Near traffic source apportionment in the City of Dresden, Saxony
PART II: Exceedances of the EU-PM10 limit value

Holger Gerwig¹, Hartmut Bittner²
¹ Saxon State Agency for Environment and Geology, Dresden
² Department of Umwelt Service, TÜV Industrie Service GmbH TÜV SÜD Group, Dresden, Germany

Freistaat Sachsen
Saxon State Agency for Environment and Geology
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   - PM10 source apportionment according to Lenschow
   - Exceedances of limit values by long range transport
   - Saharan dust caused exceedances

4. Conclusions
• **EU-directive** for protection of health
  EU/1999/30 + in Germany: 22. BImSchV (PM10)

• **Limit value**: $35 \times > 50 \, \mu g/m^3$ PM10 daily av.

• **Dresden traffic**
  2003: $53 \times > 50 \, \mu g/m^3$
  2005: $39 \times > 50 \, \mu g/m^3$ (until 08-2005)
  -> air quality plan for 2005 necessary

• **Contents** of main components varies in time, place, particle diameter:
  Ammonia, sulphate, nitrate, soot, earth crust, sea salt, organic matter

• **Project**: “Korngrößendifferenzierte Feinstaubbelastung in Straßennähe in Ballungsgebieten Sachsens”

---

**size dependent depth of penetration of particulate matter into human**

- Mucous membrane of Nose
  - >10 µm
- Larynx
  - 4.7 – 6.8 µm
- Trachea and bronchial tubes
  - 3.3 – 4.7 µm
- Sec. + terminal bronchial tubes
  - 1.1 – 3.3 µm
- Alveole
  - < 1.1 µm
“visible” urban aerosol and Saharan dust in the atmosphere

outskirts Dresden
16-12-2004
52 µg/m³ PM10

Kufstein
21-02-2004
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   • PM10 source apportionment according to Lenschow
   • Exceedances of limit values by long range transport
   • Saharan dust caused exceedances

4. Conclusions
Measurements in Dresden

11-08-2003 - 08-08-2004

outskirts
10 km Northwest

urban background
400 m Northeast

roadside station
55,000 vehicles per day
## HVS Samples
11-08-2003 - 08-08-2004

<table>
<thead>
<tr>
<th>Sampling</th>
<th>every second week for 7 days (24h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM10 and PM2.5</td>
<td></td>
</tr>
</tbody>
</table>

| location 1: | roadside |
| period: | 1 year: 11-08-2003 - 08-08-2004 |
| number: | 184 |

| location 2 + 4: | urban background and outskirts |
| period: | 5 weeks: 3 summer + 2 winter |
| number: | 35 |

<table>
<thead>
<tr>
<th>Analysis</th>
<th>main components</th>
</tr>
</thead>
<tbody>
<tr>
<td>earth crust (calculated oxides of Ca, Fe, Ti, Mn + calculated Si, Al from Fe)</td>
<td></td>
</tr>
<tr>
<td>trace elements</td>
<td></td>
</tr>
<tr>
<td>PAH</td>
<td></td>
</tr>
</tbody>
</table>
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   - PM10 source apportionment according to Lenschow
   - Exceedances of limit values by long range transport
   - Saharan dust caused exceedances

4. Conclusions
Roadside traffic station
annual average of main components
(8-2003 – 8-2004)

Dust + earth crust: more in coarse mode
Horizontal profile of PM10 in Dresden

PM$_{10}$ in µg/m$^3$

$\Delta 1-2 =$ local street traffic fraction

$\Delta 2-4 =$ urban origin

4 = outskirts + background

1 traffic

2 urban background

3 regional background

4 outskirts

Fig. modified from LENSCHOW et. al. (2001) Atmospheric Env. 35, S23-33
Roadside traffic
loc. 1

urban background
loc. 2

suburban
loc. 4

Feb-2004 + Jul-Aug-2004
Sources of PM10 at roadside station in Dresden
Emission inventories + PM10 compound concentrations at 3 stations (Lenschow)

PM$_{10}$ sources

- Local street: 28.1%
- Traffic in city: 23.4%
- Traffic in suburbs and long range transport: 24.8%
- Households: 12.3%
- Industry: 7.9%
- Agriculture and nature: 3.5%

Total traffic contribution: 71.6% (43.6% traffic)

Compositions:
- 5% ammonia
- 5.1% soot

Holger Gerwig et al.: Near traffic source apportionment in the City of Dresden
Saxony PART II: Exceedences of the EU-PM10 limit value
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   • PM10 source apportionment according to Lenschow
   • Exceedances of limit values by long range transport
   • Saharan dust caused exceedances

