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Comparison of aluminum and manganum concentration in Akmola region, Kazakhstan

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The results of seasonal Al and Mn activity on the surface of the atmosphere above the city of Nur-Sultan are shown from October 2016 to January 2017. The technique of sampling aerosols in various fractions and further analysis of the data are described. Together with scientists from the University of Hiroshima (Hiroshima, Japan) and the University of Tsukuba (Tsukuba, Japan), the composition of aerosols in the air of Astana was monitored. The aim of the project was to develop a methodology for sampling aerosols in various fractions and conduct measurements on an ongoing basis. The studies were carried out using a high-volume air sampler and a cascade of impactors that measure the size distribution and the respirable mass fraction of airborne particles of the environment. Fiberglass filters, which are a commonly used material for sample collection, were also used. The data obtained in the study of aerosol samples using a cascade of impactors allowing the selection of aerosols with sizes up to 0.49 μm showed the content of aluminum isotope in the atmosphere of the city. The smaller the clearance gap, the more particles are trapped. On average, aerosols were taken from more than 200 thousand cubic meters of air.

Keywords: aluminum, manganum, radioactivity, air, Akmola

Introduction

Heavy pollution and metals are one of the most harmful pollutants for the Earth's biosphere, having a wide variety of harmful consequences, both for human health and for the life of living organisms. The study of the effects of technogenic accumulation of heavy metals and anthropogenic pollution of the environment has now become extremely important for the health and safety of the population. Emissions from industrial enterprises have a powerful technogenic impact on the surrounding natural complexes of the steppe zone, causing disruptions in the natural development of biogeocenoses. Plants, being producers, make up the main level in the food chain of any biocenosis.

Atmospheric air is one of the main components of the natural environment. Human health, the state of the animal and plant world are associated with clean air.

Every year, a huge amount of pollutants is released into the atmosphere. Toxic gases such as carbon monoxide, sulfur dioxide, nitric oxide, chlorine, toxic substances contained in automobile gases, dust, etc. are released into the air. They have a very harmful effect on human health, cause diseases such as allergies, lung cancer, neuropsychiatric disorders, etc [1].

Most enterprises of the processing and energy complexes have imperfect technology, morally and physically worn out basic production assets, which contributes to an increase in the amount of harmful emissions. At the beginning of the 90s, about 6 million tons of pollution were annually released into the atmosphere (50% - heat power engineering, 20% - ferrous metallurgy, 13% - non-ferrous metallurgy, 4% - chemistry and petrochemistry). Most areas of high air pollution coincide with places of concentrated settlement of people. In the Karaganda and Pavlodar regions, for each inhabitant in 1993 there were 10.5 and 7.7 tons of harmful emissions, respectively. As a result of the activity of enterprises of the mining and metallurgical complex in Kazakhstan, more than 20 billion tons of industrial waste accumulated with an annual receipt of about 1 billion tons, including 230 million tons of radioactive waste. They are concentrated mainly in Karaganda - 29.4%, East Kazakhstan - 25.7%, Kostanay - 17% and Pavlodar - 14.6% of the regions. Heavy metals and oil products also contaminated the lands of the Kyzylorda, Atyrau and West Kazakhstan regions. Here, the volumes of abandoned and buried drill cuttings, oil-contaminated and low-radioactive waters, and areas of disturbed lands are difficult to assess.

The main source of air pollution is industry, especially power plants and vehicles. They account for more than half of all atmospheric emissions. Powerful thermal power plants (Ekibastuz TPP-1 and 2, Aksu TPP, Pavlodar TPP-1, 2, 3, etc.) annually emit thousands of tons of ash and sulfur dioxide. In the cities of the region, atomized products of industrial production are contained in large quantities in the form of various compounds, among which coal combustion products predominate.

Materials and methods

This experiment was carried out using a high volume an air sampler that measures the size distribution and the respirable mass fraction of airborne particles of the environment inside and outside the premises. Aerosols are sampled in the atmosphere of the city of Astana through an automated sampling station, which includes a cascade of impactors with multi-stage particle fractionation. The air sampler was installed on the roof of the training - laboratory building of the L.N. Gumilyov Eurasian National University, at an altitude of about 30 meters from the ground [2, 3].

