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Ambient Air Quality Measurements of TSP, PM10, PM2.5 and EC

Workshop "Particle Measurement", 07.08.1997, ETH Zürich

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The presentation is focused on ambient air particle measurements. The background is the recommendation of the Swiss Federal Commission on Air Hygiene to replace the existing ambient air quality standards for TSP (total suspended particulate matter) by ambient air quality standards for PM10 (particulate matter with a diameter of less than 10 µm) (overhead 1). A discussion of the human health effects of the fine particles can be found in a separate publication (ref. 1). The effects will not be discussed in this presentation.

In 1995 the National Air Pollution Monitoring Network (NABEL) started a pilot project to evaluate measuring methods for PM10 and elemental carbon (EC) (results presented in ref. 2 and ref. 3). With the beginning of 1997 the continuous PM10 monitoring started within the NABEL network. Figure 2 gives the half yearly means (01.01.97 - 30.06.97) of PM10 for urban, suburban and rural sites. The rural site Härkingen is near a highway with a high percentage of heavy duty trucks which explains the high PM10-values. PM10 concentrations decrease from urban to rural sites and with increasing altitude.

Figure 3 shows the daily PM10 and TSP averages for the suburban site Basel-Binningen. Several epiodes with high particle concentrations can be recognized. During the wintertime episodes the PM10 and TSP values are almost identical. Later in the year the PM10 fraction on TSP is lower. The summer-winter contrast in PM10 concentrations is striking.

PM2.5 measurements are also carried out at 2 sites in the NABEL network. Figure 4 shows the parallel measurements (daily averages) of TSP, PM10 and PM2.5 at the suburban site Dübendorf for march and april 1997. The PM2.5 fraction on PM10 is high (> 80 %) and the correlation between the two parameters is almost perfect. The particle pollution in Switzerland is mainly a problem of fine particles.

This can also be derived from figure 5, which presents the particle size distribution in the ambient air for four different sites. The differences between the sites are small. The accumulation mode (0.2 - 1 µm) is dominating the mass size distribution.

In the last part of the presentation results from the measurements of elemental carbon are given. The definitions of Total Carbon (TC), Elemental Carbon (EC), Black Carbon (BC), Organic Carbon (OC) and soot in overhead 6 are taken from ref. 3. At the three sites presented in figure 7, the EC fraction on PM10 is 8.3 % at Dübendorf,

10.4 % at Zürich and 16.2 % at Bern. The percentage varies with the season (fig. 8). Higher values are observed during the autumn and winter months.

Another part of the soot-study (ref. 3) was the evaluation of different monitors to measure the carbon content of the ambient air. Figure 9 shows the comparison between a coulometer and an aethalometer. The two graphs come from the same urban site but represent different months. The aethalometer measures the light absorbing part of the aerosol (black carbon, BC). The aethalometer values are lower than the coulometer values and the regression coefficients vary from month to month.

Finally, an estimation of the composition of PM10 at the rural site Payerne is given (fig. 10). The secondary aerosols sulfate, nitrate and ammonium form an important part of PM10. The elemental carbon is in the order of 10 %. An important fraction of the rest is probably the organic carbon. At urban sites the percentage of secondary aerosols is lower, whereas the fraction of the carbon components (elemental and organic) and the mechanically produced particles (e.g. tire wear) is higher. The chemical composition of PM10 is part of a new research project that started recently.

References:

1) BUWAL (1996): Schwebestaub - Messung und gesundheitliche Bewertung. Swiss Agency for the Environment, Forests and Landscape, Environmental Series No. 270. (available in german and french).

2) BUWAL (1997): NABEL - Luftbelastung 1996. Swiss Agency for the Environment, Forests and Landscape, Environmental Series No. 286, (available in german and french).

3) Fischer A., Gehrig R., Hofer P. (1997): Russmessungen in der Aussenluft, Methodik und Resultate. To be published in: Umwelt-Materialien, BUWAL, (available in german).

