

## ENVIRONMENTAL IMPACT OF SILVER IODIDE USED FOR ACTIVE INFLUENCES ON ATMOSPHERIC PROCESSES

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According to new estimates released by the World Health Organization, in 2012 approximately 12.6 million people died as a result of living or working in unhealthy environmental conditions—nearly 1 in 4 of total global deaths. Environmental risk factors, such as air, water, and soil pollution, chemical exposures, climate change, and ultraviolet radiation, contribute to more than 100 diseases and injuries [1].

A significant contribution to the environment pollution is made by aerosols. Aerosols have a considerable impact on various aspects of human life, i.e., climate, light scattering, cloud formation and properties, and health effects. Aerosol particles in the atmosphere have a direct (by absorbing and scattering radiation) and indirect impact on climate (by affecting and changing the cloud properties). The latter effect occurs because aerosols act as cloud condensation nuclei and ice nuclei and thus influence the cloud albedo, lifetime, and other cloud properties [2].

Artificial ice-forming aerosols used for active impacts on atmospheric processes constitute a particular case of aerosols. These impacts are implemented for the protection of agricultural crops and industrial facilities from hail and for the simulation of artificial precipitation.

Silver iodide is a primary component of silver iodide-based ice-nucleating complexes used in cloud seeding. It should be noted that cloud seeding activities were the source of about three metric tons of silver (as silver iodide) released into the environment, or about 0.1 per cent of the total amount [3]. This brings up the question concerning the environmental effects of silver iodide aerosols used in cloud seeding, particularly silver iodide aerosol complexes, such as silver iodide – silver chloride [4]. Despite the fact that, to date, all findings have not revealed any adverse environmental and human health impacts, environmental impact studies related to silver iodide usage in cloud seeding have been conducted since the 1960s to the present day.

The results of studies of the silver content in soil, water bodies, and air and the ice nuclei concentrations in the regions subjected to hail protection in the Republic of Moldova in 1977–1991 have been summarized. The problems of environmental pollution in the regions involved in the activities have been discussed.

According to the standards established, for example, by the U.S. Public Health Service, a concentration limit of 50 µg of silver per liter of water in public water supply is the norm to protect human health [5]. The silver concentrations potentially introduced by modern cloud seeding efforts are significantly less than this level. All of these studies have concluded that ice-nucleating agents, specifically silver iodide used in cloud seeding, represent a negligible environmental hazard.

It has been shown that long-term observations of the use of AgI-based ice-forming compositions have not revealed either a tendency of silver aerosol accumulation in the ground air or its correlation with the amount of the consumed reagent. The study of the accumulation of silver ions in water, air, and soil as a result of active influences on atmospheric processes in Moldova has clearly shown that no environmentally harmful effects arising from cloud seeding with silver iodide aerosols have been observed either for lower organisms or for higher animals.

[1] <http://www.who.int/mediacentre/news/releases/2016/deaths-attributable-to-unhealthy-environments/ru/>

[2] Friedman, B., Zelenyuk, A., Beranek, J., et al. *Atmos. Chem. Phys.*, 2013, Vol.13, Issue 23, P.11839–11851.

[3] Eisler, R. Silver hazards to fish, wildlife, and invertebrates: a synoptic review. – 1996. No.32. – 63p.

[4] Fabrega, J., Luoma, S.N., Tyler, C.R., et al. *Environment International*. – 2011. – Vol.37. – P. 517–531.

[5] Erdreich, L., Bruins, R., With, J. *Drinking Water Criteria Document for Silver*. – 1985. – PB86118288. – 102p.