Fiberglass filter is the most commonly used material for collection of samples. Particle displacement in the fiberglass retina improves particle retention and reduces possible secondary ablation. Cellulose-based filter media and metal foil can also be used as a substrate material. Substrates are thin flat sheets with 10 drilled holes, set holes on each nozzle [4]. Particles passing through nozzle openings in the selection stages sample, affect the assembly of the substrates and thus they are deposited or collected. Substrate collection also acts as a vacuum seal between sampler plates [5]. Substrate collection seems to be the most convenient method for collecting particles, unlike the use of heavy plates to collect the substrate and significantly reduces the cost selection method of mutual load, eliminating the need to purchase additional set of plates. The collection of the substrate also allows easier storage and subsequent chemical analysis [2, 6-9].

A direct measurement of the sampler is the "equivalent aerodynamic diameter", defined as the size of a spherical particle with a mass density of 1 gram/cm^3, which has the same limiting setting speed as the selected particle. Aerodynamic size is the most important in a particle, because it determines the penetration of particles into a human lung, the efficiency of particle collection in equipment for monitoring the environment, and the transport and distribution of particles in atmospheric air [9-11].

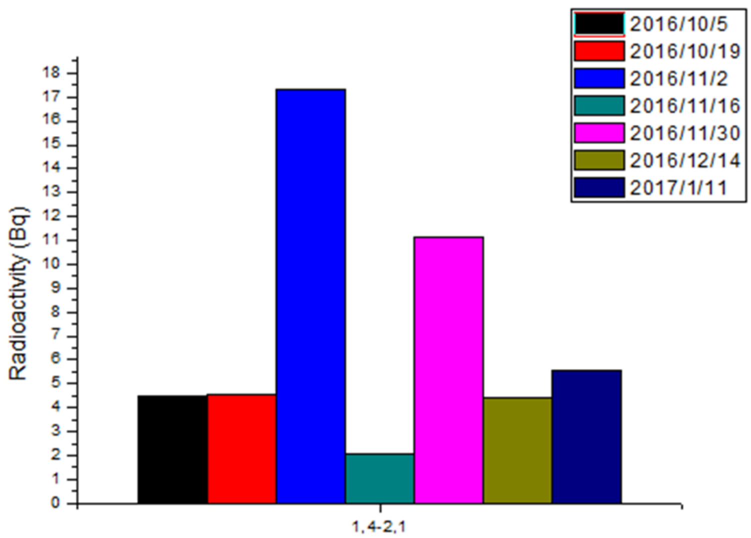

Figure 1. The level of radioactivity of aluminum for a filter of size 1.4-2.1 μm.

Results and discussion

In Figure 1, we compared the radioactivity of aluminum for a filter of size 1.4-2.1 μm from October 2016 to January 2017. A high concentration of aluminum was recorded in the month of November.

In Figure 2, we compared the radioactivity of aluminum for a filter of size 2.1-4.2 μm from October 2016 to January 2017. A high concentration of aluminum was recorded in the month of January.

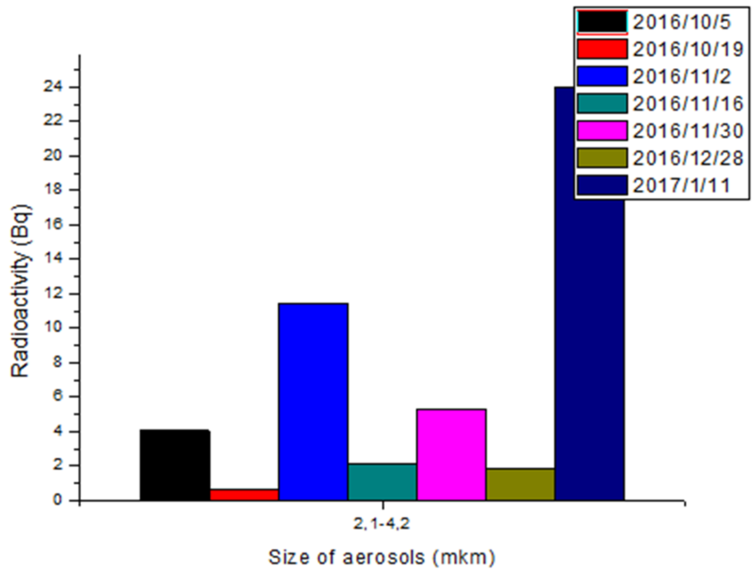

Figure 2. The level of radioactivity of aluminum for a filter of size 2.1-4.2 μm.

In Figure 3, we compared the radioactivity of aluminum for a filter larger than 10.2 μm in the period from October 2016 to January 2017. A high concentration of aluminum was recorded in the month of November.