Figure 4

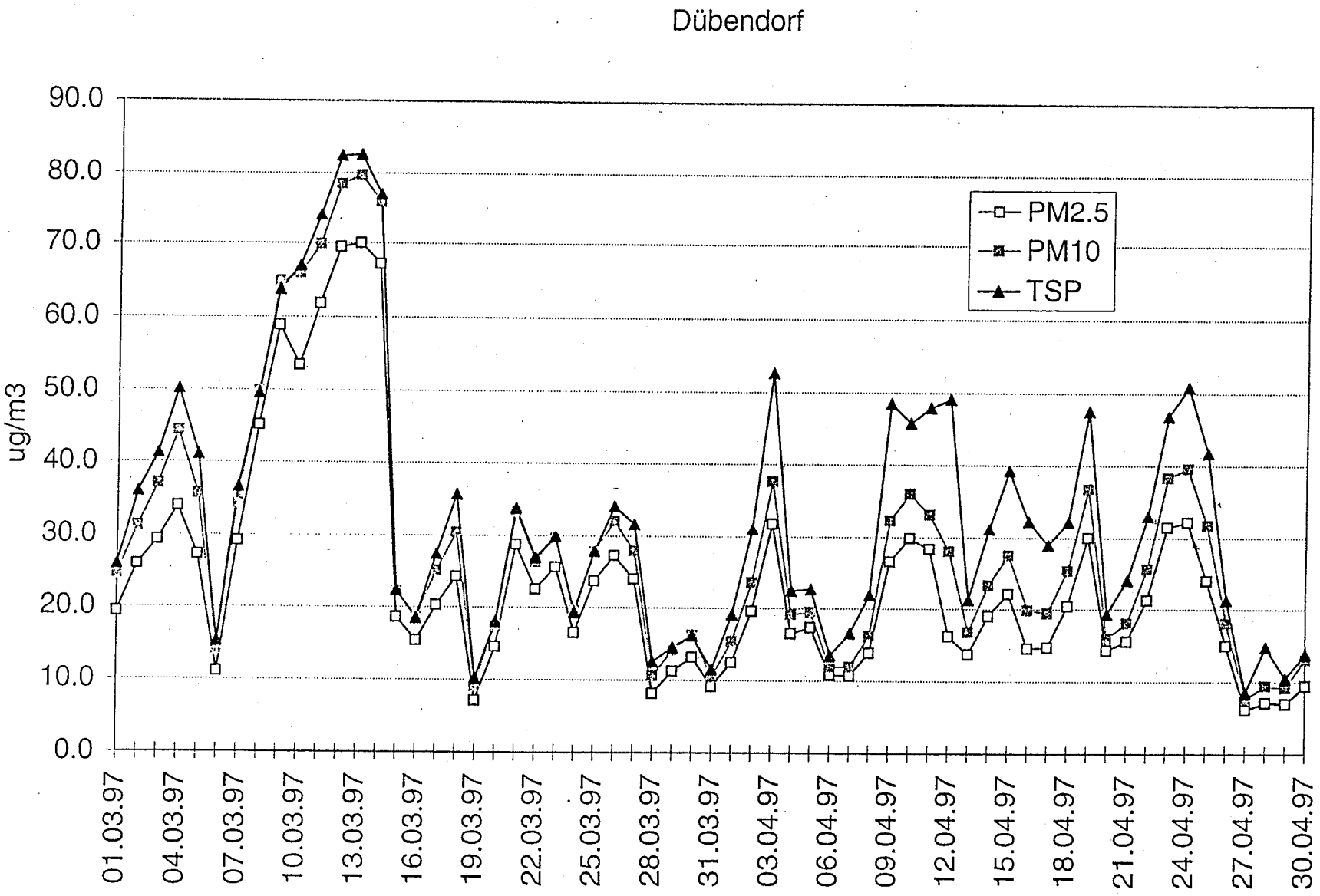

Dübendorf
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
ug/m3
PM2.5
PM10
TSP
01.03.97
04.03.97
07.03.97
10.03.97
13.03.97
16.03.97
19.03.97
22.03.97
25.03.97
28.03.97
31.03.97
03.04.97
06.04.97
09.04.97
12.04.97
15.04.97
18.04.97
21.04.97
24.04.97
27.04.97
30.04.97

