyer
GmbH & Co. KG
Karlsruhe und Dresden
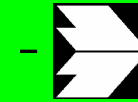
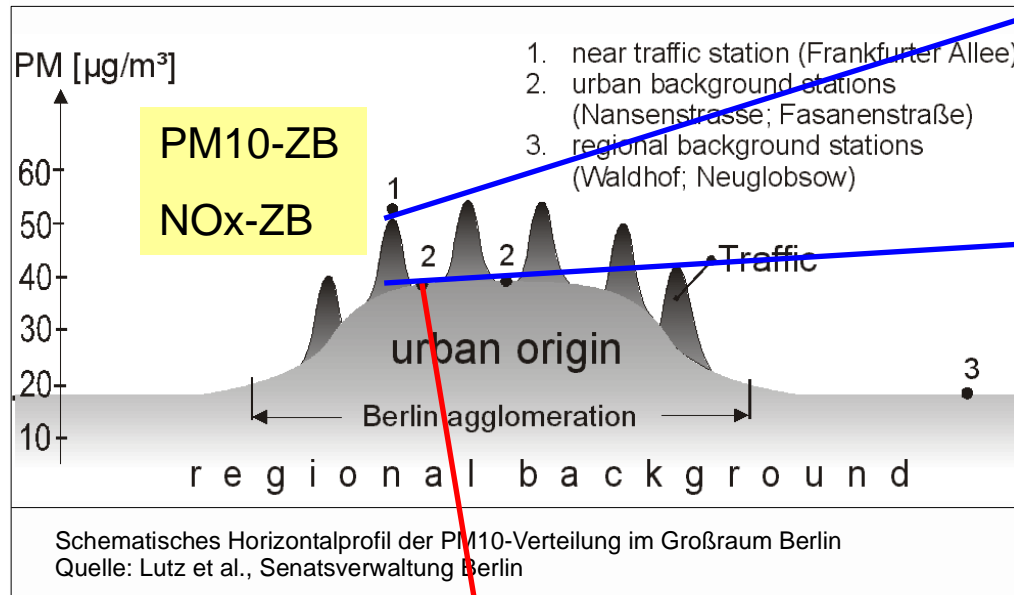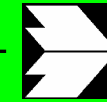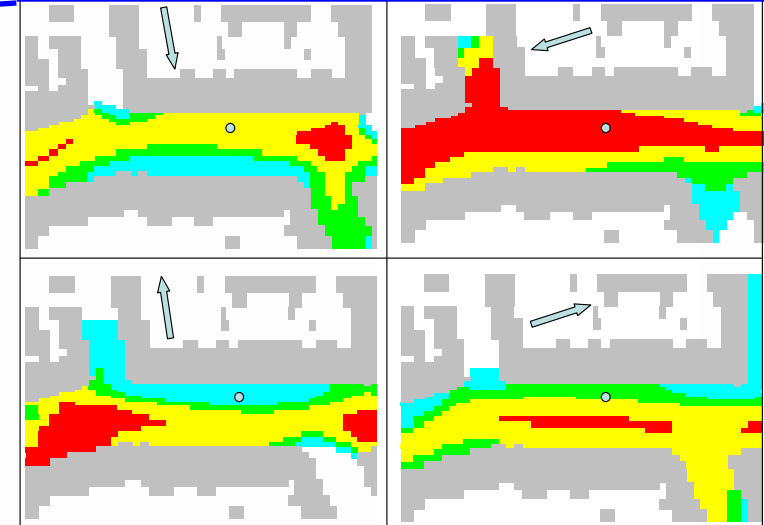## Advanced procedure:

- Regional background from measured data
- Urban background from modelling
- Determination of hot-spots by means of screening
- Detailed calculation of the hot-spot concentrations by means of microscale flow- and dispersion modell

• use of PM10 (because of limit values)

• particle conversion is neglected

• secundary particle formation is neglected

• depositions in local contribution is neglected

z.B. AUSTAL2000, LASAT, PROKAS, IMMIS, MISKAM

Advanced procedere

PM [µg/m³]

PM10-ZB

NOx-ZB

60
50
40
30
20
10

1

2   2

urban origin

Traffic

3

Berlin agglomeration

r e g i o n a l   b a c k g r o u n d

1. near traffic station (Frankfurter Allee)
2. urban background stations (Nansenstrasse; Fasanenstraße)
3. regional background stations (Waldhof; Neuglobsow)

Schematisches Horizontalprofil der PM10-Verteilung im Großraum Berlin
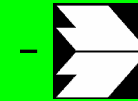Quelle: Lutz et al., Senatsverwaltung Berlin

e.g. MISKAM or PROKAS-B

Local contribution depends mainly on buildings, vehicle fleet, traffic situation and wind

Urban background e.g. with LASAT/AUSTAL

- **Road net**
- **Industry**
- **Trade**
- **Domestic combustion**
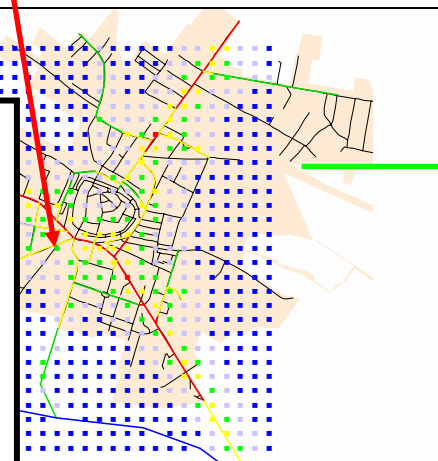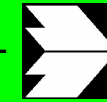
Total concentration

