

Factors influencing ambient concentrations of ^7Be over “Demokritos GAW station”

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Keywords: beryllium, correlation, temperature, pressure.

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^7Be is a relative short lived natural occurring radioactive nuclide ($t_{1/2}=53.3\text{d}$) of cosmogenic origin which is formed in the upper troposphere and lower stratosphere by spallation reactions of light atmospheric nuclei of nitrogen and oxygen with cosmic rays. ^7Be production rate in the troposphere is approximately 33% of the total production in the atmosphere. The ^7Be produced in the stratosphere, comes into the troposphere by exchange processes due to variations in atmospheric conditions associated with seasonal changes. It then attaches to aerosol particles, which finally deposit on the ground.

Since March, 2011 an atmospheric sampling program by means of High Volume samplers has been established at Demokritos urban background station (GAW-DEM, 2007) located at the North East corner of the Greater Athens Metropolitan Area and at an altitude of 270 m.a.s.l. Measurements were conducted using a six-stage high volume cascade impactor (nominal 50% cutoff sizes: 10.1, 4.2, 2.1, 1.4, 0.73, 0.41, 0.05 μm). Concentrations of radioisotopes were measured after weekly sampling. Each sample was collected after approximately 84h of sampling (Air Vol. 2500 m^3) while since September 2014, continuous weekly sampling was applied (Air Vol 4600 m^3). Cellulose Filters and impaction substrates were used (Whatman), cut in a diameter of 70mm. Gamma-spectroscopy was conducted and ^7Be was detected by its photo peak at 477.59keV. The detector used is a coaxial HP 30% Germanium detector, with energy resolution of 1.93keV for ^{60}Co (1332keV) and a 8k multichannel analyzer, with energy resolution 0.25 keV/channel. The spectra produced, were then analyzed using the software Interwinner 4.1. In this study, ^7Be concentrations’ time series and parameters from the calculated ^7Be size distributions were studied with respect to atmospheric conditions during the last 4 years.

Figure 1 displays the ^7Be seasonal variation with strong temporal variability of ^7Be atmospheric ground concentrations. ^7Be maxima are observed during summer months, and minima during winter months, which can be attributed to the stratosphere – to – troposphere exchange process. The amount of rainfall also contributes to the seasonal variation by washout, while significant increase in activity under dry meteorological conditions were due to the non-scavenging of ambient air by rainfall (fig1). The highest activities in the summer months are caused by increased vertical transport of ^7Be from the upper troposphere due to decreased stability of the troposphere

during the summer months. AMAD ranges from 0.28 to 0.38 μm (avg 0.25 μm).

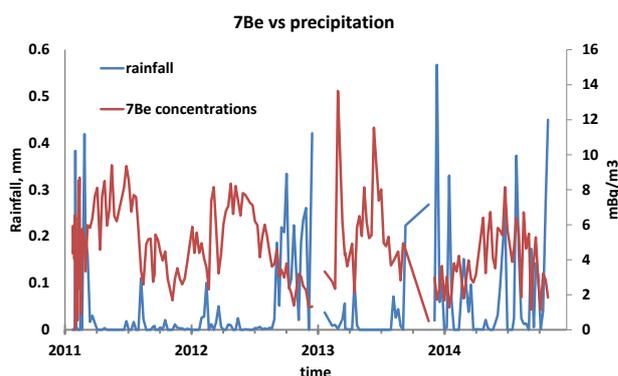


Figure 1. ^7Be concentrations in air with precipitation

This instability in the atmosphere has an impact on particles’ residence time, providing lower AMAD values during summer (Winkler et al., 1998) (fig2).

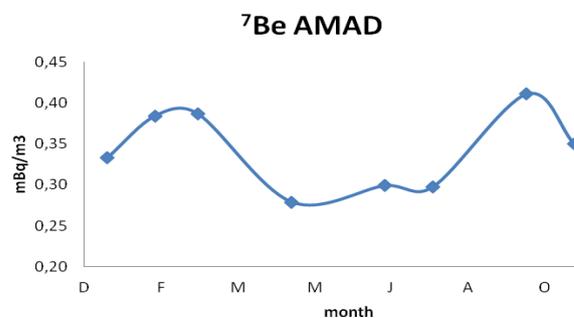


Figure 2. ^7Be AMAD in the year 2014

This study has proved negative correlation between relative humidity and the activity. This could be explained by an increase in the diameter of airborne particles caused by condensation process, which are more likely to be scavenged, thus reducing activity in the atmosphere (Percot et al., 2013).

References

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