Temporal and spatial particulate matter distribution in a complex hot spot

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The TECNAIRE project aims to diagnose the problems of air quality in urban environments by developing new monitoring and modelling techniques able to evaluate strategies for their management. Taking this into account, a complex traffic hot spot (Plaza de Fernández Ladreda, FL) in Madrid city was selected for the study. This location frequently experiences the highest pollution levels for particles and gases in the city caused by traffic emissions. It is a site of enormous complexity in terms of sources, urban geometry and intense pedestrian activities. Two campaigns were designed and performed from 13 February to 2 March (winter period) and from 25 June to 20 July 2015 (summer period).

Several instruments were deployed in the study area. An Optical Particle Counter Grimm 1107 instrument (Grimm and Eatough, 2009) was installed at 2.5 m high stand in the South of the square, next to a transport transfer station, and a Grimm 365 at the roof of a 5 m high building in the North side, both measuring PM10, PM2.5 and PM1 simultaneously. These measurements were complemented with a PM10 TEOM monitor in a municipal monitoring station located in the square. Meteorological stations were co-located at both Grimm locations, one of them providing microturbulence parameters evaluated from sonic anemometers deployed at two height levels. A TSI DustTrak DRX instrument (Tasić et al., 2012) measured the particulate matter (PM) 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. These transects were done at fast (15 minutes) or slow (3 hours) speed. Additional measurements in specific spots such as bus stops and traffic lights were made. The traffic flow, traffic light changes and pedestrian flows were also measured.

The PM levels measured were higher during the winter campaign caused by the use of domestic heating, different meteorology and boundary layer height. During this campaign, local meteorological conditions varied giving well defined periods of strong to moderate winds, accompanied by showers alternating with calm wind periods which favored pollutant stagnation and accumulation. The most important air pollution episode lasted from 19th to 21st February, when a daily cycle with two peaks linked to traffic rush hours was detected for the main pollutants. The nocturnal values remained high due to the atmospheric stability associated to surface-based temperature inversion conditions.

The transects made with the DustTrak instrument during both campaigns indicated that the highest PM concentration values were recorded at the crosswalks, especially at points 9 and 3 (See Figure 1). During the measurements both points were influenced by an intense flux of cars stopping to pick up and dropping passengers (point 9, both campaigns) or children going to school (point 3, winter campaign). The highest concentrations in a bus stop were measured when diesel buses were idling during the red lights and bus stops. These are critical points as people usually spend time at bus stops, so their exposure to PM could be significant. Remarkable differences in PM concentrations at this point were observed between diesel and Compressed Natural Gas (CNG) buses.

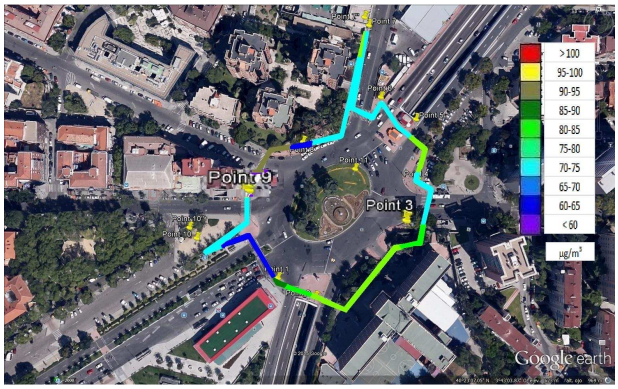

Figure 1. PM10 concentrations measured for a representative transect in FL fast roundabout 6 July 2015 starting at 6:47 UTC

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