BEHAVIOUR OF PM10 AND SOME METALS IN ATMOSPHERIC AEROSOLS IN THE SOUTHEASTERN SPAIN (MALAGA)

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Keywords:PM_{10}, metals, natural or anthropogenic origins.

UNIVERSIDAD DE MÁLAGA

DUST 2014
International Conference on ATMOSPHERIC DUST
Castellaneta Marina (TA), Italy - June 1-6, 2014

INTRODUCTION.

Studies in aerosol particles provide a means for evaluating the integrated effects of transport and meteorology on the atmospheric loadings of substances with different sources in little industrialised area in South Spain.

Weekly samples of aerosols in air were continuously monitored between 2009 and 2011 in Malaga (Spain) with a high-volume air sampler (ASS-500C). Additionally, levels of particulate matter fraction PM_{10} were monitored in one of the Atmospheric Pollution Monitoring network managed by the Environmental Health Service of the Andalusian Government. The sampling point (4º 28' 4" W; 36º 43' 40"N) was located approximately 5 km from the coastline, near the airport and surrounded by roads with traffic exhaust.

The high-volume sampler uses polypropylene square filters (44 x 44 cm^2) with a collection efficiency of 93-99%, at a flow rate of 90,000 L min^{-1} This system was configured to filter a discharge average of 600 m^3/h of air. The average weekly volume ranged from 65000 to 90000 m^3. The dust content in the filters was calculated gravimetrically by weighing the filters before and after and were analysed for the major elements Ca, Fe, Na, Mg, K, Cu, Ni, Cr, Zn and Pb by ICP-MS (NexION).

OBJETIVES

The detection of high dust content and PM_{10} events and the identification of their natural or anthropogenic origins

VARIMAX

The rotated factor loadings for each variable are presented in Table 1. The factors comprise the data, in which loadings report how each variable is related to these factors. values represent the importance of the variables for the components.
The PCA (varimax normalized) method was applied to the concentrations of metals and PM_{10} and explain 70% of the variance. Three factor groups were obtained

	Componente		
	PC1	PC2	PC3
PM10	0,668	0,224	-0,086
Cr	0,439	-0,139	0,729
Ni	0,120	0,242	0,815
Cu	0,059	0,795	0,069
Zn	-0,085	0,662	0,471
Fe	0,898	0,052	0,274
Pb	0,302	0,677	-0,070
Ca	0,891	0,011	0,272
Mg	0,884	0,050	0,215
Na	0,592	0,316	0,022
K	0,863	0,022	0,143
total variance explained	44 %	15 %	11 %

Table 1. Rotated Component Matrix

FIRST FACTOR (PC1)

In the first factor (PC1) Ca, Fe, Na, Mg, K and PM_{10} were high loaded, with crustal and marine sources, and were the major component with 44% of the total variance.
Monthly temporal evolution following the elements Fe, Mg, K, Ca, and PM10 is similar, registering the highest levels the months of July and August and the minimum in November and December. The 58% above the value data limits of PM have African origin

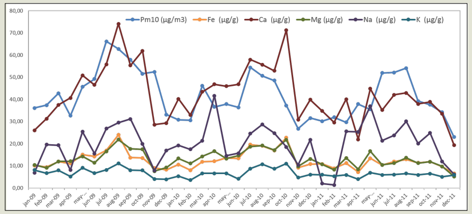

Fig. 1 Temporal variations of conentrations of Ca, Fe, Na, Mg, K and PM_{10}

SECOND FACTOR (PC2)

In the second factor, Cu had the highest load, followed by Zn and Pb. Important sources of these metals in Málaga are traffic emissions. A 15% of the variance was observed in this second factor (PC2). Table 2 shows the emissions traffic rolled in the Malaga city

