A plague of fires in the NW of Iberian Peninsula: the scavenging effect of rain on air quality

C. Blanco-Alegre[1], A.I. Calvo[1], F. Oduber[1], A. Castro[1], E.D. Vicente[2], A. Vicente[2], E. Valdemar[2], M. Evtyugina[2], C. Alves[2], T. Nunes[2], J. Barata[2], M. Cerqueira[2], F. Lucarelli[3], S. Nava[3], G. Calzolai[3] and R. Fraile[1]

[1]Department of Physics, IMARENAB University of León, León, Spain
[2]Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Aveiro, Portugal
[3]Department of Physics and Astronomy, Università di Firenze and INFN-Firenze, Sesto Fiorentino, Italy
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Presenting author email: cblaa@unileon.es

INTRODUCTION

Forest fires have a strong influence on air pollution, one of the major problems that concerns human health and climate. An example is the set of fires that occurred in the North of Spain (Galicia, Asturias and León) and the North of Portugal in October 2017.

Between 14 and 16 October, more than 100,000 ha were burned, and the plumes reached several cities of the northwestern Iberian Peninsula, including León. Two rainfall events occurred in León during and after wildfires. Besides, a Saharan intrusion over León occurred the same days.

The aim of this study is to present the main results of the chemical analysis of air filters and rain samples collected during this period.

During wildfire | After rain

Figure 1. Images of León city during fires and the day after rain.

LEÓN (NW SPAIN)
Sampling: 16 - 18 October 2017

RAINFALLS:

- RAINFALL1 - On 16 October 2017 at 1509 UTC: duration of **128 minutes** and an accumulated rainfall of **0.84 mm**.
- RAINFALL2 - On 17 October 2017 at 0154 UTC: duration of **582 minutes** and an accumulated rainfall **of 4.84 mm**.

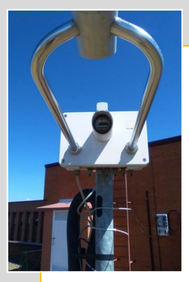
4 quartz filters → **2 teflon filters** → **2 rain samples** → **2 quartz filters from rain samples**

SAMPLING INSTRUMENTS

A High-Volume Air Collector, CAV-A/Mb model equipped with 150 mm diameter quartz filters

A Low Volume Collector TECORA ECHOPM that operates with 47 mm diameter teflon filters

An automatic wet-only collector Eigenbrodt model UNS130/E

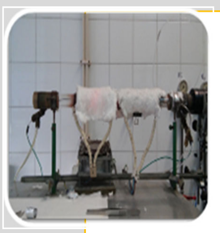


A Laser Precipitation Monitor (LPM) of Thies Clima to register rainfall, on one-minute basis.

Figure 2. Quartz filters after sampling:
- air (during fires)
- rainwater filtering.

ANALYSIS

Gravimetric quantification of PM_{10} quartz filters using an electronic microbalance (Mettler Toledo, XPE105DR)



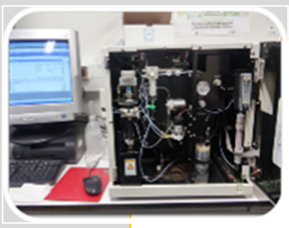
A thermal–optical technique (Pio et al., 2011) for the determination of elemental and organic carbon

Ion chromatography for the quantification of water-soluble inorganic ions

PIXE (Particle-Induced X-ray Emission), following the methodology described by Lucarelli et al. (2015), for the determination of the major trace elements

Gas chromatography–mass spectrometry (GC–MS) for organic speciation, including polycyclic aromatic hydrocarbons (PAH) and aliphatics

Mannosan and levoglucosan concentrations by ion chromatography



Dissolved organic carbon (DOC) content in rain samples by combustion and infrared detection in a Total Organic Carbon Analyzer from Shimadzu (TOC-VCPH)

RESULTS

- The maximum **hourly PM_{10}** concentration registered during wildfires was **100.6** µg m^{-3}, whilst before the event the mean daily PM_{10} concentration was 13.9 µg m^{-3}.
- A total accumulated rainfall of 5.7 mm was registered.

