The daily pattern of black carbon, ultrafine and fine particles and its dependence on air mass origin

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INTRODUCTION

Air pollution in urban sites is one of the main problems of humanity in the 21st century. Evidence of this is that, in 2019, air pollution was considered by WHO as the **main environmental risk to human health**. The study of the **daily pattern** of atmospheric pollutants is essential to establish **mitigation measures**. These actions will directly impact on multiple essential policy objectives such as air quality, economy or traffic restrictions (Viard and Fu, 2015).

The main aims of this study are:

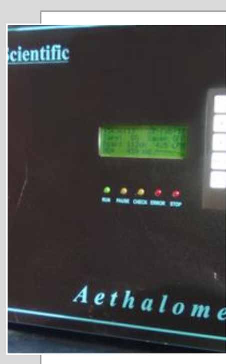
- to characterize the daily pattern of black carbon, fine and ultrafine particle concentration in León (Spain).
- to establish a methodology to fit the daily pattern of any pollutant.
- to analyze the daily pattern characteristic of each air mass origin.

MATERIAL AND METHODS

Sampling at **León** (NW Spain)

January 2016 → March 2017

High resolution nanoparticle sizer (SMPS Model 3938). Particles with diameters between 14 and 1000 nm in 104 channels were sampled.



An AE31 Aethalometer for measuring equivalent Black Carbon (eBC) concentration. The contribution of the main sources of eBC, fossil fuel (eBC_{ff}) and biomass burning plus coal combustion (eBC_{bb+cc}) was estimated applying the Sandradewi et al. (2008) approach.

A weather station to monitor some meteorological variables.

To determine the origin of air masses during the study period, HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) four-days back-trajectories were calculated every day at 1000 m (https://ready.arl.noaa.gov/HYSPLIT_traj.php) using the methodology developed by Blanco-Alegre et al. (2019).

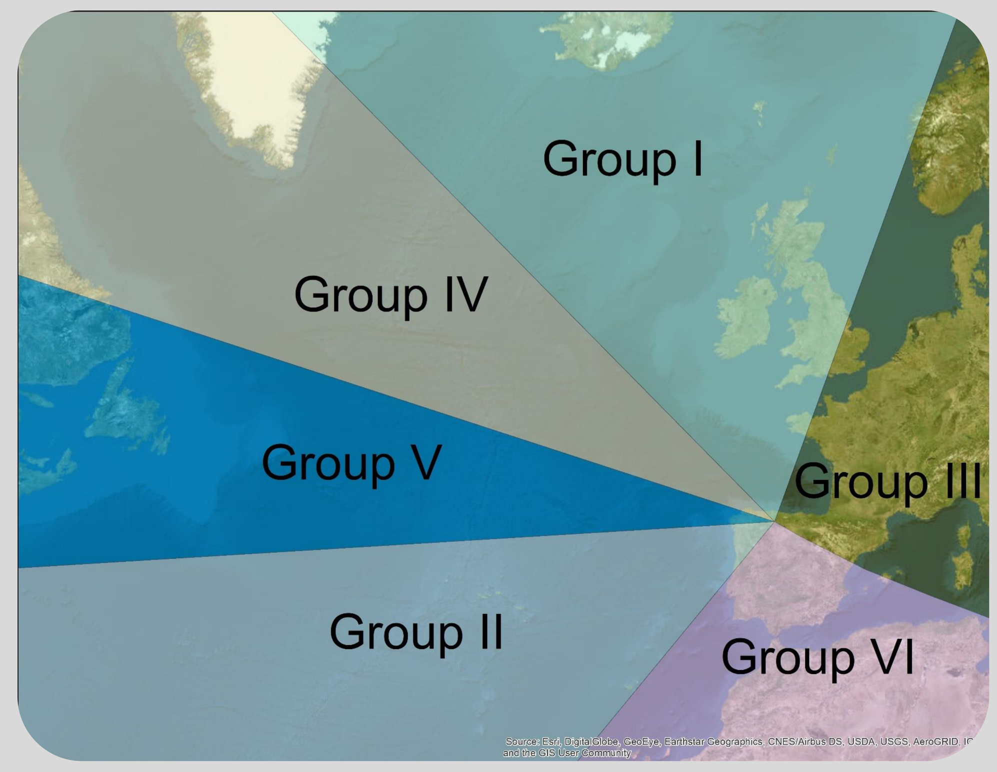


Figure 1. Air mass classification: Arctic (I); Atlantic (II); Continental (III); North America (IV); North Atlantic (V) and Saharan (VI).

