DISTRIBUTION OF PARTICULATE MASS CONCENTRATIONS IN A COMPLEX TRAFFIC HOT SPOT

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1.Introduction

Urban hot spots are areas where atmospheric pollution distribution presents a high degree of complexity which must be taken into account for air quality assessment. Two air quality field campaigns were performed in 2015 during winter and summer in a complex traffic hotspot in Madrid. The campaigns aimed at evaluating the different features that influence the microscale spatial and temporal variations of ambient pollutant concentrations. Ambient particulate mass concentration levels (PM_{10}, $PM_{2.5}$ and PM_1) were measured at different atmospheric conditions and sites during these campaigns. Results evidence the great heterogeneity in horizontal concentration fields that follow complex atmospheric dynamic patterns linked to local emissions. Those present very short-time variations associated to traffic and sequentially to the traffic lights schedule. Other anthropogenic activities, like school start times, weekends, and commercial activities also influenced local emissions distribution in the area. This information along with the pedestrian flows, which were also characterized, will be used to obtain the exposure levels to ambient pollutants.

2.Location

Plaza de Fernández Ladreda, Madrid, Spain
40°23'8.51"N 3°43'1.42"O

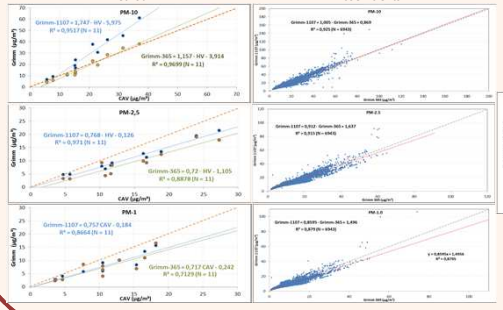
3.Instrumentation

Several Optical Particle Counter instruments were deployed in the study area, two of them (GRIMM 365 and 1107) (Grimm et al., 2009) installed at two points (transport transfer station and Iberdrola building) along the main axis (NE-SW) and at two different heights, 12 and 2.5 meters, respectively. A DustTrak™ DRX measured the particle levels around the experimental area following a dynamic measurement pattern. These instruments were previously validated against the reference gravimetric method and against a TEOM™ instrument operating at the air quality station of the Madrid municipal network at the experimental site. Particle measurements were complemented with meteorological and microturbulence parameters obtained by two stations located in the study area (0.42 km²) one of them instrumented with two sonic anemometers.

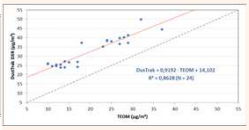
Meteorological data were obtained from a station located in Madrid, that allows temperature measurement at two heights.

Comparison of two models of Optical Particle Counter with HV-gravimetric reference method.

Comparison of two models of Optical Particle Counter, corrected with reference method coefficients.

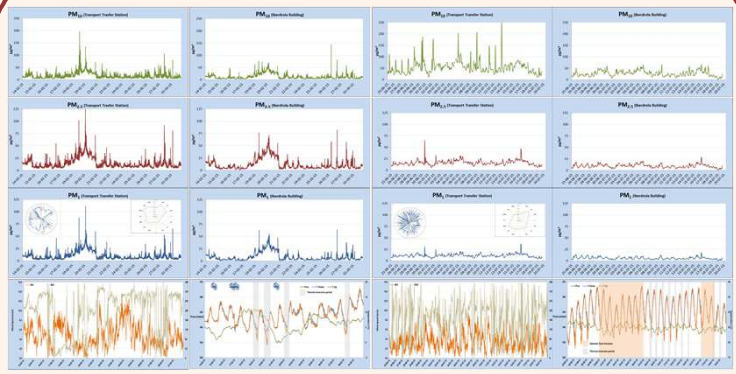


Comparison of portable Optical Particle Counter DustTrak, with TEOM instrument.

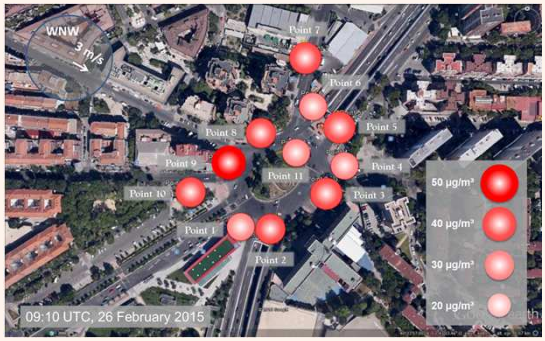


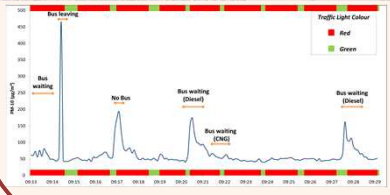
4.Results

winter summer



Meteorological conditions during the two campaigns were rather different and representative of the two seasons, winter and summer. In winter, high pressures dominated the atmospheric situation, which was characterized by low winds and strong stability, thermal inversions and periods of high pollutant concentrations (19-21 February). Turbulence was almost inhibited during these periods, but high concentration levels were also recorded at the highest site (Iberdrola building) albeit lower than at site closer to the ground (transport transfer station). Three raining episodes with wind direction change reduced the concentration of particle matter (14, 17 and 21 of February). Short time variations at coarse and finest fractions, associated to traffic emissions, were recorded at both sites. During the summer campaign, characterized also by low winds, an African dust outbreak event took place over Madrid and the Iberian peninsula, giving rise to higher general concentrations, which were recorded mostly affecting the coarse fraction. Differences in ambient particulate concentrations due to height of measurement were also noticeable during this campaign. Two episodes of Saharan dust out brake occurred, maintaining a high basal level of large particles for the campaign. On the other hand, DustTrak measurements performed along a 11-point path around the square showed the main hot spots of the experimental area. These coincided with main high density traffic lights, and typical car stops related to human activities (e.g. school entrance).





The effect of the traffic exhaust emissions due the traffic light cycles and the kind of bus technology have a great influence in the particle concentrations, which were measured at a bus stop of the square. Motion start and idle operations had a strong impact on local concentrations, with the consequent impact on air quality and population exposure levels.

5.Conclusions

Local emissions have a great influence in the particle concentration field in urban hot spot areas. Even under high wind speeds and turbulence, concentration fields and their time evolution do not appear to be dominated by the general atmospheric dynamics, but rather by anthropogenic activities. Traffic exhausts are the main particulate sources, as particulate matter mass is mostly in the smaller fraction, PM_1. Hot spot sites within the experimental area have been identified by mobile instruments and short time variations at specific sites have been found to be highly influenced by features like traffic density, traffic light cycles and bus technology. A clear dependence of the measurement height has also been observed, even when turbulence conditions inhibit the vertical mixing.

Other external contributions like African dust outbreaks, also perturb the particle mass concentration field and size distributions, highlighting the difficulty of simulations and assessment at these complex areas. Thus, the high complexity of this urban scenario requires further studies to categorize the impacts of local sources and activities under a wider range of conditions.

6.Acknowledgements

This work has been partially funded by the TECNAIRE-CM project. The authors gratefully acknowledge the Madrid Air Quality authority, Iberdrola, S.A. and Madrid Transport Consortium for their support during the field campaigns. The Saharan dust intrusion data were obtained from DGCA (Spanish Ministry of Agriculture and Environment).

7.References

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Air Quality 2016
10th International Conference on Air Quality - Science and Application