

Time variation of the dust concentration and deposition in Sofia during the period 1981-2002

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Introduction

Dust or total suspended particulate matter in the atmosphere is one of the main pollutants of the urban air together with nitric oxides, sulfur dioxide, ozone and lead. The pollution of Sofia city with dust is due to two main factors: 1) the presence of many and various types and capacity sources of air pollutants, (see General Structural Plan of Sofia. Stage ??? Part: Ecology. "Softproect". May 2002) and 2) local meteorological conditions and microclimate. Sofia is situated in a mountain valley, where calm weather conditions and temperature inversions are observed during the considerable part of the year, Blaskova et al. (1983), Branzov et al. (1992), Andreev et al., (2004a). The results of one of the field investigations of the air quality in Sofia region, carried out in 1982, showed that the maximum in averaged dust concentration is observed in the central part of the city on the direction northeast-southwest, Andreev (1982). The results discussed in the present work are based on measurements at NIMH, placed in the eastern part of Sofia.

Concentration

The samples for total suspended particulate matter (TSP) are collected on nitrocellulose Synpor filters during the 24-hours period at high of 2m above the grass covered ground. The samples are changed every day at 6:00 UTC. The volume of the passed air is measured by flow-meter. The dust concentration is measured gravimetrically. Because the main purpose of this sampling program is monitoring of the gross beta radioactivity of the atmospheric aerosol, the efficiency of retention of the filters for short lived beta emitters is estimated as > 95% .

Deposition

Dust deposition is also collected and measured for every 24-hours period. Deposition samples are collected in a standard container with a bottom covered with distilled water at 1m high over the grass covered ground at approximately 400m distance from the TSP sampling point. An aliquot of 0.5l is evaporated to few ml, quantitatively transferred to an aluminum plate and evaporate to dryness. The dust deposition is measured gravimetrically in the same laboratory. This system allows to obtain long-term series of diurnal values, with no analog from other Bulgarian data sets. Andreev et al., (2004b). There is no change in the sampling point placement and sampling methodology during the years and the number of missing values is very low with exception of the period March 1989 – January 1990.

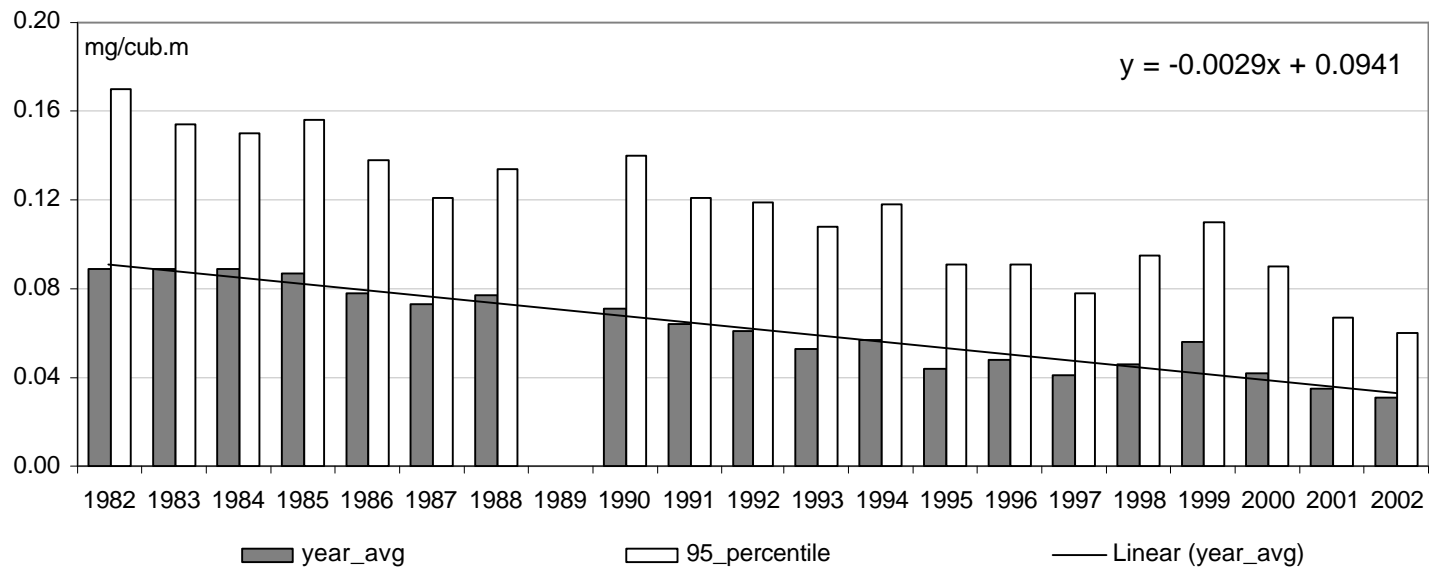


Fig.1. Yearly mean concentration of dust and its 95 percentile in the surface air in Sofia, NIMH station, during the period 1982-2002..