RESULTS

Data were fitted to a lognormal distribution in order to parameterized the daily pattern of eBC_{ff} and eBC_{bb+cc} at cold and warm months with an R^2 between 0.93 and 0.99 (**Fig. 2**).

The Absorption Ångström Exponent (AAE) shows high values (near to 1.60) during cold seasons at night-time. It is probably caused by the emissions from household combustion of coal and biomass (**Fig. 3**).

Figure 4 shows the frequency for each air mass category during the sampling campaign (**399 days**) as result of the retrotrajectory analysis showed in **Fig. 5**.

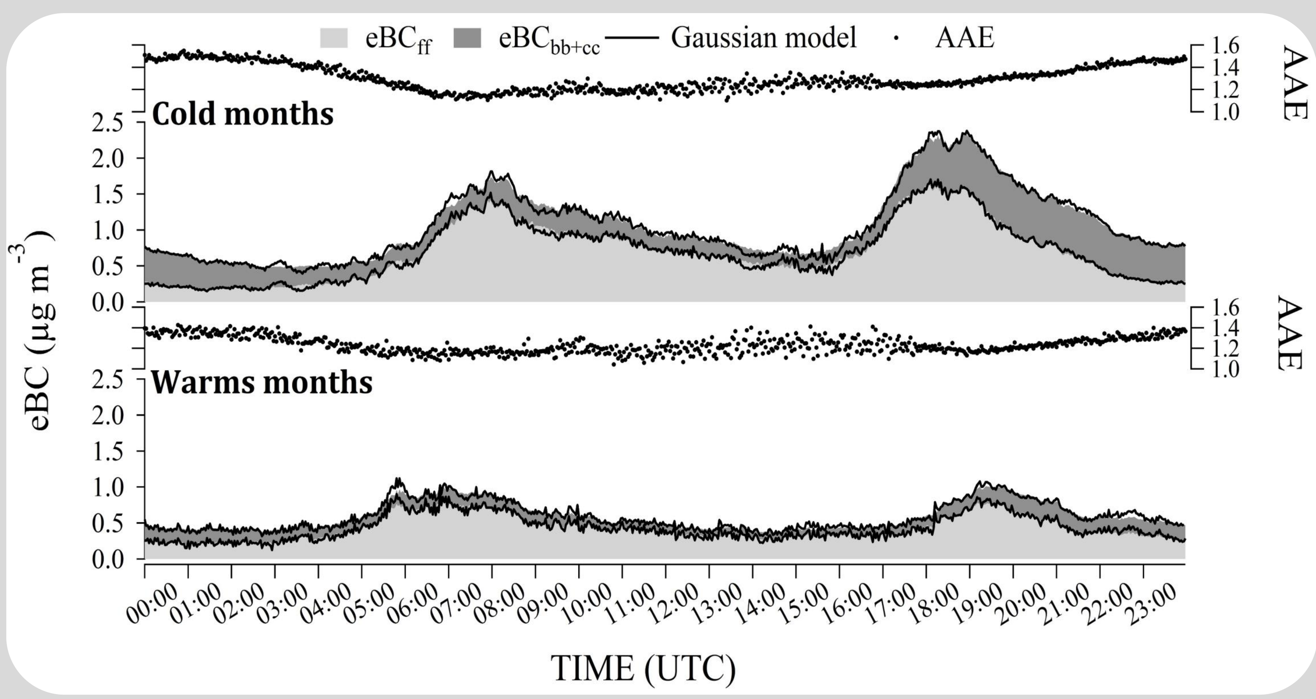


Figure 2. Daily pattern during cold and warm months of AAE and total eBC discerning between its components: eBC_{bb+cc} (dark grey) and eBC_{ff} (light grey) measured during sampling. The continuous lines show the Gaussian fitting.

