Below-cloud scavenging of aerosol particles after a winter Saharan dust intrusion

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INTRODUCTION

Saharan dust intrusions are one of the main natural sources of aerosol particles in Southern Europe and mainly occur in spring and summer. So, winter Saharan dust outbreaks are uncommon events (Díaz et al., 2017). Between 21 and 23 February 2016 a Saharan dust intrusion entered the Iberian Peninsula affecting León (Spain) and causing a high pollutant burden in the city. The following day, a rain event occurred between 1154 and 1519 UTC, with an accumulated rainfall of 1.92 mm and a mean rain intensity of 0.56 mm h^{-1}.

The main goal of this study is to analyze the Below Cloud Scavenging (BCS) of aerosol particles in different size ranges and to study the influence of the rain characteristics on the scavenging after a winter Saharan dust intrusion.

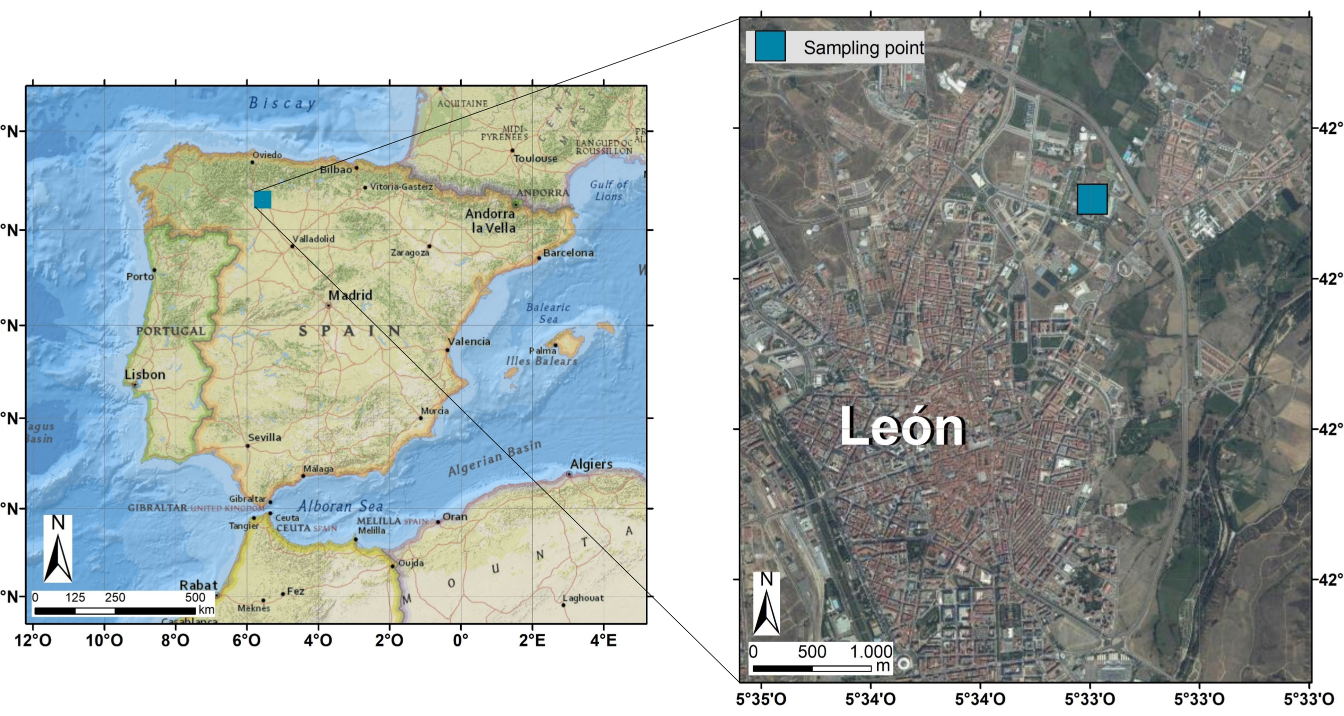


Figure 1. Geographic location of the city of León and sampling site.

LEÓN (NW SPAIN)

Sampling: 21 - 23 February 2016

The $\Delta C\%$ was determine by:

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

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

SAMPLING INSTRUMENTS

Optical spectrometer PCASP-X. Particles with diameters between 0.1 and 26.8 µm in 31 channels were measured.

High resolution nanoparticle sizer (SMPS Model 3938). Particles with diameters between 7.6 and 310.6 nm in 104 channels were sampled at dry conditions (RH < 40 %).

A laser disdrometer Thies LPM (raindrops between 0.125 and 8 mm size in 22 channels).

