DEPOSITION PATTERNS OF ATMOSPHERIC ^{7}BE, ^{210}PB AND ^{40}K IN COST OF WEST MEDITERRANEAN SEA, MALAGA (SPAIN)

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INTRODUCTION. The deposition of radionuclides on the ground is an essential process to understand atmospheric transportation, sedimentation and geological process, being the major removal pathway for airborne particulates. To predict the long-term radiological consequences of an accidental deposition of the radionuclides , it is a prerequisite to know the environmental long-term behaviour of these radionuclides an a relatively large number of values are required for statistically meaningful conclusions. ^{7}Be and ^{210}Pb are radionuclides which have been measured routinely in many places in order to study the description of environmental processes such as aerosol transit and residence times in the troposphere, aerosol deposition velocities and others . ^{40}K is also a natural radionuclide and has been associated with the arrival of coarse re-suspended material from the Africa continent. The bulk atmospheric deposition of ^{7}Be , ^{210}Pb and ^{40}K has been measured at Málaga, south-eastern Spain **from January 2005 to December 2015,** on monthly basis.

MATERIAL AND METHODS

The sampling site is one of the environmental radioactivity monitoring network stations operate by the Spanish Nuclear Security Council (CSN). The sampling point is located above the ground, on the roof of the Faculty of Sciences (24 m.a.sl.), University of Málaga (4°28'80" W; 36°43´40´´ N). Monthly precipitation and dry fallout samples were routinely collected on a monthly basis using a steel tray 1m^2 in area as a collecting system and polyethylene vessels of 25L capacity for rainwater samples reservoirs. Measurements by gamma spectrometry were performed to determine the ^{7}Be , ^{210}Pb and ^{40}K activities of the samples using an intrinsic REGe detector.

RESULTS AND DISCUSSION

The results from specific activities (in Bq/L) of ^{7}Be, ^{210}Pb and ^{40}K were analyzed to derive the statistical estimates. **Table 1** provides the summary of the descriptive statistics such as number of samples (N), arithmetic mean (AM), geometric mean (GM), standard deviation (SD), maximum and minimum values, the coefficient of variation (CV) and Skewness(GI).

Table 1.- **Summary statistics of the activity concentrations of the radionuclides**

	N	AM	GM	SD	MAX	MIN	CV (%)	GI
^{7}Be	132	2.60	2.09	1.60	8.30	0.29	62.3	4.9
^{210}Pb	132	0.40	0.33	0.22	1.32	0.05	57.7	6.5
^{40}K	69	0.20	0.16	0.14	0.84	0.02	70.9	6.5