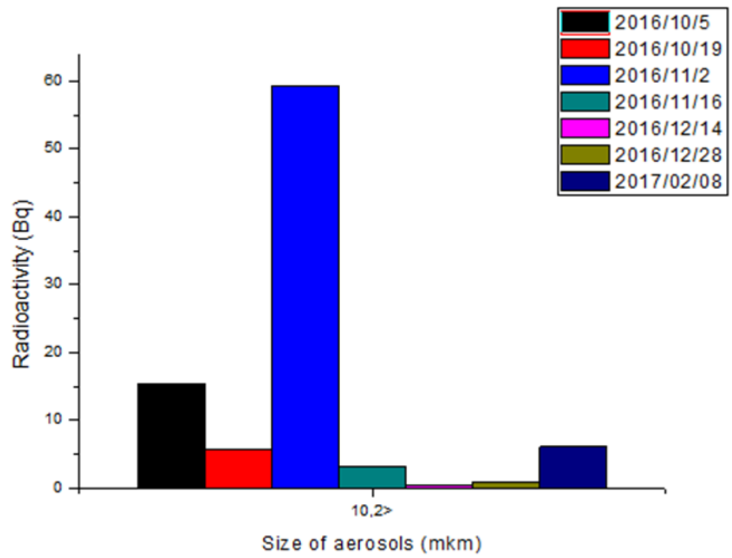

Figure 3. The level of radioactivity of aluminum for a filter of size >10.2 μm.

In Figure 4, we compared the radioactivity of aluminum for a filter smaller than 2.1 microns in the period from October 2016 to January 2017. A high concentration of aluminum was recorded in October and early November.

In the general column, we can see that the activity of Aluminum increases in November. The difference in the concentration of aluminum can be associated with worsening weather, namely, an increase in wind speed. Also since the beginning of

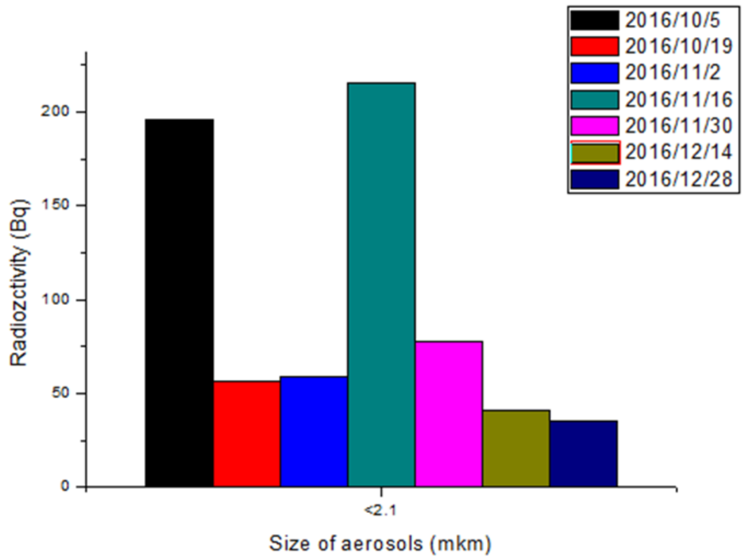

Figure 4. The level of radioactivity of aluminum for a filter of size <2.1 μm.

December there have been precipitations in the form of snow that clogged the filter. In this regard, sampling at the beginning was carried out under worse weather conditions.

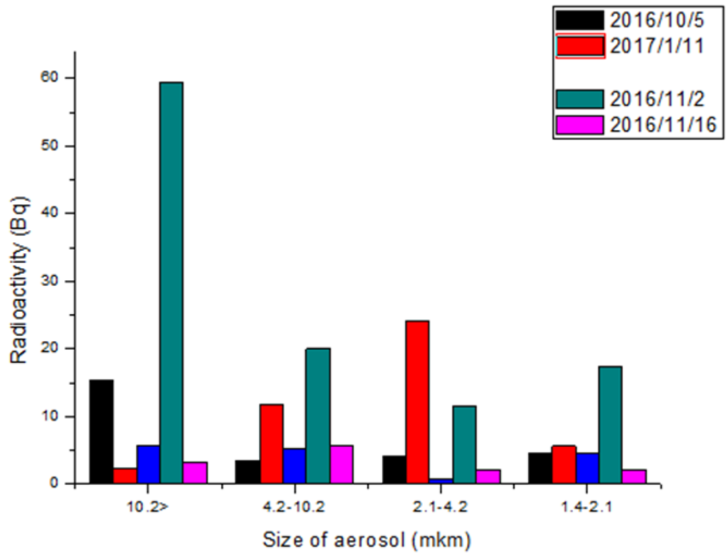

Figure 5. The level of radioactivity of aluminum.

