Urban particulate matter monitoring on a mobile platform: a real time experiment on a long term scale

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In this paper we propose an innovative approach to the study of urban pollution dynamics, with a particular emphasis to vehicular traffic and generated aerosols. In synthesis, a mobile monitoring platform has been developed exploiting the urban transport system in Perugia (Italy), called Minimetrò. It is based on a monorail train, exploiting a relatively high number of cabins (in average 20) driven by a wire rope continuously running at medium low speed (4-5 m/s) along a radial transect (~3 km, in approx. 20 minutes) over the city. The cabins travel on a monorail built 5 meters above the road level. The cabin path starts from a large suburban parking area, it crosses various heavy traffic roads and road crossings, passes through a park, climbs Perugia hill, and finally reaches the city center inside a terminal tunnel. All these features make the Minimetrò system a good mobile platform for real time investigation of the dynamics of formation and dispersion of pollutants in the urban area.

The basic idea has been to customize and integrate an Optical Particle Counter (OPC, 6 sec. resolution, 22 size classes) inside the cabin. To complement the information coming from the mobile station, two other fixed OPCs (FAI Instruments) have been installed at both ends of the Minimetrò line. Moreover the Minimetrò line passes at short distance (50 m) from the urban background and traffic monitoring stations of air quality. These provide hourly averaged O_3, NO_x, Benzene and CO concentrations, as well as 24h PM_{10} and $PM_{2.5}$ data records. In addition, the main weather parameters are recorded as well as a PBL stability monitor (FAI Instruments) has also been installed in this station. Finally, traffic rates are recorded continuously in two points along the Minimetrò line with a 5 minutes time resolution.

An example of aerosol data is shown in Figure 1, where the number concentration of coarse fraction particles (D_P>1 μm) is shown, for a particular day, as a function of the position along the path (*y* axis, in meters) and time of the day (*x* axis). The color code are number concentration of particles per volume of air. In this particular example the variable impact of a Saharan dust intrusion occurring in the late afternoon is evidenced in different areas of the city. In addition, higher particles concentrations (red areas in the graph) are observed near heavy traffic roads, which point to a role of particle resuspension.

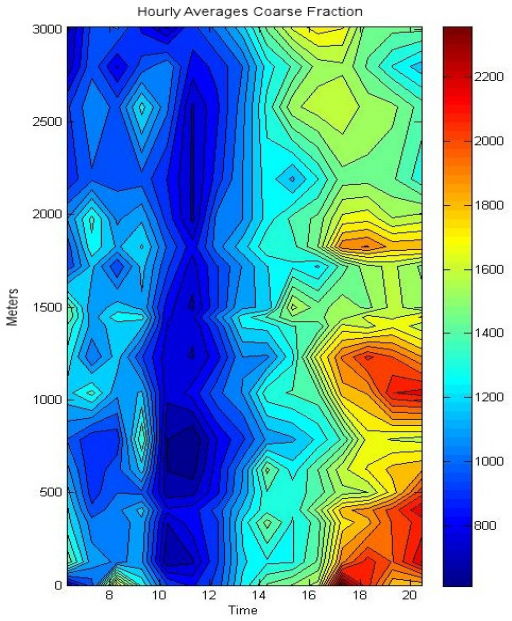

Figure 1 - Spatial – temporal distribution of coarse fraction particles recorded in date 20/10/2012.

The data acquisition started in September 2012 and will last one year. Ad-hoc statistical techniques are employed to fully exploit this large amount of information: functional data analysis can handle high frequency time series, while additive models can produce maps as those in Figure 1 and explain the contribution of covariates.

Special interest has been paid to the characterization of the aerosols in the underground paths of the Metro line in order to analyze the impact of degrading metal and rubber parts of the system. In this case the specific emission of the Metro system has been characterized, exploiting two HVS multistage impactors which allowed simultaneous samplings inside and outside the tunnel for metals and IPA size distributions. Moreover EC/OC ratios, black carbon as well as morphological a mineralogical assessments via electron microscopy on samples taken inside the tunnel have been used to integrate the mobile cabin data. Detailed results will be presented at the Conference.