Figure 3

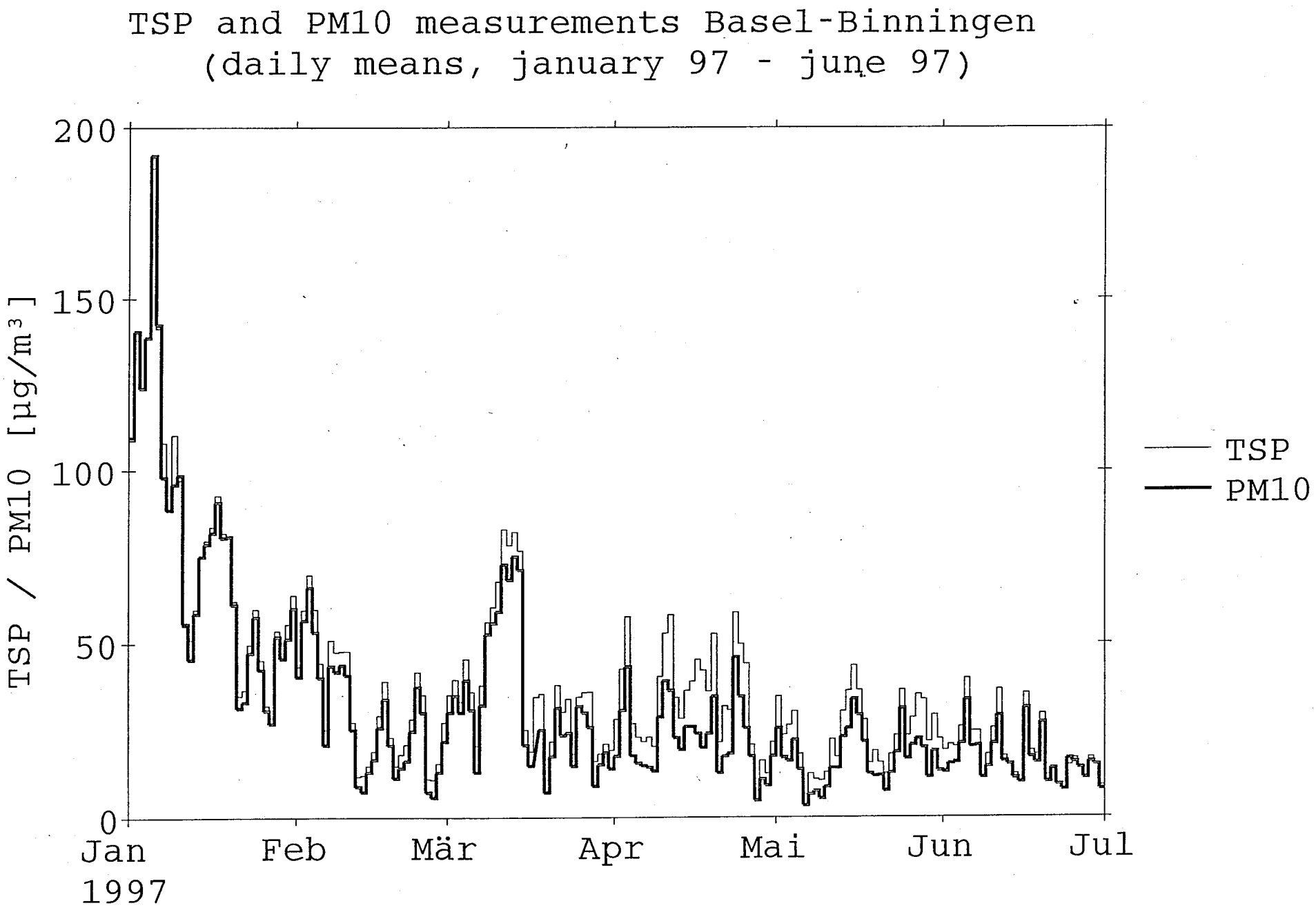
