Winter air quality in an urban area with high coal consumption in domestic devices

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Air pollution is the 4th leading risk factor for mortality worldwide (HEI, 2020). Particulate matter (PM), classified as carcinogenic for humans (Group 1) (Loomis et al. 2013), is the leading environmental contributor to the global burden of disease contributing (European Environment Agency, 2019). Despite the improvements on outdoor air quality in Europe, PM levels can be heightened under episodic events provoked, for example, by seasonal emission sources under stagnant weather conditions. In this study, a winter monitoring campaign was carried out at the city center of León (Spain) in order to evaluate the PM_{10} concentrations, chemical composition and toxicity.

A sampling campaign was carried out from 17th to 24th January to evaluate the PM levels in the city centre of León, during winter, when high usage of domestic heating devices is expected. The monitoring week was one of the coldest of the 2021 – 2022 winter. León is surrounded by mountain ranges on the west, north, and east. The climate is characterized by cold winters and hot summers. León is located in a coal-mining region, where the use of coal in domestic heating devices is still widespread. The main particle emission sources in the urban area is road traffic as well as coal and biomass burning in winter (Blanco-Alegre et al. 2019). Samplers were located on the rooftop of an official building located in front of a circular square with heavy traffic. Meteorological data (wind, temperature, precipitation and relative humidity) was recorded with a weather station. PM_{10} samples were collected using a low-volume sampler (TCR Tecora, model 2.004.01) and a high-volume sampler (MCV, model CAV-A/mb) equipped with teflon and quartz fibre filters, respectively. Samples were taken in parallel for 23h30 every day for one week, starting at 1100 and ending at 1030 UTC. Chemical composition was obtained by PIXE (elements), ion chromatography (water-soluble inorganic ions) and thermal-optical analysis (organic and elemental carbon). The ecotoxicity of the PM_{10} samples was evaluated by the *Vibrio fischeri* bioluminescence inhibition assay (Vicente et al., 2021).

The average daily temperature recorded during the sampling period was 3.5 ± 1.7 °C and the relative humidity 63.7 ± 4.57%. No precipitation events occurred during the studied period. The daily average PM_{10} concentrations were always below the EU daily limit value, ranging between 20.0 and 39.2 μg m^{-3}. OC and EC represented 22.2% ± 2.21% wt. and 2.69% ±1.69% wt. PM_{10}, respectively. Water-soluble ions accounted for 11.1% - 36.7% wt. of the PM_{10} mass. The dominant water-soluble species were sulphate, nitrate and ammonium which globally represented 64% - 76% of the total ionic content. These secondary inorganic ions were significantly correlated. The dominant elements in PM_{10} samples were Si (2.66% – 6.71% wt. PM_{10}) and Cl (3.59 – 5.18% wt. PM_{10}). The concentrations of Se, a coal burning tracer, ranged from 2.03 to 10.6 ng m^{-3}. All the samples inhibited the bioluminescence of the bacteria, indicating that all the samples were toxic.

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