

INVESTIGACIÓN
EN MARCHA. Evaluación de la actividad investigadora.
TESIS DOCTORAL
CURSO 2025-26



DOCTORADO EN
MEDIO AMBIENTE Y SOSTENIBILIDAD
UNIVERSIDAD MIGUEL HERNÁNDEZ DE ELCHE



Título provisional:

Physico-chemical properties of Brown Carbon in atmospheric aerosols. Analysis of its acellular and cellular toxicity

Doctorando:

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DOCTORAL PROGRAMME ENVIRONMENT AND SUSTAINABILITY

Thesis title

**Physico-chemical properties of Brown Carbon in atmospheric aerosols.
Analysis of its acellular and cellular toxicity**

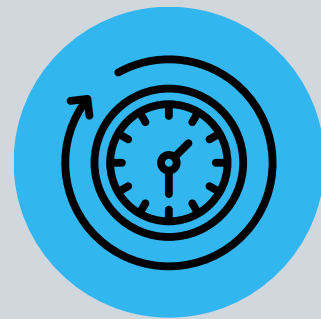
PhD Student name: Hend Ferchichi

Supervised by Eduardo Yubero Funes & Nuria Galindo Corral

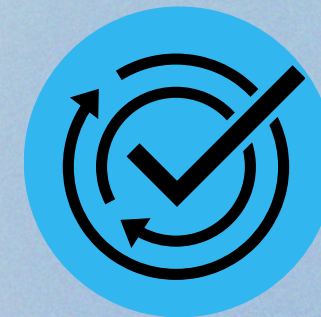
Academic year: 2025-2026



Objectives



Research Progress/timeline



EXPECTED RESULTS & IMPACT

Objectives



To characterise the physicochemical properties of Brown Carbon (BrC) and estimate its concentrations in PM_{2.5} samples collected in urban and rural environments.



To compare its contribution in urban and rural environments, analysing the effect of meteorology and specific events such as agricultural waste burning



To compare BrC light absorption determined by optical and spectrophotometric analysis.



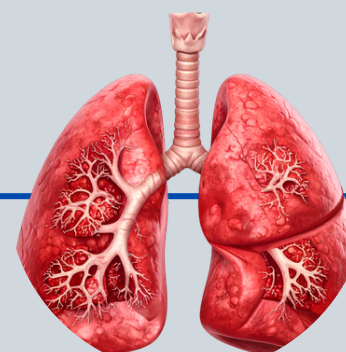
To assess the relationship of BrC and other aerosol components with acellular and cellular toxicity assays

State of Art



Climate

BrC absorbs solar radiation and contributes to global warming, but its radiative forcing remains highly uncertain compared with black carbon.



Health

Metals, Humic-like substances (HULIS) and quinones generate reactive oxygen species (ROS). Studies linking BrC, oxidative potential and health are still scarce in Spain.



Methodology

There are no standardised methods to quantify BrC absorption e.g., direct optical measurements versus spectrophotometric analysis of solvent extracts), which hinders comparison between studies.

SAMPLING

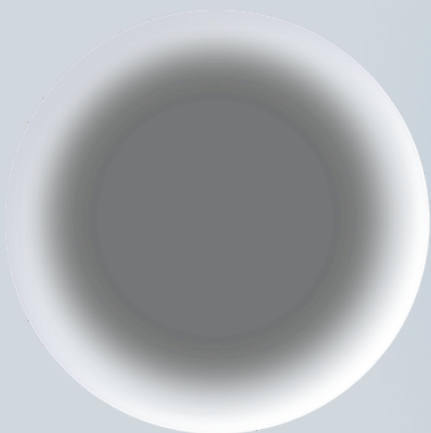


SUBURBAN BACKGROUND : UMH-ELCHE

Low traffic Volume, heating, and urban activity.



