Physical-chemical characterisation of atmospheric aerosol in León (NW Spain): an integrated study during the period of highest consumption of coal for heating purposes

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Keywords: Scattering and absorption Angström exponent; Elements; Carbonaceous content; PM10
Associated conference topics: 2.11, 2.8, 1.6 Presenting author email: cmaig@unileon.es

In the last few years, the World Health Organisation has identified air pollution as the greatest environmental health risk and one of the main drivers of climate change (WHO, 2019). A determining factor in the evolution of the climate system is the concentration of atmospheric aerosols, which can alter the radiative balance of the atmosphere. This climate effect is complex and depends on aerosols chemical, physical and optical properties. These properties are highly variable at both spatial and temporal scales, due to the short atmospheric lifetime of the aerosols and its heterogeneous sources.

A sampling campaign was set in León (NW Spain), with the aim of studying the optical properties, chemical speciation and sources of PM10 in an urban site with high consumption of coal in domestic devices, for heating purposes. Measurements were conducted between 1 December 2021 and 3 May 2022, which coincides with the period of greatest use of heating devices. The sampling site was located on a public building in downtown León, at a height of around 20 m above street level. According to its location, the sampling site is representative of urban/traffic conditions.

The aerosol scattering and backscattering coefficients were measured with an integrating Nephelometer (Model Aurora 3000, Ecotech). The measurement of the aerosol absorption was performed using an Aethalometer (model AE33, Magee Scientific). This instrument was connected to a Total Carbon Analyser (Model TCA08, Magee Scientific) in order to provide near real time total carbon (TC), organic carbon (OC) and elemental carbon (EC) measurements. For the continuous monitoring of particle size distributions an optical particle counter (PCASP-X) and a high-resolution nanoparticle sizer (SMPS Model 3938) were used. For the chemical characterisation of the particulate matter two automatic collectors were used: a low volume sampler (TCR Tecora, ECHO PM) with teflon filters and a high-volume sampler (CAV-A/Mb MCV, S.A.) equipped with quartz filters. Teflon filters were used for the analysis of trace elements (by PIXE) and quartz filters for determining PM10 concentration, carbon content (by a thermo-optical method) and water-soluble inorganic ions (by ionic chromatography). The meteorological parameters were continuously recorded by an automatic weather station.

During the monitoring period, the average daily temperature was 8°C, ranging from minimum values of 1°C (in winter) to a maximum of 17.6 °C (in spring). The average relative humidity was 65 ± 12% and the total accumulated precipitation reached 174 mm, with rainiest days in spring. The optical parameters studied in this work, such as scattering/absorption Angström exponent (SAE and AAE) and backscattering fraction (BF) reflect the nature of the aerosols. Throughout the sampling campaign, the mean daily PM10 concentration was 24 μg m^{-3} with a minimum of 6.5 μg m^{-3} and a maximum of 370 μg m^{-3}. On four days, the PM10 concentrations exceeded the daily limit value of 50 μg m^{-3} set by the Air Quality Directive 2008/50/CE. These exceedances matched with dust transport events from North Africa, affecting the PM10 concentrations in March. During the studied period the organic and elemental carbon (OC, EC) represented 3.5% ± 2.4% wt. and 0.5% ± 0.4% wt. of the PM10 mass, respectively. The dominants elements and water-soluble inorganic ions were Cl, Na, Si and SO_4^{2-}, NO_3^-, Ca^{2+}, respectively.

This work was partially supported by the Junta de Castilla y Leon co-financed with European FEDER funds (Grant LE025P20) and by the AEROHEALTH project (Ministry of Science and Innovation, co-financed with European FEDER funds. Grant PID2019-106164RBI00). This research has also been supported by the RADIATE project under the Grant Agreement 824096 from the EU Research and Innovation programme HORIZON 2020. Furthermore, it is part of the project TED2021-132292B-I00, funded by MCIN/AEI/10.13039/501100011033 and by the European Union "NextGenerationEU"/PRTR.

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