Emisiones	Almería	Cádiz	Córdoba	Granada	Huelva	Jaén	Málaga	Sevilla	ANDALUCÍA
CH_4 (t)	116	156	106	178	82,5	102	236	245	1222
CO (t)	10714	16670	11431	21208	9742	11939	26591	25161	133457
COVNM (t)	2053	3046	2130	3685	1654	1968	4828	4751	24115
N_2O (t)	146	192	133	189	102	123	297	319	1500
NO_x (t)	7178	8768	6704	9685	5011	6688	13623	14944	72601
PM (t)	706	849	665	983	457	650	1278	1490	7078
PM_{10} (t)	599	720	566	840	385	553	1081	1268	6013
$PM_{2,5}$ (t)	515	620	489	727	331	479	931	1095	5187
SO_2 (t)	38,8	46,3	35,7	50,7	25,5	35,1	70,4	80,7	383
NH_3 (t)	100	157	91,2	150	92,1	85,7	262	219	1158
Cd (kg)	5,92	7,05	5,44	7,80	3,84	5,30	10,7	12,3	58,3
Cr (kg)	65,9	78,1	60,8	88,8	40,9	57,4	116	135	643
Cu (kg)	3929	4644	3627	5329	2399	3384	6848	8041	38201
Ni (kg)	65,4	77,6	60,2	87,4	41,3	57,5	116	135	640
Pb (kg)	324	518	313	520	310	303	868	730	3885
Se (kg)	4,86	5,79	4,46	6,34	3,19	4,38	8,80	10,1	47,9
Zn (kg)	1780	2110	1632	2383	1129	1558	3165	3659	17416

Table 2. **. Emissions traffic rolled (Junta de Andalucía)**

THIRD FACTOR (PC3)

In the third factor the highest loading corresponded to Cr, followed by Ni and Zn. Their principal sources are industrial emissions and the variance in this factor was 11%. Table 3 shows emissions of Cement industry in the Malaga city

Emisiones	Almería	Cádiz	Córdoba	Granada	Huelva	Jaén	Málaga	Sevilla	ANDALUCÍA
As (kg)	14,8	32,4	6,88	4,96	13,0	8,80	8,12	30,2	119
Cd (kg)	11,1	4,19	5,90	9,10	0,350	14,9	8,39	70,0	124
Co (kg)	18,6	7,27	1,51	2,22	13,0	0,712	0,313	12,7	56,4
Cr (kg)	30,4	22,7	5,41	22,7	33,9	42,0	71,8	179	408
Cu (kg)	1868	37,1	14,8	9,602	28,0	16,13	38,2	2636	4648
Hg (kg)	65,9	16,1	15,7	9,00	0,900	21,1	26,3	48,2	203
Mn (kg)	325	31,2		1,11	233	50,2	41,4	184	866
Ni (kg)	316	15,5	4,92	344	26,0	515	264	1386	2872
Pb (kg)	30,9	22,7	49,1	12,2	63,0	31,9	248	93	551
Sb (kg)	11,9	32,4	0,272	1,93	8,00	0,365	4,38	5,73	64,9
Se (kg)	163	65,1	32,0	9,21	23,7	39,3	76,5	135	544
Tl (kg)	6,86	16,1	0,865		27,0	13,4	79,1	2,68	146
V (kg)	5,40	75,1	0,022	11,7	27,0	2,05	1,78	26,3	149
Zn (kg)	127	111	91,5	19,7	492	56,6	2266	258	3422

Table3: Emissions Industry (Junta de Anadalucia)

CONCLUSIONS

- The principal component analysis has facilitated us the study of metals and PM behavior in the surface atmosphere. This results showed that behavior of aerosols in Malaga (Spain) was represented by three groups explained 70 of the total variance of the dataset.

- In short, exploratory data analysis, VARIMAX, has shown to be quite useful in studying the behavior of aerosols in the surface atmosphere of Malaga (Spain) according to its climate and geographical characteristics.

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ACKNOWLEDGMENT
The authors wish to thank to the Atmospheric Pollution Monitoring network managed by the Environmental Health Service of the Andalusian Government, for the provision of data used in this study.