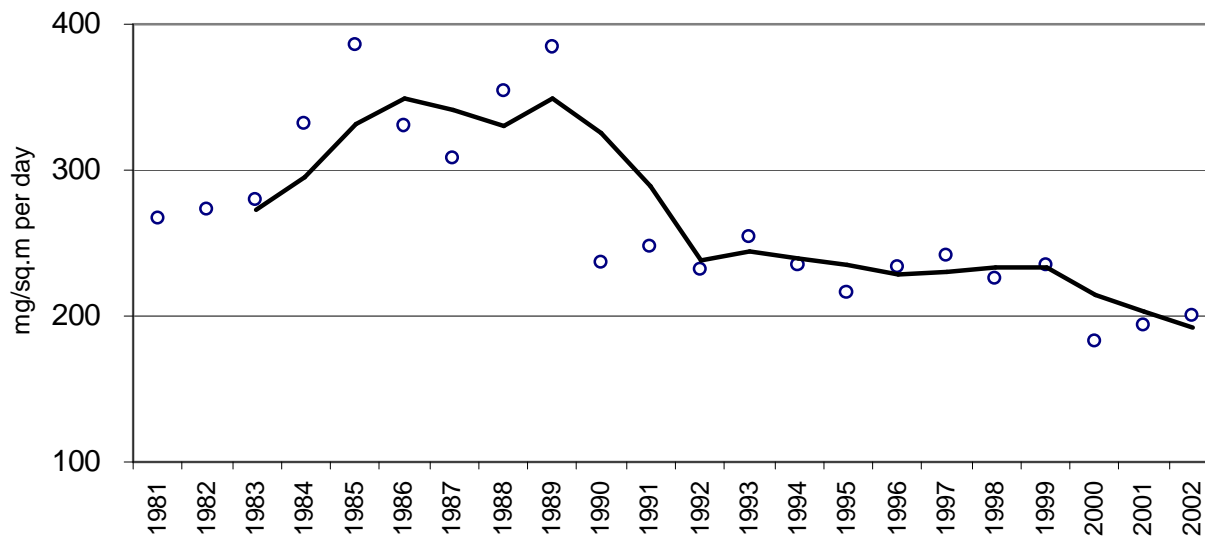
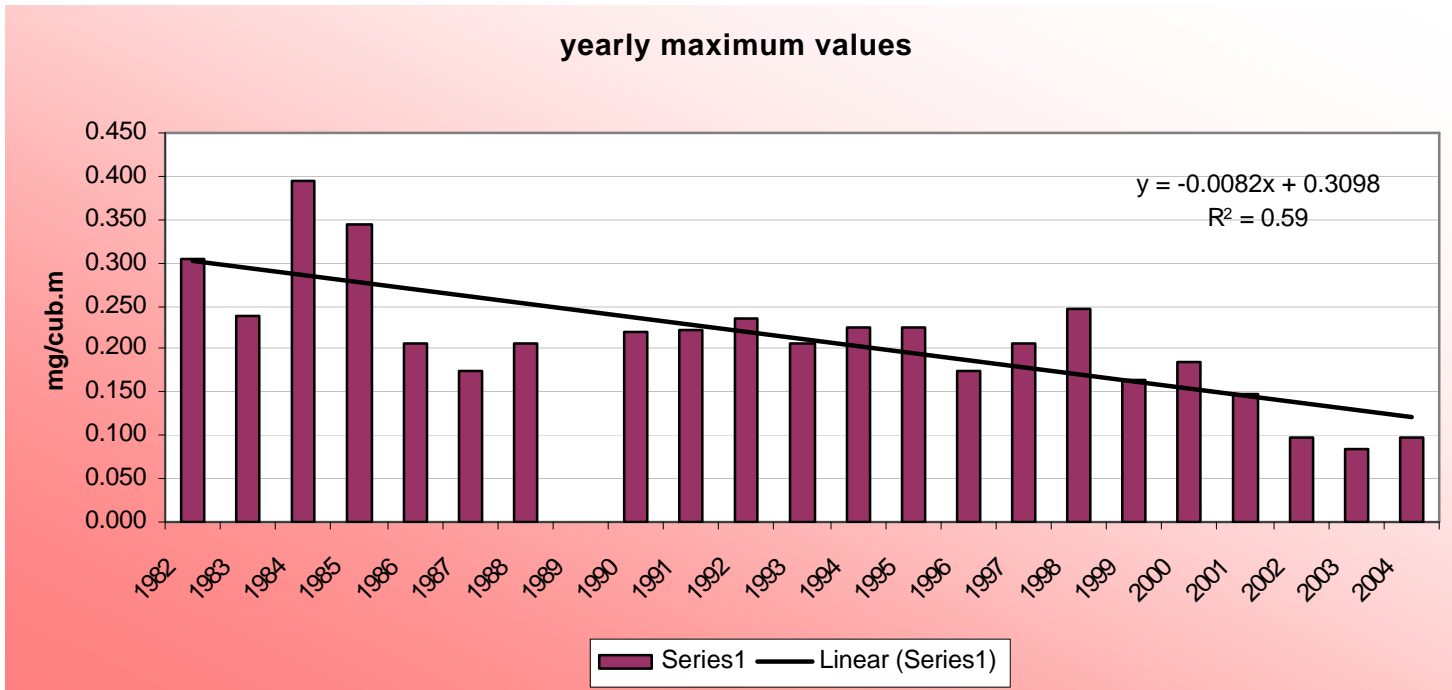


