3D Variability of Different Particle Metrics in Urban Areas: Findings from the "Supersito" Project in Bologna, Italy

Zauli Sajani S, Marchesi S.*, Trentini A**, Bacco D**, Ricciardelli I**, Cattaneo A**, Poluzzi V**, Lauriola P**

*Regional Agency for Environmental Portection of Emilia-Romagna, Centre for Environment and Health, Modena, Italy
** Regional Agency for Environmental Portection of Emilia-Romagna, Centre for Urban Environment, Bologna, Italy
*** University of Insubria, Department of Science and High Technology, Como, Italy

Summary

Objective The study aimed at assessing the 3D spatial variability of air pollutants within urban areas in order to estimate the potential for misclassification in epidemiological studies. The main goal was to improve the characterization of population exposure to different metrics of airborne particles.

Conclusions Little horizontal and vertical variation was found for PM2.5 concentrations. Large horizontal gradients was found for UFP. Marked differences in relation to traffic proximity was found for size distributions. An unexpected increase of UFP from ground level to higher floor was found. A dramatic decrease in concentrations with height was found for NO2 and BTEX. The results of the study provided the basis for a ranking of potential for exposure misclassification in relation to different particle metrics.

Methods

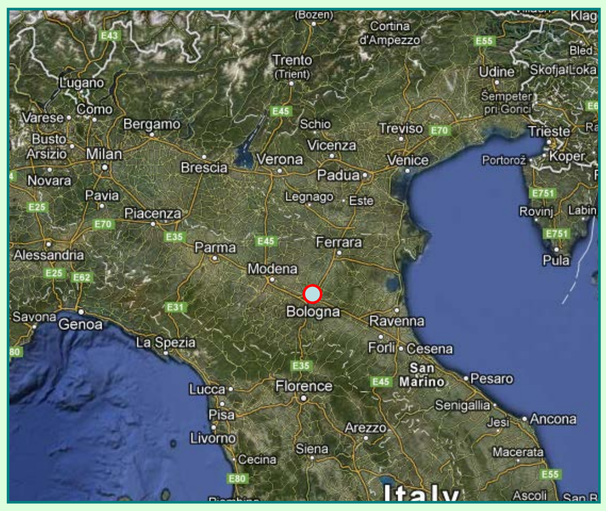


Figure 1. Location of the urban area of Bologna

- Several monitoring campaigns conducted in different sites and seasons during the period 2012-2015.
- Measurements included size distribution, mass and chemical composition of $PM_{2.5}$.
- Monitoring sites located within the urban area of Bologna (Italy), lone of the most urbanized, industrialized and polluted areas of Europe.
- $PM_{2.5}$ mass measured with gravimetric method, size distributions by spectrometers (FMPS-TSI), gaseous pollutants (NO_2, BTEX) with passive samplers.
- Monitoring sites included two high and low traffic areas, front and back of a building placed near a busy street, and high rise building with measurements at different floors.

Results

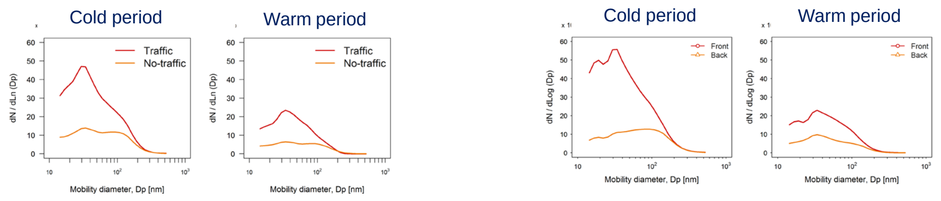
Horizontal variability

Figure 2. High and low traffic sites

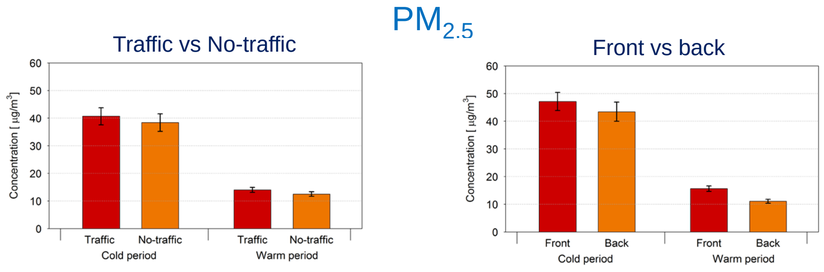
The comparison between high and low traffic sites showed a very little variability of PM2.5 concentrations (< 15%). On the contrary very strong variability was found in the finer fractions of the size distribution and Ultrafine Particle Concentrations (3.5 times higher concentrations at the traffic site). Measurements at the front and rear of a building which fronted onto a major urban road showed differences very similar to those found comparing high and low traffic areas. Sharp peaks at 20-30 nm were found in the particle size distribution near traffic sources. These peaks similarly disappear at the low traffic site and at the rear of the building.