4. Conclusions
Days $\text{PM}_{10} > 50 \mu\text{g/m}^3$

9 of 27 days $>50 \mu\text{g/m}^3$ during sampling period were analyzed

- earthcrust+metals
- NH4
- NO3
- SO4
- org. mat.
- soot
- sea salt
- UM (water)

PM$_{10}$ in μg/m$^3$

- 27-1
- 29-2
- 26-1
- 9-3
- 28-1
- 8-3
- 18-12
- 13-8
- 21-10

Secondary aerosol

Earthcrust Hcr
**Hsec** 32-55% *secondary aerosols* ; < 0°C

**Hcr** 30-38% *earth crust*

**L** < 20 µg/m³ PM10

The diagram illustrates the predominant components of PM10 in Dresden, Saxony, with a focus on near traffic source apportionment. The bars represent different categories:

- **earthcrust+metals**
- **NH4**
- **NO3**
- **SO4**
- **org. mat.**
- **soot**
- **sea salt**
- **UM (water)**

Secondary aerosols and earth crust dominate the PM10 composition, with secondary aerosols accounting for 32-55% and earth crust for 30-38%.
Class Hsec + Hcr (> 50µg/m³), n = 9
- no rainfall 1-6 days before
- wind velocity half of group L (1.1 m/s)
- more inorganic secondary aerosol or earth crust
- 96h backward trajectories: at least one source regions: Czech basins, the Ruhr area or southwest Poland

Class L (< 20µg/m³), n = 39
- Almost every day rain
- Wind velocity: 2.2 m/sec
- 96h backward trajectories: 14 x North Atlantic, Scandinavia; 12 x from West; 13 x different origins

Conc. all compounds: L < H exception magnesiuim
27 days of exceedance (During sampling period) could probably reduced with traffic reduction by x days:

- Traffic in suburbs and long range transport
- Traffic in city
- Local street
- Diesel soot

Reduction in number of days > 50 µg/m³ PM$_{10}$ with less traffic.
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   • PM10 source apportionment according to Lenschow
   • Exceedances of limit values by long range transport
   • Saharan dust caused exceedances

4. Conclusions
PM2.5 / PM10 minimum, (< 0.75) on 22-02-2004

\[ y = 0.75x - 2.98 \]

\[ R^2 = 0.90 \]
Saharan dust events

• 10 days per year in Leipzig on av. (ANSMANN, 2004)

• more of coarse fraction (PM2.5/PM10<0.75)

22-2-2004 96h Backwards trajectories (Draxler, NOAA HYSPLIT)

21-2-04 Saharan dust over Sardinia NASA (MODIS)
Exceedances of the EU-PM10 limit value

1. Introduction: Why detecting PM10 exceedances?

2. Measurements in Dresden

3. Results
   • PM10 source apportionment according to Lenschow
   • Exceedances of limit values by long range transport
   • Saharan dust caused exceedances

4. Conclusions
Conclusions

- **Traffic** is the **source** of 44% of PM10 at a **roadside station** in Dresden, 5% from **diesel soot** from **local street** emissions

- **Exceedances** of limit value > 50 µg/m³ PM10 daily average:
  - **no rain**, low wind speed, air masses from **polluted areas**
  - 2 classes
    - Hsec: high conc. **secondary aerosols** + days < 0°C
    - Hcr: high conc. **earth crust + street dust**

- **Saharan dust** caused exceedances on 22-02-2004 with about 40 µg/m³ and PM2,5/PM10 < 0,75

Interpretations regarding Size Segregated Characterization of Main Components with MOUDI + Berner Impactors:

- EAC-presentation: Tuesday 11:30 Aerosol Chemistry (J. v. Eyck room)
- report: [www.umwelt.sachsen.de/lfug/luft-laerm-klima_5356.html](http://www.umwelt.sachsen.de/lfug/luft-laerm-klima_5356.html)
Acknowledgements

- **Department Umwelt Service, TÜV Bau und Betrieb GmbH, Dresden, Dr. Bittner**
  - Analytics of PM$_{10}$ and PM$_{2.5}$ filter

- **Staatliche Umweltbetriebsgesellschaft**
  - Mr. Lohberger, Dr. Müller et al.
  - Sampling PM$_{10}$ and PM$_{2.5}$

- **Saxon State Agency for Environment and Geology, Dresden**
  - Financing the project
Holger Gerwig et al.: Near traffic source apportionment in the City of Dresden, Saxony PART II: Exceedences of the EU-PM10 limit value