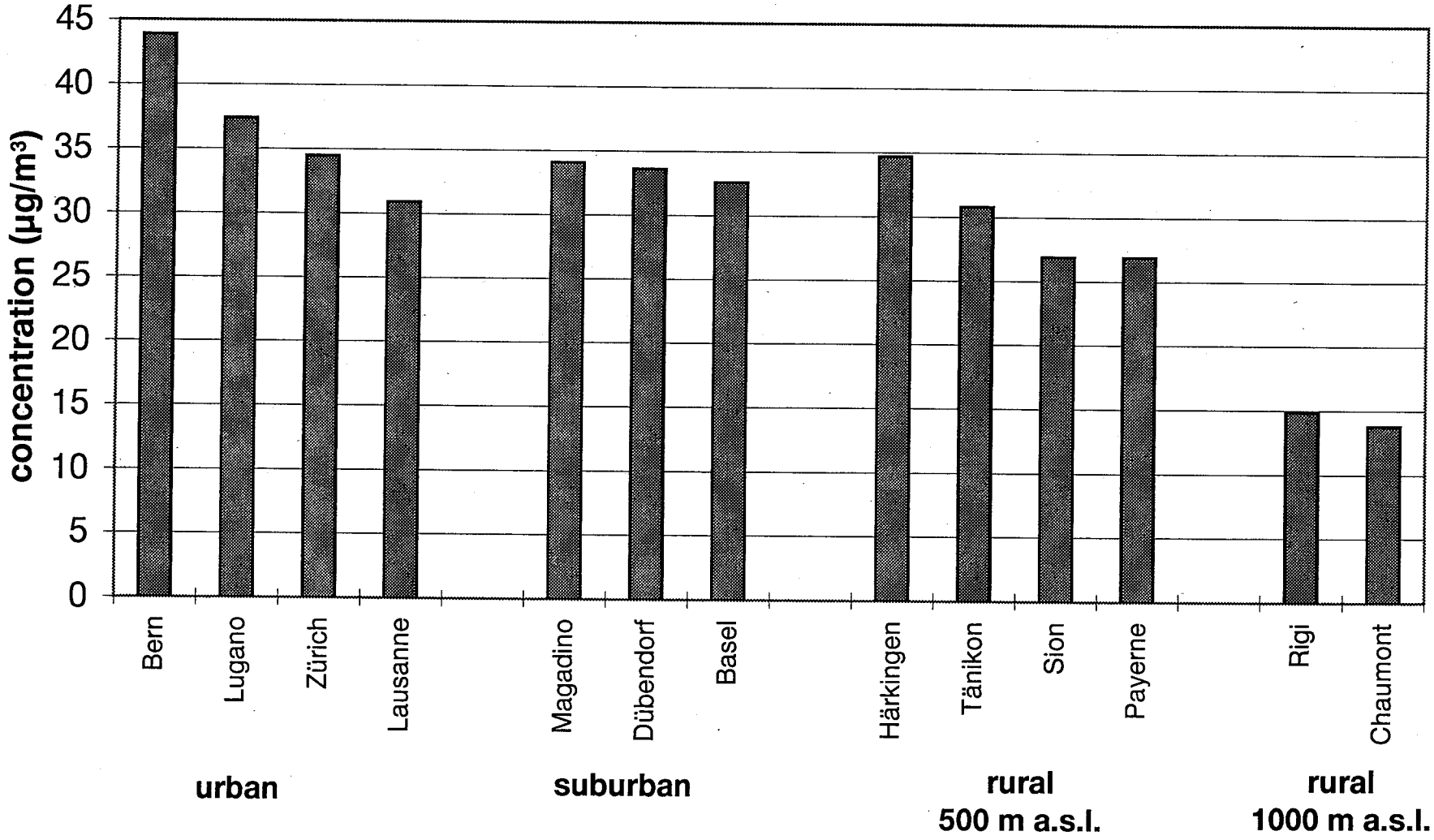

