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(54) Title: A METHOD FOR REDUCING CLIMATE-RELATED RISKS ASSOCIATED WITH WEATHER ANOMALIES AND A SYSTEM FOR ITS IMPLEMENTATION

(57) **Abstract:** The invention relates to the field of reducing climate-related risks associated with weather anomalies and can be used in agriculture, industry and other sectors of economy to fight with drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution in cities, industrial zones and other infrastructure facilities. The technical result achieved by implementing the claimed methods is the reduction of climate-related risks associated with weather anomalies, such as drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution. The use of the claimed system allows to achieve higher uniformity of precipitation, as well as to cover large areas and volumes of atmosphere layers. The technical result of the claimed invention is achieved through the synergy between the effect of ionized air flows on the lower layers of the atmosphere and the use of stationary, mobile and airmobile ion generators (ionizers) and highly effective environmentally friendly reagents sprayed in the lower layers of the atmosphere by using stationary, mobile and airmobile devices combined into a single system, with the ability to remotely control the system by means of special programs, in accordance with which the area of effect and operating modes of the system are established.

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A METHOD FOR REDUCING CLIMATE-RELATED RISKS ASSOCIATED WITH WEATHER ANOMALIES AND A SYSTEM FOR ITS IMPLEMENTATION

The invention relates to the field of reducing climate-related risks associated with weather anomalies and can be used in agriculture, industry and other sectors of economy to fight with drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution in cities, industrial zones and other infrastructure facilities.

It is known that the main climate-related risks due to global warming and climate change are drought and land desertification, prolonged, intense rainstorms and floods associated with them, forest and steppe fires, dust and sand storms, as well as fogs, smog and atmospheric air pollution in cities and industrial zones.

It is known that such climate-related risks as drought, desertification, forest and steppe fires, dust and sand storms, abnormally high temperatures and heat waves, as well as smog and atmospheric air pollution, are due to extensive anticyclones that are established over a long period of time over large areas of land, seas and oceans and lead to an abnormal deficiency of atmospheric precipitation and temperature anomalies.

It is known that in extensive anticyclones that are established over a long period of time over large areas of land, seas and oceans, at altitudes of up to 2 km and more, temperature inversions, such as surface inversions, raised inversions or subsidence inversions, occur due to the downward movement of atmospheric air and its adiabatic heating, preventing the occurrence of convection air flows. An established atmospheric anticyclone and a stable restraining inversion layer hinder the vertical movement and mixing of humid air masses, the formation of rain clouds and precipitation, which

leads to a prolonged absence of precipitation and droughts, as well as to the occurrence of smog and atmospheric air pollution.

It is also known that an established atmospheric anticyclone and a stable restraining inversion layer hinder the occurrence of vertical convection air flows and contribute to the occurrence of smog, fog and an increase in the level of atmospheric air pollution in cities and industrial areas.

Thus, to fight with drought and land desertification, first of all, it is necessary to break the stable temperature inversion layer, which will lead to the occurrence of vertical convection air flows and the launch of cyclonic processes accompanied by deformation, displacement and partial or complete breaking of the atmospheric anticyclone, inflow of humid air masses from overly humid areas and water areas of seas and oceans, with the formation of clouds and precipitation in the form of rain or snow.

Also, the breaking of the stable inversion layer and the occurring vertical convection air flows will contribute to the elimination of smog, purification and improvement of the quality of atmospheric air, as well as to the elimination of other atmospheric anomalies.

In this case, the stable inversion layer may be broken by producing turbulence of air flows and/or by producing thermal convection of large volumes of atmospheric air.

A method for breaking a temperature inversion layer in the troposphere is known, which is proposed in patent RU2694200C1 published on 09.07.2019, in which a temperature inversion layer in the troposphere is broken by producing turbulence and an ascending flow of hot air by using rapid-fire artillery systems and synchronously detonating plasma-optical ammunition at various heights, mathematically calculated for that particular state of the atmosphere. The main disadvantages of the method are low efficiency, significant energy and economic costs for heating large volumes of atmospheric air and breaking massive inversion layers and the non-compliance with the requirements of ecological safety for the environment and the population.

A method for breaking a temperature inversion layer in the atmosphere by heated convective jets produced by heat sources in the form of air balloons with a blackened side surface for their heating by solar rays, which are located above the upper boundary of the inversion layer, is known, which is described in US patent No. 3666176 published on 30.05.1972. The main disadvantages of the described method and device are the low efficiency of convective jets produced by air balloons with a blackened side surface and the low efficiency of breaking the temperature inversion layer.