The specific activity of ^{7}Be exhibit its maximum values in spring (**Fig. 1**). The higher values of ^{7}Be can be due to the rapid exchange of aerosols between stratosphere and troposphere by contraction of tropopause in the spring season.
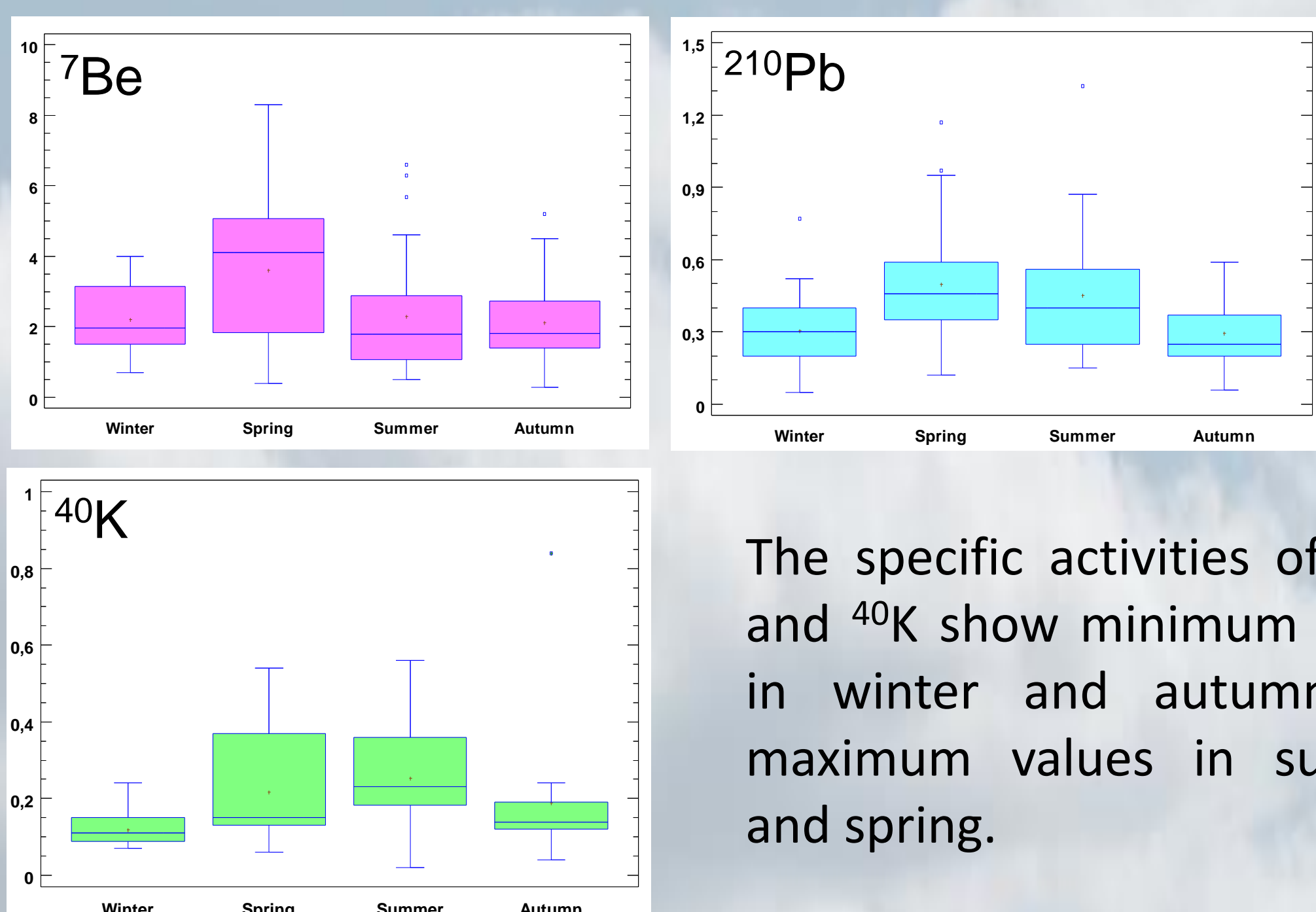

The specific activities of ^{210}Pb and ^{40}K show minimum values in winter and autumn and maximum values in summer and spring.

Fig. 1.-Seasonal variation of specific activities of ^{7}Be , ^{210}Pb and ^{40}K

