

# **Investigations of a possibility to reduce the solar radiation flux by a layer of artificial aerosols aimed at stabilization of the global climate at its present-day level.**

## **Results of field experiments carried out in Russia.**

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A necessity to use new technologies for stabilization of the climate current level becomes clear in view of continuing warming on our planet as well as by insufficient effectiveness of the Kyoto Protocol measures aimed at a control of the greenhouse gases emissions into the atmosphere. Even the most ambitious proposals of about 50% reduction of the global emissions of the greenhouse gases by 2050 without participation of developing countries are not able to solve the problem how to maintain the present-day climate.

In 1974, M.Budyko (USSR) had drawn attention to decreasing of the low atmosphere temperatures on the USSR territory after eruption of the large active volcano Agung (Alaska). He explained this effect as a reflection of the solar radiation coming to the Earth by the fine particles of the volcanic origin.

Since 2005, a group of Russian scientists (headed by the author of this report) perform intensive studies with a purpose of using the man-made stratospheric aerosols to maintain the present-day climate. (Rather many theoretical papers on this subject were published in different countries from 2006). We performed theoretical investigations together with laboratory experiments on different aerosol particles in the imitation cameras. We have found that optimal size (radius) of the particles allowing attenuation of the direct solar radiation is  $0.275\ \mu$ ; according to preliminary estimates, a quantity about 1-5 Mt of such aerosols, permanently sustained in the low stratosphere, are required to decrease the lower atmosphere temperature by 1-2 °C.

In March of 2008, at the meeting of 13 leading academies of science the author of this report had presented a talk on a possibility to stabilize the present-day climate by means of new technologies including the use of stratospheric artificial aerosols absorbing some part of the solar radiation. As a result of this, the presidents had written in their resolution: "There is also an opportunity to promote research on approaches which may contribute towards maintaining a stable climate (including so-called geo-engineering technologies and reforestation), which would complement our greenhouse gas reduction strategies. The G8+5 academies intend to organize a

conference to discuss these technologies ...” (from: Joint science academies’ G8+5) statement: Climate change adaptation ..., Tokyo, March 18, 2009).

Such conference is starting now.

Since 2008, for the first time in the world, a series of limited field experiments over the area of  $200\text{ km}^2$  ( $20 \times 10\text{ km}$ ) were carried out in Russia for generation of artificial aerosol layer, resulting in a partial attenuation of the direct solar radiation and possible the temperature drop in the low atmosphere.

The following specialists prepared and carried out this experiment were Yu.A. Izrael, V.M. Zakharov, V.N. Ivanov, A.G. Ryaboshapko, N.N. Petrov, Yu.A. Andreev, I.A. Borzenkova, V.A. Gulevsky, B.G. Danelyan, V.G. Eran’kov, D.V. Kirin, V.P. Kulyapin, Yu.C. Rusakov, A.V. Savchenro, P.N. Svirkunov, D.A. Severov, E.A. Chayanova, and V.V. Folomeev.

Our ground equipment included 8 solar photometers, 6 actinometric modules, lidar, and photoelectric counter of aerosol particles. The aviation complex consisted of lidar, photo- and video- recorders aboard a helicopter.

Generator, installed aboard the helicopter, produced extended aerosol clusters at a height up to 3,0 km. Attenuation of the radiation in our experiments changed from 62% down to 1% due to diffusive dispersing of the aerosol plume.

Thus, attenuation of the solar radiation by an order of 1% has been obtained over the area of  $200\text{ km}^2$  that corresponds to a concentration of the stratospheric aerosols sufficient for the global climate stabilization if this method would be applied at the global scale.

Our further field experiments were successful investigations of the air temperature change under influence of a layer of artificial stratospheric particles.

Our calculations had shown that a fallout of the sulfate aerosol particles, caused by the geo-engineering method, is about thousand times less than it takes place under industrial emissions.

In conclusion, we should note that existing International Convention of 1978 “On Prohibition of a Military or Another Hostile Use of Means of Any Impact upon the Environment” does not forbid any actions aimed at the environmental modification for the peaceful goals. This provides a way for wide discussion of the above method, including a possibility to raise an issue on organization of a large-scale international experiment.