Positive Matrix Factorization of suburban aerosols: a first time approach in NW Spain

Fernanda Oduber[1], Ana I. Calvo[1], Carlos del Blanco-Alegre[1], Amaya Castro[1], Teresa Nunes[2], Célia Alves[2], Franco Lucarelli[3], Silvia Nava[3], Giuliana Calzolai[3], Joana Barata[2], Roberto Fraile[1]

[1]Department of Applied Chemistry and Physics, IMARENAB University of León, 24071 León, Spain.
[2]Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal.
[3]Department of Physics and Astronomy, University of Florence and INFN-Florence, Italy.

celia.alves@ua.pt

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INTRODUCTION

Aerosols are important components of the atmosphere and their physical, chemical and optical characteristics depend largely on their sources and formation processes. In a specific location, aerosol concentrations are related to several factors (meteorological conditions, regional background, local and regional sources, etc.). Aiming to create mitigation strategies for improving air quality, the source identification and apportionment is essential. The goal of this study was the identification of the main aerosol sources, using Positive Matrix Factorization (PMF), by means of the chemical composition of the samples collected in a one-year campaign carried out between March 2016 and March 2017 in León city, Spain. This is the first time that such a study has been performed in León.

STUDY AREA

The sampling campaign was carried out in the Campus of the University of León, at León city, Spain (42º 36′ N, 05º 35′ W and 838 m a.s.l) (Fig. 1), in a sampling period between 09 March 2016 and 14 March 2017.

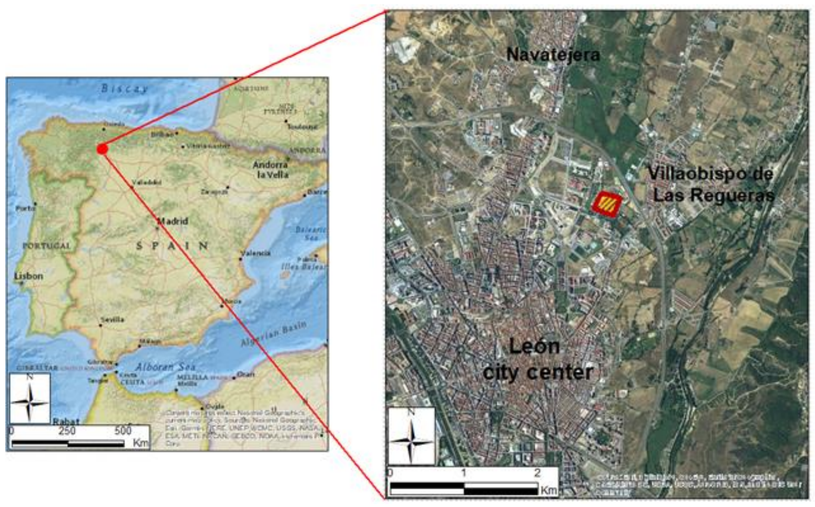


Fig. 1. Map of Iberian Peninsula and localization of León.

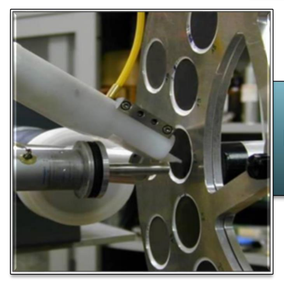
Sampling

Automatic weather station recorded temperature, wind speed and direction, and relative humidity

Low volume sampler (TECORA, ECHOPM): Collection of PM_{10} (47 mm diameter teflon filters) at 24 hour intervals.

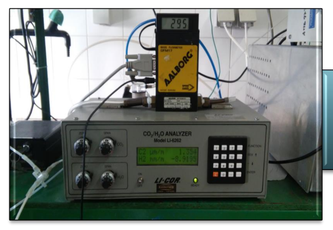
High volume sampler (CAV-A/Mb): Collection of PM_{10} (150 mm diameter quartz filters) at 24 hour intervals.

Analysis



PIXE (Particle-Induced X-ray Emission): analysis of major and trace elements

Thermo Scientific Dionex™ ICS-5000 Ion Chromatography: water soluble ions and levoglucosan



Organic (OC) and elemental (EC) carbon analysis by termal-optical technique

Fig. 2. Sampling and analytical instrumentation.

RESULTS AND CONCLUSIONS

The best fit was provided by a 6-factor solution, allowing the identification of the following sources in the city of León: mineral, marine, traffic, secondary aerosols, biomass burning and aged sea salt (Fig. 3).