TSP and PM10 measurements Basel-Binningen
(daily means, january 97 - june 97)
TSP / PM10 [µg/m³]
200
150
100
50
0
Jan
1997
Feb
Mär
Apr
Mai
Jun
Jul
TSP
PM10

Figure 2

National Air Pollution Observation Network (NABEL)

PM10 concentrations (01.97 - 06.97)

(measurements by high volume samplers)



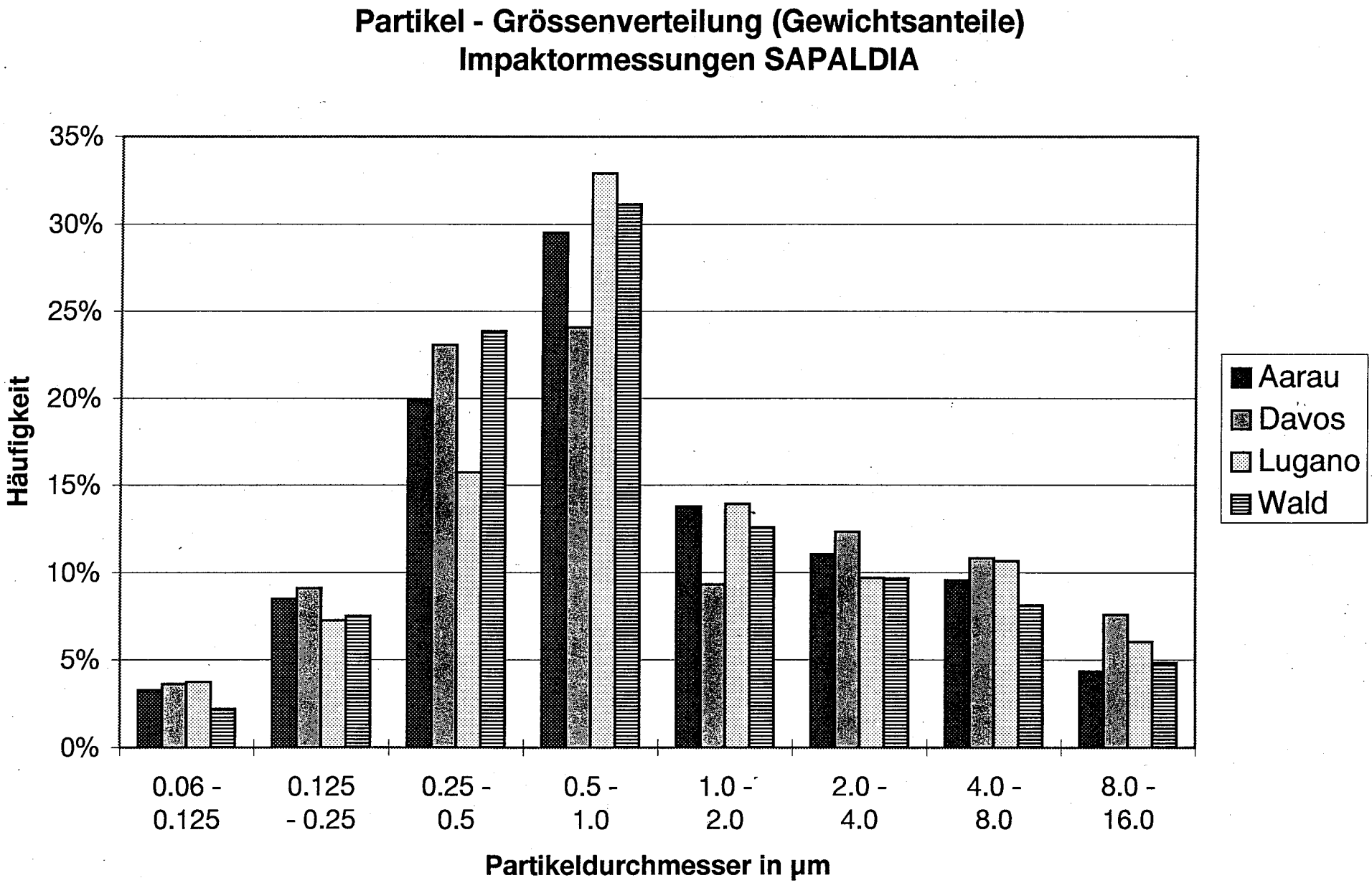
Proposed PM10 Air Quality Standards in Switzerland

(Recommendation of the Swiss Federal Commission on Air Hygiene)

20 µg/m^3	**annual average**
50 µg/m^3	**24-hr-average, may be exceeded only once per year**

see report: Schwebestaub - Messung und gesundheitliche Bewertung (BUWAL Schriftenreihe Umwelt Nr. 270; available in german and french)

Figure 5


Partikel - Grössenverteilung (Gewichtsanteile)
Impaktormessungen SAPALDIA
35%
30%
25%
20%
15%
10%
5%
0%
Häufigkeit
0.06 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 8.0
8.0 - 16.0
Partikeldurchmesser in µm
Aarau
Davos
Lugano
Wald

Definitionen

Russ umfasst alle primären partikelförmigen, kohlenstoffhaltigen Produkte eines unvollständigen Verbrennungsprozesses (elementarer Kohlenstoff und organische Verbindungen)

Gesamter Kohlenstoff (Total Carbon, TC) ist die Summe aller Kohlenstoff-verbindungen (ohne Carbonate) als C [µg/m^3] berechnet

Elementarer Kohlenstoff (Elemental Carbon, EC) ist nicht löslich und in einer inerten Atmosphäre bis 650 °C stabil. EC und BC bezeichnen im Idealfall dieselbe Fraktion des partikelförmigen Kohlenstoffes, die Unterscheidung bezieht sich einzig darauf, ob der Anteil optisch (BC) oder thermisch (EC) gemessen wird.

Schwarzer Kohlenstoff (Black Carbon, BC) ist der lichtabsorbierende Anteil des Aerosols

Organischer Kohlenstoff (Organic Carbon, OC) ist die Summe aller organischen Kohlenstoffverbindungen als C [µg/m^3] berechnet

