Below cloud scavenging of pollen during rainfall events (2012-2018) in NW Spain

C. Blanco-Alegre[1], A.I. Calvo[1], F. Oduber[1], A. Castro[1], D. Fernández-González[2,3], R.M. Valencia-Barrera[2], A.M. Vega-Maray[2] , A. Rodríguez-Fernández[2], T. Molnar[4] and R. Fraile[1]

[1] Department of Physics, IMARENAB University of León, 24071 León, Spain
[2] Department of Biodiversity and Environmental Management, University of León, León, Spain.
[3] Institute of Atmospheric Sciences and Climate, National Research Council, Bologna, Italy.
[4]Institute of Agricultural Sciences and Rural Development. Szent Istvan University, Szarvas, Hungary
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Presenting author email: cblaa@unileon.es

INTRODUCTION

Air pollution is one of the main concerns of human health. It is caused by several pollutants, such as bioaerosols (like pollen, fungal spore, bacteria), that are related to human diseases such as influenza, lungs diseases or allergies (Oduber et al., 2019).

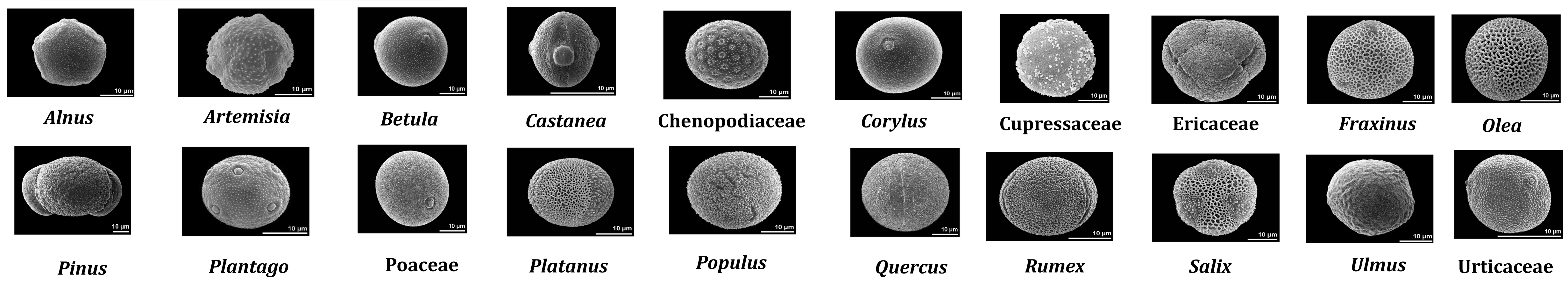
One of the main sinks of aerosols is the washing by rain. Thus, the study of Below Cloud Scavenging (BCS) under different rain intensities or rainfall amount is crucial. Therefore, the main aim of this study is to analyze the evolution of pollen concentration during rain events with different rain conditions. 20 types of pollen have been identified in this work.

Sampling campaign

2012 → **2018**

León (NW Spain)

20 pollen types



Images from PalDat – a palynological database (2000 onwards, www.paldat.org)

METHODOLOGY

The concentration-weighted average $\%\Delta C$ was determined as:

$$\%\Delta C = -\left(\frac{C_2 - C_1}{C_1}\right) \cdot 100$$

to evaluate the change in pollen concentration between t_1 and t_2 with concentrations C_1 and C_2.

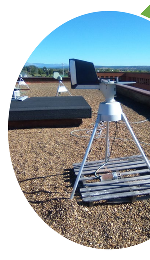
The Effective Scavenging (ES) was determined by:

$$ES = \left(\frac{N_{\Delta C\% > 0}}{N_{Total}}\right)$$

to evaluate the sensibility of each type of pollen to rain, where $N_{\Delta C\% > 0}$ is the number of events with effective scavenging and N_{Total} is the total number of events.

Selection criteria of rain events	
	Only events with complete rain and bioaerosol data
	Hourly accumulated precipitation higher than 0.1 mm
	A minimum of 2 rain-free hours between events
	Temperature and wind speed variations below ±3 °C and ±2 m s^{-1}, respectively, between 2 h before and after rain
	Global amount of pollen concentration higher than 1 grain m^{-3} before rain
	The correction by the daily pattern of each type of pollen has been taken into account to eliminate its influence (Figure 2)

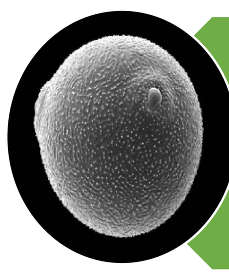
SAMPLING INSTRUMENTS



The hourly concentration of pollen of 10-100 μm size was sampled with a Hirst type volumetric sampler.

