



Long-term atmospheric fluxes of radionuclides at a coastal Mediterranean station

¹C. DUEÑAS, ¹M.C. FERNÁNDEZ, ¹E. GORDO, ²E. LIGER, ¹S. CAÑETE and ³M. PÉREZ.

¹Department of Applied Physics I, Faculty of Sciences.

²Department of Applied Physics II, Faculty of Computer Engineering.

³Department of Radiology and Health Physics, Ophthalmology and OIT, Faculty of Medicine.,

University of Málaga 29071 Málaga (SPAIN)

E-mail: mcduenas@uma.es



INTRODUCTION. ⁷Be is one of the radionuclide produced by spallation reactions of cosmic rays with light atmospheric nuclei. ⁷Be rapidly associates primarily with submicron-sized aerosol particles. Gravitational settling and precipitation processes largely accomplish transfer to the earth's surface. ²¹⁰Pb which is one of the natural radionuclide of the ²³⁸U series is widely used as a tracer. ²¹⁰Pb depositional pattern gave us information on continental aerosols in lower troposphere. These two radionuclides with their different sources and therefore are useful to understand the mechanisms of aerosol removal from the atmosphere. These radionuclides have 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 aerosol trapping by ground vegetation. ⁴⁰K has been associated with the arrival of coarse re-suspended material from the Africa continent. The bulk atmospheric deposition of ⁷Be, ²¹⁰Pb and ⁴⁰K has been measured at Málaga, south-eastern Spain, from January 2005 to December 2012 for monthly periods.

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 was located above the ground, on the roof of the Faculty of Sciences (24 Meters Above Sea Level), University of Málaga (4° 28' 80 "W; 36° 43 40 N). Precipitation samples are collected on a monthly basis with a bulk rain collector. Monthly precipitation and dry fallout samples were routinely collected using a steel tray 1m² in area as a collecting system and polyethylene vessels of 25 l capacity for rainwater samples reservoirs. Measurements by gamma spectrometry were performed to determine the ⁷Be, ²¹⁰Pb and ⁴⁰K activities of the samples using an intrinsic REGe detector. The peak analysis of ⁷Be (I= 10.52%, 477,7 KeV), ²¹⁰Pb (I= 4%, 45 KeV) and ⁴⁰K (I=10,7%, 1460 KeV) was done using GENIE 2K peak analysis software. The counting time was 172800s.

RESULTS AND DISCUSSION

The results from specific activities of ⁷Be, ²¹⁰Pb and ⁴⁰K were analyzed to derive the statistical estimates characterizing the distributions. Table 1 provides: Number of cases (N), arithmetic mean (AM) and related statistical information such as geometric mean (GM), standard deviation (SD), maximum and minimum values, the coefficient of variation (CV) and Skewness(GI). These values are given in Bq/l

	N	AM	GM	SD	MAX	MIN	CV%	GI
⁷ Be	96	2.6	2.2	1.7	8.30	0.60	64	4.7
²¹⁰ Pb	96	0.41	0.34	0.24	1.32	0.05	58	5.5
⁴⁰ K	37	0.21	0.17	0.16	0.84	0.02	75	5.6

Table 1. Statistical parameters of the activity concentrations of ⁷Be, ²¹⁰Pb and ⁴⁰K

Log-normal distribution for both are significant at the 0.1 level. Assuming these types of distribution, the GM for both data a should be used to characterize average values.

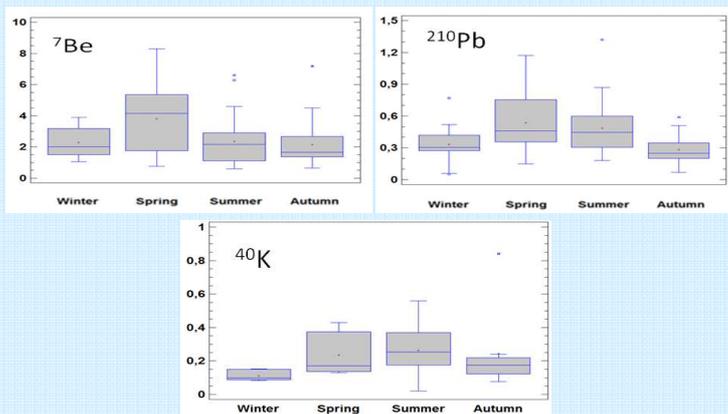


Fig. 1.-Seasonal variation of specific activities of ⁷Be and ²¹⁰Pb

The specific activity of ⁷Be exhibit their maximum values in spring. The higher values of ⁷Be 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 ²¹⁰Pb and ⁴⁰K show minimum values in winter and autumn and maximum values in summer and spring. Taking into account the local features of precipitation in Málaga, with strong rain events followed by long dry periods, different parameters have been considered: number of intrusions, rainfall amount, rainfall duration, number of dry days and number of wet days, see Table 2.

	⁷ Be	²¹⁰ Pb	⁴⁰ K
Number of intrusions	0.27	0.48	0.47
Rainfall amount	-0.17	-0.36	95
Rainfall duration	-0.24	-0.42	95
Number of dry days	0.15	0.42	95
Number of wet days	-0.16	-0.40	95

Table 2.-Linear correlation coefficient between the activities and some factors

The next figures show the monthly variations in the deposition fluxes of Be-7, Pb-210 and K-40. The lower values were observed during the period of June to September. The higher values were observed during the month of October to April.

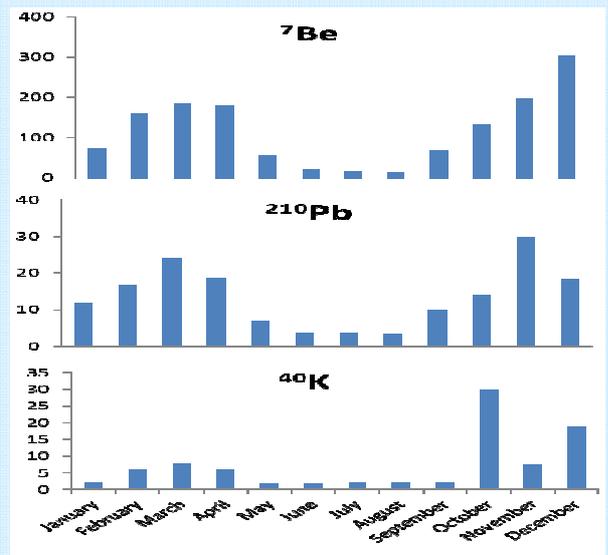


Fig.2. Depositional fluxes of Be-7 and Pb-210 during the sampling period: January 2005-December 2012.

	⁷ Be	²¹⁰ Pb	⁴⁰ K
r			
Rainfall amount	0.84	0.90	0.66
Rainfall duration	0.32	0.85	0.59
Number of dry days	-0.51	-0.69	-0.55
Number of wet days	0.53	0.72	0.61

Table 3.-Linear correlation coefficient between the fluxes and some factors

The ⁷Be, ²¹⁰Pb and ⁴⁰K depositions are correlated with the rainfall amount, rainfall duration, number of dry days and number of wet days. Such relations have been commonly observed and explained by the fact that rainfall constitutes the major depositional pathway of these radionuclides.

ACKNOWLEDGMENT

The authors wish to thank to Spanish Nuclear Safety Council (CSN) for financial support. The authors gratefully acknowledge to Spanish Meteorological Agency (AEMET), for the provision of data used in this study.