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

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Keywords: aerosols, modes, scavenging, size distributions, SMPS.
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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 analyse 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.

Methods

Continuous monitoring of particle size distributions has been carried out through a high resolution nanoparticle sizer (TSI-SMPS Model 3938) at dry conditions (RH <40%). The size range analysed was between 14.3 and 1000 nm in 110 channels. Furthermore, a Laser Precipitation Monitor (*LPM*) of Thies Clima has been used to register raindrops between 0.125 and 8 mm in 22 channels. The scavenging efficiency ($\Delta C\%$) and the scavenging coefficient (λ) have been estimated as:

$\Delta C\% = ((C_2 - C_1)/C_1) \cdot 100$, $\lambda(d_p) = -1/(t_2 - t_1) \cdot \ln(C(d_{p2})/C(d_{p1}))$,

respectively, following the methodology proposed by Laakso *et al.* (2003). The raindrop gamma distribution parameters have also been obtained. The *BCS* has been studied by modes: nucleation (14-30 nm), Aitken (30-100 nm) and two accumulation modes (100-300 and 300-1000 nm).

Conclusions

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. Regarding rainfall characteristics, a total of 1.2×10^7 raindrops m^{-2} were registered. 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. Moreover, the values of gamma distribution were: $\alpha = 2.32$, $\beta = 4.82$ mm^{-1} and the mode was 0.27 mm.

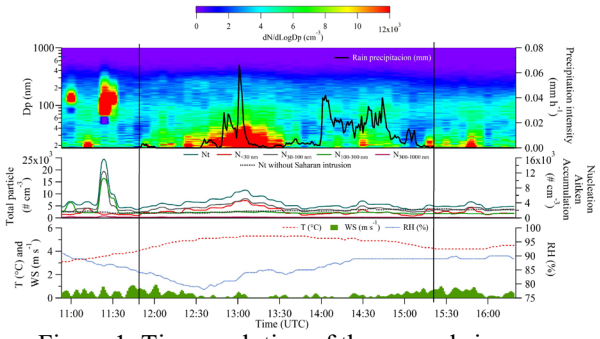

Figure 1. Time evolution of the aerosol size distribution (graduate coded), precipitation intensity (black line), number of particle concentration (total and by modes) with and without intrusion and meteorological variables during the rain event.

Thus, the rainfall event caused a clear effective scavenging in the aerosol concentration registered in León after the winter Saharan dust intrusion, except in the nucleation aerosol mode.

This work was partially supported by the Spanish Ministry of Economy and Competitiveness (Grant TEC2014-57821-R), the University of León (Programa Propio 2015/00054/001) and the AERORAIN project (Ministry of Economy and Competitiveness, Grant CGL2014-52556-R, co-financed with FEDER funds). C. del Blanco Alegre acknowledges the grant FPU16/05764 from the Spanish Ministry of Education, Culture and Sports.

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