Calculation of person-weighted average concentrations of NO_2, PM_{10} and $PM_{2.5}$ in Oslo for 1992-2002

S.E. Walker †, P. Rosland ‡
† Norwegian Institute for Air Research (NILU)
‡ Norwegian Public Road Administration (NPRA)

Introduction

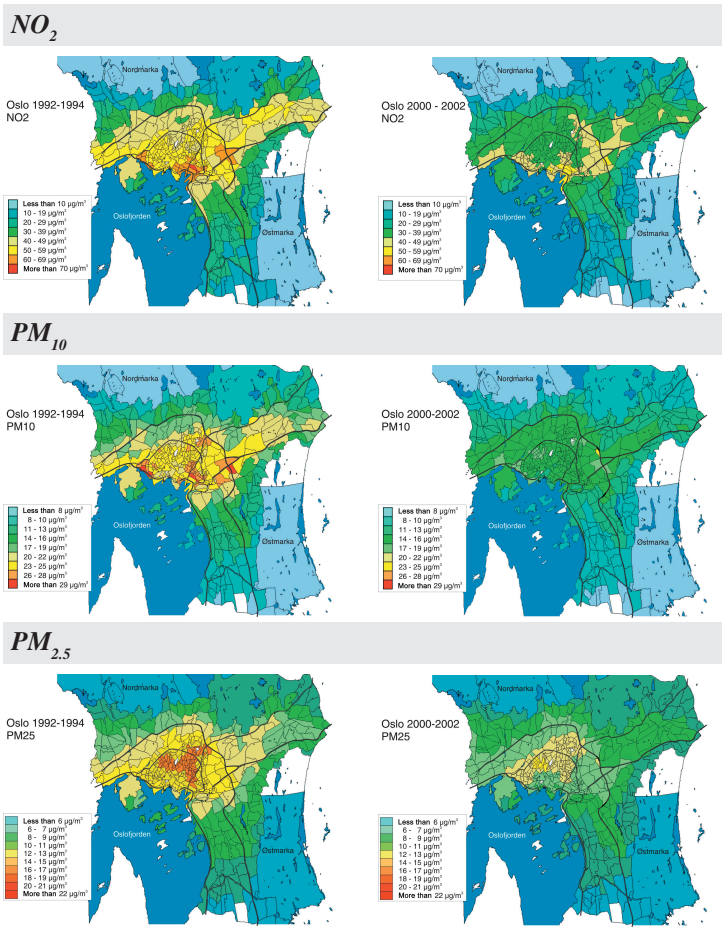
Person-weighted average concentrations of NO_2, PM_{10} and $PM_{2.5}$, for different averaging periods from 1 hour up to 3 years, have been calculated for all the 429 smallest administrative geographic areas of Oslo for the period 1992 – 2002. The calculations are based on NILUs AirQUIS system using a 22 x 18 km^2 Eulerian grid model, with sub-grid scale line source modelling of concentrations at buildings close to streets in Oslo with high traffic load (*McInnes, 2004; Denby, 2004; Slørdal et al., 2003*).

Building points and administrative areas

The AirQUIS database contains up to 8275 building points for the period 1992-2002 depending on the year. For each building point the system stores the number of persons associated with the point as home address. Only active building points are selected as receptor points in the dispersion calculations. These are points which lies close to streets with heavy traffic, and for which sub-grid scale models are used to calculate concentration values. For the other building points only km^2 grid concentrations are used. The number of active building points varies from 3813 in 1992 to 8009 in 2002. The total number of persons living in Oslo is approximately 500 000. The number of persons belonging to building points in the database varies from 63 176 (1992) to 77 814 (2002), while the rest population in the areas varies from 444 291 (1992) to 429 653 (2002).

Emissions

The AirQUIS database contains emissions from traffic in the period 1992-2002 consisting of approximately 1900 individual line sources with data such as location, elevation, width, annual average daily traffic, percentages of different light and heavy duty vehicles etc. The time variations of traffic during each day is partly based on countings at the main roads in Oslo. The percentage of vehicles with studded tyres in the winter season (15 Oct. – 23 Apr.) is set separately for each year based on data from the NPRA. It varies from 81% in 1992 to 32% in 2002. Studded tyres contributes significantly to the resuspension of PM_{10}. In addition to traffic, home heating based on wood- and oil-burning is the main source of air pollution in Oslo.



Person-weighted 3-year average concentrations of NO_2 (top) PM_{10} (middle) and $PM_{2.5}$ (bottom) for all the smallest administrative geographic areas of Oslo for 1992-94 (left) and 2000-02 (right). Unit: µg/m^3.

Meteorology and boundary conditions

The meteorological data are based on observations from the stations Valle Hovin, Blindern and Nordahl Brunsgt. in Oslo and consists of data for wind speed, direction, temperature and vertical temperature gradient (stability), and in addition precipitation and relative humidity. The last two parameters are mainly used as input for the PM_{10} emission calculations. A topographically based wind field model (MATHEW) is used to generate the wind fields. Background concentrations are based on observations at stations Prestebakke, Birkenes, Nordmoen, Hurdal and Jeløya in South-Norway.

Calculation of person-weighted averages

Person-weighted average concentrations in the administrative areas of Oslo is calculated by the following formula:

$$\overline{C_a} = \frac{1}{N_a}\left\{\sum_{b=1}^{nb} N_b \cdot C_b + \sum_{r=1}^{nr} N_r \cdot C_r\right\} \quad (1)$$

where N_g represents the total number of persons in the area, N_b og N_r are the number of persons associated with building point b and a random point r in the area respectively, and C_b and C_r represents hourly average concentrations in the same points. The random points are distributed in a uniform way within each area using a random draw procedure. The density of this point distribution is 1 per 100 x 100 m^2. The concentration values in these points are taken from the gridded concentration values. In the expression (1), nb represents the number of building points and nr the number of such additional random draw points within the area. Building point concentrations are taken from either the grid model concentration values or the corresponding sub-grid scale receptor point concentrations. If the building point lies outside the buffer-zones around the roads with most traffic, the concentration value is set equal to the corresponding model grid value. Otherwise the sub-grid scale calculated building point concentration is used. The hourly values for each area are summed and averaged in the form of 3-year average concentrations, first for the period 1992-1994, then for 1993-1995, etc., until the last 3-year period 2000-2002.

Results and conclusion

The results generally show that the person-weighted 3-year average concentration level declines throughout the period for all components., which is in accordance with earlier results indicating a similar trend (McInnes, 2004).

Observational data from monitoring stations in Oslo shows that for some areas, and over short averaging periods (hours and days), there exists quite high levels of air pollution during the winter season (*Oslo Department of Public Health, 2004*), with several exceedances of the limit values, to be reached for the years 2005 and 2010, especially at stations situated close to main roads. Our results do not focus on such hot-spots. Instead they describe the average concentration over the administrative areas taking into account where people live. The resulting database of person-weighted concentrations is useful for epidemiological studies of mortality and other health related issues of air pollution exposure in Oslo.

References

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