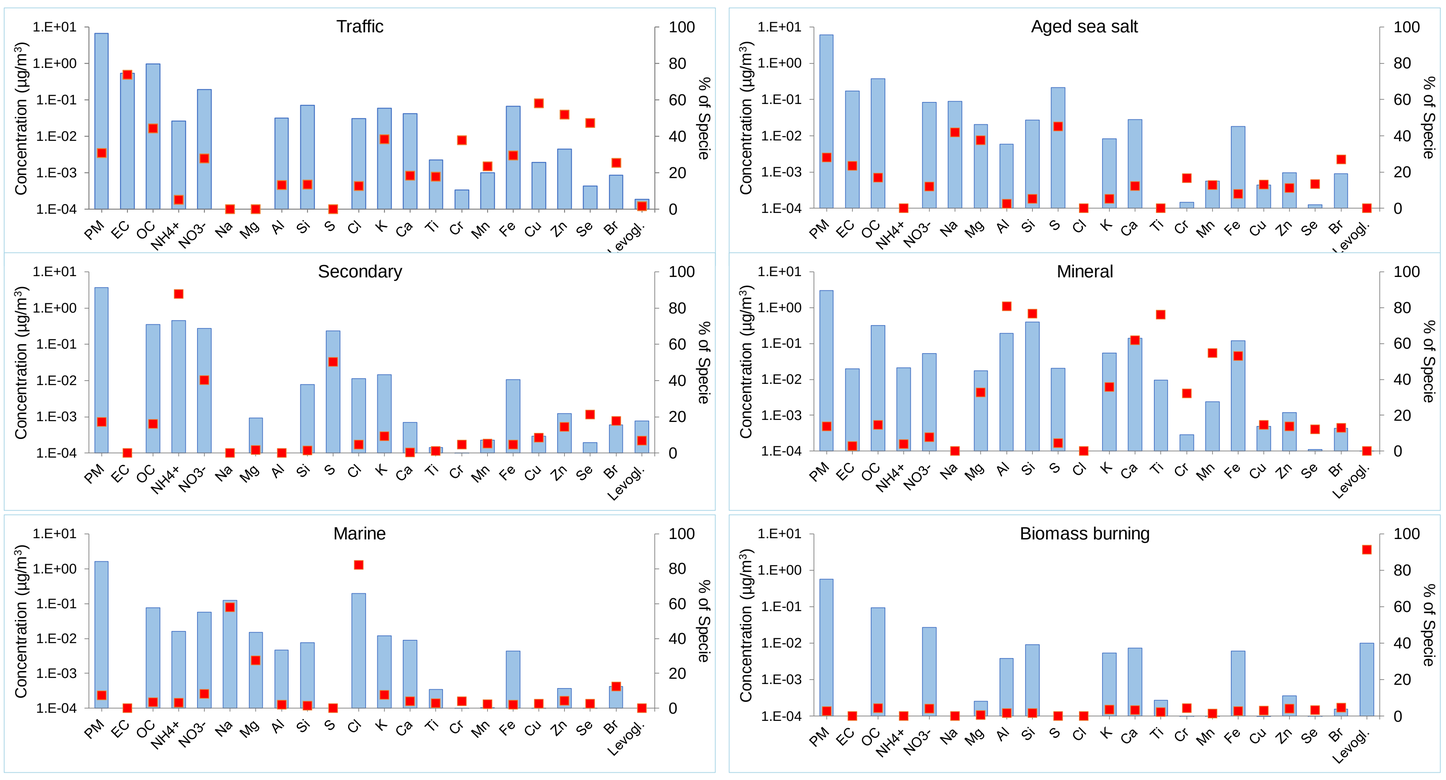


Fig. 3. PMF factor profiles obtained in the sampling area of León. Blue bars show the mean concentration of the species and red points show the percentage of each species in each factor.

Daily source contributions of particulate matter as a function of wind speed and direction were also analyzed. In general, PM_{10} mass concentrations decrease with increasing wind speeds (Fig. 5). The main emissions of the traffic factor come from the center of the city of León (SW) and neighboring towns such as Navatejera (NW). The emissions from the burning of biomass come mainly from the use of domestic heating devices in neighboring towns such as Villaobispo de las Regueras.

