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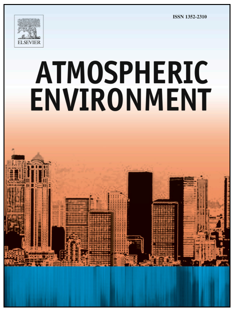

Mobile monitoring for mapping spatial variation in urban air quality: development and validation of a methodology based on an extensive dataset

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Mobile monitoring for mapping spatial variation in urban air quality: development and validation of a methodology based on an extensive dataset

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Abstract

Mobile monitoring is increasingly used as an additional tool to acquire air quality data at a high spatial resolution. However, given the high temporal variability of urban air quality, a limited number of mobile measurements may only represent a snapshot and not be representative. In this study, the impact of this temporal variability on the representativeness is investigated and a methodology to map urban air quality using mobile monitoring is developed and evaluated.

A large set of black carbon (BC) measurements was collected in Antwerp, Belgium, using a bicycle equipped with a portable BC monitor (micro-aethalometer). The campaign consisted of 256 and 96 runs along two fixed routes (2 and 5 km long). Large gradients over short distances and differences up to a factor of 10 in mean BC concentrations aggregated at a resolution of 20 m are observed. Mapping at such a high resolution is possible, but a lot of repeated measurements are required. After computing a trimmed mean and applying background normalisation, depending on the location 24 to 94 repeated measurement runs (median of 41) are required to map the BC concentrations at a 50 m resolution with an uncertainty of 25 %. When relaxing the uncertainty to 50 %, these numbers reduce to 5 to 11 (median of 8) runs. We conclude that mobile monitoring is a suitable approach for mapping the urban air quality at a high spatial resolution, and can provide insight into the spatial variability that would not be possible with stationary monitors. A careful set-up is needed with a sufficient number of repetitions in relation to the desired reliability and spatial resolution. Specific data processing methods such as background normalisation and event detection have to be applied.

Keywords: Mobile monitoring , Urban air quality , Black carbon , High resolution , Mapping , Spatial variation

1. Introduction

The urban environment shows a high variability in air pollutant concentrations. The dynamics of primary emissions and secondary formation induce important differences in pollution levels in space and time. Especially for traffic-related air pollutants such as NOx and fine particulate matter (PM), these differences can occur on a small scale (Seinfeld and Pandis, 2012; Kaur et al., 2007) and are important to take into account for mapping the pollution levels and accurate exposure assessment (Fruin et al., 2014). In contrast to traditional stationary monitoring stations, mobile platforms are able to acquire air quality data at a high spatial resolution (Wallace et al., 2009; Zwack et al., 2011b). But at the same time, due to the high temporal variability of the urban air quality and the mobile nature of the measurements, the representativeness of the mobile measurements is a major issue. These considerations are very relevant given the increasing use of mobile air quality monitoring as a solution to measure micro-scale variability at a high spatial and temporal resolution. Kuhlbusch et al. (2014), for example, mention mobile monitoring to collect highly spatially and temporally resolved data in their recommendations for future European air quality monitoring.

The objective of this study is to develop and validate a method to map urban air quality at high spatial resolution using mobile monitoring. Based on a large experimental dataset of mobile air quality