Application of Dispersion Modelling for Analysis of Particle Pollution Sources in a Street Canyon

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1. Introduction

The dominating source of particles in urban air is road traffic. However, the main contribution from traffic is within the range of ultra-fine particles, i.e. particles of a diameter less than ca. 100 nm [Wåhlin 2001a, 2001b].

For these particles the dispersion conditions are expected to be like for gases and therefore the particle concentrations in a street canyon can be calculated using dispersion models developped for gaseous pollutants.

Analysis of these measurements by application of the Operational Street Pollution Model (OSPM) [Berkowicz, 1996] is presented here.

Previously, the particle measurements were analysed using receptor modelling [Wåhlin 2001a, 2001b] and the relative contribution from diesel and petrol vehicles was determined. The dependence on wind was neutralised by using a ratio particle/gas.

Using meteorological dispersion models the absolute source contribution to particle pollution can be determined.

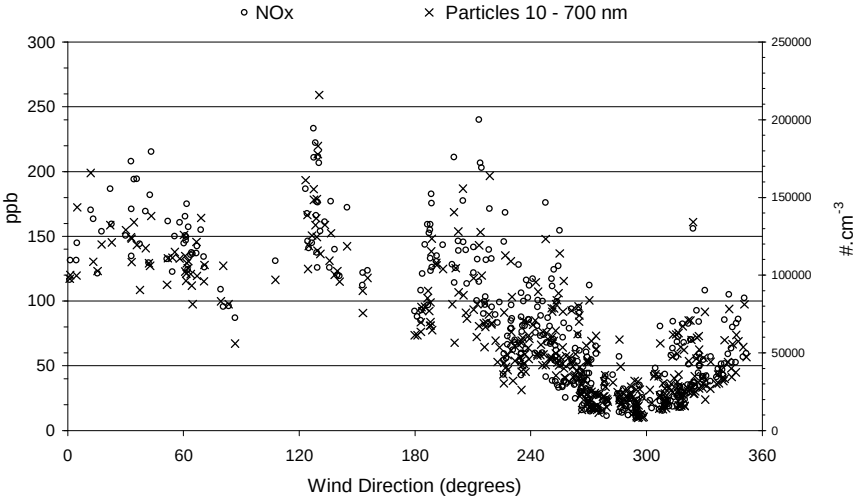

Figure 3.1 NO_x and total particle concentration versus wind direction - Jagtvej winter 1999

2. Methodology

Two extensive measuring campaigns (January - March 1999 and January - March 2000) were conducted in the street Jagtvej in Copenhagen, Denmark. During these campaigns the particle size distributions were measured by a Differential Mobility Analyser (DMA) providing high time resolution data (½ hourly) on a continuous basis. Simultaneously with these measurements also

measurements of NO_x and CO were available. The meteorological data were provided from a nearby meteorological mast.

3. Results and Discussion

3.1 Dilution properties

Pollution measurements performed at the street sites exhibit a pronounced dependence on meteorological conditions. The observed dependence of concentrations on wind is an indirect manifestation of formation of a wind vortex in the street canyon.

Particle measurements in the Jagvej station present the same dependence on wind speed and wind direction as CO and NO_x (figure 3.1).

The direction of the Jagvej street is about 30° and the station is on the East side: in consequence the clean part of the vortex corresponds to direction 300° and the polluted part to direction 120°. The effect of clean sector appears to be particularly evident on figure 3.1

3.2 Calculation of the dilution

A street pollution dispersion model, the Operationel Street Pollution Model (OSPM), has shown to give a satisfactory description of the air gas pollutant dispersion in urban street [Berkowicz, 1996].

On the base of the meteorological data basis, it calculates the fraction of pollution arriving on the sample point ($F_{meteorology}$). On the opposite, it is possible to calculate the emission of pollutant (Q), from the measurements (C and $C_{background}$):

$$Q = \frac{C - C_{background}}{F_{meteo}} \qquad (1).$$

The total Emission Q is calculated using linear regression (e.g figure 3.2). It has to be noted that $C_{background}$ for particles has not been measured.

