Optical properties and chemical composition of the atmospheric aerosol in León city, Spain

C. Gonçalves[1], E. D. Vicente[1], A.I. Calvo[1], C. Blanco-Alegre[1], A. Rodríguez-Fernández[2] and R. Fraile[1]

[1]Department of Physics, IMARENAB, University of León, Campus de Vegazana, 24071, León, Spain
[2]Department of Biodiversity and Environmental Management, University of León, León, Spain
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Presenting author email: cmaig@unileon.es

Atmospheric aerosols influence the Earth's climate by modifying the radiative balance. This climate effect is complex and depends on aerosols chemical, physical and optical properties. These properties are highly variable in space and time, due to the aerosol's short lifetime and its heterogeneous emissions. Scattering and absorption are the most relevant optical properties of aerosols. Different techniques have been developed to measure and characterize different properties of the aerosols in the column and at surface level (Forster et al. 2007).

In this framework, an experimental campaign was set in the city of León, in northern Spain, with the aim of studying the optical properties and chemical composition of the particulate matter in a middle-size urban area. Measurements started in December 2021 and will run until April/May 2022 on an official building in downtown León (Figure 1), at a height of around 20 m above street level.

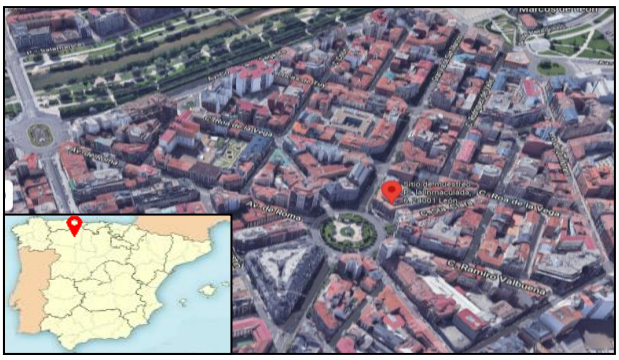

Figure 1 - Sampling location.

The site is in an urban setting near streets with a high traffic density and it is representative of urban conditions. It is mainly affected by anthropogenic aerosols originated by traffic, coal combustion for heating purposes and, sporadically, by natural aerosols with desert (Saharan) origin or wildfires (Oduber et al. 2021).

The aerosol scattering (σ_{sp}) and backscattering coefficients (σ_{bsp}) were measured with an integrating nephelometer (Model Aurora 3000, Ecotech) equipped with a PM_{10} cut-off inlet. The measurements were performed under dry conditions (RH < 40%) through a controlled automatic heater following ACTRIS recommendations. This instrument draws the ambient air at a flow rate of 3 L min^{-1}, providing measurements of σ_{sp} and σ_{bsp} at three wavelengths (450, 525 and 635 nm). Calibration of the nephelometer was carried out using CO_2 as a span gas and zero air (particle free air). In this study, non-idealities due to truncation errors were corrected using the method described by Anderson and Ogren (1998) that account for the particle-size dependence of the truncation error through the measured wavelength dependence of light scattering.

The measurement of the aerosol absorption was performed using an Aethalometer (model AE31, Magee Scientific). This instrument provides the absorption coefficient at seven wavelengths (370,470, 520, 590, 660, 880 and 950 nm) and 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. Both devices were equipped with a PM_{10} cut-off inlet. Additionally, carbonaceous component was determined by a thermal-optical method in PM_{10} samples collected onto quartz filters using a high-volume sampler (CAV-A/mb, MCV).

The calculated parameters studied in this work, such as scattering Ångström exponent (SAE), backscattering fraction (BF) and asymmeter parameter (g) reflect the nature of the aerosols.

In this study, the optical results will be discussed with the chemical measurements to investigate the sources of the aerosol, including its temporal variability and trends.

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