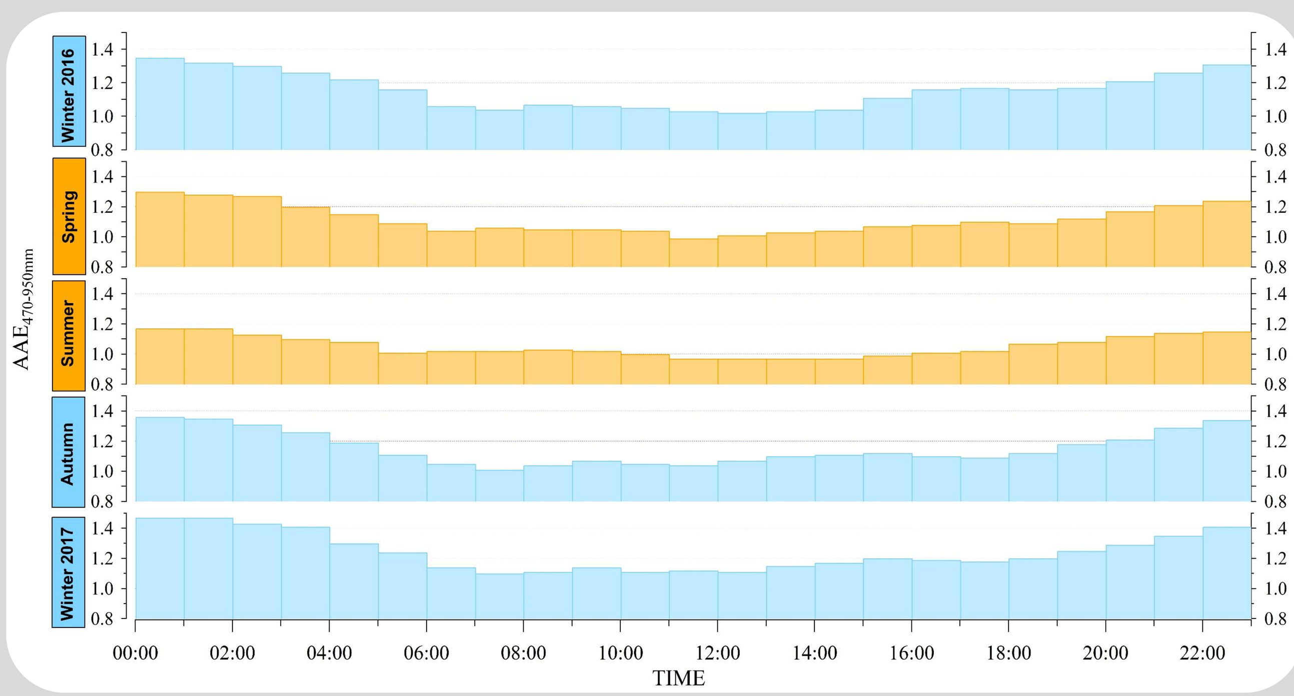


Figure 3. Daily pattern of Absorption Ångström Exponent (AAE) by seasons measured at León.

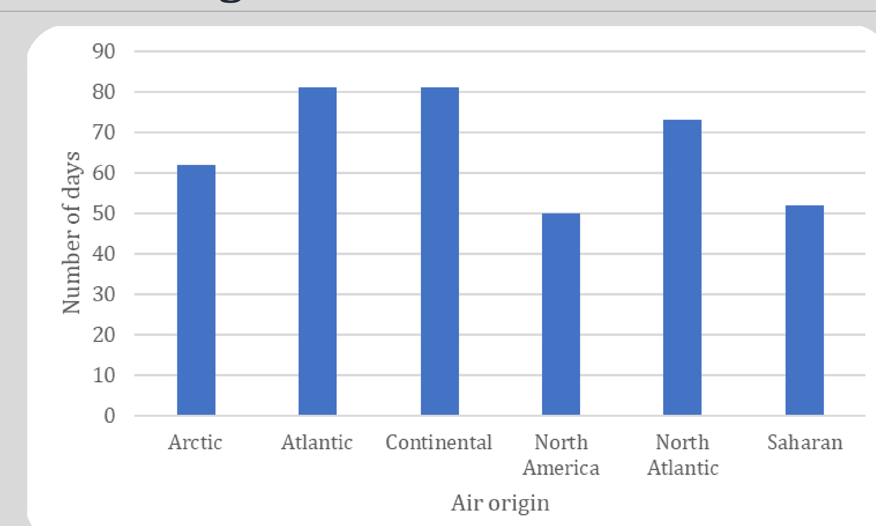


Figure 4. Number of days of each air mass origin during the sampling campaign.