A common form of the existence of metals in the air is aerosols and dust. Among them, the so-called suspended dust is a fraction with a particle diameter of less than 2 pm, in regions with developed industry and transport there are significant amounts of heavy metal ions in it. In the total emission of dusts, the fuel and energy industry produces about 60% of dust, while metallurgy of iron and steel - about 10%. The effect of metal ion pollution on the photochemistry of air pollution is significant in areas with developed industry and urbanization. Together with rain or snow, the fraction of suspended dust falls on the surface of the soil and water, which leads to their secondary pollution.

In Figure 6, we compared the radioactivity of manganum for a filter of size

>10.2 μm from October 2016 to January 2017. A high concentration of aluminum was recorded in the month of November.

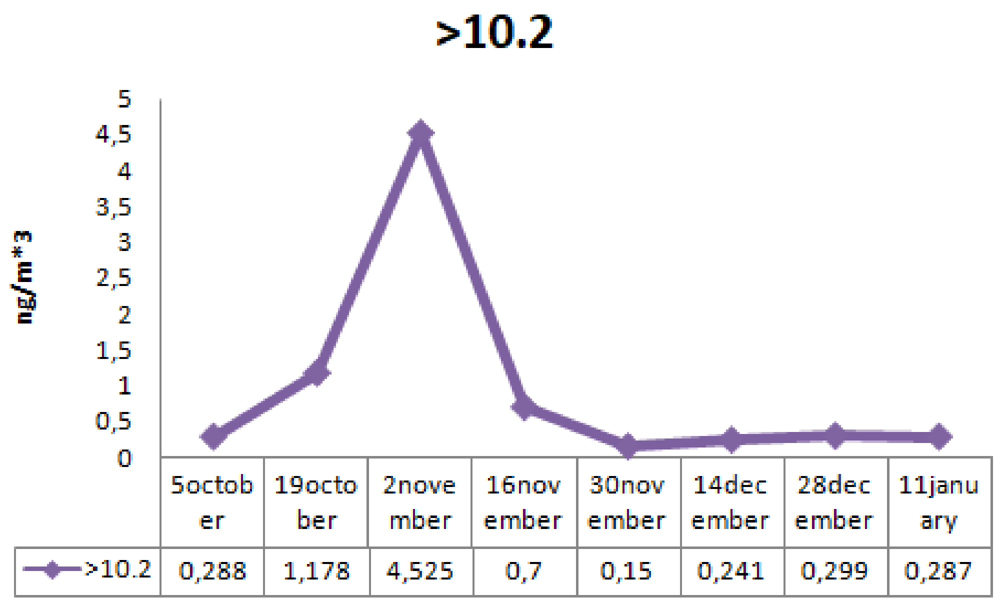

Figure 6. The level of radioactivity of manganum for a filter of size >10.2 μm.

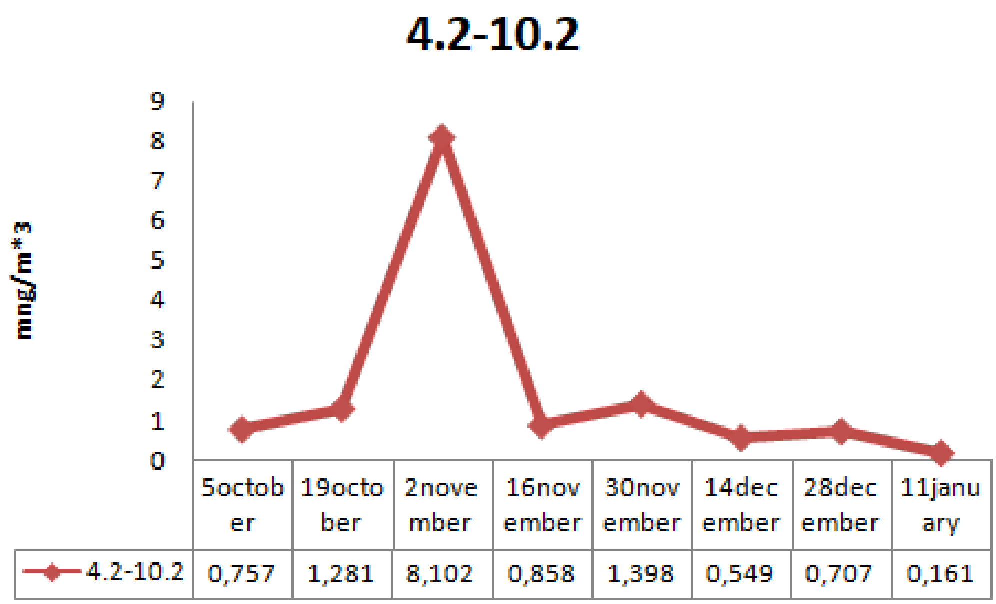

Figure 7. The level of radioactivity of manganum for a filter of size 4.2-10.2 μm.