Blank filters before measuring

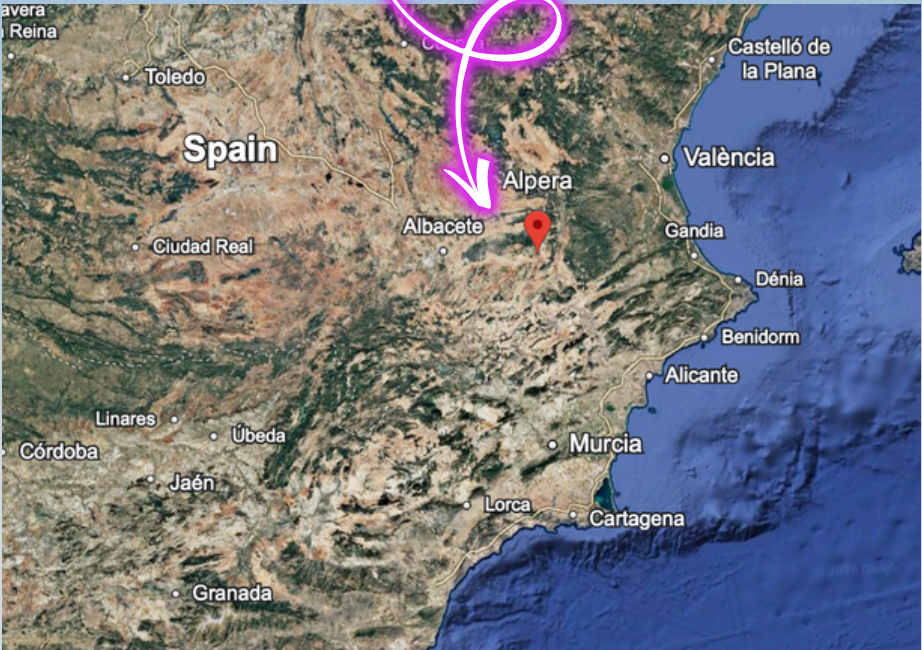
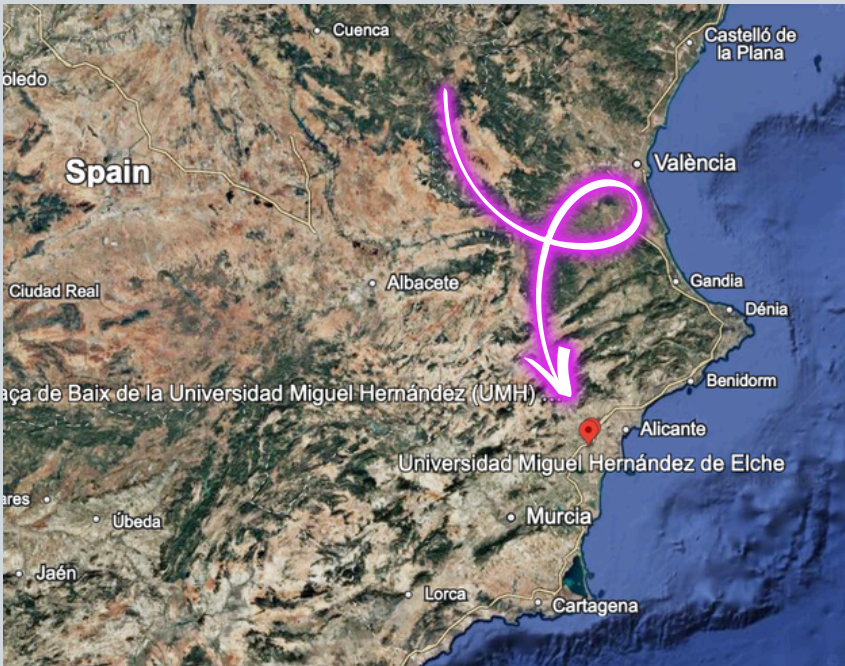


filter with PM2.5 particles



RURAL BACKGROUND: ALPERA

Agricultural and biomass burning; rural setting.



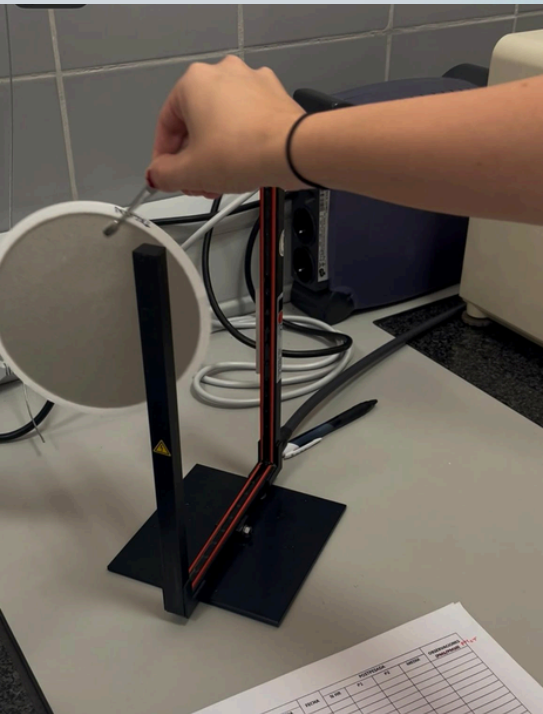
- PM_{2.5} collection with high-volume samplers
- **Simultaneous** real-time measurements of PM_{2.5} concentrations

