"Physics of Auroral Phenomena", Proc. XXVIII Annual Seminar, Apatity, pp. 126-129, 2005
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CHANGES OF RADIONUCLIDE BE-7 IN RELATION TO CYCLIC AND SPORADIC VARIATIONS OF COSMIC RAYS

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The variations of cosmogenic radionuclide Be-7 are studied in relation to variations of cosmic rays at the ground level and in stratosphere. The radionuclide Be-7 is formed at the interaction of cosmic rays with nuclei of air atoms at stratospheric heights.

The data on Be-7 were taken from the daily selection of both deposits and aerosol tests and their gamma - spectrometer analysis (Fig. 1). The variations of cosmic ray background were studied on the basis of the neutron monitor and stratospheric measurements in balloon flights in Apatity (Fig. 3-6). The data obtained for the period from 2001 to the beginning of 2005 were analyzed. This period corresponds to the decline phase of the 23-d cycle of solar activity.

Daily sampling of atmospheric aerosols and precipitations and their gamma-spectrometric analysis, together with meteorological data, allows us to establish certain relations between the variations of the Be-7 radionuclide concentration and weather-climatic phenomena in the Kola peninsula (Fig. 2).

The performed studies show that atmospheric precipitations and aerosols collected in the northern latitudes contain significant amounts of cosmogenic radionuclide Be-7, with, in most cases, higher contents of Be-7 found in aerosols than in atmospheric precipitations.

The Be-7 content shows rather strong time variations. The cause of these variations can be both changes of cosmic ray intensity in the stratosphere and the processes of stratosphere-troposphere exchange, occuring during the off-season periods. A possible consequence of such processes can be uneven increase of Be-7 concentration in aerosols during April and July, 2002-2004.

Usually, there is no clear relation between Be-7 concentration in the troposphere and solar proton events. The isotope Be-7 is created in the stratosphere by cosmic rays and can get into troposphere only during vertical air mass movements. In this regard, a significant growth of Be-7 concentration in atmospheric aerosols and precipitations after the powerful solar proton events in October - November 2003 was rather unusual (Fig. 7, 8).

One may suppose that the solar proton activity in autumn, 2003 coincided with alternate off-season stratosphere-atmosphere exchange.

The ground and stratospheric cosmic ray complex in Apatity provided recording of unique phenomena of solar cosmic rays on October 28 and 29 and November 2003, which caused an increase of Be-7 concentration in atmospheric precipitation.

The correlation between the long-term variations of galactic cosmic rays connected with the 11-year solar cycle, as well as with sporadic events of solar cosmic rays, are investigated. The effects in concentration changes of Be-7 are studied, in particular, during superevents in solar cosmic rays in October – November 2003, July 2004 and January 2005.

Results

- The temporal and season variations of cosmogenic radionuclide Be-7, which provides the greatest contribution to the total radioactivity of atmospheric precipitation and aerosols are investigated.
- The maximal radioactivity is revealed in spring and autumn periods. Sporadic increases of Be-7 were also found during extreme solar-terrestrial disturbances in October - November 2003, July 2004, and January 2005.

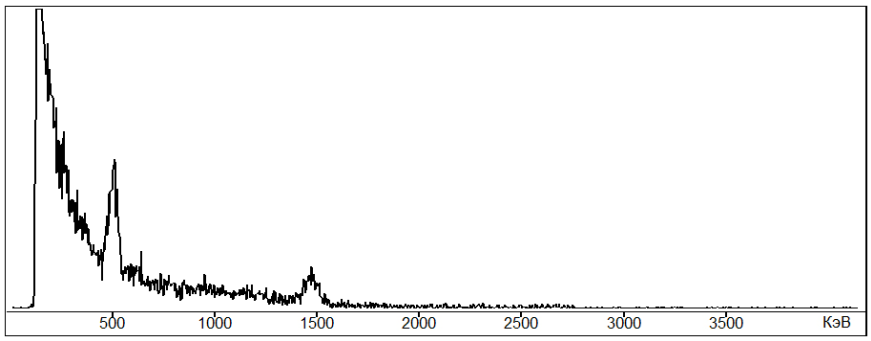

Fig. 1. Gamma - spectrum of aerosol sample, August 2004: 7Be= 98140 ± 14490 Bq/kg; 212Pb = 1010 ± 464 Bq/kg

