Book of Abstracts
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Pollutants emissions in a urban area: definition of emission factors, atmospheric dispersion modelling and support of intervention policies

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1. Summary

Within a urban context, the most important pollutants that should be studied and reduced in a urban context in order to ensure the sustainability of the metropolitan environment are NO_x and PM_{10}. While the emission factors for NO_x are well known for all the sources, the PM emission from traffic are of two types, exhaust and non-exhaust. The latter type of emission is due to vehicle components' wear (tyres, brakes), road abrasion and dust re-suspension and its quantification is not straightforward. In this paper we tried to calculate the total PM emission factors due to traffic by means of the measured PM concentrations for a 50,000 inhabitants town in NW Italy. Then we assessed the different contributions to air quality due to the different emission sources in two medium towns of NW Italy, both for PM_{10} and NO_x. An important effort has been made in order to define the background concentration due to stagnation phenomena of pollutants within the urban contexts. The described approach should be applied in order to understand who is the main responsible of the existing critical condition of air quality and to get some general information on the positive effect obtainable through different intervention policy.

Keywords: Traffic, air quality, atmospheric modelling, PM_{10}, non-exhaust emissions, background concentration

2. Extended Abstract

The analysed area is the province of Cuneo, Piedmont, N-W Italy, within the Po basin, one of the most polluted areas in Europe due to the presence of strong emissive sources and unfavourable climatic and topographic conditions. In order to apply atmospheric dispersion models and define the effect of emission sources on the air quality within a urban context, a very critical parameter is the background concentration of pollutants. In the analyzed area, all the monitoring stations are all placed in urban areas. So we don't have any background monitoring station at disposal for our purposes. Moreover, on the basis of our experience, the background concentration that can be measured in the countryside is not the same as the one that can be measured in a urban environment because of the different emission mixtures and dispersion capabilities, so that it can be strongly site-specific. Based on the reported arguments, we tried to define the background concentration for stable parameters, such as CO and also PM_{10}, by calculating the average concentration from 0:00 am to 5:00 am, when the traffic is low in our towns and the heating plants are not working. The described method, called "night method", has been tested for stable parameters such as CO and PM_{10} in different monitoring stations and it turned out to be surprisingly reliable, as Figure 1 points out (here the modelled concentrations mostly due to traffic were calculated by the OSPM model (Berkowicz et al.) and added to the background concentrations).

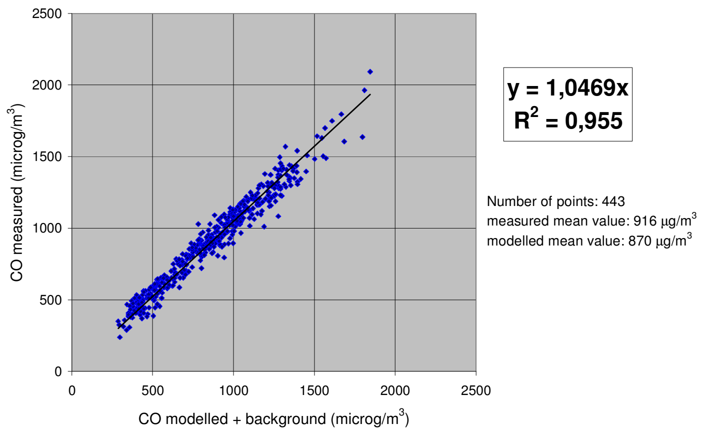

Figure 1: Comparison of measured and modelled CO daily mean concentrations

When managing unstable compounds, such as NO_x, complex photo-chemical reactions in atmosphere can have strong impacts on daily average concentrations. This way we tried to correct the night method by weighting the effect of the night concentration on daily background concentration by the numerical factor 5/24 during the period from May to September, so as to take into account the "consumption" of the accumulated NO_x due to atmospheric reactions. Then we applied the corrected method in the second largest town of the district, Alba, and we obtained satisfactory results: also in this case the modelled concentrations (traffic + factories + heating plants) were very close to the measured ones, with a correlation coefficient r= 0,82 over 366 days.

Once the background concentration in a urban area is defined by a reliable approach, one of the most complex parameter is the PM emission factor due to traffic, that can be exhaust and non-exhaust; the quantification of the latter type of emission is not straightforward, as the variability of the corresponding emission factors found in literature demonstrates (see for example the N.E.R.I. of Denmark, TNO, German UBA, the Swedish model). The provided database are quite variable (the range is 30-1200 mg/veh/km) and, most of all, the values are strongly site-specific; so the emission factor cannot be easily transported to other context such as Northern Italy. A more general and reliable approach could be the so called "tracer method", used within the Swedish Empirical Model (Oemstedt et al.) in order to obtain the total PM emission factor, including both direct emissions and emissions from the dust layer. The method can be written as follows, using for example CO as tracer:

$$e_f^{PM} = e_f^{CO} \cdot \left(\frac{C_{PM}^{roadside} - C_{PM}^{background}}{C_{CO}^{roadside} - C_{CO}^{background}} \right)$$

where e_f^{CO} is the emission factor for CO, often more well known than the PM one.
We applied the tracer method using the data measured at the monitoring station in Cuneo, where the background concentrations for both the parameter have been obtained by the night method previously described. The daily total PM_{10} emission factor has been calculated for 443 days; as obvious, the parameter changes according to the season and the wetness of the atmospheric conditions. The emission factor varies around a mean value of 257 mg/km/veh ± 164 mg/km/veh, with a maximum value of 1136 mg/km/veh. It is important to report that the mean exhaust PM emission factor is 47 mg/km/veh (we assumed an average vehicle speed of 40 km/h). As one can easily observe, the reported emission factors studied for the analysed area in NW Italy are much higher than the values referred by the "German method" and the "Danish method" while they are quite near to the CEPMEIP-TNO suggested data and most of all to the Swedish values, in particular the described range 200-1200 mg/km/veh. Figure 2 reports the trend of the calculated PM emission factors during the 15 analysed months. It is interesting to notice the correlation between rain falls and the monthly running average of the emission factors.

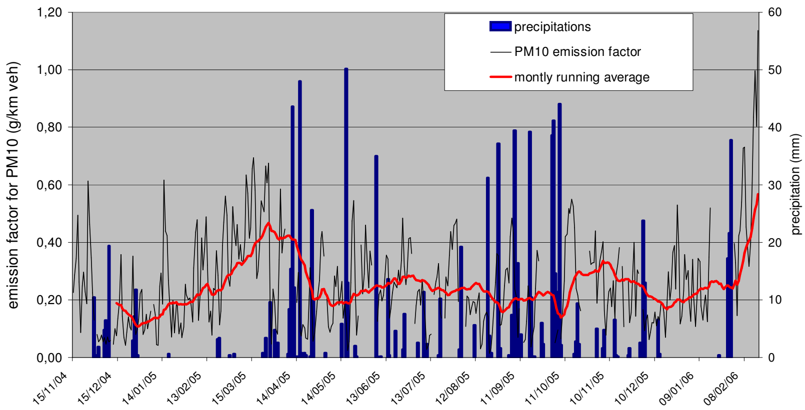

Figure 2: Calculated PM_{10} emission factor (exhaust + non-exhaust)

Based on the so defined PM emission factors, the modelled concentrations at the ground level turned out to be well correlated to the measured ones (r=0.959).
Finally, based on the calculated emission inventory for both the towns and the reliability of the applied models, we found out that the main responsible for the bad air conditions of the analysed area is the traffic. As a consequence, proper intervention policies could be studied together with their effect on air quality.

References

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