A Davis Weather Station to monitor some meteorological variables.

RESULTS

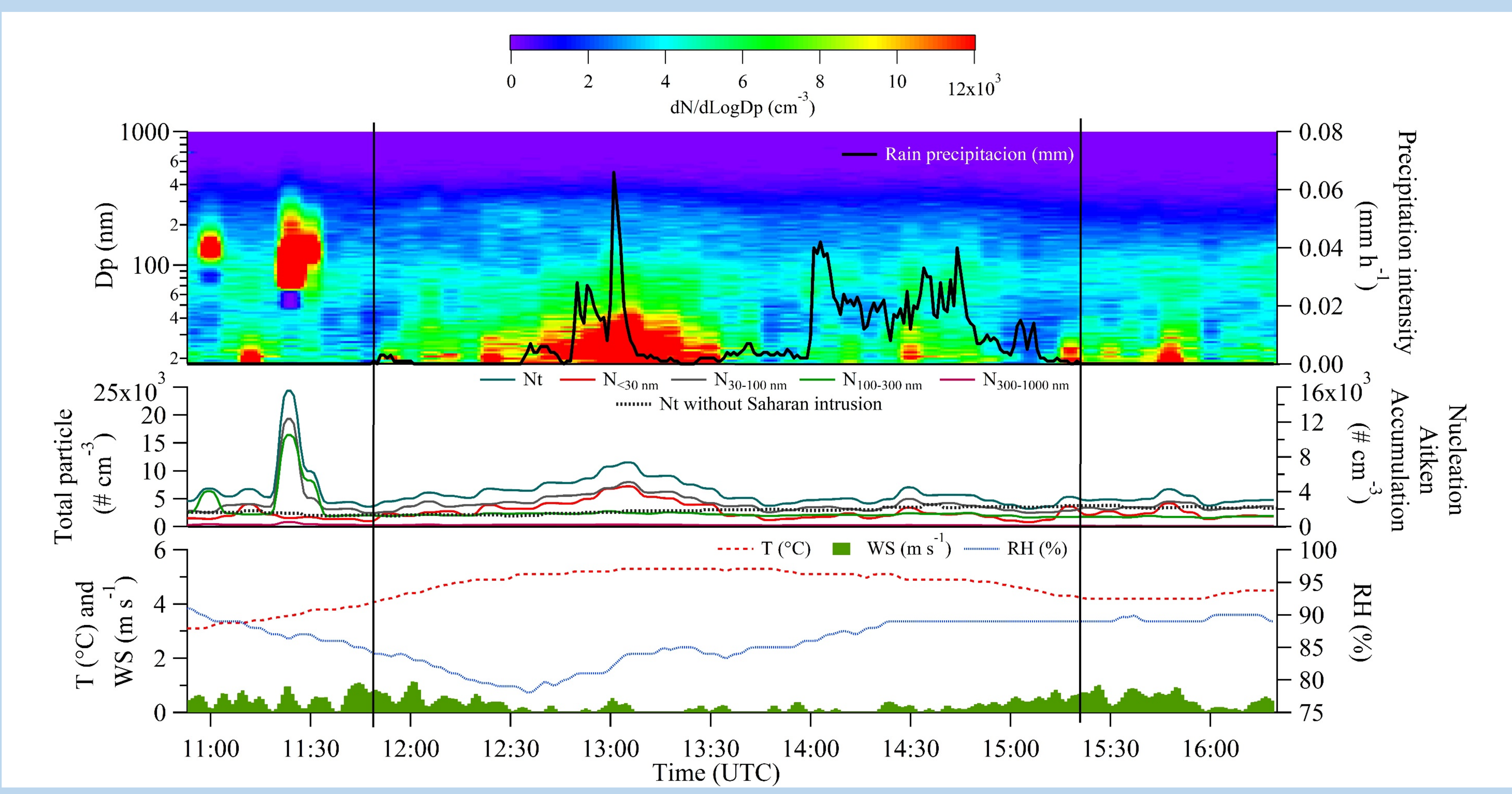


Figure 2. Time evolution of the aerosol size distribution (graduate coded), precipitation intensity (black line), number of particle concentration (total and by modes) with and without intrusion and meteorological variables during the rain event.

- During the rain event, there was a $\Delta C\%$ of -36 % for aerosol particle sizes between 18 and 661 nm. One hour before rain, there were 7,700 particles cm^{-3}, whereas 4,900 particles cm^{-3} were registered one hour after the rain event (Figure 1).
- Nucleation mode did not suffer an efficient scavenging (33%), while Aitken (-33%), $accumulation_{100\text{-}300nm}$ (-63%) and $accumulation_{300\text{-}1000nm}$ (-63%) presented an efficient scavenging by interception mechanism Figure 2).