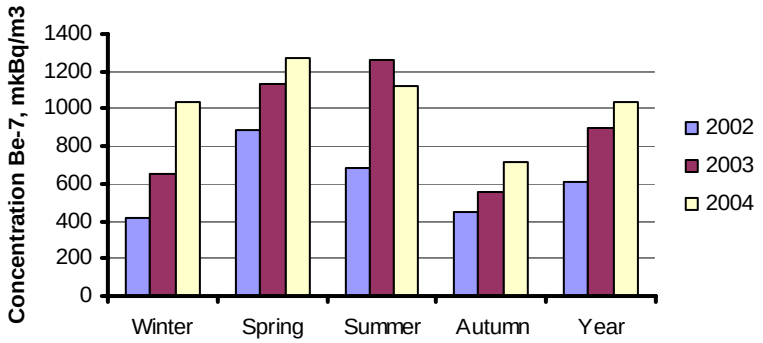

Fig. 2. Season variations of Be-7 in aerosols, 2002-2004.

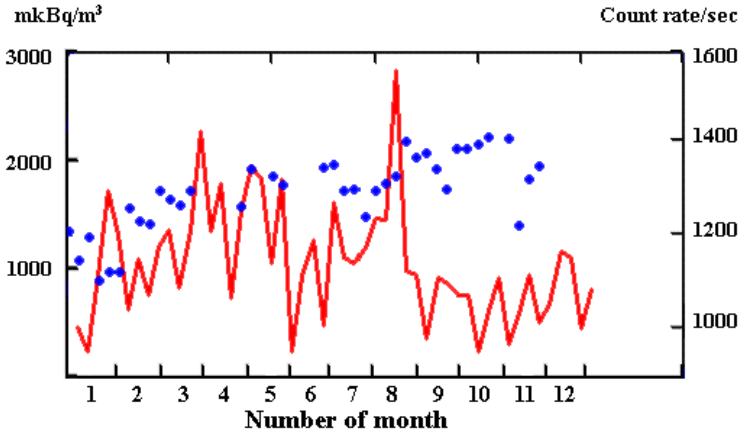

Fig. 3. Variations of Be-7 concentration in aerosols (gamma - spectrometric data are shown with the solid line, mkBq/m^3) and the intensity of cosmic rays in the stratosphere (balloon data are shown with the points, c/s), 2004.

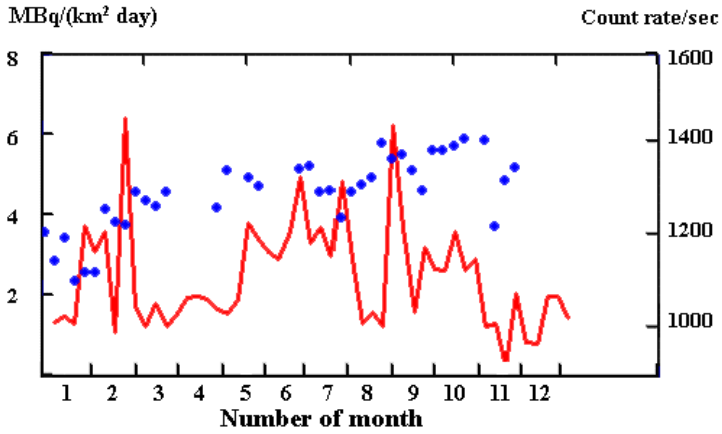

Fig. 4. Variations of Be-7 concentration in atmospheric precipitation (the solid line refers to Be-7, MBq/(km^2 day)) and the intensity of cosmic rays in the stratosphere (balloon data are shown with the points, c/s), 2004.

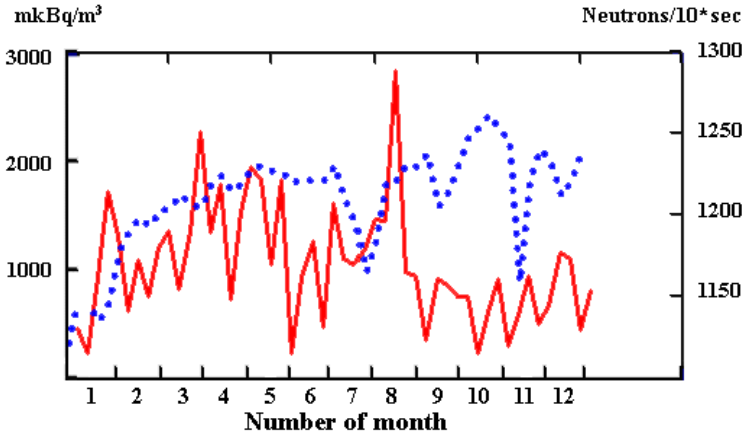

Fig. 5. Variations of Be-7 concentration in aerosols (the solid line, mkBq/m^3) and the intensity of cosmic rays (the neutron screen monitor, the dashed line, neutrons/10ñ), 2004.