Gravimetric Analysis

SUMMER CAMPAIGN: SUBURBAN VS RURAL

47 VALID PM_{2.5} SAMPLES AT THE SUBURBAN SITE

	Mean (µg/m³)	Standard Deviations
PM2.5	14.45	5.55



WINTER CAMPAIGN: SUBURBAN VS RURAL

105 VALID PM_{2.5} SAMPLES AT THE SUBURBAN SITE

	Mean (µg/m³)	Standard Deviations
PM2.5	9.27	5.87

99 VALID PM_{2.5} SAMPLES AT THE RURAL SITE

	Mean (µg/m³)	Standard Deviations
PM2.5	11.10	6.09



CHEMICAL ANALYSIS :



XRF



ANHYDROSUGARS



OC-EC

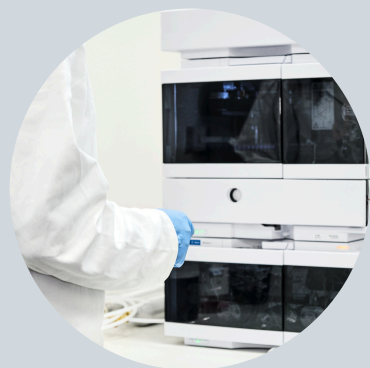


ION CHROMATOGRAPHY



TOTAL ORGANIC CARBON ANALYZER

physico-chemical analysis



**ION CHROMATOGRAPHY
(IC)**

Water-soluble ions



**ENERGY-
DISPERSIVE
X-RAY
FLUORESCENCE
(ED-XRF)**

Trace elements and
metals.



TOC ANALYZER

Water-soluble
organic carbon
(WSOC) and
inorganic carbon
(IC).



OC-EC ANALYZER

Organic Carbon (OC)
and elemental (EC)
carbon.



**UV
SPECTROPHOTOMETRY**

Optical properties
and light absorption.

Title: Estimation of the biomass burning contribution to rural and urban aerosols

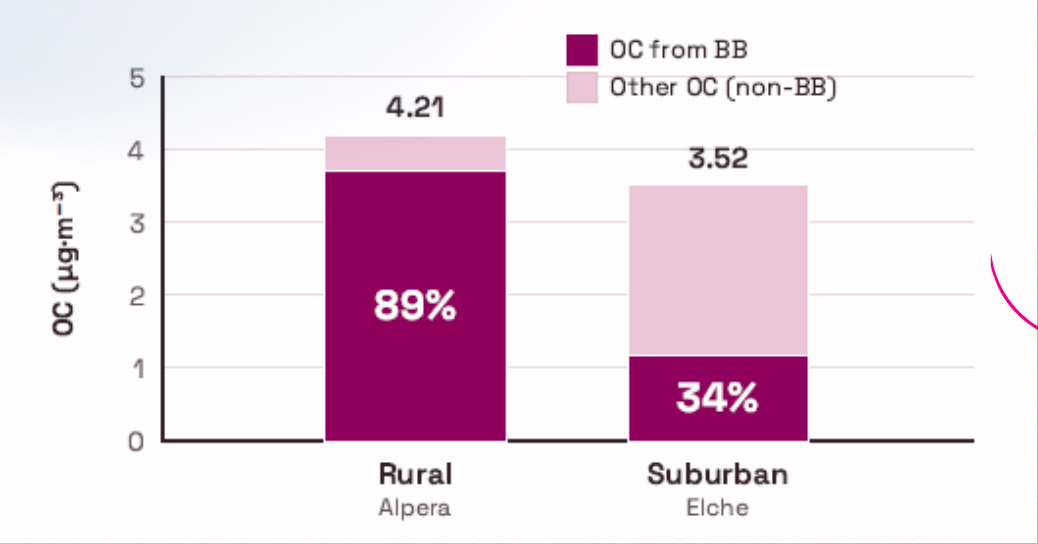


Figure 1: Biomass burning (BB) Vs Other OC

The biomass-burning fraction of organic carbon was estimated from levoglucosan, following the methodology of Nirmalkar et al. (2020)

$$OC_{BB} = Levoglucosan \times f$$

where f is the OC to levoglucosan ratio in **BB** aerosols. The remaining OC is associated with other combustion activities or atmospheric process.