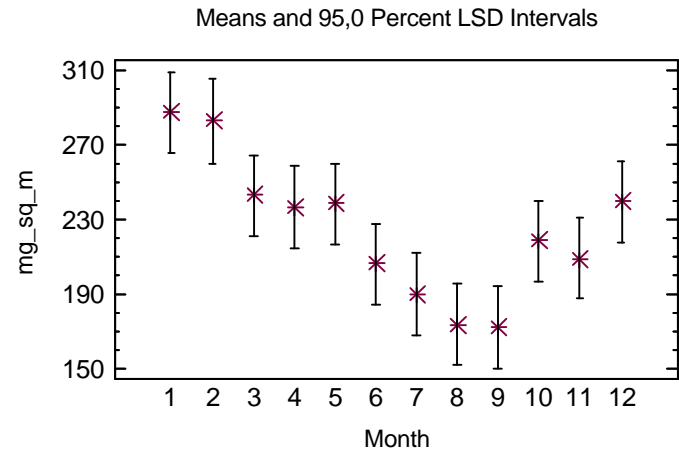
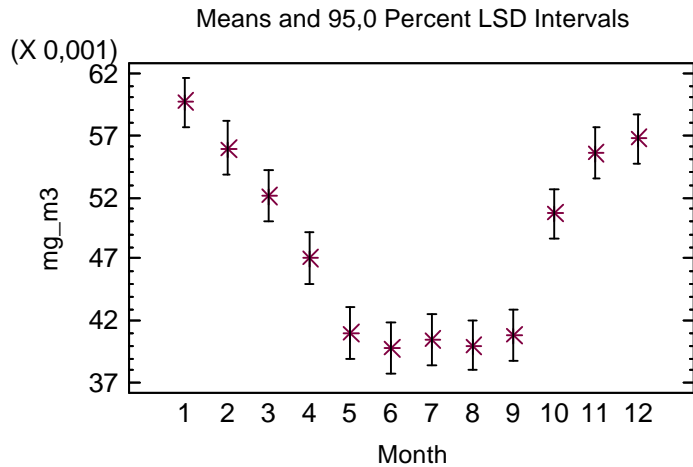
Fig. 2. Yearly mean dust deposition values in mg.m⁻².day⁻¹ (dots) and moving average (line) during the period 1981-2002.

(BG limit for yearly averaged values - 350 mg.m⁻².day⁻¹)

Two different periods could be distinguished 1981-1990 and 1991-2002. Yearly deposited dust vary from 66,7 t/km² (year 2000) to the maximum of 140.6 t/km² (1985).

