Optical properties of atmospheric aerosols in León (Spain)

S. Natal, C. Blanco-Alegre, A. Castro, A.I. Calvo, F. Oduber and R. Fraile

Department of Physics, IMARENAB University of León, 24071 León, Spain
Keywords: density, optical properties, PM_{10}, refraction index
Associated conference topics: 1.1, 1.4, 5.5
Presenting author email: cblaa@unileon.es

Nowadays, there is clear evidence that aerosols directly and indirectly impact thermodynamic processes and radiative fluxes of the Earth's atmosphere (Andreae & Rosenfeld, 2008). Aerosols influence atmospheric radiative balance directly through the interaction of radiation and particulate matter, such as scattering and absorption, and indirectly some act as cloud condensation and ice nuclei. There are also semi-direct effects, e.g. black carbon deposition to ice/snow enhances the absorption of shortwave radiation inducing melting process (Conrady et al., 2013).

The study reported here aims to analyze the optical parameters and to evaluate the density and refractive index of particulate matter during one year. The study site is located at the campus of the University of León (Spain). León is a city placed in the NW of the Iberian Peninsula (42° 36′ N, 05° 35′ W and 838 m above sea level). The data collection was carried out between March 2016 and February 2017.

Particle size distributions were measured over one minute averages using an optical spectrometer PCASP-X, manufactured by Particle Measuring Systems, Inc. (PMS). This instrument measures aerosol diameters ranging between 0.1 and 26.8 µm in 31 channels on the basis of the light-scattering properties of the particles at a wavelength of 633 nm. In this study, we are presenting PCASP-X size distributions adjusted for refractive index using Mie theory (Bohren and Huffman, 1984). For every month, a mean density and refractive index have been derived from the chemical analysis of daily sampling filters. For the determination of the optical parameters, only the PCASP-X data from the samples recorded while the sun was above 10º on the horizon have been considered.

Table 1. Refraction index and density of aerosol particles in León between March 2016 and February 2017.

Month-Year	Refractive index $m = n - ki$	Density (g/cm^3)
03-16	1.557–0.012*i*	1.83
04-16	1.561–0.013*i*	1.96
05-16	1.557–0.011*i*	1.90
06-16	1.564–0.015*i*	1.74
07-16	1.545–0.006*i*	2.03
08-16	1.547–0.006*i*	2.05
09-16	1.552–0.008*i*	2.15
10-16	1.560–0.013*i*	1.82
11-16	1.556–0.012*i*	1.84
12-16	1.559–0.013*i*	1.79
01-17	1.550–0.009*i*	1.95
02-17	1.544–0.007*i*	2.02

Monthly mass efficiencies of scattering (MSE), absorption (MAE), extinction (MEE) and backscattering (MBSE) have been estimated from PCASP data for fine and coarse modes using three different wavelengths: 440, 670 (visible) and 870 nm (near infrared).

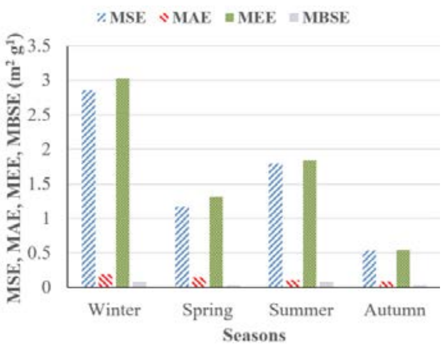

Figure 1. MSE, MAE, MEE and MBSE at wavelength 440 nm by seasons.

Preliminary results indicate that the average particle density in León was higher in summer, reaching a maximum in September (2.15 g/cm^3) (Table 1). The monthly pattern of the optical parameters was similar for the three wavelengths analyzed. The highest values for the MSE, MAE, MEE and MBSE were reached in winter, with values of 3.3±2.3, 0.3±0.1, 3.5±2.4 and 0.1±0.1 m^2g^1, respectively (Figure 1). This may be due to the higher aerosol concentration produced by an increase in traffic and in the use of domestic heating devices, together with a decrease in the depth of the mixing layer in winter. The coefficients obtained for fine mode were very similar to those obtained for the total distribution of particles. These results and other obtained for ultrafine mode will be implemented in the Global Atmospheric Model (GAME) to analyze the effect of different aerosol particles on radiative forcing.

This work was partially supported by the Spanish Ministry of Economy and Competitiveness (Grant TEC2014-57821-R), the University of León (Programa Propio 2015/00054/001) and the AERORAIN project (Ministry of Economy and Competitiveness, Grant CGL2014-52556-R, co-financed with FEDER funds). F. Oduber acknowledges the grant BES-2015-074473 from the Ministry of Economy and Competitiveness. C. del Blanco Alegre acknowledges the grant FPU16/05764 from the Ministry of Education, Culture and Sports. D. Baumgardner, Droplet Measurement Technologies, provided the Fortran code for calculating the optical coefficients from the size distributions measured with the PCASP and edited the abstract.

Andreae, M.O., Rosenfeld, D. (2008) *Earth-Science Reviews*, **89**(1–2), 13–41. doi:10.1016/j.earscirev.2008.03.001.
Bohren C.F., Huffman D.R. (1984) *Absorption and Scattering of Light by Small Particles*, Wiley. ed. New York.
Conrady, K., Heinke Schlünzen, K., Herber, A. (2013) *Atmospheric concentration of black carbon in the western Arctic*. Universität Hamburg.