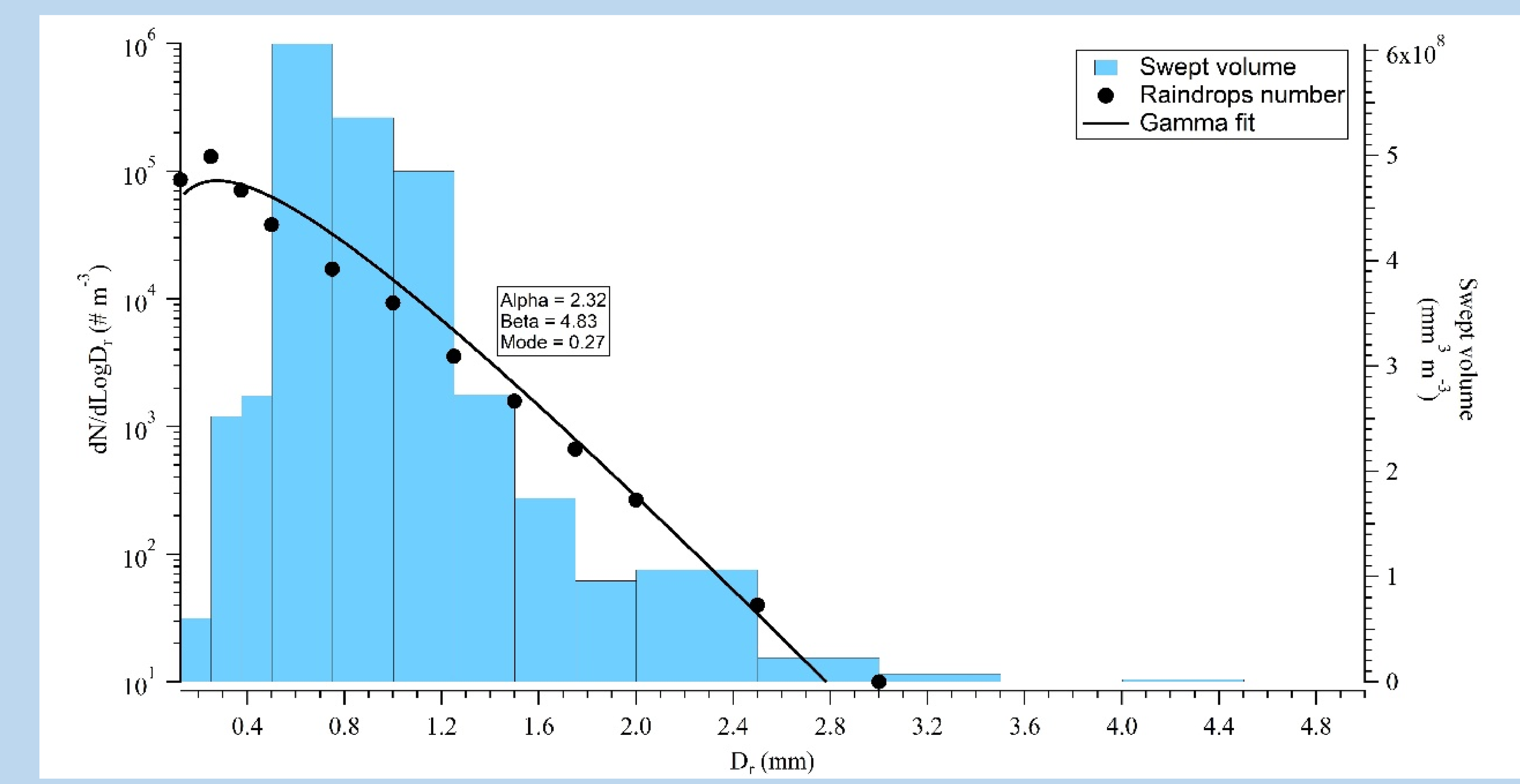
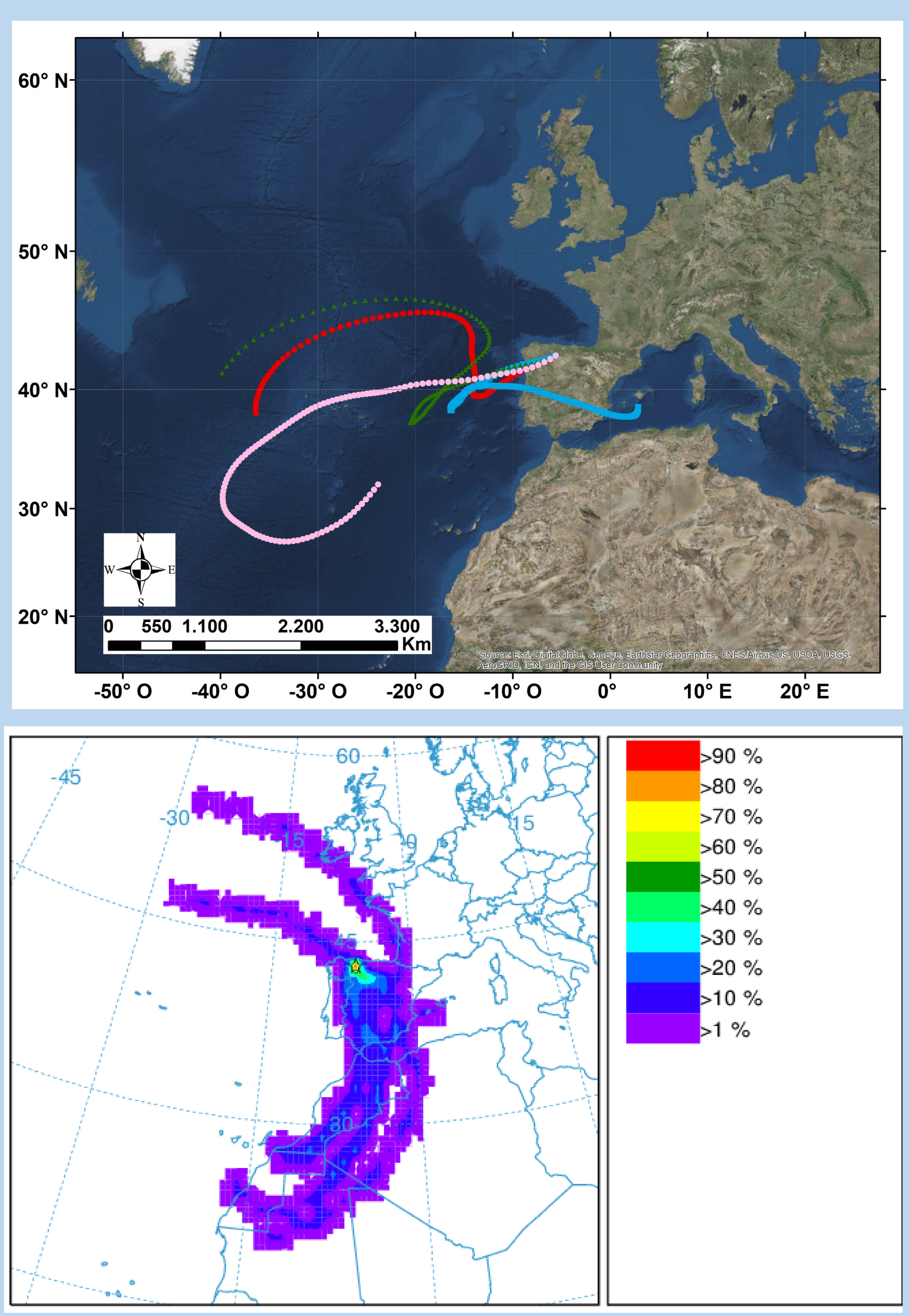