Yearly maximum values of dust concentration





?)

b)

Fig.3 Dust averaged monthly concentration ?) and deposition b) and 95% confidence interval (Fisher's least significant difference) in the surface air of Sofia, 1991-2002..

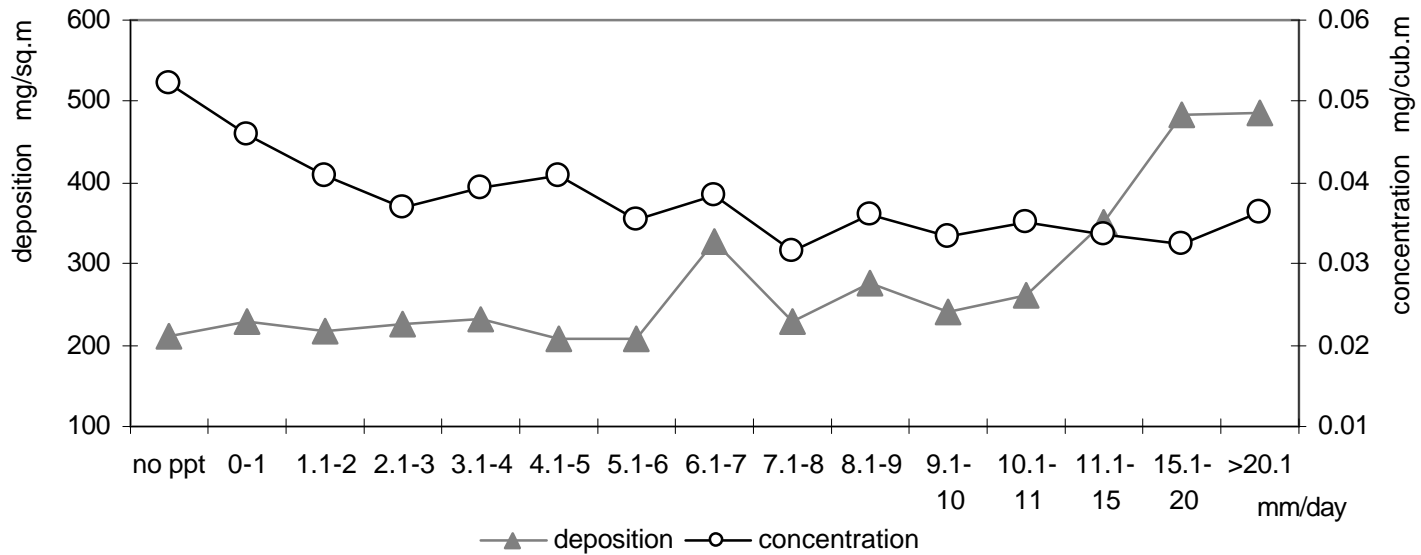


Fig.4. Average dust concentration and deposition over the gradation of 24-hours precipitation quantities in Sofia, NIMH station, years 1991-2002.

For the Sofia valley the driest year during the 20th century is 2000. During the dry year 1985 the highest mean annual dust deposition – 385.2 mg.m-2.day-1 is registered and the maximum mean annual concentration of 0.087 mg/m3 is close to 0.089 mg/m3 (the maximum measured in the period 1982-1984).

