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Variability of levels of PM, black carbon and particle number concentration in selected European cities

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In many large cities of Europe standard air quality limit values of particulate matter (PM) are exceeded. Emissions from road traffic and biomass burning are frequently reported to be the major causes of such exceedances. As a consequence of these exceedances a large number of air quality plans, most of them focusing on traffic emissions reductions, have been implemented in the last decade. In spite of this implementation, a number of cities did not record a decrease of PM levels. Thus, is the efficiency of air quality plans overestimated? Or do we need a more specific metric to evaluate the impact of the above emissions on the levels of urban aerosols?
This study shows the results of the interpretation of the 2009 variability of levels of PM, black carbon (BC), aerosol number concentration (N) and a number of gaseous pollutants in seven selected urban covering road traffic, urban background, urban-industrial, and urban-shipping environments from southern, central and northern Europe.
The results showed that variation of PM and N levels does not always reflect the variation of the impact of vehicle exhaust emissions on urban aerosols. However, BC levels vary proportionally with those of traffic related gaseous pollutants, such as CO and NO2 and NO. Due to this high correlation, one may suppose that monitoring the levels of these gaseous pollutants would be enough to extrapolate exposure to traffic-derived BC levels. However, the BC/CO, BC/NO2 and BC/NO ratios vary widely among the cities studied, as a function of distance to traffic emissions, vehicle fleet composition and the influence of other emission sources such as biomass burning. Thus, levels of BC should be measured in air quality monitoring sites.
During traffic rush-hours, a narrow variation of primary road traffic N/BC ratios was evidenced, but a wide variation of this ratio was determined for the noon period. Although in central and northern Europe N and BC levels tend to vary simultaneously, not only during the traffic rush hours but also during the whole day, in southern Europe maximum N levels coinciding with minimum BC levels are usually recorded at midday. These N maxima recorded in southern European urban background environments are attributed to midday nucleation episodes occurring when gaseous pollutants are diluted and maximum insolation and O3 levels occur. The occurrence of SO2 peaks may also contribute to the occurrence of midday nucleation bursts in specific industrial or shipping-influenced areas, although in several central European sites similar levels of SO2 are recorded without yielding nucleation episodes.
Accordingly, it is clearly evidenced that N variability in different European urban environments is not equally influenced by the same emission sources and atmospheric processes. We conclude that N variability does not always reflect the impact of road traffic on air quality, whereas BC is a more consistent tracer of such influence.
The combination of PM10 and BC monitoring in urban areas potentially constitutes a useful approach to evaluate the impact of road traffic emissions on air quality.

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