In Figure 7, we compared the radioactivity of manganum for a filter of size 4.2-10.2 μm from October 2016 to January 2017. A high concentration of manganum was recorded in the month of November.

In Figure 8, we compared the radioactivity of manganum for a filter of size 2.1-4.2 μm from October 2016 to January 2017. A high concentration of manganum was recorded in the month of November.

In Figure 9, we compared the radioactivity of manganum for a filter of size

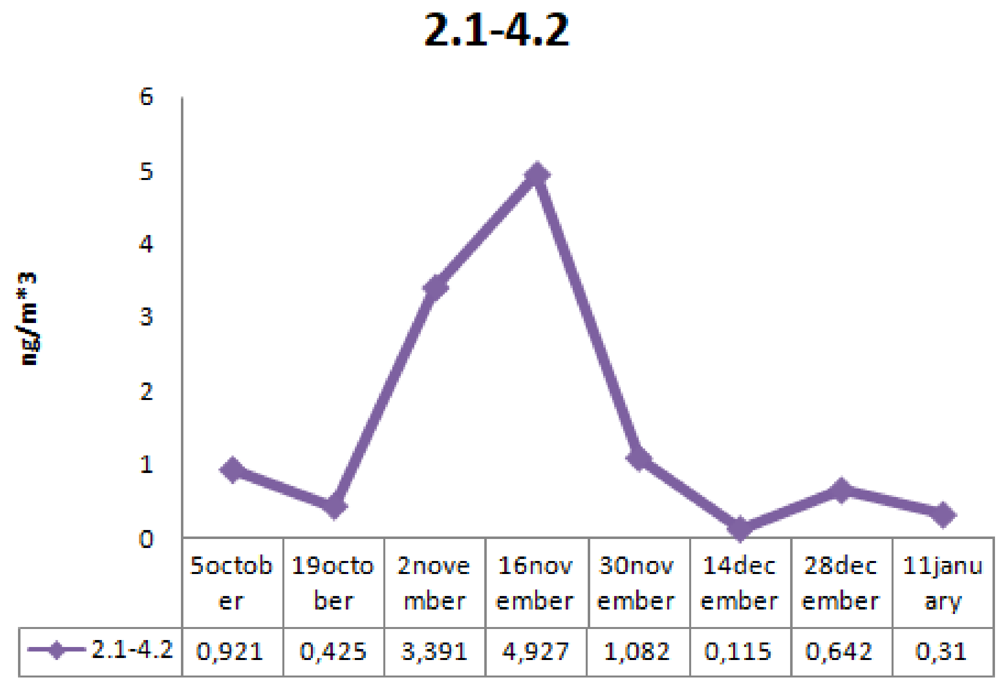

Figure 8. The level of radioactivity of manganum for a filter of size 2.1-4.2 µm.

1.4-2.1 µm from October 2016 to January 2017. A high concentration of manganum was recorded in the end of October and November.

