Below cloud scavenging on nine pollen types by different rain conditions

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INTRODUCTION

Nowadays, air quality is one of the main concerns for human health, often compromised by several pollutants, as bioaerosols (like pollen, fungal spore, bacteria), related to human diseases such as influenza, lung 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. Nine pollen types have been sampled in this work.

Sampling campaign

January 2015 → **December 2018**

León (NW Spain)

METHODOLOGY

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

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

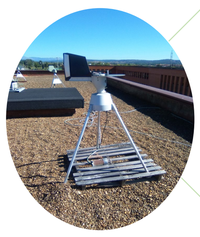
to evaluate the change in pollen concentration between t_1 and t_2 with concentrations C_1 and C_2.

The $\%ES$ was determine by:

$$\%ES = \left(\frac{N_{\Delta C\% > 0}}{N_{Total}}\right) \cdot 100$$

to evaluate the sensibility of each type of pollen.

SAMPLING INSTRUMENTS

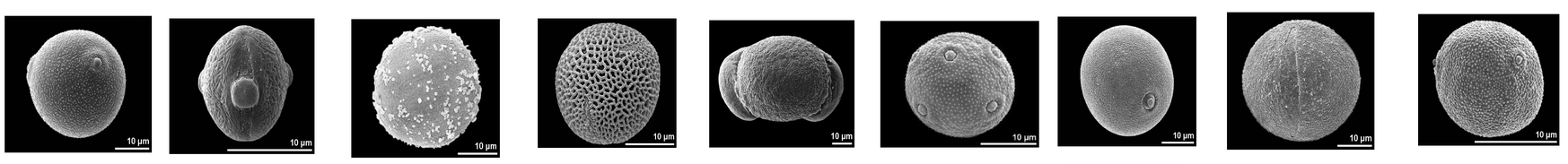


The hourly concentration of pollen of 10-100 µm size was measured with a volumetric Hirst type sampler.

A Laser Precipitation Monitor (LPM) of Thies Clima was used to register raindrops size and velocity, on one-minute basis.

A Davis Weather Station to monitor some meteorological variables

Nine pollen types



Betula | *Castanea* | Cupressaceae | Oleaceae | *Pinus* | *Plantago* | Poaceae | *Quercus* | Urticaceae

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

Rain intensity groups

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

RESULTS

- A global analysis of all rain events, 122 along sampling campaign, was carried out
- A 71% of the total events presented effective scavenging (Table 1)
- The sum of pollen concentration showed a clear scavenging ($\%\Delta C$ = 24±18 %)

Table 1. Mean, percentiles P_5 and P_{95} and quartile 2 values of $\Delta C\%$ are shown, and mean and SD of $\%\Delta C$ obtained for each type of pollen and for total pollen concentration.

	Total pollen	*Betula*	*Castanea sativa*	Cupressaceae	Oleaceae	*Pinus*	*Plantago*	Poaceae	*Quercus*	Urticaceae
N	122	11	5	47	24	31	39	49	33	24
%ES	71	82	60	66	75	55	77	78	73	63
P_5	-400	-73	0	-486	-50	-400	-105	-93	-100	-134
Q_2	50	100	100	86	100	-67	100	100	75	42
P_{95}	100	100	100	100	100	100	100	100	100	100
$\%\Delta C$	24.3	15.1	40.3	70.9	16.7	20.1	24.6	15.3	14.8	14.2
SD	17.9	5.5	4.5	39.0	5.5	15.1	6.3	7.7	7.5	9.4