Taking into account the local orography and meteorological features in Málaga, with strong rain events followed by long dry periods, different parameters have been considered to study their influence on the concentrations of these radionuclides: number of African dust outbreaks (days), rainfall amount (mm), rainfall duration, number of dry days and number of wet days. Best significant correlations found are shown in **Fig. 2**.
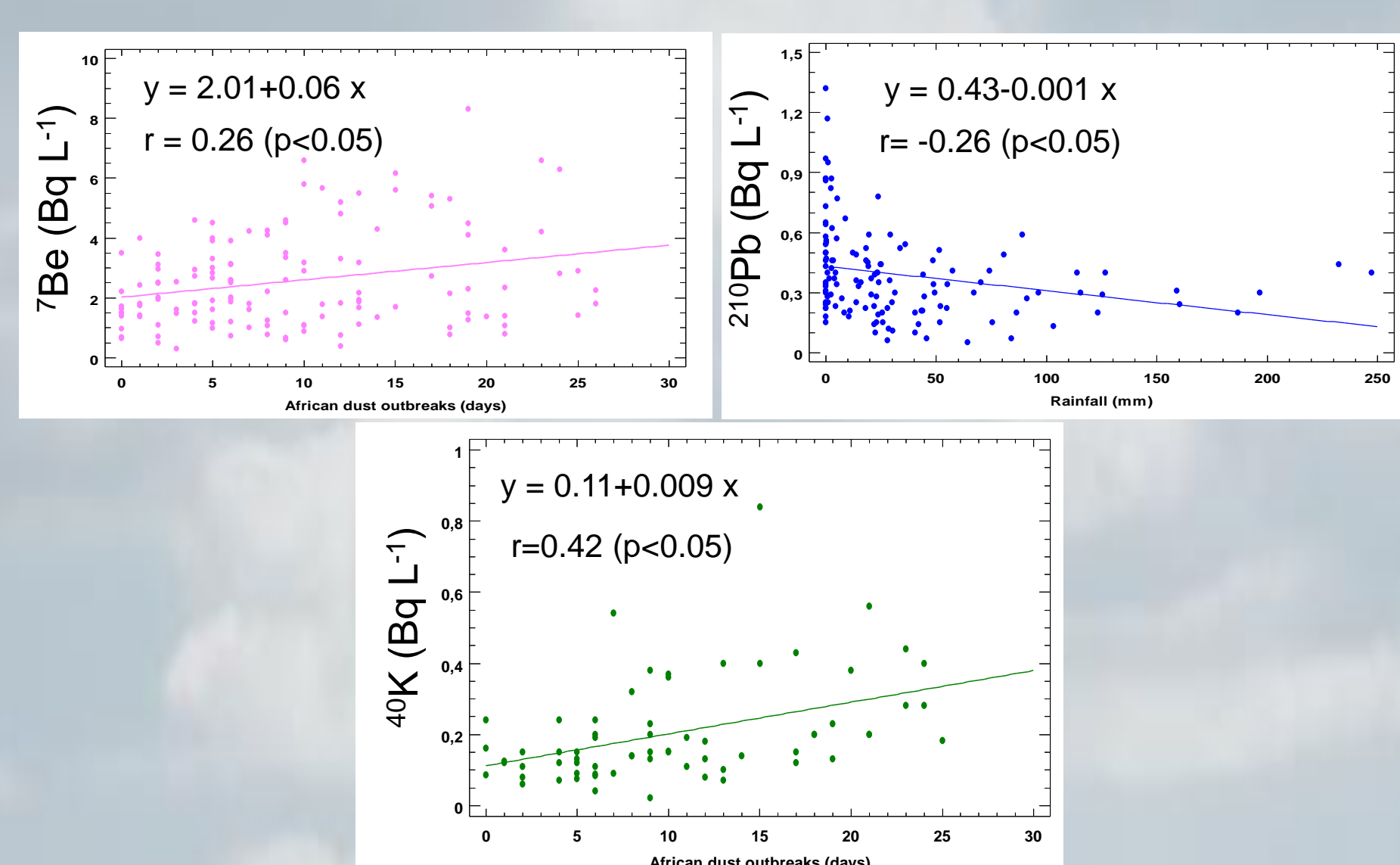