Figure 3. Front/back measuring site

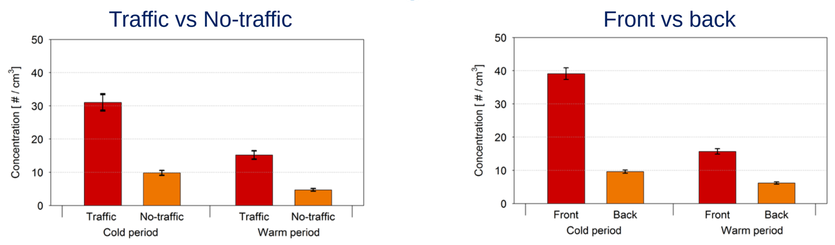
Size distribution



$PM_{2.5}$

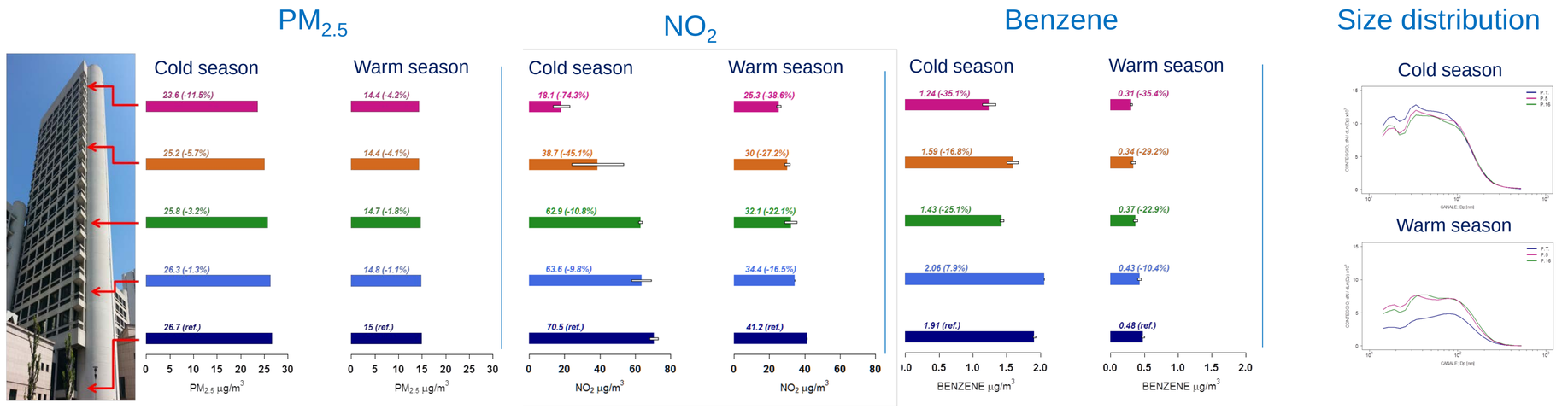


UFP



Vertical variability

Little variation with height was found for $PM_{2.5}$ concentrations (a 11.5% down-top drop during the cold season and a 4.2% during the warm season). An unexpected increase of UFP concentrations was found from ground floor to 5th floor with no significant variations up to the 16th floor. No significant differences were found in the shape of the size distributions at the three levels. Large vertical gradients resulted for NO_2 and BTEX with NO_2 concentrations at the 16th floor during the winter season 74% lower than at ground floor. Lower vertical gradient was found during the summer season. Similar findings were found for Benzene with a down-top reduction equal to about 35% almost constant in the warm and the cold season.



Contacts: Zauli Sajani Stefano – ARPA Emilia-Romagna – Via Begarelli 13, 41121 Modena (Italy) Tel +39 059 433626 E-mail: szauli@arpa.emr.it