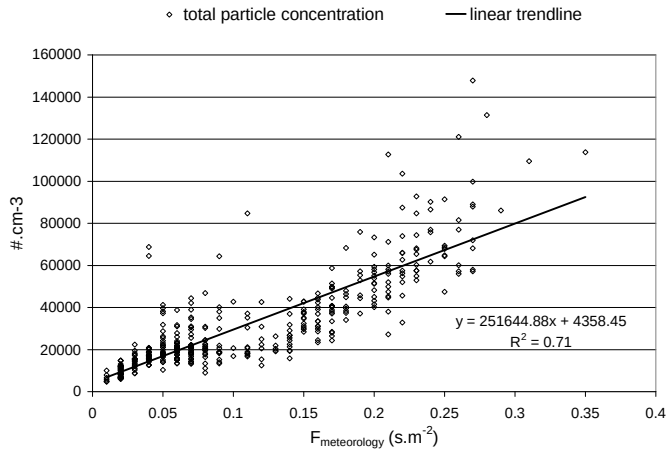

Figure 3.2 Total concentration of particles versus $F_{meteorology}$ – Jagtvej winter 2000

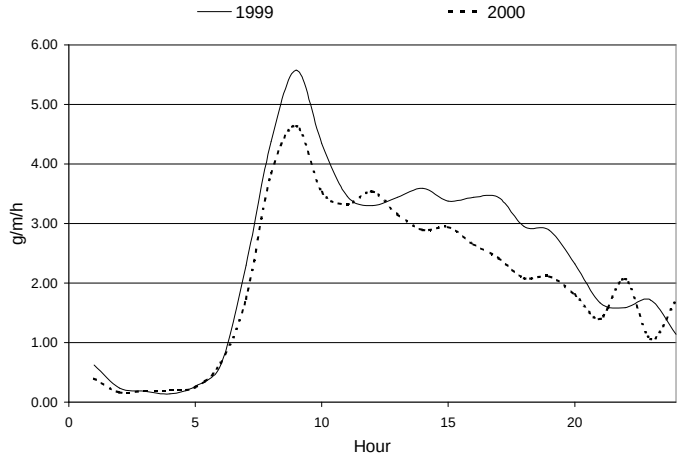

Figure 3.3 Daily total emission of NO_x – working days – winter 1999 and 2000

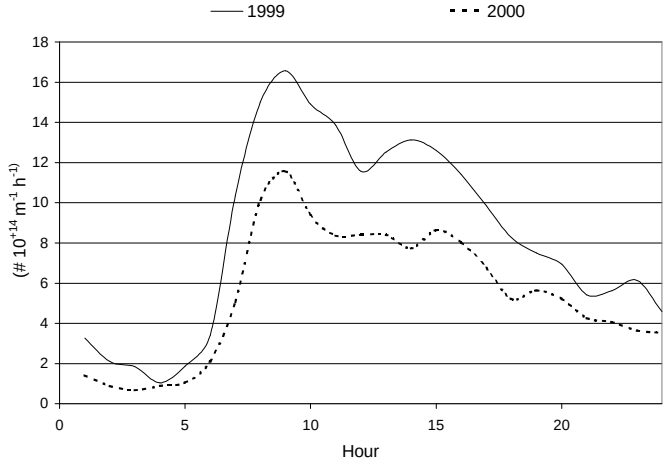

Figure 3.4 Daily total emission of particles – working days – winter 1999 and 2000

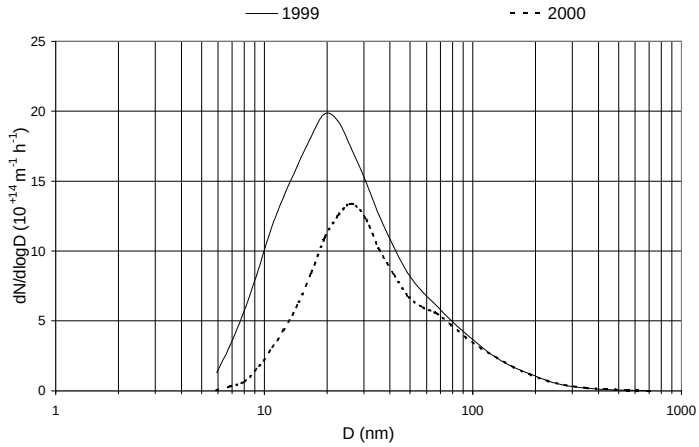

Figure 3.5 Size distribution of the total emission of particles – working days, 11:00 – winter 1999 and 2000

The results for particles are well correlated with gas measurements and traffic. The daily total emissions of NO_x are similar from winter 1999 to winter 2000 (Figure 3.3).

Figures 3.4 and 3.5 compare the 1999 and 2000 campaigns for particles. We observe a decrease of the concentration and a shift to the larger diameters; that is in accordance with the previous results [Wåhlin, 2001b].

We intend to use this method for detailled evaluation of particle emissions from traffic.

4. References

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5. Acknowledgements

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