Alpha radioactive aerosols behavior in the ground atmosphere

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Investigation of behavior of environmental background radioactivity (aerosols and gases) is one of the main tasks when solving problems of low dose effects. It also useful for investigation of electrical properties of atmosphere and climate global change forecasting, because of air radioactive aerosols and gases and their balance regulate the surface layer of atmospheric plasma. The main purpose of this work was to investigate temporal and spatial dynamics of α-radioactive aerosols in the ground atmosphere. The general distinctions of this investigation are: 1) synchronous measurements of characteristics of α- and β-radiation fields and volumetric activity of atmospheric radionuclides (radon isotopes and their aerosol decay products (DPs)) at one point; 2) parallel measurements at different heights up to 35 m; and 3) high time resolution of data series. Such approach allowed getting more informative data to reach the purpose of the work.

The long-term experiment was performed at Tomsk Observatory of Radioactivity and Ionizing Radiation (TORIR). Instrumental equipment included: scintillation detectors of α- and β-radiation (ATOMTEX, Republic of Belarus) installed at series of heights (0.1; 1; 5; 10; 25 and 35 m); radon isotopes and DPs radiometers (EQF 3200, SARAD, Germany; RRA-01-03, Russia; Ramon-01, Kazakhstan) and automated devices for radon (RFD) and thoron (TFD) flux densities measurements (Fig. 1). In order to determine the degree of external factors influence the monitoring of meteorological, actinometrical and atmospheric-electrical values was performed via automated information measuring system.

In accordance with simplify radon and PDs transport model (only turbulent diffusion) in air the vertical distribution of their concentrations follows exponential law and decrease with height. Results of experiment with help of scintillation α-detectors showed inverse dependence (Fig. 2), i.e. increasing of α-radioactive aerosols concentration with height.

The results of numerical simulation of radon isotopes and their DPs transport in ground atmosphere with using complex model (turbulent diffusion, moving under the influence of vertical wind, removal by gravity and precipitation) showed that turbulent diffusion coefficient and vertical component of wind velocity are the most important factors, which influence vertical aerosols distribution. But only when wind blows upwards (from ground surface) we can observe such inverse situation in vertical distribution of radioactive aerosols.

Because of α-active aerosol (radon isotopes and DPs) concentration is direct (by radioactive complex decay low) related with β-active aerosol concentration (DPs), the experimental check of vertical distribution for β-radioactivity in air was also applied. The results (Fig. 2) revealed different dependences of flux density from height for α- and β-radioactivity in air.

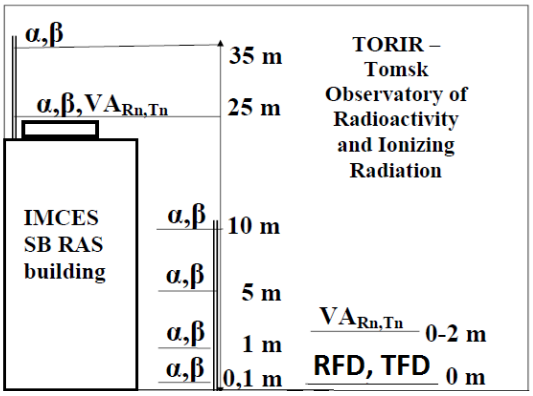

Figure 1. The scheme of experiment in Tomsk

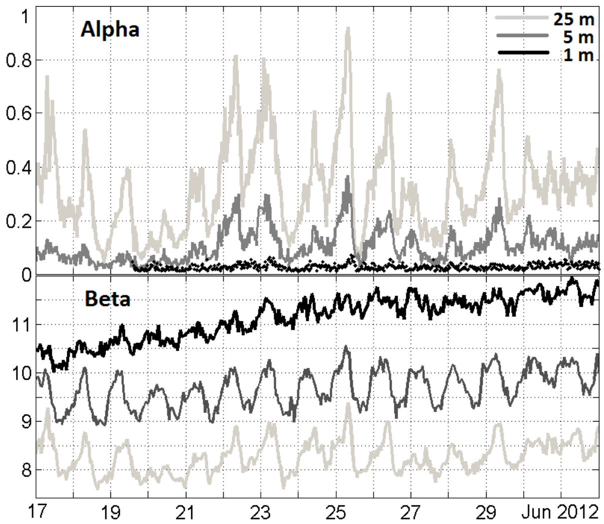

Figure 2. Temporal dynamics of α- and β-radiation flux densities in units of $m^{-2}s^{-1}$ at different heights

Detail discussion of behavior of α-radioactive aerosols in ground atmosphere during 2011–2013 and influencing factors are presented in the report.

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