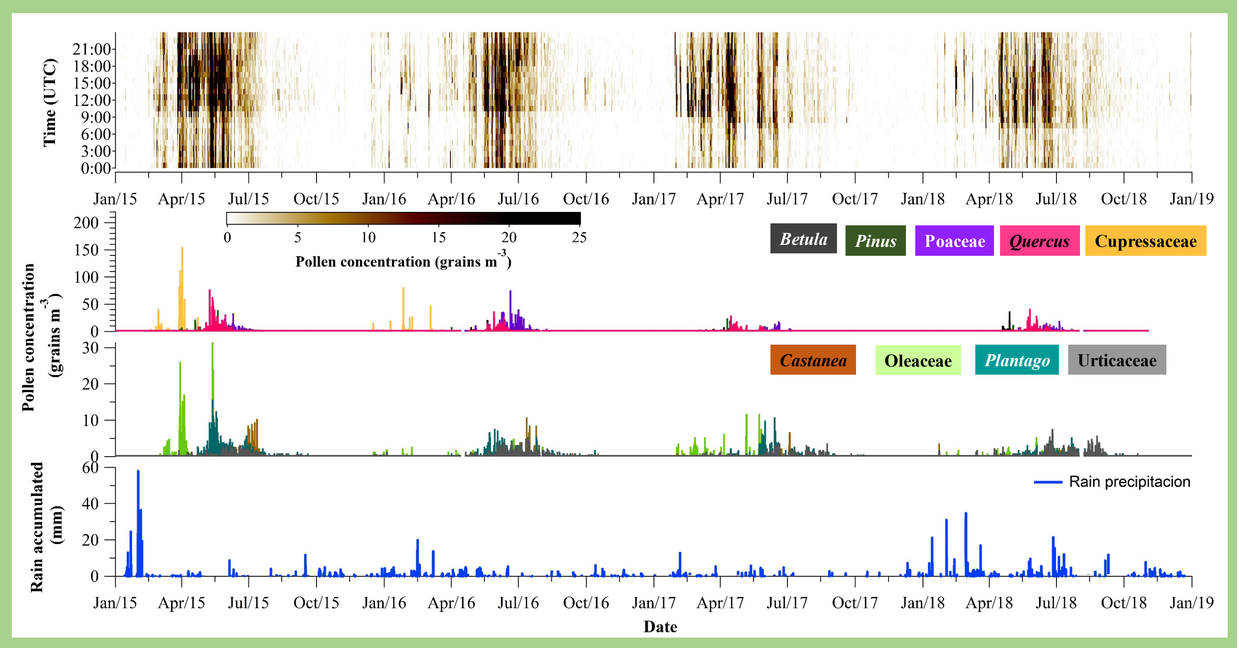


Figure 1. Distribution of rain events selected along sampling campaign. Precipitation accumulated (bars) and pollen concentration of different types show in graduate coded.

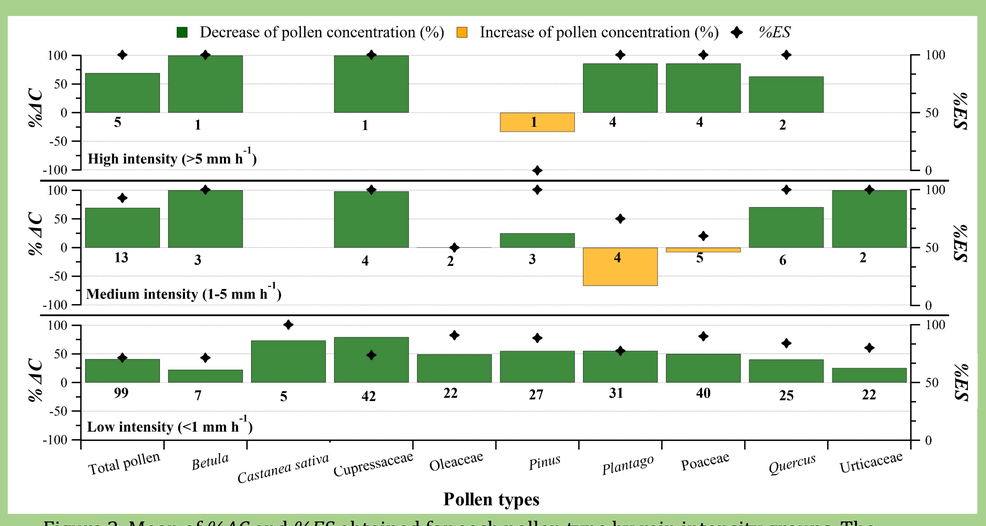


Figure 2. Mean of $\%\Delta C$ and $\%ES$ obtained for each pollen type by rain intensity groups. The number indicates the number of events.

- All pollen types presented an effective scavenging between before and after rain (Figure 2), but there were differences according rain intensity groups.
- The **medium** and **high** rain intensities caused the **highest scavenging** (69.7 and 69.2 %, respectively) on pollen concentration, mainly on *Castanea* and Cupressaceae types (Figure 2).
- The low rain intensity group presented an effective scavenging of 40.9 %.

- The number of events of each type of pollen was consistent with the precipitation characteristics in León. As in León, summer is the season with less rainfall, there are few rain events to study the washing of the most characteristic summer pollens (such as *Castanea sativa*) (Figure 1).
- The rain events presented a mean duration of **214 minutes**, a mean rain accumulated of **3.58 mm** and a mean rainfall intensity of **0.87 mm h^{-1}**.

CONCLUSION

The 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 a shower.

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.

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