- After rainfall, the rain scavenging caused a **decrease of PM_{10}** concentration of **42 %**.

The maximum total carbon concentration registered by thermal-optical technique was **4.9** µg m^{-3} with an **OC/EC** ratio of **5.6**.

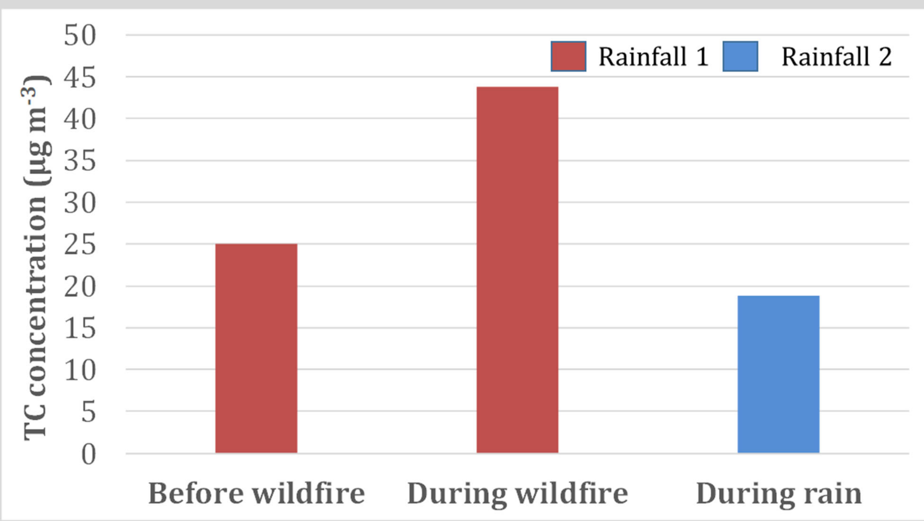


Figure 4. Total carbon concentration (µg m^{-3}) in rain samples during wildfires and after wildfires.

- The PIXE analysis indicates the high concentration of trace fire element (**K**) in León (Figure 3) (**3 times higher** than the mean concentration obtained during a sampling campaign of 13 months), together with typical elements of Saharan outbreaks (Si, Al).
- The **Total Carbon** concentration (µg m^{-3}) in **rain samples** indicate the scavenging effect (Figure 4).