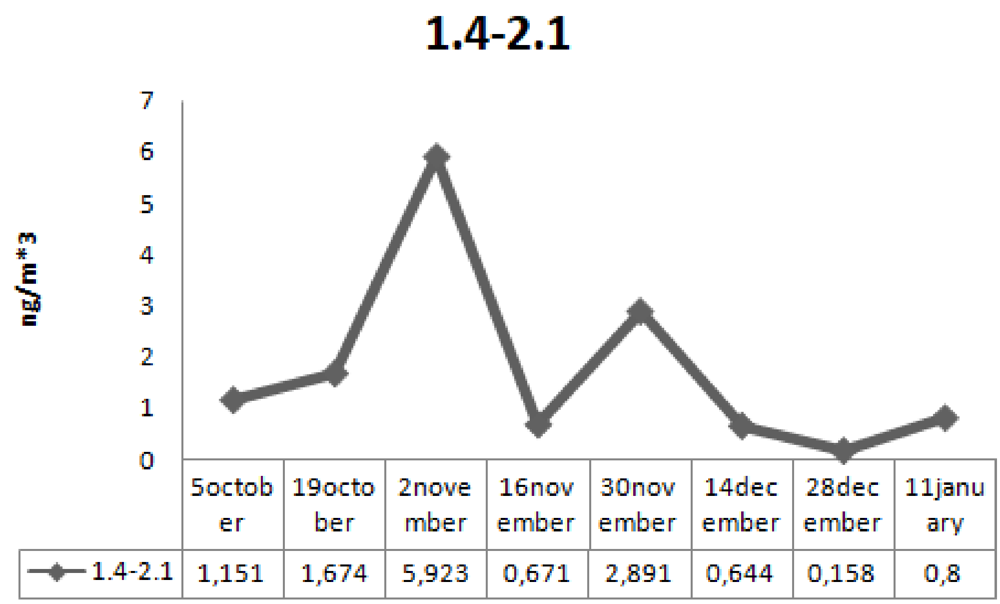

Figure 9. The level of radioactivity of manganum for a filter of size 1.4-2.1 µm.

In Figure 10, we compared the radioactivity of manganum for a filter of size <1.4 µm from October 2016 to January 2017. A high concentration of manganum was recorded in the month of October.

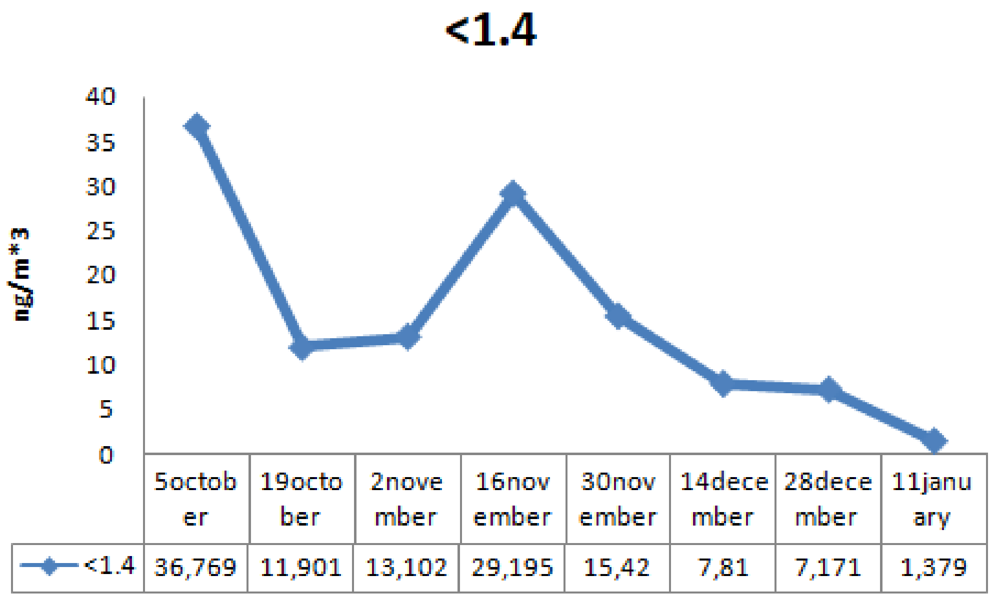

Figure 10. The level of radioactivity of manganum for a filter of size <1.4 μm.

Conclusion

We have conducted research of radionuclide composition in the atmosphere of Nur-Sultan. Together with scientists from Hiroshima University and Tsukuba University, the aerosol composition in the air was monitored over the Nur-Sultan using an automated aerosol sampling station and a multistage cascade of impactors. The cascade of impactors is a device for Sampling in which particles collected from an aerosol accumulate on a series of storage plates, the deposition principle is used.

The first data obtained in the study of aerosol samples, using a cascade of impact elements, which allows you to choose aerosols up to 0.49 microns, showed the content of aluminum and manganum isotopes in the city air. On average, aerosols were collected from more than 200,000 cubic meters of air. In this case, the increase in the weight of the filter element used as a substrate in the stages of the striker stage is different, the smaller the transmission width, the more particles are captured. It was also noted that the main isotope masses are deposited in the range 1.4 to 0.49 μm.

At the entrance of the measurements we recorded the activity of Al in various fractions of air aerosols. The measurements showed that the main activity of Al in the fine fractions of aerosols, since the concentration of lead is higher precisely in the filter <1.4 μm in size. The difference in the concentration of aluminum can be associated with worsening weather, namely, an increase in wind speed. Also since the beginning of December there have been precipitations in the form of snow that clogged the filter.

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