Impact of Saharan dust outbreaks on the chemical composition of PM_{10} at Mt. Aitana (southeastern Spain)

N. Galindo, E. Yubero, J.F. Nicolás, M. Varea, R. Castañer, S. Caballero, J. Gil-Moltó, C. Pastor and J. Crespo

Atmospheric Pollution Laboratory (LCA-UMH), Miguel Hernández University, Elche, Spain
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Presenting author email: ngalindo@umh.es

From 17th March 2014 to 4th September 2015, more than 150 PM_{10} daily samples were collected at Mt. Aitana (38°38'56.8"N 0°15'55.2"W; 1558 m a.s.l.) using a high-volume sampler (Digitel, 820 m^3/day). Samples were analysed by ion chromatography, ED-XRF and a thermal-optical method for the determination of major ions, elements and carbonaceous species (organic and elemental carbon), respectively.

Table 1 shows summary statistics for PM_{10} and its main chemical components during the study period.

Table 1. Average values, standard deviations, minima and maxima of PM_{10} main components (ng/m^3).

	Mean	SD	Min	Max
PM_{10}	13325	12079	784	92344
Cl^-	113	202	<DL[a]	2087
NO_3^-	817	553	<DL[a]	2585
SO_4^{2-}	1504	895	88	4224
$C_2O_4^{2-}$	156	45	6	492
NH_4^+	388	268	<DL[a]	1490
Na^+	240	240	<DL[a]	865
K^+	61	57	<DL[a]	375
Mg^{2+}	52	52	<DL[a]	206
OC	1927	695	720	4603
EC	70	41	6	247
Ca	413	668	<DL[a]	6192
S	270	162	14	725
Fe	173	329	<DL[a]	2811
Ti	20	40	<DL[a]	311

[a] <DL: concentrations below the detection limit

The mean PM_{10} concentration for the whole study period was a little higher than the value measured at another high altitude site in norhteastern Spain (Mt. Montsec; Ripoll *et al* 2014; 12 µg/m^3, three-year average). This can be attributed to the measurement period, which does not cover two complete years. This is important since PM levels at high altitude stations exhibit a clear seasonal cycle with minimum values during winter (Galindo *et al* 2016).

OC and SO_4^{2-} were the main components of PM_{10}, accounting for approximately 25% of the total concentration. In addition to OC and secondary inorganic ions (SO_4^{2-}, NO_3^- and NH_4^+), crustal components, represented by Ca, Fe and Ti, were also major contributors to the PM_{10} mass. The common origin of these elements was supported by the high correlations obtained between them (r > 0.72). Due to the close proximity of the measurement location to the Mediterranean coast, marine ions (Na^+, Mg^{2+}, Cl^-) also showed significant concentrations.

Figure 1 presents a comparison between concentrations calculated for days under the influence of Saharan dust intrusions and days without intrusion.

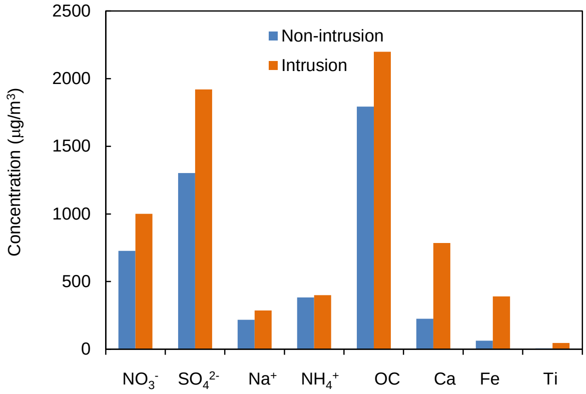

Figure 1. Average concentrations on intrusion and non-intrusion days.

As expected, the impact of Saharan dust outbreaks on the concentrations of crustal elements was significantly higher than for the other PM_{10} components. However, the relative increase in the concentrations of Fe and Ti (500%) was much greater than that calculated for Ca^{2+} (250%), indicating that in this region: (1) calcium is not the best tracer of Saharan events and (2) the ratios Ca/Fe and Ca/Ti decrease on intrusion days; in fact, the Ca/Ti ratio could be used as a sensitive indicator of Saharan events. Similar results were reported in previous works performed in the study area (Nicolás *et al* 2008, 2009).

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