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TECHNICAL NOTE

Air aerosol sampling station AZA-1000 at Polish Polar Station in Hornsund, Spitsbergen

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Abstract The high volume air sampler AZA-1000 was built in the Environmental Protection Laboratory of the Andrzej Sołtan Institute for Nuclear Studies. In July 2002, this air sampler AZA-1000 was installed in the Polish Polar Observatory of the Polish Academy of Science in Hornsund, Spitsbergen. The device was built with numerous specific features which make possible to operate such station in extra difficult climatic conditions of polar region. Since July 2002, radioactive aerosols were collected at the Petrianov filter tissue FPP-15-1.5 and measured using high resolution γ spectrometry in the Environmental Protection Laboratory at Świerk. The concentration of the airborn, cosmogenic radionuclide ^{7}Be and of other natural and man maid radionuclides like ^{137}Cs was determined. A comparison of the preliminary results with those from the ASS-500 sampling station operating at Świder is presented.

Key words air sampling • radioactive aerosols • radioactive air pollution • radionuclides • polar air monitoring

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Introduction

History of Polish studies of radioactive pollution in the polar region goes back to the year 1957. As a member of the Polish Expedition of the International Geophysical Year 1957/1958, Prof. Z. Jaworowski from the Institute of Nuclear Research of the Polish Academy of Sciences organized and performed in the period from September 1957 till February 1958 measurements of air, snow and rain fallout radioactivity in Hornsund. His work was in 1958 continued by Prof. W. Wiśniewski from the Astronomic Observatory of Jagiellonian University. The results of measurements carried out at that time were used for comparison with results which were obtained in Poland using the same measurement methods.

The measurements of radioactive pollution of ground level air present in aerosols started in July 2002, when in the fjord Hornsund station AZA-1000 was assembled (at the premises of the Polar Station of Institute of Geophysics of the Polish Academy of Sciences). The construction was initiated by a team of the Department PII of the Institute for Nuclear Studies at Świerk.

The Polish station AZA-1000 in Hornsund (77°00' N, 15°33' E) is one of the stations positioned close to the polar pole (Figs. 1 and 2).

The aim of the work was to asses, with the use of AZA-1000, the concentration of radioactive isotopes

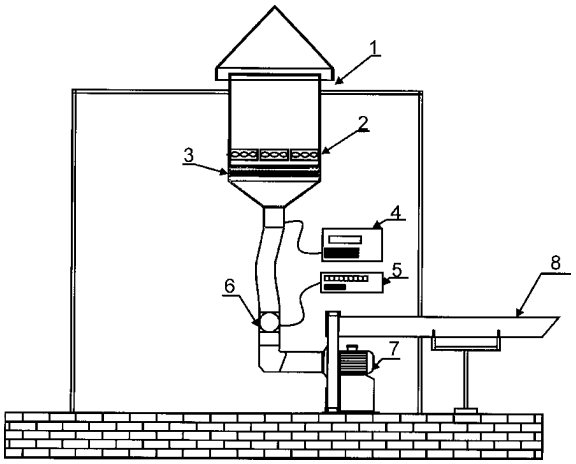

Fig. 1. Schematic picture of AZA-1000 set-up. 1 – Suction head cover with air inlet; 2 – 4 infrared heaters; 3 – filter frame tray; 4 – electric box for power supply; 5 – flowmeter display; 6 – flowmeter type VR-600; 7 – air pump high-pressure fan type ZWP-1300 (Venture Industries); 8 – outlet tube.

in the near ground atmospheric layer over Hornsund by analysing the gathered data [2]. This enables to learn the behaviour of different radionuclides in the near-pole region. The results are used to compare with the data obtained from stations situated at intermediate latitudes, e.g. with data from the Polish station ASS-500 at Świder at the Kalinowski Geophysical Observatory of Geophysics Institute of the Polish Academy of Sciences placed in a forest region far from urban pollution and highways (52°07' N, 21°15' E). Based on this, one may evaluate the influence of different geographical and weather factors on changes of radionuclide concentration [1].

Fig. 2. General view of AZA-1000 installation inside environmental studies container.

Experimental

The station was built as air aerosol sampler to be installed at the Polish Polar Station in Hornsund.

The instrument was designed to operate in all-weather condition of the cold polar region. To avoid the influence of extremely low temperature and severe snow precipitation, this device was not installed in the open air, but in a container where the temperature inside does not drop below 0°C. The station is accommodated for continuous operation in different meteorological conditions. The sampling part which collects aerosol from the air through the air inlet is placed at a roof about 3 m above the summer season ground level when snow disappears.

The high airflow rate about 400 m^3/h through a chlorinated vinyl polychloride filter or a polypropylene filter allows to take representative aerosol air samples. Collection of aerosols from about 10,000–60,000 m^3 enables accurate spectrometric measurements of radionuclides in a wide range of their concentration with detection sensitivity above 0.5–1 $\mu Bq/m^3$.

The high volume air sampler consist of: suction head cover with air inlet, 4 infrared heaters, filter frame tray, electric box for power supply, flowmeter display, flowmeter type VR-600, air pump high-pressure fan type ZWP-1300 (Venture Industries), outlet tube.

The configuration of the instruments inside the station contains a suction tube which penetrates the roof of the environmental studies container. This tube is covered by a roof with walves and shields protecting against snow penetration in to the sampler. Four infrared heaters of 500 W each are installed in the airflow above the filter to keep it dry. The filter is installed on a supporting mesh in the bottom of the air tube about 0.5 m below the ceiling of the protecting container. The filter change can be done inside the container not disturbed by outside weather or precipitation. The airflow is forced by a fan producing a pressured difference corresponding to the fan airflow efficiency 1000–1300 m^3/h (without filter). The filtered air is ejected off the station and container by a 4 m long outlet tube fixed under the container.