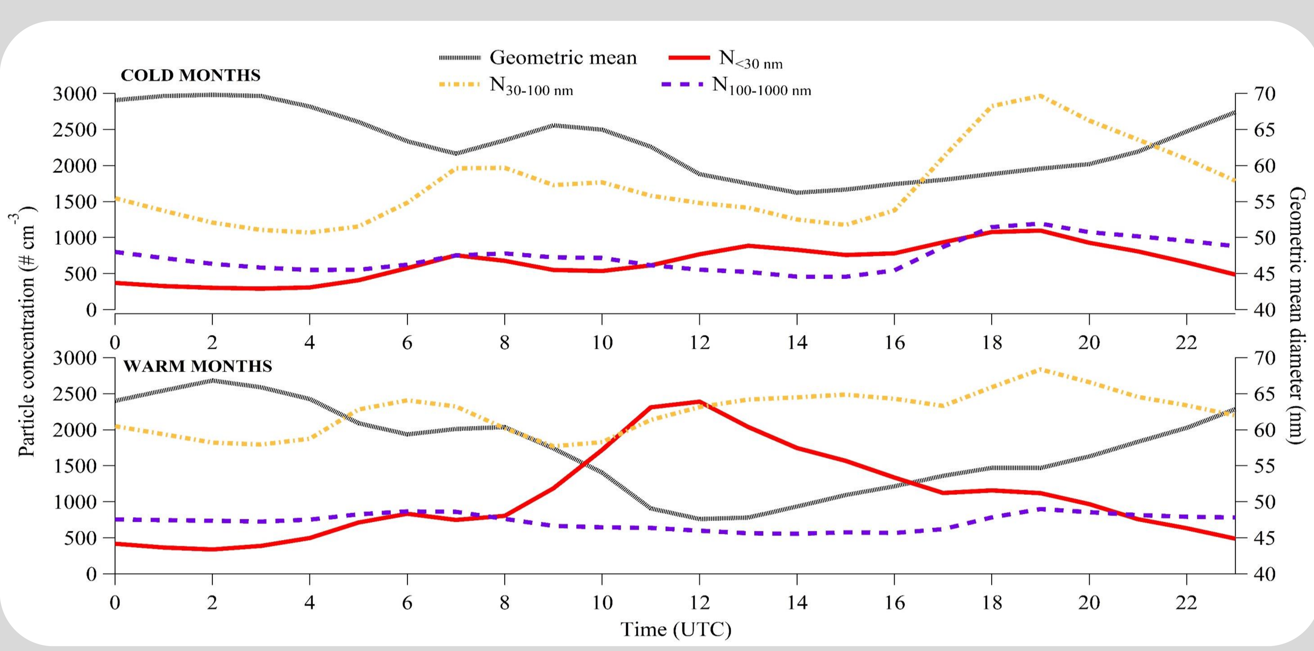


Figure 6. Daily pattern during cold and warm months of nucleation ($N_{<30\ nm}$), Aitken ($N_{30\text{-}100\ nm}$) and accumulation ($N_{100\text{-}1000\ nm}$) modes and geometric mean diameter of particles measured during sampling campaign.