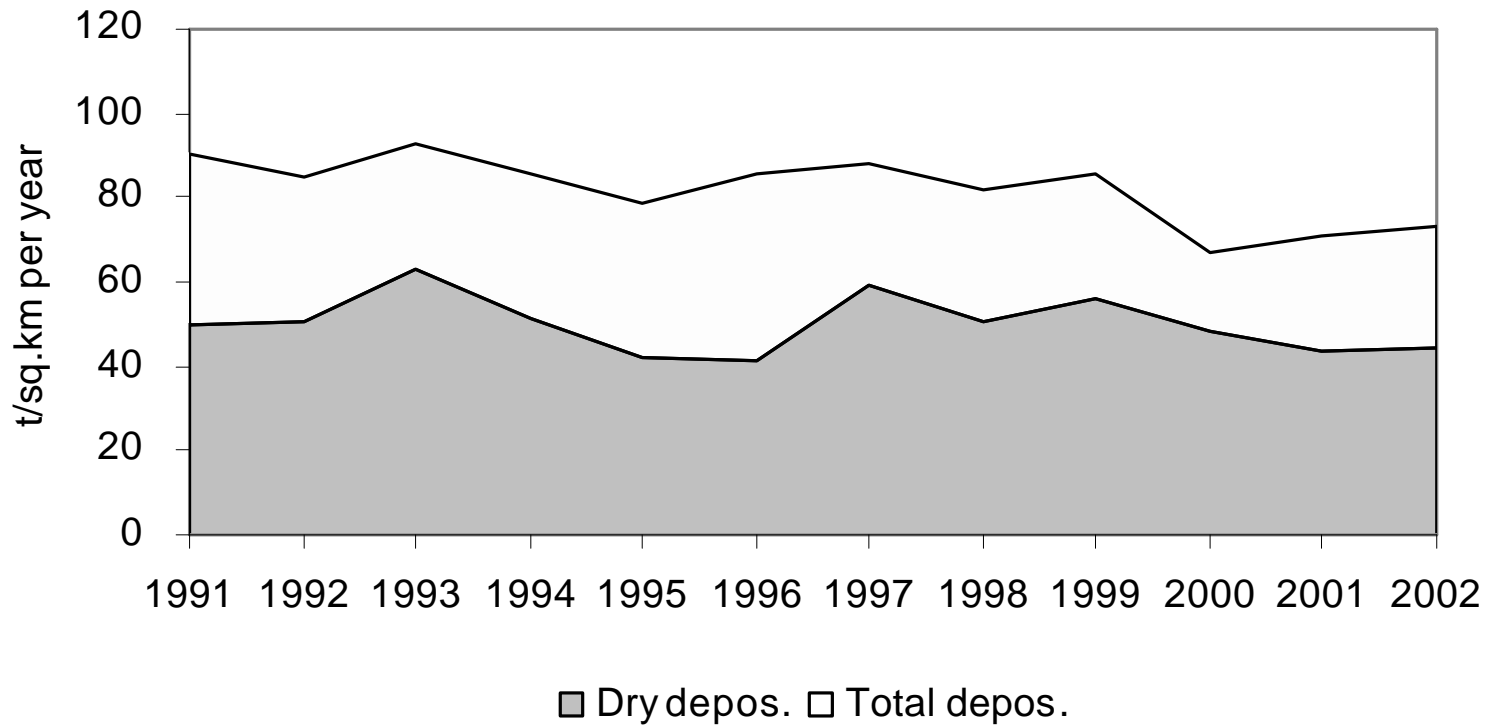


Fig. 5. Yearly deposited dust, upper line in $t.km^{-2}.y^{-1}$ and the part due to dry deposition (grey area).

The attempt to evaluate the impact of different dust sources was done based on the concentrations during working days and weekend, when the intensity of auto-transport is sufficiently lower. Averaged over the days of the week values rises from lowest value on Sunday - 42.0 $\mu\text{g}/\text{m}^3$ to 50.6 $\mu\text{g}/\text{m}^3$ on Thursday and Friday. Fisher and Kruskal-Wallis tests show statistically significant difference between mean and median of the distributions. The difference in concentrations during the working days and weekend suggested that 15-20% of the air pollution with dust is due to the intensive auto-transport in the region of sampling.

When comparing the level of TSP in Sofia and other European cities for the year 1993 it appears that TSP in the sought-eastern part of Sofia is somewhere in the middle of the scale (Air Quality in Europe, 1993 - A Pilot Report, EU 1995). In about of 50% of the cities of Denmark, Finland, Germany, Portugal, Czech Republic, Slovakia and Spain the measured maximum of 24-hours TSP concentration in 1993 exceeded the observed maximum of 0.208 mg/m^3 at NIMH, Sofia.

The tendency of decrease of the level of pollution of TSP is reported for some regions in Germany, Switzerland and Belgium and it is interesting to note that often the maximum in mean yearly concentrations were observed during the period 1982-1985.

Conclusions

The tendency of decrease of dust concentration and deposition levels at station of NIMH, Sofia is shown during the period 1981-2002, in connection with some variation in meteorological conditions and with change in type and capacity of the sources of emissions.

The annual change in mean monthly concentration presents distinguished maximum during the cold period of the year, from November to February and minimum during the period May-September. During the summer months the minimum of dust deposition is also observed.

The rough estimation for the impact of the auto-transport suggests that approximately 15-20% of the pollution with atmospheric suspended matter is due to this source.

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