BB is the dominant source of OC in winter: $OC_{BB} \approx 89\%$ of OC at the rural site **vs** $\approx 34\%$ at the suburban site.

The levoglucosan/mannosan ratio is a well-established diagnostic ratio for BB source identification. L/M values range from 3 to 6 for **softwood (Conifers)** and 13 to 25 for **hardwood**, while crop residue yields significantly high ratios

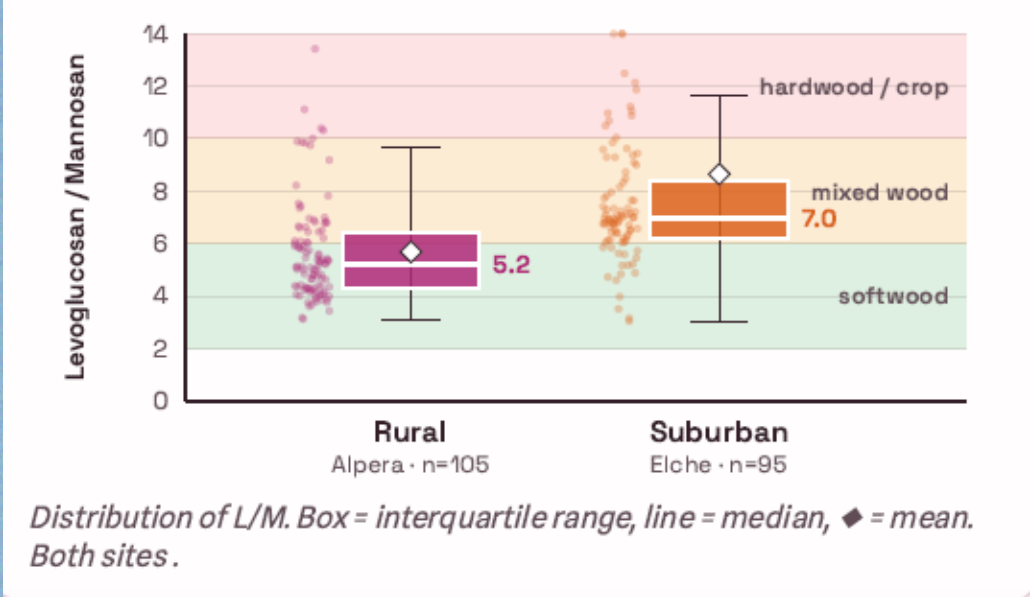


Figure 3: Levoglucosan /Mannosan Distrubution

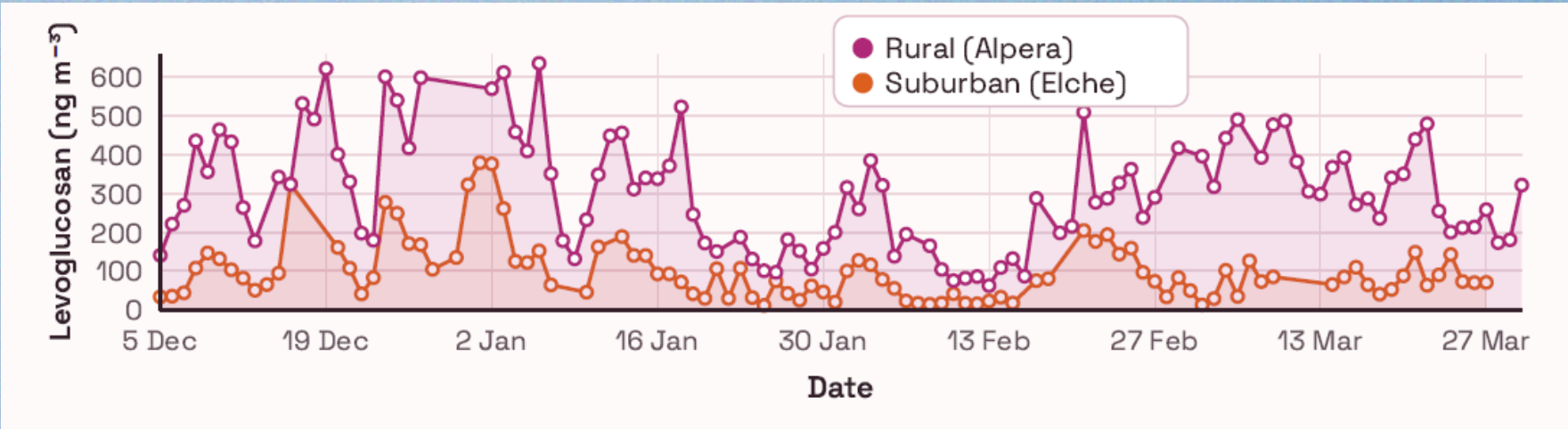


Figure 2: Levoglucosan Variation through the campaign at both sites

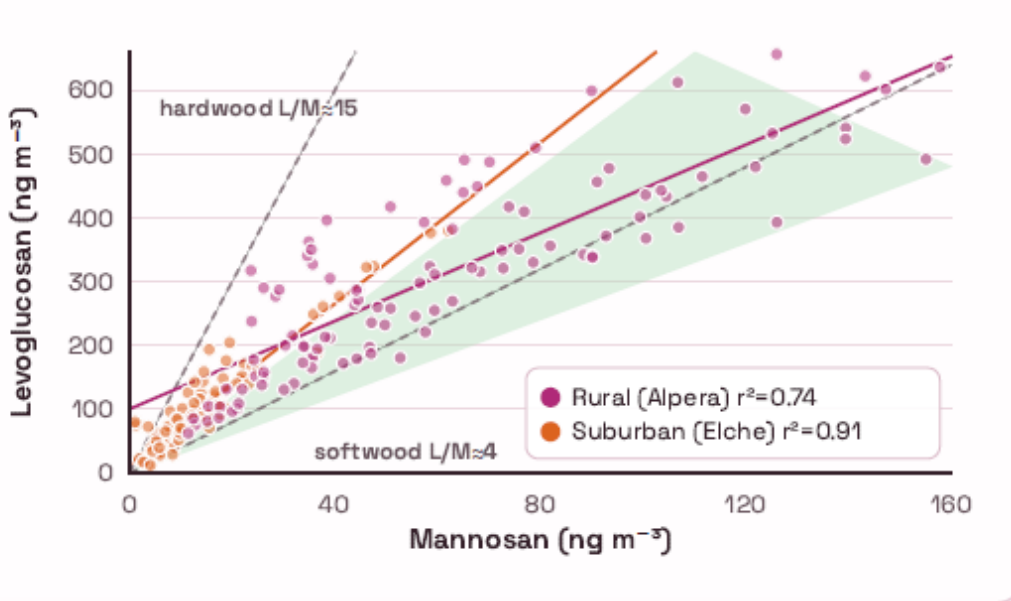


Figure 4: Wood-type signature

At the suburban site, concentrations remained elevated throughout the December–January heating period and gradually decreased through March. Meanwhile, concentrations at the rural site were consistently higher.

THREE-YEAR WORK PLAN

Done

undone

TASKS	S1	S2	S3	S4	S5	S6
Sampling campaigns and real-time measurements						
Sample analysis and source apportionment (PMF)						
Oxidative potential assays (DTT, AA)						
Cellular toxicity assays (MTT, oxidative stress)						
Results integration and statistical analysis						
Publications, dissemination and transfer						
Thesis writing and defence						

