DISTRIBUTION OF PARTICULATE MASS CONCENTRATIONS IN A COMPLEX TRAFFIC HOT SPOT

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Summary

Two air quality field campaigns were performed in 2015 during winter and summer in a complex traffic hotspot in Madrid. Apart from gaseous species, the ambient particulate mass concentration levels (PM10, PM2.5 and PM1) were measured at different atmospheric conditions. Several Optical Particle Counter instruments were deployed in the study area, two of them installed at two points in the North –South axis. 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. Particle measurements were complemented with meteorological and microturbulence parameters from two stations located in the study area (0.42 km^2). Results evidence the great heterogeneity in horizontal concentration fields and observed spatial distributions that follow complex atmospheric dynamic patterns. Local emissions present very short-time variations and traffic lights schedule seem to be relevant for exhaust emissions at these hottest sites The pedestrian flows were also characterized to obtain their exposure to ambient particles.

Introduction

The TECNAIRE project aims to diagnose the problems of air quality in urban environments by developing new measuring and modelling techniques able to evaluate strategies for their resolution. Within this framework, two campaigns were designed and performed during the winter period 13 February-2 March and the summer period 25 June-20 July 2015 in a complex traffic hot spot (Plaza de Fernández Ladreda) in Madrid. This spot frequently experiences the highest pollution levels for particles and gases of the city caused by traffic influence. It is a site of enormous complexity in terms of sources, urban geometry and intense pedestrian activities.

Methodology and Results

Several Optical Particle Counters (Grimm and Eatough, 2009) were deployed in the study area, where a municipal monitoring station also measured PM10 with a TEOM monitor. A Grimm 1107 instrument was installed at 2.5 m high stand in the South of the square, next to a transport station, and a Grimm 365 at the roof of a 5 m high building in the North side. Meteorological stations were installed at both locations, one of them providing microturbulence parameters (measured by sonic anemometers). A TSI DustTrak DRX instrument (Tasić et al., 2012) measured the particulate mass levels at 14 points around the experimental area in a dynamic pattern by moving the instrument around the square and measuring at a mean adult height respiration level. Additional measurements in specific spots such as bus stops and traffic lights were made. The traffic, traffic light changes and pedestrian flows were also measured.

During the winter monitoring campaign, local meteorological conditions varied giving well defined periods of strong to moderate winds, in occasions accompanied by showers, alternating with wind calm periods which favoured pollutant stagnant and accumulation. The most important episode lasted from 19th to 21st February and the highest concentrations of pollutants were recorded at the air quality monitoring station. During this episode a daily cycle with two peaks linked to traffic rush hours could be detected for the main pollutants. The nocturnal values remained high due to the atmospheric stability associated with temperature inversion conditions. Turbulent kinetic energy was less than 1 m^2s^{-2} during 19 and 20 February, with nocturnal values below 0.1 pointing out the low turbulence associates to these days, even during the diurnal time. PM10 hourly concentrations higher than 50 μgm^{-3} were reached in occasions. Measurements during the fast rounds confirmed that the maximum concentration values correspond to crosswalks, especially during the car accumulation associated to traffic lights. This situation was studied in further detail in a bus stop where the highest concentrations were measured when diesel buses were waiting during the red lights.

Conclusions

Local emissions had a great influence in the concentration field, which, even under higher wind speeds and turbulence, did not follow a clear pattern dominated by the atmospheric dynamics. Most of the particulate matter mass was in the smaller fraction, PM1, pointing to traffic exhaust as the main source in this hot spot. Nevertheless, 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.

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