Influence of air mass origin on the chemical composition of PM_{10} at a Mediterranean high mountain site

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

Department of Physics, Miguel Hernández University, Avda. de la Universidad s/n, 03202, Elche, Spain
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Presenting author email: j.gil@umh.es

Atmospheric aerosols have several adverse effects on human health and also affect the global radiative balance. These impacts depend mainly on particle size and chemical composition. The size and composition of particles depends on the multiplicity of emission sources, both natural and anthropogenic, the physical and chemical processes that lead to their formation, and the atmospheric transport and dispersion conditions. Since all these factors vary substantially with time and space, the complex scientific knowledge behind all these processes still contains many gaps. Regional background stations provide the opportunity to study aerosol formation and transformation processes in the lower troposphere without the interference of local anthropogenic emissions. Additionally, when these stations are located at high elevations, they are especially suitable for identifying natural and anthropogenic aerosols transported over long distances.

A sampling campaign was carried out between March 2014 and September 2015 at a high altitude site located at Mt. Aitana in southeastern Spain (38°39´ N; 0°16´ W; 1558 m a.s.l.). More than 150 daily samples were collected using a high-volume sampler (Digitel, 820 m^3/day) and 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.

Back trajectories of air masses arriving at Mt. Aitana were calculated using the HYSPLIT model developed by the National Oceanic and Atmospheric Administration (NOAA) (Draxler and Rolph, 2003).

Table 1 summarises the mean concentrations of chemical PM_{10} components for north Atlantic, African and regional episodes observed during the studied period.

Table 1. Average composition of PM_{10} as a function of the air mass origin.

	ANW	NAF	REG
PM10 (μg/m^3)	8,18±4,62	25,32±19,23	12,52±6,45
OM (μg/m^3)	2,87±1,07	4,11±1,52	3,24±1,69
TC (μg/m^3)	1,65±0,61	2,36±0,85	1,86±0,97
OC (μg/m^3)	1,59±0,59	2,28±0,84	1,8±0,94
EC (ng/m^3)	58,34±42,49	83,88±44,3	58,14±51,95
Cl^- (ng/m^3)	135,5±150,77	193,24±354,8	52,63±77,62
Fe (ng/m3)	61,2±73,36	513,78±567,14	95,47±69,53
SO_4^{2-} (μg/m^3)	1,05±0,78	1,79±0,82	1,49±1,1
Zn (ng/m^3)	8,75±12,64	5,34±11,32	4,23±8,24
NO_3^- (μg/m^3)	0,60±0,44	1,19±0,54	0,65±0,61

ANW (Atlantic NW); NAF (North African); REG (Regional)

OM was calculated by multiplying OC concentrations by a factor of 1.8.

The PM_{10} average concentration for the whole study period was 13.3 μg/m^3, which is of the same order than that observed by Ripoll *et al* (2014) at another regional background environment of western Mediterranean basin (12 μg/m^3 at Mt. Monsec).

Mt. Aitana was mainly affected by air masses coming from the Atlantic Ocean (47%) and North of Africa (23%), while regional episodes prevailed for 23% of the measurement days. On the other hand, air masses from Europe and the Mediterranean Sea were much less frequent.

The lowest PM_{10} concentrations were associated with Atlantic air masses. Under this scenario, the contribution from organic matter (OM, calculated by multiplying OC concentrations by a factor of 1.8) to the PM_{10} mass was highest (36%), while crustal components such as Fe were considerably less abundant than for NAF and REG episodes.

The highest PM_{10} levels were observed during North African episodes that showed a clear increase in the concentrations of crustal elements (Fe, Ti, Ca, Mn, Sr).

Regional episodes, typical of the summer months, are characterized by a low renovation of air masses leading to the accumulation of PM and other pollutants in the study area (Millan *et al*, 2000). The high photochemical activity during these episodes favours the formation of secondary aerosols such us sulfate and secondary organic aerosols (SOA).

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