A Laser Precipitation Monitor (LPM) of Thies Clima was used to register raindrop sizes (from 0.125 to 8 mm) and velocities, on one-minute basis.

A Davis Weather Station to monitor some meteorological variables (temperature, relative humidity, wind speed and wind direction)



The hourly optical microscopic counts for the visual detection of pollen were carried out following the recommendations of the Spanish Aerobiological Network

Rain intensity groups

- Low (<1 mm h^{-1})
- Medium (1-5 mm h^{-1})
- High (>5 mm h^{-1})

RESULTS

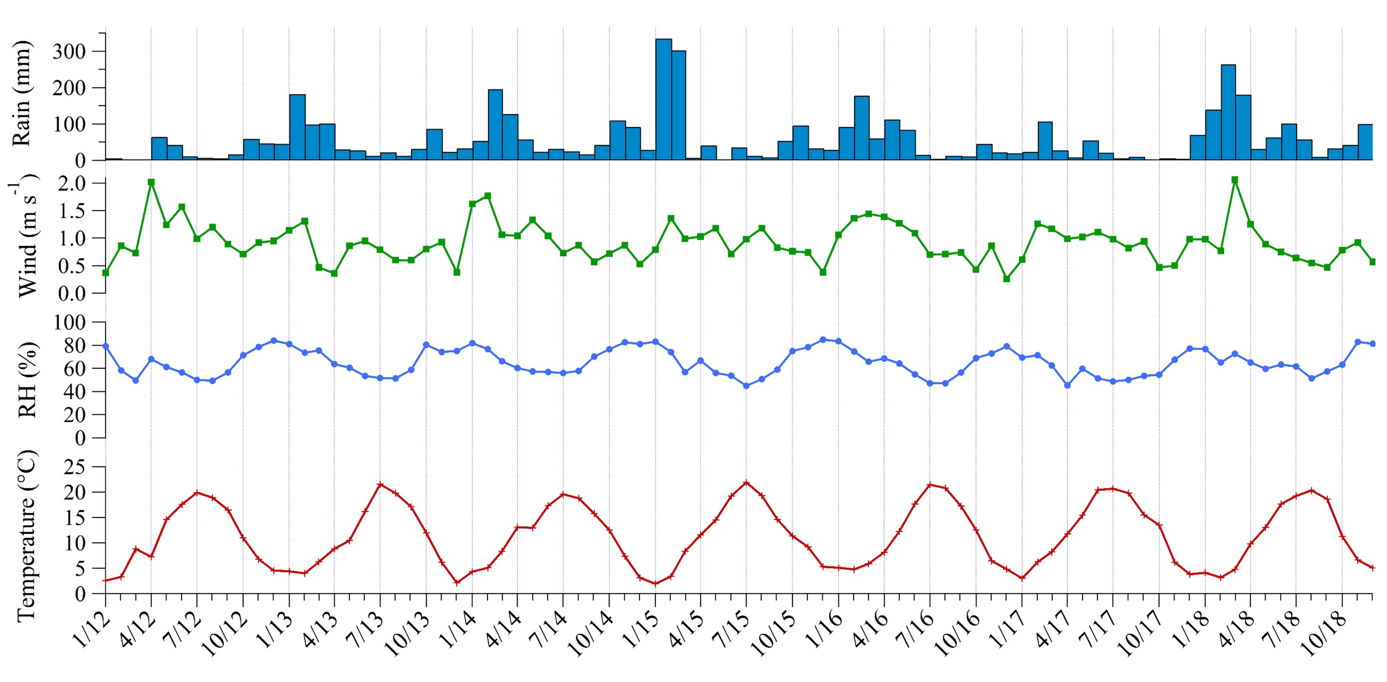


Figure 1. Evolution of monthly rain, temperature, relative humidity (RH) and wind speed averages between 2012 and 2018 in León (Spain).

- A global analysis of 184 rain events (Figure 1), along sampling campaign, was carried out.
- They presented a mean duration of 119 minutes, a mean rain accumulated of 2.3 mm and a mean rainfall intensity of 0.59 mm h^{-1}.