Fig. 2.- Scatter plots of radionuclides concentrations and some factors

Figure 3 shows the average of the monthly variations in the deposition fluxes (in Bq/m^2 month) of ^{7}Be, ^{210}Pb and ^{40}K, as well as the monthly rainfall (in mm). The lowest values were observed from June to September and the highest values from October to April. ^{7}Be, ^{210}Pb and ^{40}K fluxes show respectively the correlation coefficients of 0.88, 0.89 and 0.66 with the rainfall.
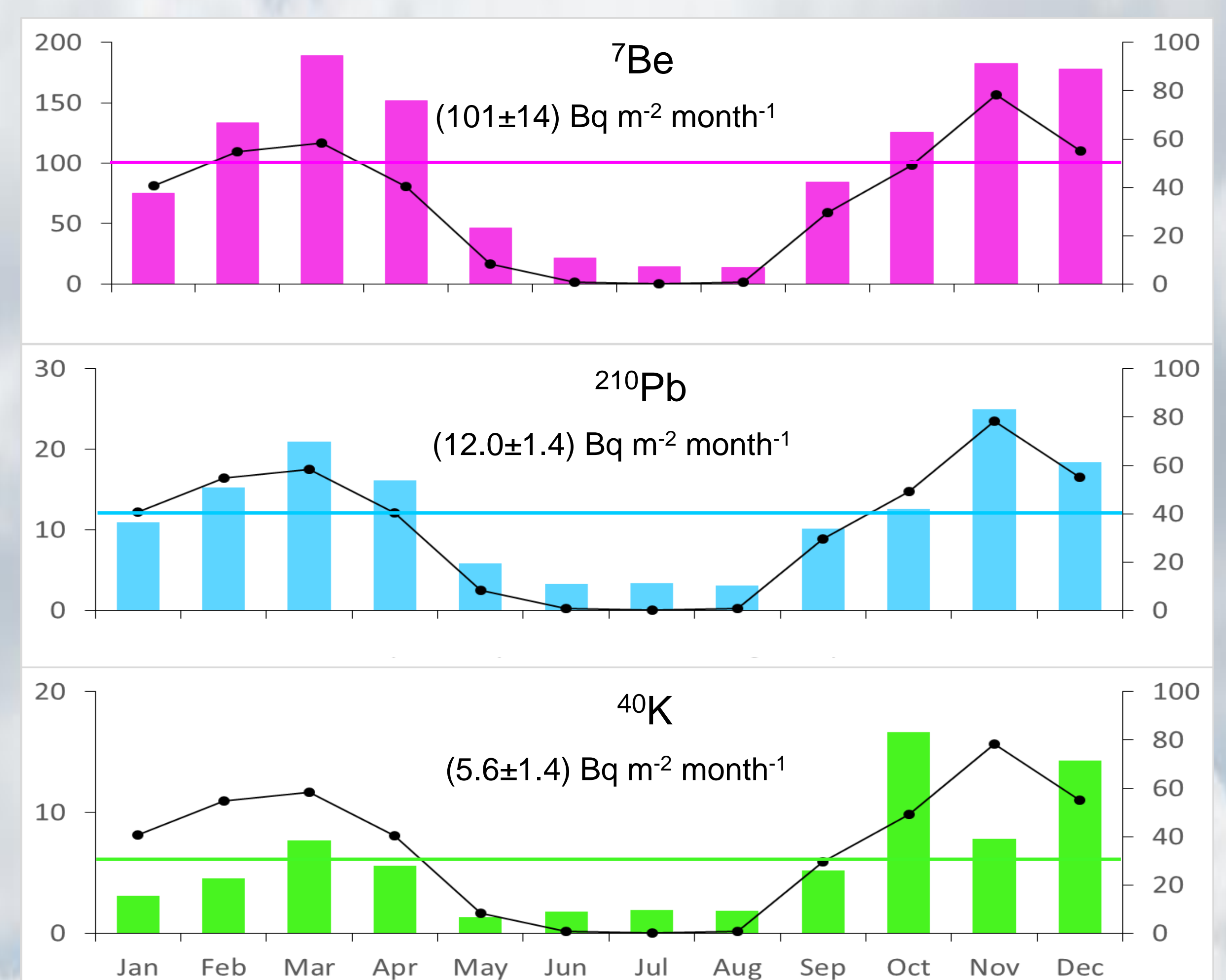

Fig.3.- **Depositional fluxes of the three radionuclides during the eleven years study period.**

Table 2.- **Results from factor analysis applied on ^{7}Be, ^{210}Pb and ^{40}K depositional fluxes and some parameters.**

	PC 1 (55%)	PC 2 (21%)
^{7}Be	**0.885**	-0.078
^{210}Pb	**0.941**	-0.048
^{40}K	**0.749**	0.250
PM10	0.197	**0.785**
Air temperature	-0.407	**0.779**
Relative humidity	**0.724**	-0.291
Number of intrusions	-0.166	**0.796**
Rainfall amount	**0.930**	-0.146
Rainfall duration	**0.894**	-0.309

The first principal component (PC1) explained 55% of the total variance of the data set. Values listed in **Table 2** for PC1 illustrate a positive correlation with fluxes of ^{210}Pb, ^{7}Be, ^{40}K rainfall amount, rainfall duration and relative humidity.

The second one (PC2) explained 21% of the total variance. The number of African outbreaks is correlated with PM10 and air temperature due to most of the African outbreaks occurs during the summertime.

The ^{7}Be, ^{210}Pb and ^{40}K depositions are significantly correlated with the rainfall amount and rainfall duration. Such relations explained that rainfall constitutes the major depositional pathway of these radionuclides.