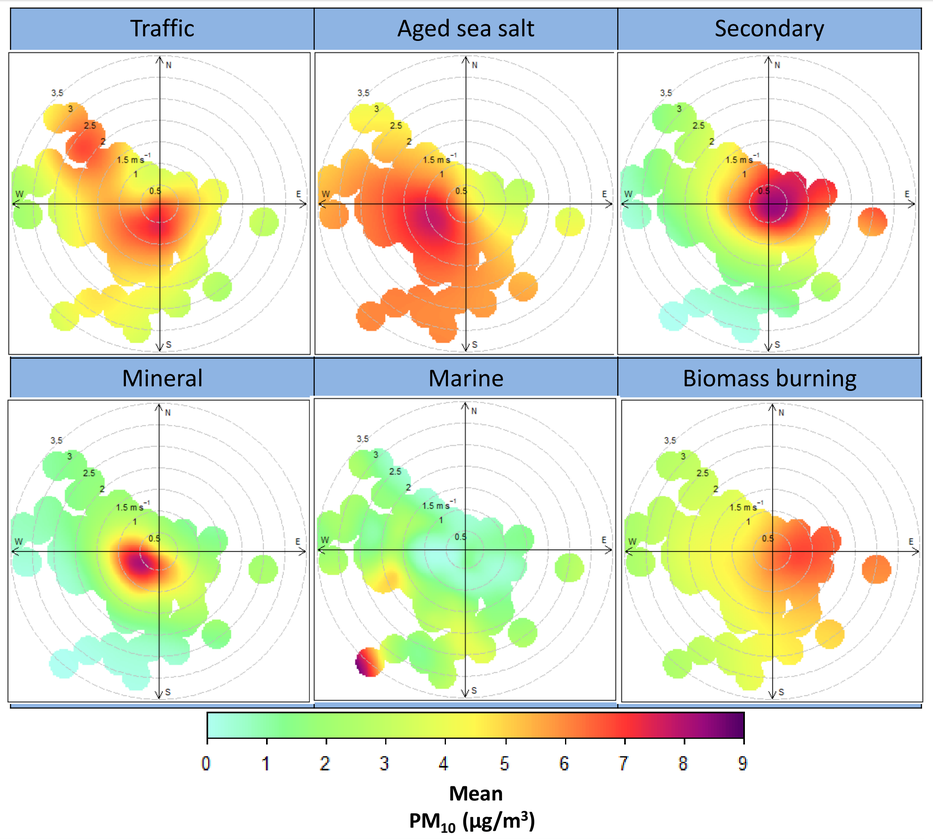


Fig. 5. Polar plots of daily particulate matter source contributions as a function of wind speed and direction in León.

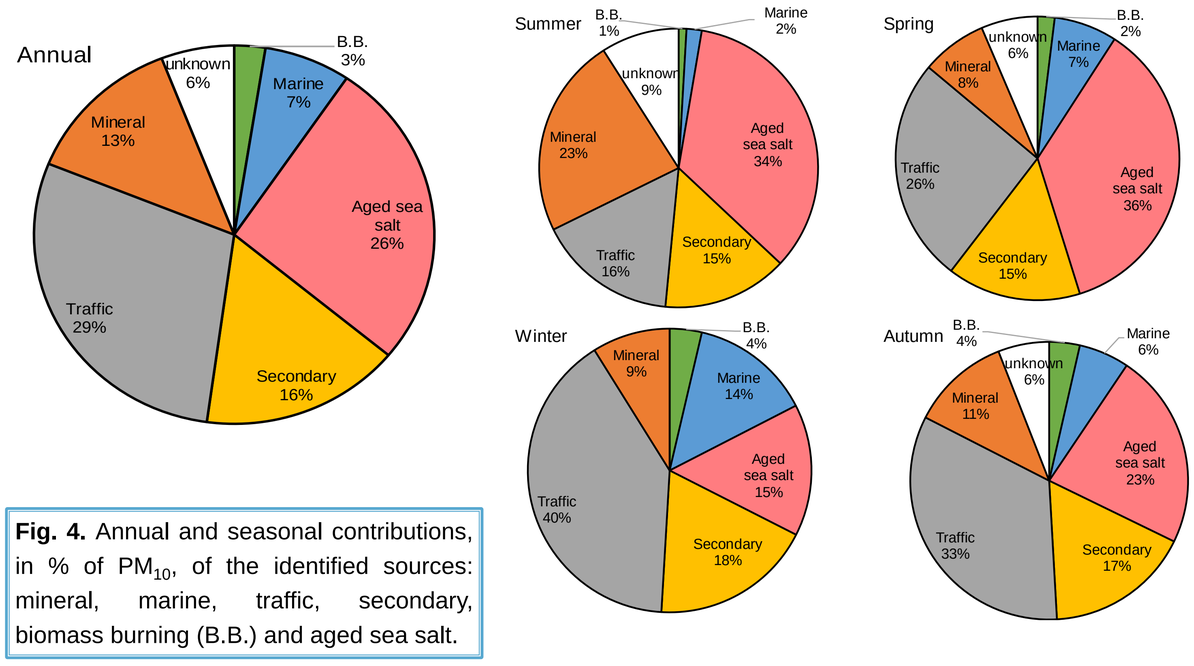


Fig. 4. Annual and seasonal contributions, in % of PM_{10}, of the identified sources: mineral, marine, traffic, secondary, biomass burning (B.B.) and aged sea salt.

Aged sea salt is the second most important factor contributing to the annual PM_{10} loads (26%). Summer and spring are the seasons with the highest representativeness of this source. This factor is characterized by a deficit of Cl^-, caused by the reaction of both SO_2 and sulfuric acid (H_2SO_4) with sea salt particles, mixed with the contribution of dust particles (Hsu et al., 2007).

Summer showed the highest mineral factor contribution, with 23%, mainly due to the high occurrence of African dust intrusions, which reached the NW of Spain.

Traffic is the prevailing aerosol source in León city in the entire year, accounting for 29% of PM_{10} mass (Fig. 4).

Secondary aerosol contributes to 16% of the PM_{10} mass and remains constant in all seasons, while biomass burning contribution increase in winter up to 4%, due to the emissions from heating devices.

The marine factor has the highest contribution in winter (14%), due to the high frequency of westerly weather types, which are characterized by humid air masses loaded with marine salts from the Atlantic Ocean.

ACKNOWLEDGEMENTS
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