A method for producing turbulence and an ascending flow of hot humid air by means of a meteotron is known, which is invented by the French professor Henri Dessen and proposed in the Russian Federation patent RU41123U1 published on 10.10.2004, in which a temperature inversion layer in the troposphere is broken and cyclonic processes are produced by heating the air to a temperature above 1000 °C and by producing a flow of atmospheric air at a speed of more than 500 m/s by means of turbojet aircraft engines the service life of which expired. The main disadvantages of the described method and device are low efficiency, huge financial costs, fuel costs and high ecological hazard for the environment and the population.

A method for remotely exerting an effect on the atmosphere to cause atmospheric precipitation by using electromagnetic radiation is known, which is proposed in the patent RU2058071C1 published on 20.04.1996, which involves a directional effect on the atmosphere over a given area with pulsed low-energy electromagnetic radiation that occurs over a period of time not exceeding 80 h and at a time when the given area is in the centre of the night side of the Earth corresponding to it. The main disadvantage of this method is the high non-uniformity of precipitation.

A method for stimulating atmospheric precipitation with acoustic waves is known, which is described in Russian Federation patent RU189068U1 published on 07.05.2019, in which the acoustic waves increase the frequency of collisions of water vapour molecules in a compacted layer of air, which contributes to an increase in the

size and mass of atmospheric humidity droplets and to precipitation. The main disadvantage of the method is that it needs clouds or high humidity of atmospheric air.

A method for regulating precipitation from convective clouds is known, which is described in Russian Federation patent RU2061358C1 published on 10.06.1996, in which clouds are seeded with reagents for initiating precipitation, which include ionic hygroscopic substances, and with reagents that include silver iodide, to dissipate clouds and reduce or prevent precipitation. Seeding clouds with reagents to initiate precipitation contributes to a change in the phase state of clouds, to formation of centres of condensation of water vapour included in the atmospheric air and to precipitation.

The main disadvantage of the method is that it needs convective clouds and high humidity of atmospheric air.

The closest prior art of the method for disrupting anticyclonic circulation and the device for its implementation is described in Russian Federation patent RU2233578C2 published on 10.08.2004. The method involves forming, by means of an ascending flow of ionized air, an area of low atmospheric pressure in the upper part of the anticyclone zone until there emerges a cyclonic vortex that breaks the inversion layer and weakens the anticyclone, brings humid air masses to arid areas and leads to precipitation.

To implement this method, a device being the closest prior art of the claimed system, comprising at least one ion generator having a corona-forming electrode and an ion extractor, is used. The corona-forming electrode is located around the ion extractor along an inclined surface that tapers towards the base of the latter.

The main disadvantages of the method are territorial non-uniformity and poor controllability of precipitation intensity.

The disadvantage of the device is that only one type of effect can be used.

It is known that such climate-related risks as prolonged and intense precipitation leading to floods are due to massive large-scale cyclones that develop over large land areas over a long period of time.

The closest prior art of the method for weakening cyclonic circulation and the device for its implementation is described in the Russian Federation patent RU2321870C2 published on 10.04.2008. The method involves forming, by means of an ascending flow of ionized air, in the zone of a warm frontal surface and/or a cold sector of the cyclone, an area of low atmospheric pressure, followed by the formation of a secondary cyclone that deprives the cyclone of energy supply and leads to its weakening or elimination.

A device for producing a flow of ionized air, which is the closest prior art of the claimed system, comprises at least one ion generator comprising a corona-forming electrode, an extractor of electrons and ions located in the cavity of the corona-forming electrode and an external electrode.

The main disadvantage of the method is the poor controllability of atmospheric circulation.

The disadvantage of the device is that only one type of effect can be used.

The closest prior art of the method for reducing climate-related risks associated with weather anomalies by eliminating fog, smog and reducing the concentration of suspended PM2.5 particles in the atmospheric air is the method for exerting an effect on atmospheric formations, which includes producing a vertical convective thrust through ionization of the air and a zone that feeds this thrust, which is described in Russian Federation patent RU2098942C1 published on 20.12.1997. Such a zone is produced along the periphery of the formed vertical convection zone also through air ionization.

The disadvantage of this method is that there is a possibility of excessive humidification of air masses, which, in turn, will lead to a large amount of precipitation.

The purpose of the claimed invention is to develop methods and devices for reducing climate-related risks associated with weather anomalies, such as drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution.

The technical result achieved by implementing the claimed methods is the reduction of climate-related risks associated with weather anomalies, such as drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution, increasing their efficiency compared to the existing solutions and providing for higher uniformity of precipitation.