Operation procedure

1. The Petrianov filter is placed on the mesh frame and introduced to a sucking tube.
2. The airflow is switched on and controlled by a three-position display showing:
   a. the total airflow from a given starting point,
   b. instantaneous airflow.
3. The infrared heaters can be switched on manually depending on actual needs.
4. The aerosol is collected on the filter during one week.
5. After a week, the filter is replaced by a new one. The flowmeter indications are recorded.

6. The filter tissue with collected aerosol is dried under an UV lamp and sealed into a plastic bag.
7. Several times a year, the filters are mailed to the Environmental Protection Laboratory at Świerk, Poland, where they are weighed and pressed into $\Phi = 5$ cm discs.
8. Concentration of radionuclides present in the collected aerosols is determined using γ-spectrometric techniques with a high volume HPGe detector Canberra GX320 with a carbon epoxy window placed in a low background chamber built out of 10 cm thick selected lead bricks.

Results

In this work, a comparison of dustiness and concentration of ^{210}Pb, ^{7}Be, ^{137}Cs, ^{40}K in the near ground air layer at Świder and Hornsund was performed. The data from Świder were used during the same period in which the station in Hornsund was operating (i.e. from 7.07.2002 till 19.07.2003). The data from Hornsund were recalibrated to correct the errors resulting from the different exposition time of the filters. This period is not always exactly 7 days. As an example, (Fig. 3) shows the raw data for ^{7}Be with real exposition times. For further analyses, the data were recalibrated to the same time of exposition equal exactly to one week (Fig. 3).

The preliminary results give evidence that radioactivity measured in aerosols collected in the filters is not proportional to the amount of dust in both studied regions. The dust amount is obtained by weight.

Concentration of ^{210}Pb in Spitsbergen as well as at Świder is within the limit from 0 to about 1200 μBq/m^3. There are seasonal changes of ^{210}Pb concentration observed at Świder and Hornsund, but the time of occurrence the maxima and minima differs. The other interesting feature of radioactive pollution in the polar region is a negligible concentration of ^{40}K independently of meteorological parameters. It also appears that the concentration of ^{210}Pb (which is a decay product originating from ground Rn) is strongly correlated with wind direction from inland at Hornsund. Concentration of ^{7}Be at Świder is higher than in Hornsund (Fig. 4). Its maximal value encompasses 5000 μBq/m^3, while the maximum from Hornsund is about 3300 μBq/m^3. It is interesting because ^{7}Be is a cosmogenic nuclid arising

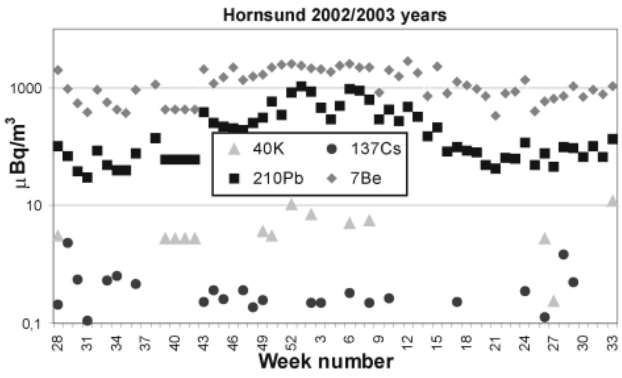

Fig. 3. Weekly concentration of ^{7}Be, ^{210}Pb, ^{40}K, ^{137}Cs, radionuclides at ground level air at Hornsund.

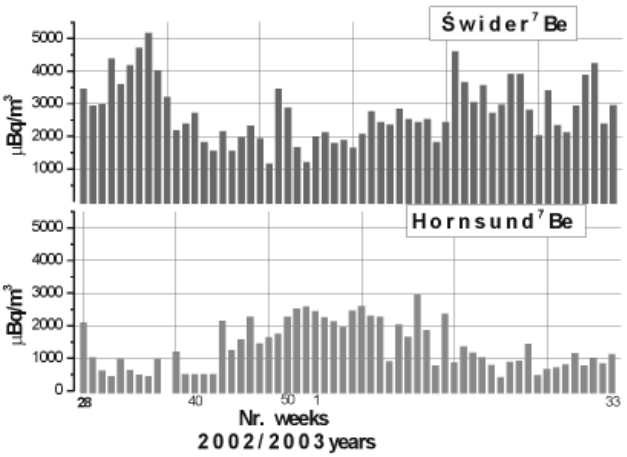

Fig. 4. The air born ^{7}Be concentration at Hornsund and at Świder near Warsaw.

in nuclear reactions of cosmic radiation with different components of atmosphere. Cosmic radiation consists mostly of particles with electrical charge which are deflected by the Earth magnetic field. In effect one would expect in the region near to Pole (Hornsund) higher concentration of ^{7}Be as compared with the concentration at an intermediate latitude (Świder). However, the measured values are contradictory to this. Similar results [3] were presented for polar stations in Greenland at Thule (76°36') and Kap Tobin (70°25') as well as in Alaska at Barrow (71°10').

For our both stations, the periods of the year when the maxima occur are different. For Świder it is summer for Hornsund – winter. The summer maximum of ^{7}Be concentration, regularly recorded in Poland, Germany and other countries of medium geographical latitude, appears when in the polar region concentration is minimal. These observation point to the dependence of ^{7}Be concentration on the intensity of solar radiation and on the vertical transport in atmosphere caused by a gradient of temperature.

Conclusion

The station during two years of continuous work in severe polar conditions has proven very useful in the study of aerosols in the near ground air. As radioactivity is an important factor in ionising phenomena in the air, we consider a complementary activity of the station in the future by including measurements of electrical parameters.

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