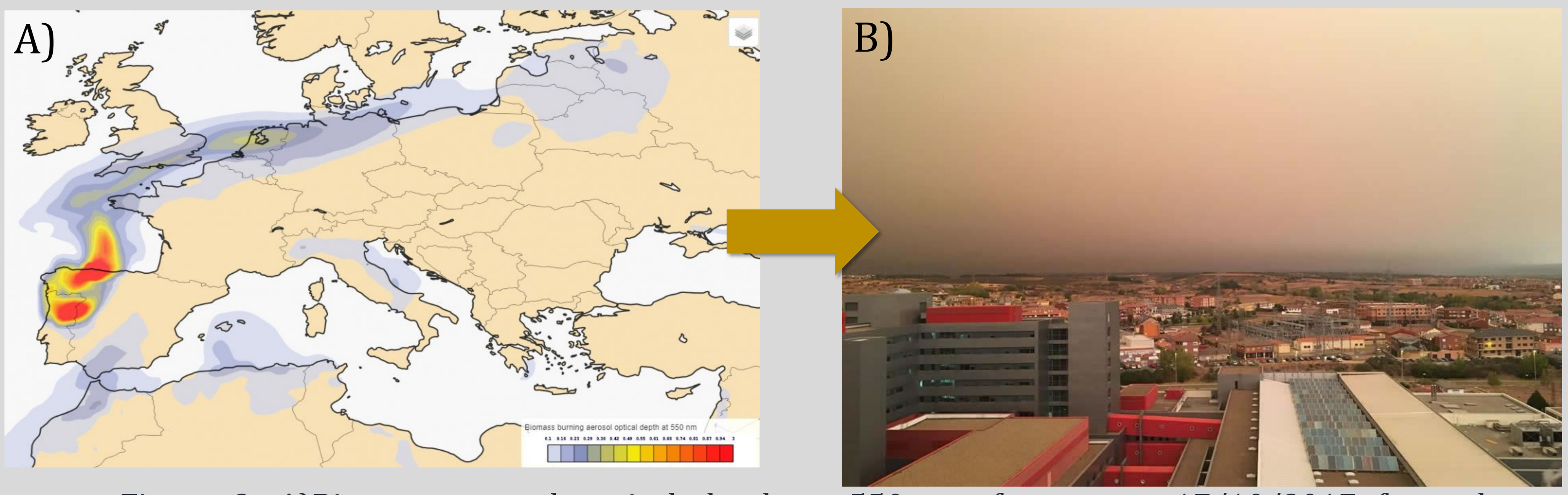


Figure 2. A)Biomass aerosol optical depth at 550 nm forecast at 17/10/2017 from the Copernicus Atmosphere Monitoring Service. B) Image of atmospheric aerosol burden over León.

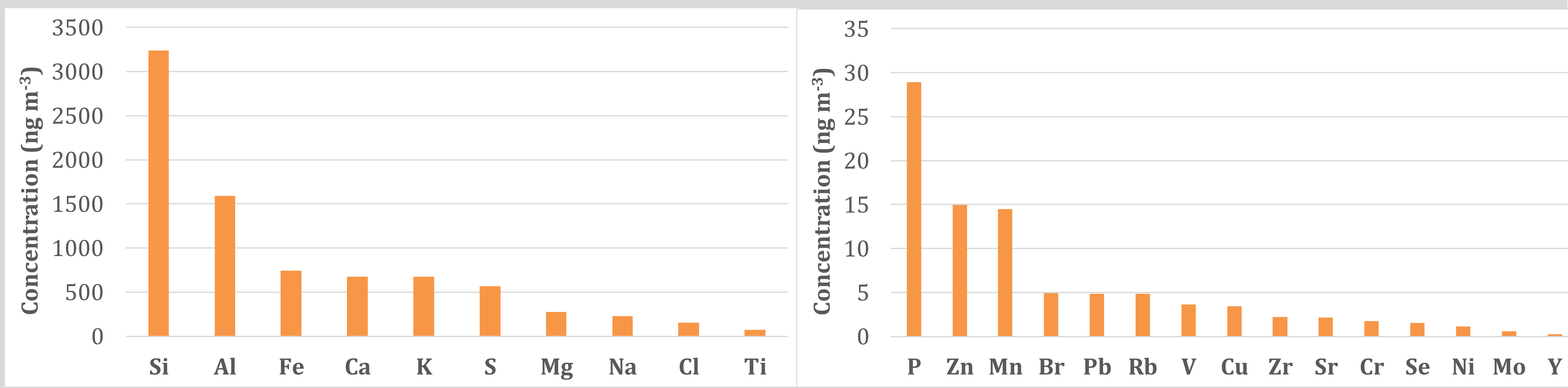


Figure 3. Determination of the major trace elements through PIXE (Particle-Induced X-ray Emission) analysis.

Two tracers of biomass burning presented high concentration during these days: **Levoglucosan** concentrations were **100 and 137** ng m^{-3}, and **mannosan** concentrations were **10 and 20** ng m^{-3}, before and after first rainfall, respectively.

Conclusions

- The rain samples and PM_{10} obtained during wildfires bring to light the effective scavenging caused by rain. However, the chemical analysis did not reflect a clear scavenging after rainfalls.
- The analysis of trace elements will allow us obtain the elements profile with wildfire and Saharan intrusion through Positive Matrix Factorization (PMF).
- This study complements a previous work already presented (Blanco-Alegre et al., 2018) on the physical properties of aerosols and precipitation in this sampling campaign.

References

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