Complex procedure:

- Regional background from European scale modelling
- Urban background from modelling
- Determination of hot-spots by means of screening
- Detailed calculation of the hot-spot concentrations by means of microscale flow- and dispersion modell

- secondary particle formation in background is not neglected
- deposition is not neglected
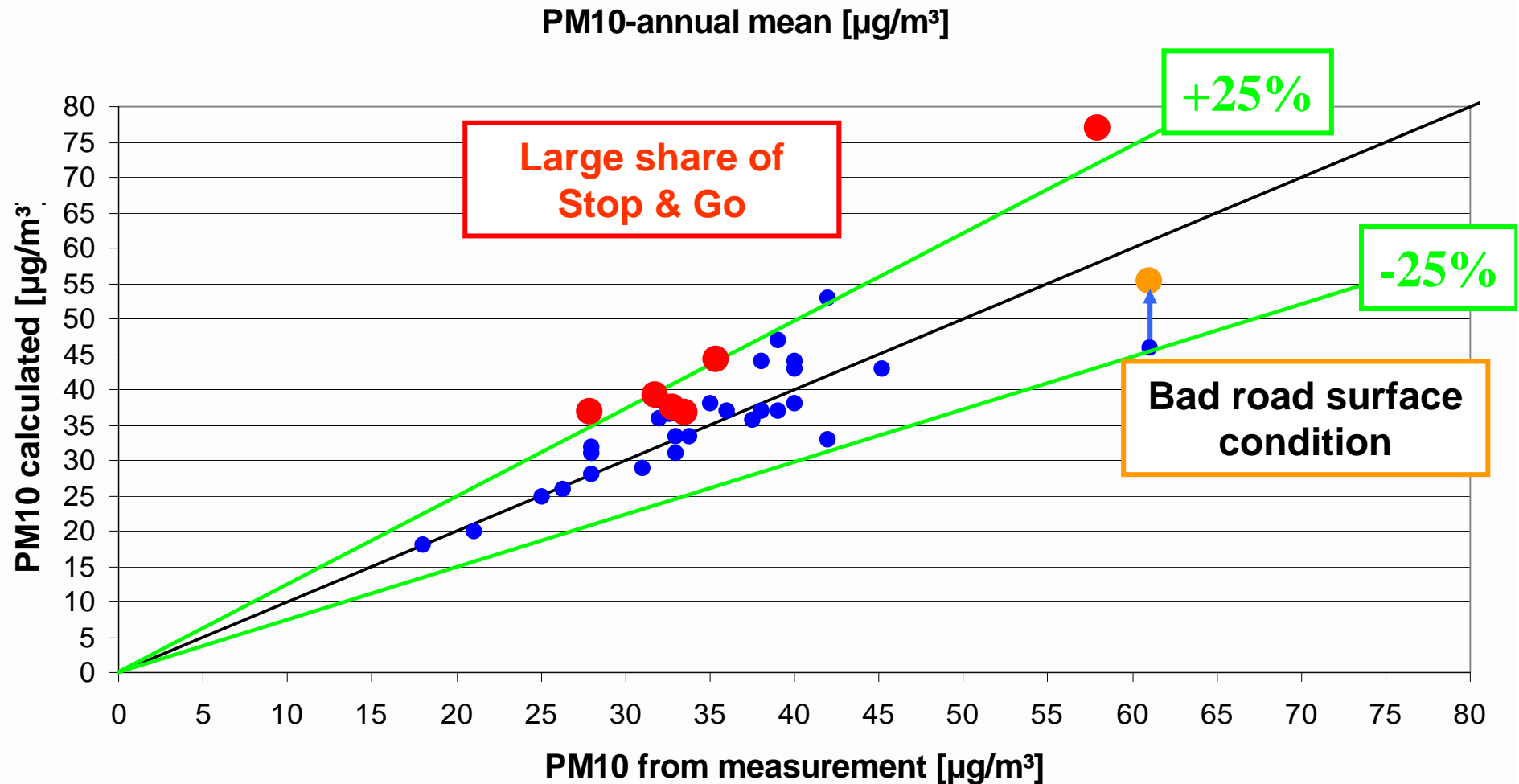
e.g. REM-CALGRID+MICRO-CALGRID + AUSTAL2000

High demand of input data, problems of accuracy because of partly insufficient european emission database

PM10-annual mean [µg/m³]

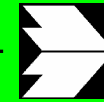- Influence of state of the street surface and -material on PM10-emission
  ➔ new results FE 02.0265/2005/LRB (BASt) by end of 2007

- Influence of vehicle speed on PM10-emission
  ➔ new results FE 02.0265/2005/LRB (BASt) by end of 2007; FE 77.486/2006 (BASt) by end of 2008

- Influence of meteorology on PM10-emission ➔ new results FE 02.0265/2005/LRB (BASt) by end of 2007

- Influence of sloop of the road on PM10-emission

- Influence of traffic volume on PM10-emission-factor

- Influence of share of Stop&Go on PM10-emission-factor

- Share of the emissions on the size-distribution PM1/PM2.5/PM10
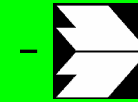
- Influence deposition?

- Interaction of the particles among each other

- Interaction of the particles with meteorology (moisture, rain, wind etc.)

Thank you for your attention