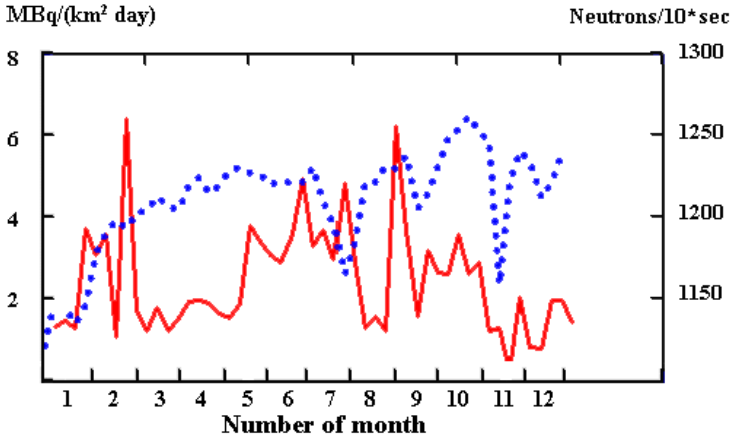

Fig. 6. Variations of Be-7 concentration in atmospheric precipitation (the solid line, mkBq/m^3) and the intensity of cosmic rays (the neutron screen monitor, the dashed line, neutron/10ñ), 2004.

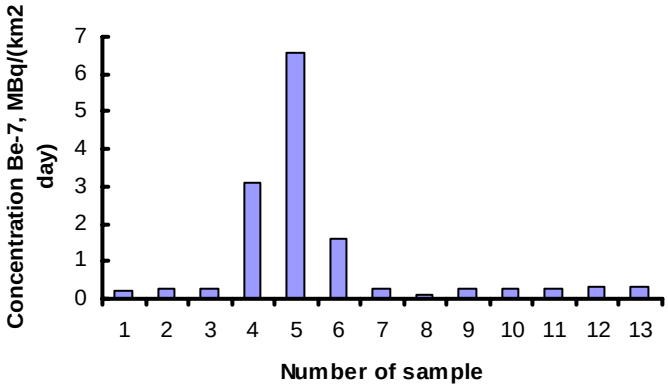

Fig. 7. The comparative histogram of Be-7 concentration in atmospheric precipitations in the period August to December, 2003 (points 4-6 refer to the samples in period SCR from 20 October to 10 November 2003; (Apatity, 67.55 °N, 33.33 °E)

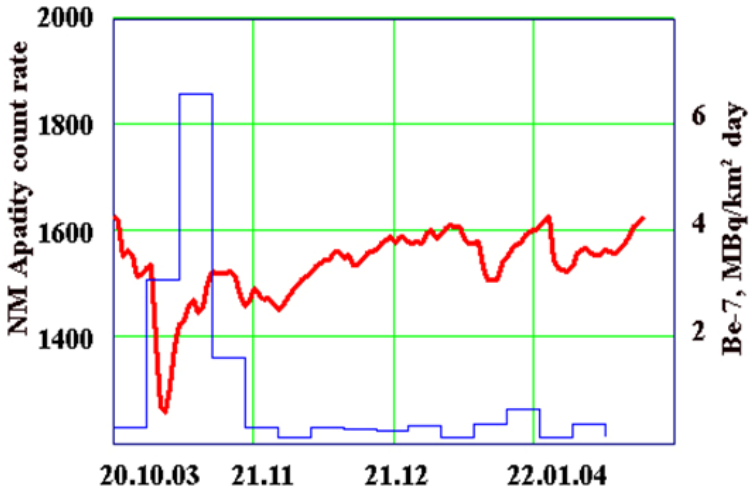

Fig. 8. Variations of Be-7 concentration in atmospheric precipitations related to the events SCR in the period from 20 October 2003 to 10 February 2004.