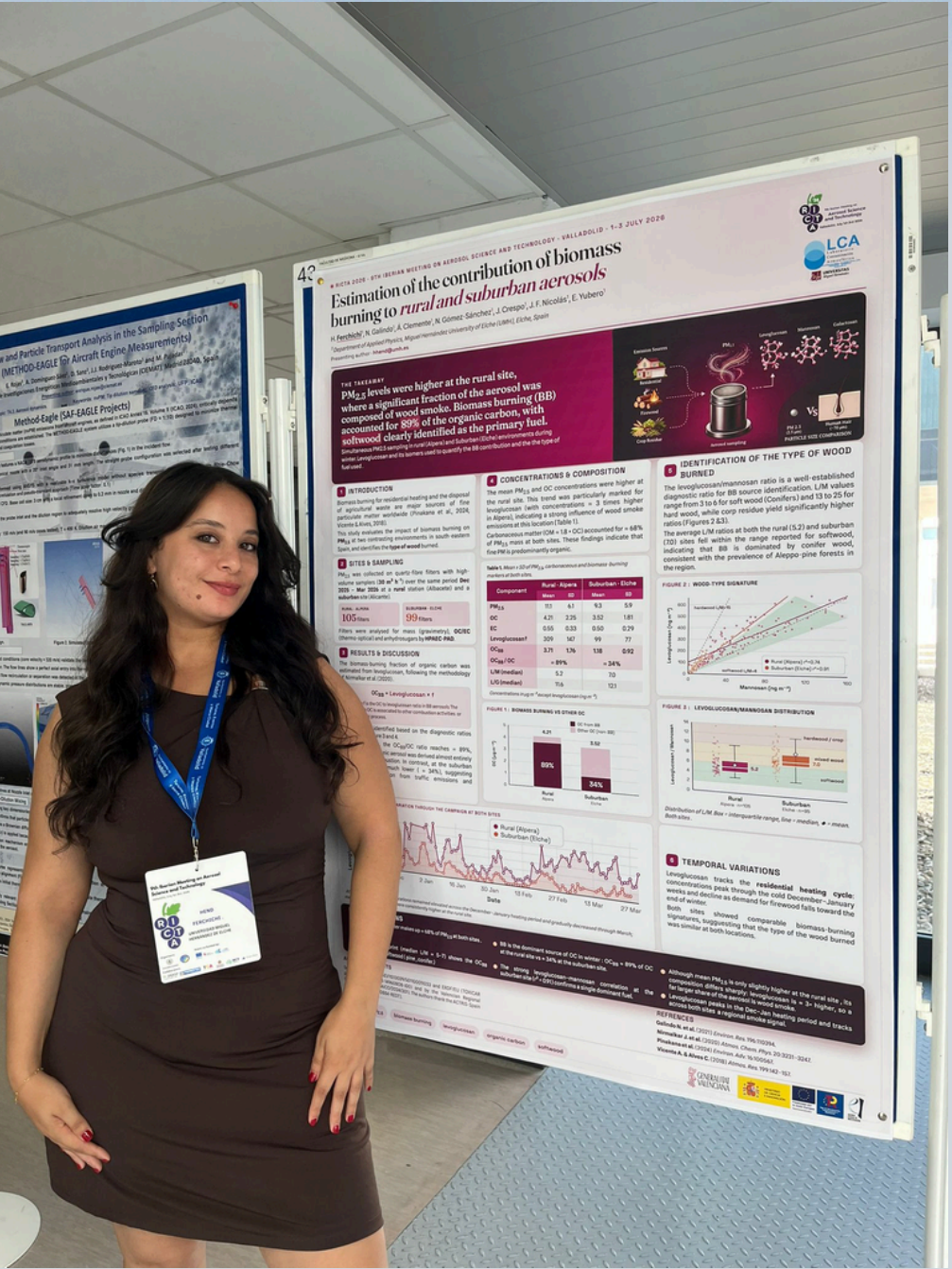
Activities and courses related to the PhD program

CONGRESS: RICTA – 9TH IBERIAN MEETING ON AEROSOL SCIENCE AND TECHNOLOGY: 1- 3 JULY 2026. PRESENTATION OF 4 POSTERS:

- Estimation of the biomass burning contribution to rural and urban aerosols. **H. Ferchichi**, N. Galindo, Á. Clemente, N. Gómez-Sánchez, J. Crespo,J.F. Nicolás, E. Yubero
- Cytotoxic effects of PM_{2.5} from rural and urban sites on A549 cells. N. Gómez-Sánchez, N. Galindo, M. Alfosea-Simón, **H. Ferchichi**, Á. Clemente, J.F., Nicolás, J., Crespo y E. Yubero.
- PM10 chemical composition at two sites in the Dominican Republic: A comparative assessment of carbonaceous components. A. Binet-Álvarez, N. Gómez-Sánchez, **H. Ferchichi**, M.J. Lozoya, E. Yubero, N. Galindo.
- Impact of Saharan dust on light absorption by Black Carbon at an urban background station. M. Alfosea-Simón, N. Galindo, N. Gómez-Sánchez, L. Pastor, **H. Ferchichi**, Á. Clemente, J. Crespo, J.F. Nicolás, E. Yubero

Future Activities and courses related to the PhD program

- ACTRIS AEROSOL IN-SITU COURSE AT NAOK (KOSETICE) : **27 SEPTEMBER -3 OCTOBER 2026**
- RESEARCH STAY ABROAD
- ATTENDING OTHER CONGRESSES AND CONFERENCES.



Thank you!!