Surface activity levels of ^{7}Be, ^{210}Pb, ^{40}K and other atmospheric species and the influence of African air mass intrusions

E. Liger[1], E. Gordo[2], C.Dueñas[3], S Cañete[2], P. Rudner[2], M. Cabello[3] and M. Pérez[3]

[1]Department of Applied Physics II, University of Málaga, Málaga, 29071, Spain, [2]Central Research Facilities, University of Málaga, Málaga, 29071, Spain, [3]Department of Applied Physics I, University of Málaga, Málaga, 29071, Spain, [4]Department of Radiology and Health Physics, University of Málaga, 29071, Spain

Keywords: Atmospheric radionuclides; Aerosols; Back-trajectories; Dust intrusions
Presenting author email: eliger@uma.es

Natural radionuclides from terrestrial and upper atmospheric sources and of anthropogenic origin are widely used as tracers to examine atmospheric processes relevant to air quality and climate and to validate atmospheric models. ^{7}Be and ^{210}Pb are elements which may be used as indicators for air mass flow and vertical interchange dynamics between the stratosphere and troposphere. ^{40}K is found in most types of soil and can easily be transported by re-suspended material. Concentrations of ^{7}Be, ^{210}Pb, and ^{40}K in air are continuously monitored using a high-volume air sampler and a high resolution gamma-ray spectrometer in Málaga, a Mediterranean coastal city in South Spain located to receive pollution from different sources by means of air mass transport (Gordo *et al.*, 2015). The high frequency of mineral dust plumes blown across from Africa to the Iberian Peninsula significantly affects dust levels in the atmosphere (Rodriguez *et al.*, 2001). Therefore, it is of great interest to analyse and quantify the African dust loading over the region due to the impact it has on air quality.

This work presents results from a 2-year sampling campaign carried out to provide information on the frequency and impact of these African dust episodes on the concentrations of radioactive matter and non radioactive matter in the lower atmosphere at this Mediterranean coastal site. The sampling campaign was started on January 2013 and continued until December 2014. Aerosol samples for radiometric measurements were collected at the University of Málaga (36° 43′ 40″ N; 4° 28′ 8″ W) over 3-day periods (occasionally 4 days) using a high-volume sampler fitted with square polypropylene filters (440x440 mm^2). In addition to the normal operation, we added samples collected according to dust forecasts provided by CALIMA network (www.calima.es). All the radiometric measurements were performed by low-level gamma spectrometry with a coaxial-type germanium detector and it was calibrated using certified reference gamma ray cocktail. Additionally, concentrations of particulate matter fraction PM10, SO_2, NO_2, CO and O_3 were obtained from the monitoring station "Carranque" (36º 43' 40" N; 4º 28' 4" W), belonging to the Atmospheric Pollution Monitoring network managed by the Environmental Health Service of the Andalusian Government. The identification of African events was confirmed by means of 4-day backward trajectories (at 500, 1500, 3000 m.a.g.l.) computed using the HYSPLIT model (Draxler and Rolph, 2013) and BSC-Dream8b dust images.

Basic statistics on the overall radionuclide dataset are summarized in Table 1. Higher average concentration values were found for the three radionuclides in the set of samples collected under the influence of African dust events.

Table 1. Statistical summary of the activity concentrations of the three gamma radionuclides.

Radionuclides (Bq/m^3)	AM	GM	Max	Min	SD
^{7}Be ($\cdot 10^{-3}$)	2.89	2.71	6.18	0.50	0.98
^{210}Pb ($\cdot 10^{-4}$)	0.57	0.47	1.58	0.08	0.35
^{40}K ($\cdot 10^{-5}$)	1.77	1.52	6.84	0.29	1.12

The correlation patterns of the three radionuclides with meteorological variables and with the concentrations of the other atmospheric species were examined, both on the total set as well as on dusty and non-dusty basis. Significant correlations were found for ^{7}Be, ^{210}Pb, PM10 and temperature during non-dusty days. Under the influence of African dust outbreaks, correlations among the different variables changed, being ^{7}Be positively correlated with ^{210}Pb, PM10, temperature and O_3. Additionally, significant correlations were found for ^{40}K with PM10, SO_2, NO_2 and O_3, during days with dust episodes. This study highlights the importance of multidisciplinary monitoring campaigns and the need to include radiotracer measurements in atmospheric studies. The use of natural radiotracers and other atmospheric species provides a solid background for the characterization of atmospheric transport as well as in supporting source apportionment of pollutants.

Acknowledgments

This study was financed by the Spanish Ministry of Economy and Competitiveness (Project CTM12-37598-C02-02). The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) and to Barcelona Supercomputing Center for the images and models used in this study.

References

Draxler R.R., Rolph G.D. (2013). HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory). NOAA Air Resources Laboratory, College Park, MD.

Gordo, E., Dueñas, C., Fernández, M.C., Liger, E., Cañete, S. *Environ Sci Pollut Res.* DOI 10.1007/s11356-014-4039-5.

Rodríguez, S., X. Querol, A. Alastuey, G. Kallos, and O. Kakaliagou (2001). *Atmos. Environ.*, **35**, 2433– 2447.