Figure 4. Raindrop gamma distribution (black continuous line), number of raindrops measured (black points) and swept volume caused by different raindrop sizes (blue boxes) in the case of study.

- Through the analysis of four-days back retro-trajectories and frequencies of the air masses present in León at 22 February 2016 the presence of the winter intrusion was confirmed (Figure 3).



- Regarding rainfall characteristics, a total of 1.2×107 raindrops m^{-2} were registered. (Figure 4)
- The raindrop size range with higher number of raindrops was 0.125-0.250 mm.
- However, the channel 0.5-0.75 mm presented the highest swept volume.
- The values of gamma distribution were: α = 2.32, β = 4.82 mm^{-1} and the mode was 0.27 mm.

Figure 3. Four-days back trajectory frequencies arriving at 3,000 meters a.g.l. at 22/02/2016.

CONCLUSIONS

- The **rainfall** characteristics of this event caused a **clear effective scavenging** of pollutant burden presented in León after winter Saharan dust intrusion.
- The particle concentration in **nucleation** mode **increased**, but particle concentration in Aitken and accumulation modes presented a clear decreased caused by rain.
- The main scavenging was caused by **raindrops** ranged between **0.5 and 0.75 mm**, although the number of raindrops was less than measured in channels between 0.125 and 0.5 mm.

References

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