Figure 7

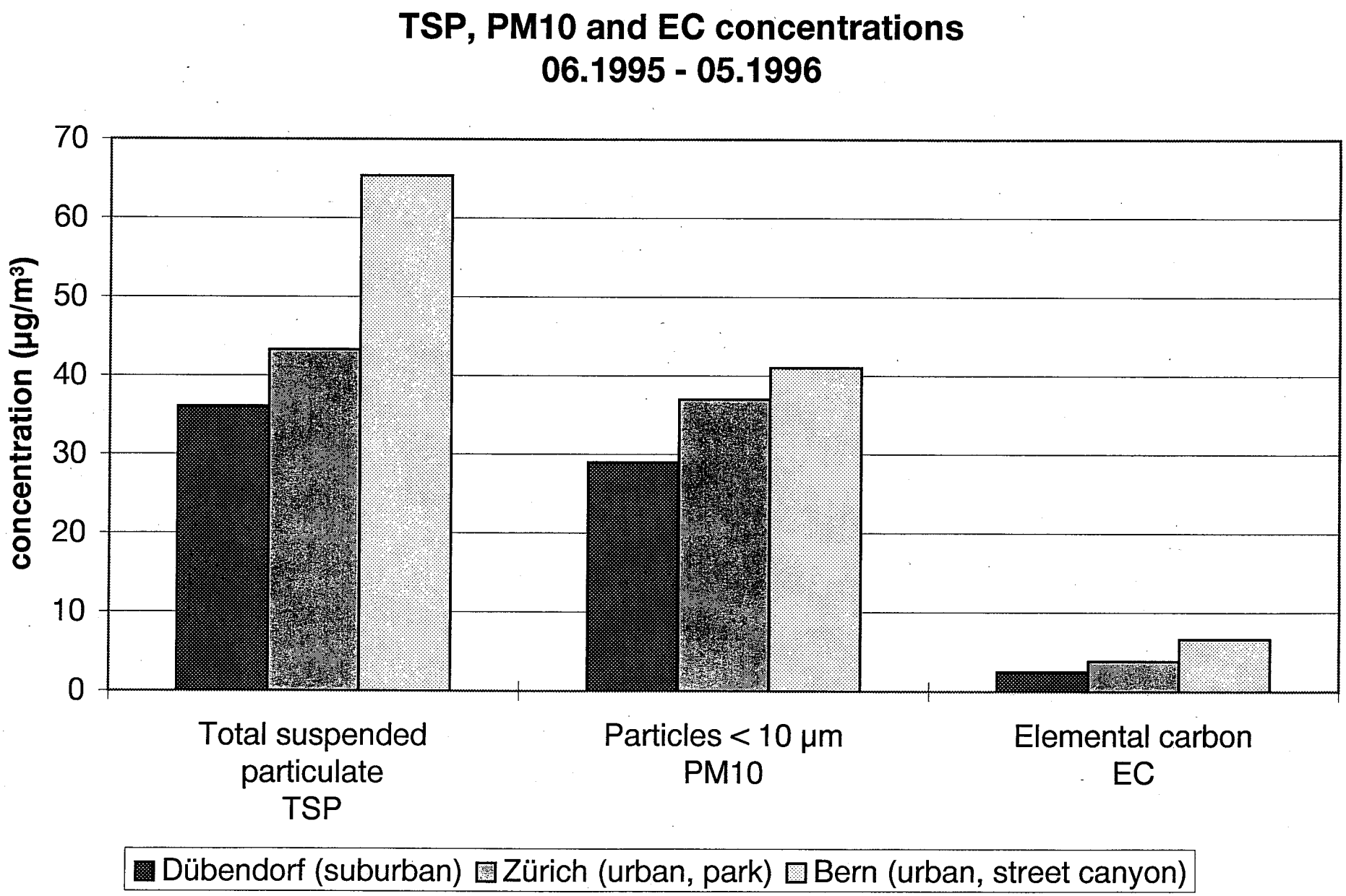

TSP, PM10 and EC concentrations
06.1995 - 05.1996
concentration (µg/m³)
70
60
50
40
30
20
10
0
Total suspended particulate TSP
Particles < 10 µm PM10
Elemental carbon EC
Dübendorf (suburban)
Zürich (urban, park)
Bern (urban, street canyon)