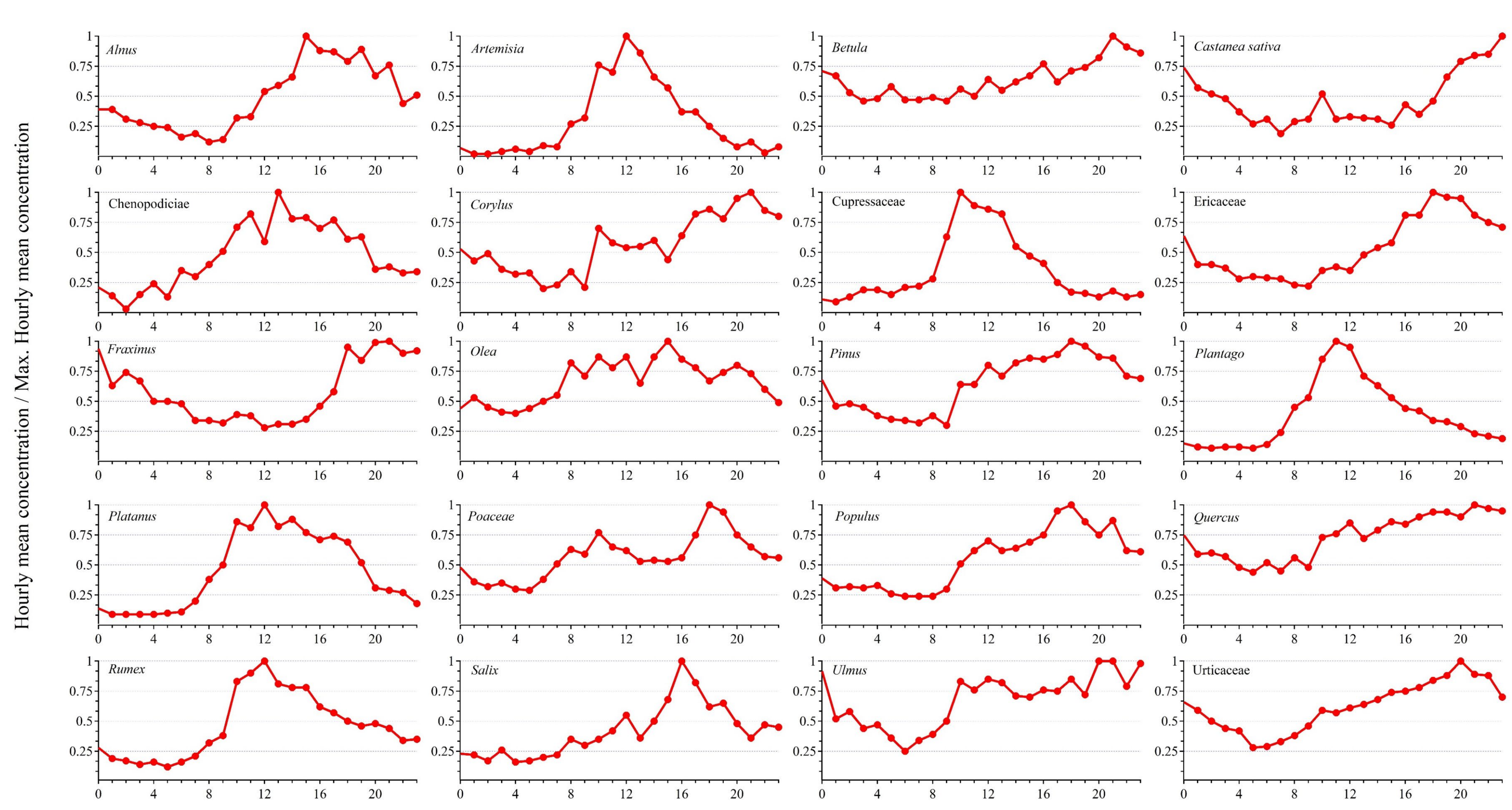


Figure 2. Daily pattern of 20 types of pollen in days without rain between 2012 and 2018 in León.

- 78 % of the total events presented effective scavenging (mean $\Delta C\%$ = 46±28 %) (Table 1).

Table 1. Mean values of $\Delta C\%$ and ES obtained for each type of pollen.