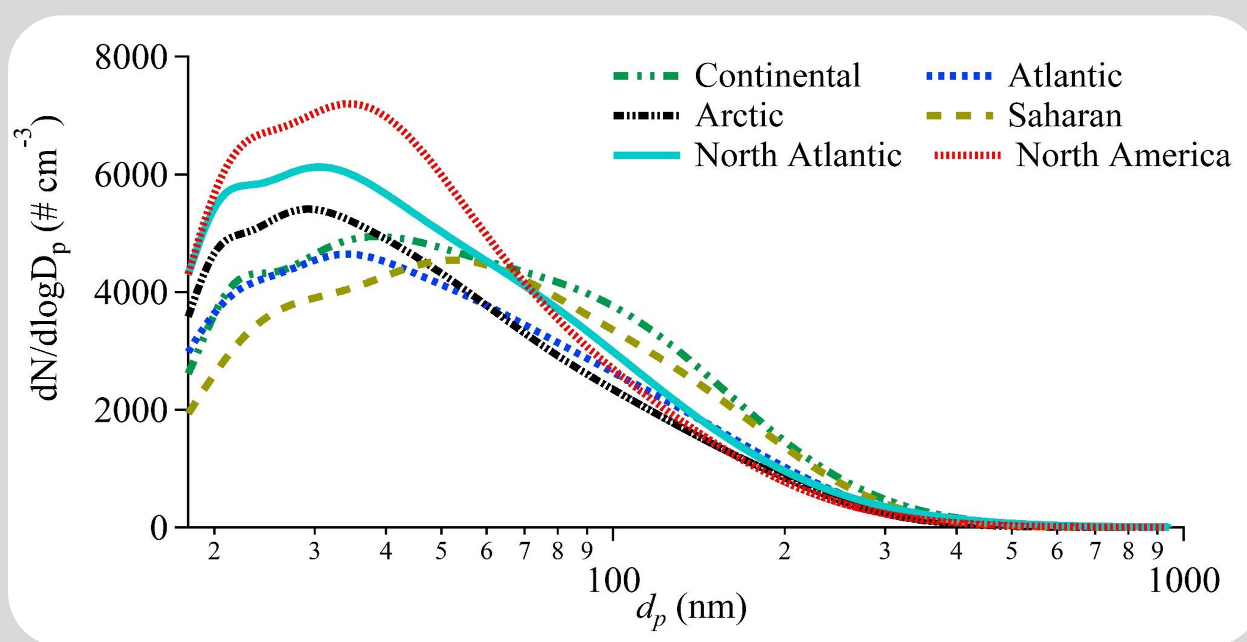


Figure 7. Aerosol particle size distribution characteristic of each air mass group (see **Fig.1**).

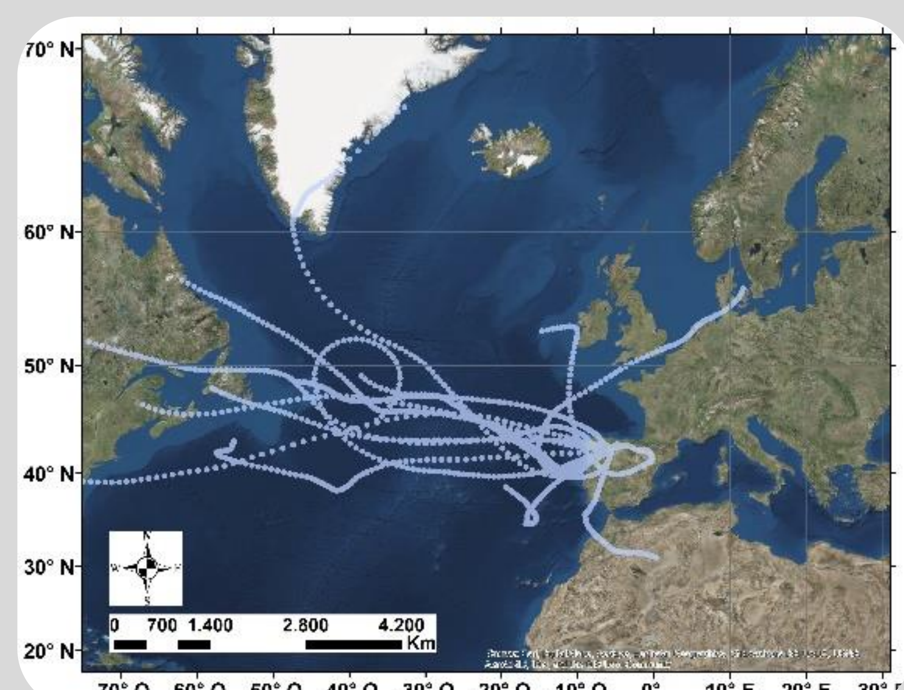


Figure 5. Example of four-days back trajectories arriving at León at 1000 m a.g.l during autumn 2016.

Nucleation mode ($N_{<30\ nm}$) presents higher values in warm months and at the central hours of the day due to the occurrence of new particle formation events. Furthermore, two peaks corresponding to the entries (0600-0700 UTC) and exits (1700-1800 UTC) to schools and works are registered (**Fig. 6**).

The characteristic aerosol particle size distribution of each air mass trajectory was obtained (**Fig. 7**). European Continental and Saharan desert origins show the highest number of aerosol particles with diameters higher than 65 nm. All air mass trajectories present a trimodal fitting, except Arctic origin that present four peaks.

CONCLUSION

The study of daily patterns of pollutants, by air mass origin in a coal-mining region, will contribute to improve air quality models in the suburban areas of NW of Iberian Peninsula. Further, this new methodology can be helpful in the establishment of mitigation measurements.

References

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