Figure 8

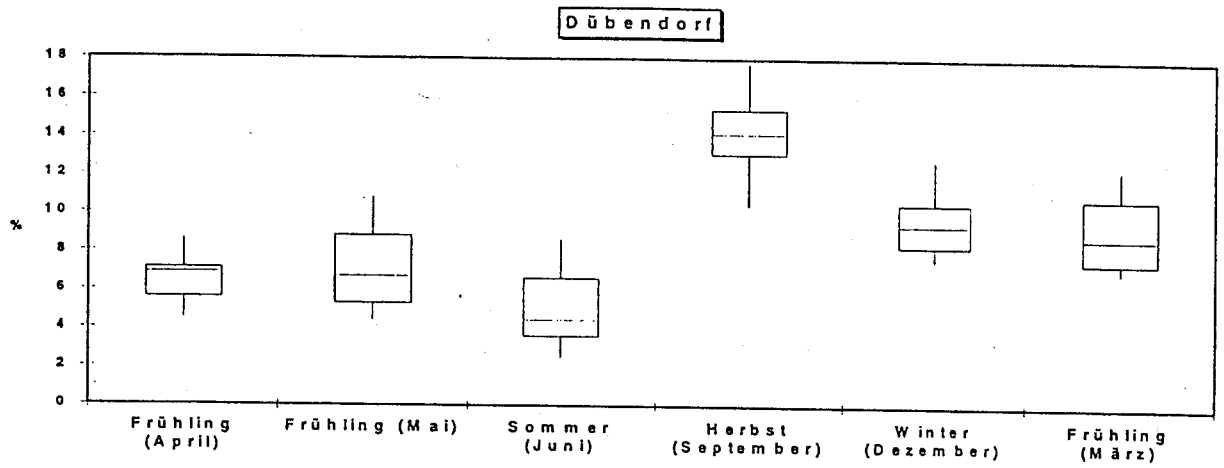


Abb. 54: Prozentualer Anteil von EC an der PM10-Schwebstaubkonzentration in Dübendorf.

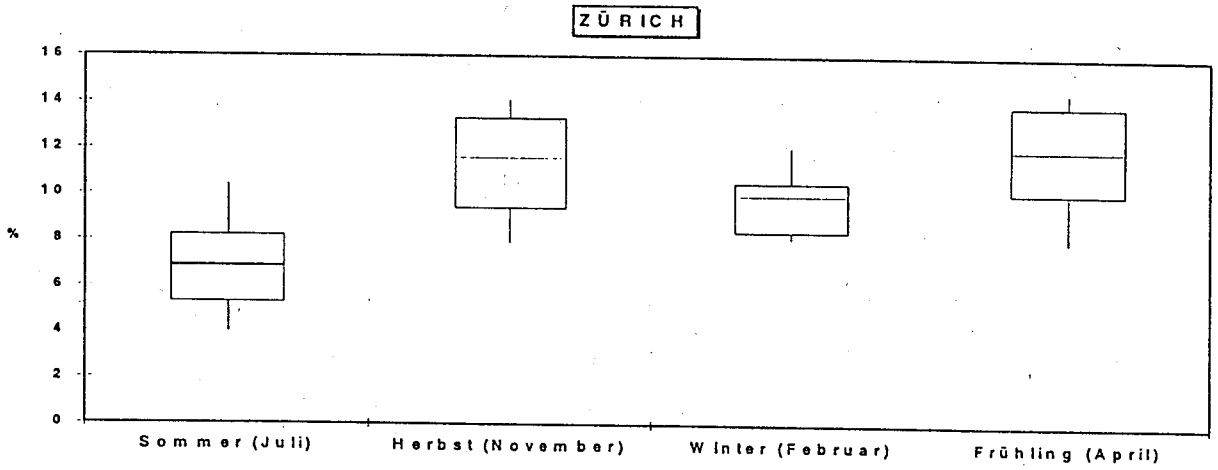


Abb. 55: Prozentualer Anteil von EC an der PM10-Schwebstaubkonzentration in Zürich.