Type of pollen	%ΔC			ES		
	Low	Medium	High	Low	Medium	High
Alnus	86	70		0.84	0.67	
Artemisia	-10	100	100	0.70	1	1
Betula	57	100		0.92	1	
Castanea sativa	38	100		0.60	1	
Chenopodiaceae	72	100	14	0.57	1	1
Corylus	70	100		0.96	1	
Cupressaceae	80	96	50	0.93	1	1
Ericaceae	68		12	0.83		1
Fraxinus	54	60	57	0.86	0.88	0.67
Olea	10	97	100	0.70	1	1
Pinus	65	80	90	0.91	0.50	1
Plantago	42	75		0.80	1	
Platanus	87	100		0.83	1	
Poaceae	93	26		0.94	1	
Populus	39	4	-25	0.82	0.33	0
Quercus	83	100		1	1	
Rumex	83	-15		0.92	0.50	
Salix	83	100	100	0.86	1	1
Ulmus	57	95	-5	0.87	1	0.67
Urticaceae	50	100	74	0.80	1	1
Total pollen	45	67	30	0.77	0.75	1

- With low rain intensity, Poaceae (93 %) and Quercus (83 %) showed the highest $\%\Delta C$ values and Artemisia (-11 %) the lowest one.
- Events with medium intensities caused the highest scavenging (67 %) on total pollen concentration.
- Except *Populus*, high rainfall intensities caused an effective scavenging in all types of pollen.
- The swept volume was caused mainly by raindrop sizes between 0.5 and 0.75 mm (Figure 3).

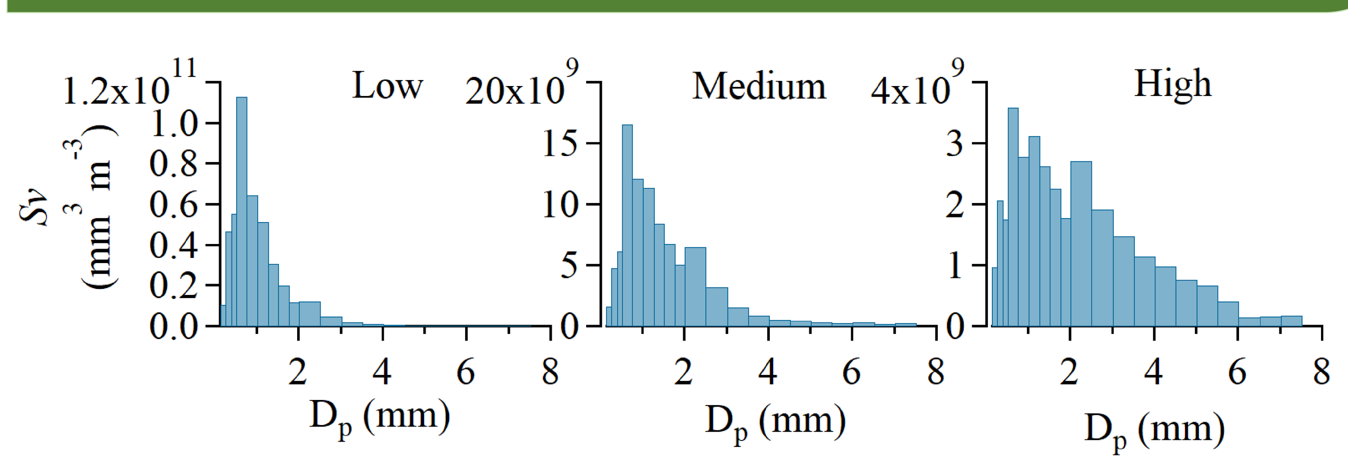


Figure 3. Swept volume by raindrop sizes during rain events for the total of pollen.

- The correction of concentration before and after rain with the daily pattern concentration in days without rain (Figure 2) is vital to analyze the scavenging effect of rain on pollen concentration.

CONCLUSION

Rain characteristics affect the effective scavenging of pollen and, furthermore, this washing effect depends on the type of pollen. This kind of studies constitutes a valuable tool for the forecast of pollen concentration after rain.

Future studies will focus on the study of scavenging effect caused by raindrops of different sizes on different pollen types, taking into account its morphology and size.

References

- Oduber, F., Calvo, A.I., Blanco-Alegre, C., Castro, A., Vega-Maray, A.M., Valencia-Barrera, R.M., Fernández-González, D., Fraile, R. (2019) Links between recent trends in airborne pollen concentration, meteorological parameters and air pollutants. Agric. For. Meteorol. 264, 16–26.

Acknowledgements

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