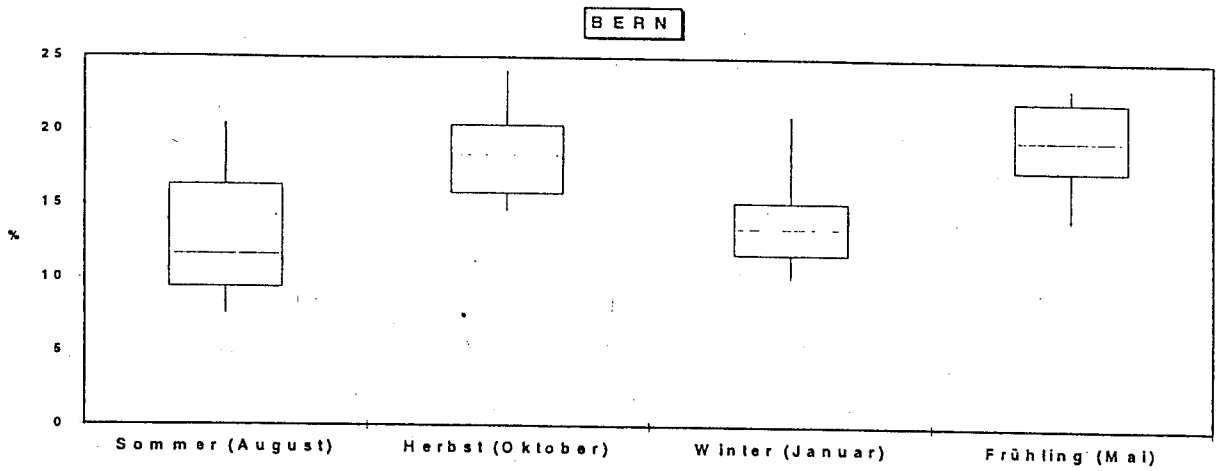
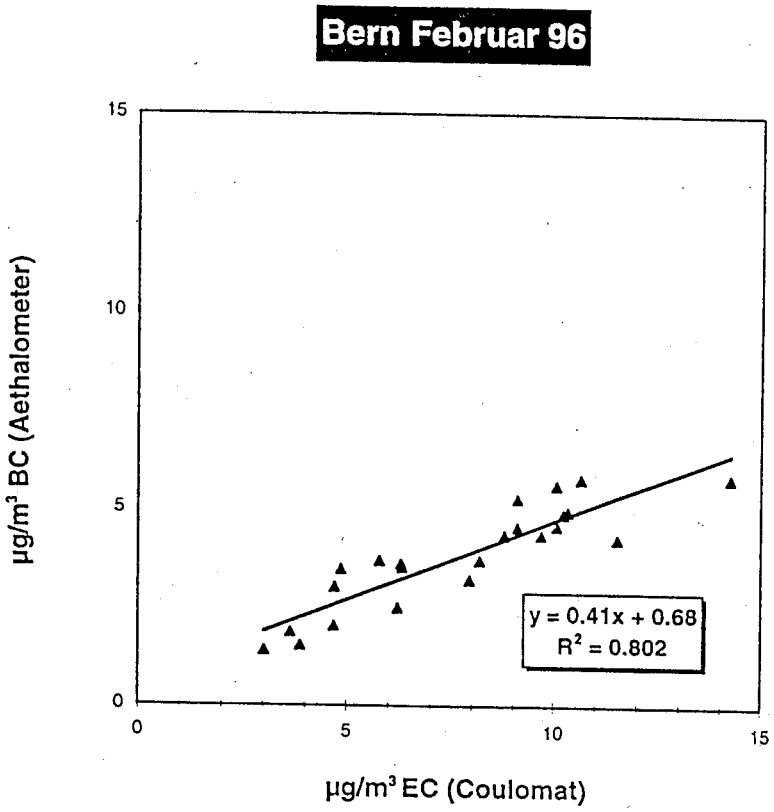


Abb. 56: Prozentualer Anteil von EC an der PM10-Schwebstaubkonzentration in Bern.

Figure 9



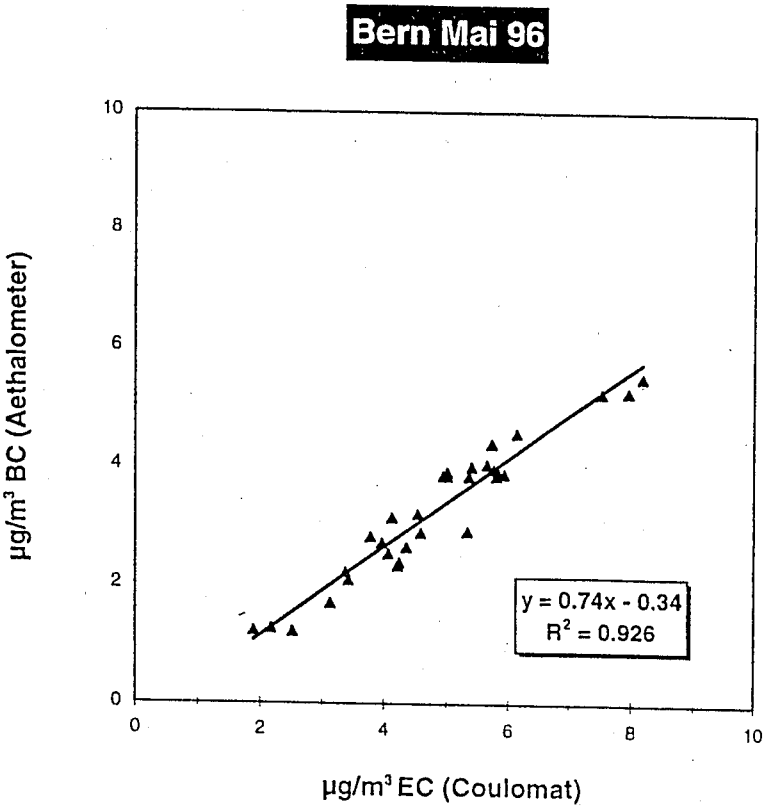


Abb. 16: Vergleich der 24h-Mittelwerte der Grössen EC (Referenzverfahren) und BC (Aethalometer) am Standort Bern im Februar 96 (oben) und im Mai 96 (unten).

PM10 - Zusammensetzung Payerne (rural)

(Schätzung 95-96)