The technical result achieved when using the claimed system is the ability to effectively eliminate various types of weather anomalies, such as drought, desertification, sand and dust storms, forest and steppe fires, abnormally high temperatures and heat waves, rainstorms and floods, fogs, smog and atmospheric air pollution, as well as the ability to use the system in large territories to cover a larger area and large volumes of atmosphere layers.

The technical result of the claimed invention is achieved through the synergy between the effect of ionized air flows on the lower layers of the atmosphere and the use of stationary, mobile and airmobile ion generators (ionizers) and highly effective environmentally friendly reagents sprayed in the lower layers of the atmosphere by using stationary, mobile and airmobile devices combined into a single system, with the ability to remotely control the system by means of special programs, in accordance with which the area of effect and operating modes of the system are established.

The system operates in the mode of weakening the anticyclone, increasing the amount of precipitation at low air humidity in conditions of the developed anticyclone.

In conditions of the developed anticyclone, in the absence of convective clouds and very low air humidity, the technology of seeding clouds has almost zero efficiency.

In this case, the synergy between the technology of unipolar electrical ionization of the lower layers of the atmosphere and the technology of seeding clouds with reagents is used.

Electrical ionization of the lower layers of the atmosphere carried out by means of a group of stationary and mobile ion generators (ionizers) controlled from a central control station produces vertically ascending flows of ionized air that contribute to the formation of an area of low atmospheric pressure and initiate the vertical movement of ionized air masses that lead to the breaking of the temperature inversion layer and weakening of the anticyclone.

At the same time, electrical ionization of the lower layers of the atmosphere creates conditions that ensure transfer of humid air masses from overly humid areas of oceans and seas to arid areas and leads to the occurrence of cyclonic processes, saturation of the atmosphere with humidity, formation and development of new clouds in the lower layers of the atmosphere, condensation of atmospheric humidity and leads to an increase in the amount of precipitation.

However, cyclonic processes are very dynamic, which leads to non-uniformity of precipitation. To increase the amount of precipitation and improve the uniformity of precipitation, the convective clouds and the lower layers of the atmosphere are "seeded" by spraying environmentally friendly reagents, for example, spores of puffball mushrooms (basidiospores) by means of a group of stationary, mobile and airmobile (aircraft) devices controlled from a central control station.

In this case, additional centres of condensation of atmospheric humidity are produced, which lead to an increase in the amount of precipitation and a higher uniformity of precipitation.

Thus, in the present invention, the synergy of using the technology of electrical ionization of the lower layers of the atmosphere and the technology of seeding clouds with reagents allows to achieve higher uniformity of precipitation and better controllability of the amount of precipitation.

In this case, meteorological data such as air humidity, height of humid air layer, wind speed and direction obtained from satellite systems and weather radars are used.

Also, the mode of increasing the amount of precipitation allows to effectively redistribute seasonal atmospheric precipitation by increasing the amount of precipitation during the dry period of sowing and vegetation of crops and decreasing the amount of precipitation during the monsoon period.

The system operates in the mode of weakening the cyclone, shortening the duration and decreasing the intensity of precipitation and decreasing the total amount of precipitation.

Electrical ionization of the lower layers of the atmosphere in the zone of developed or developing cyclone carried out by means of a group of stationary and mobile ion generators (ionizers) controlled from a central control station produces vertically ascending flows of ionized air that contribute to the formation of an area of low atmospheric pressure and to the emergence of secondary cyclonic processes and lead to a weakening of the cyclone and a decrease in the total amount of precipitation.

The process of weakening of the cyclone is very dynamic, which may lead to short-term, local and non-uniform precipitation and unwanted local floods on a certain territory.

To eliminate the non-uniformity of local precipitation and unwanted local floods on a certain territory, the lower layers of the atmosphere in the zone of a weakening cyclone are “seeded” by spraying environmentally friendly reagents, for example, spores of puffball mushrooms (basidiospores) by means of a group of stationary, mobile and airmobile (aircraft) devices controlled from a central control station.

In this case, additional centres of condensation of atmospheric humidity are produced, which lead to redistribution of precipitation and a higher uniformity of precipitation, which reduces the likelihood of occurrence of unwanted local floods on a certain territory.

Thus, in the present invention, the synergy of using the technology of electrical ionization of the lower layers of the atmosphere in the zone of a weakening cyclone and the technology of seeding clouds with reagents allows to weaken the cyclone, redistribute precipitation, decrease the total amount of precipitation and reduce the likelihood of occurrence of unwanted local floods on a certain territory.

In this case, meteorological data such as air humidity, height of humid air layer, wind speed and direction obtained from satellite systems and weather radars are used.

The system operates in the mode of cloud scattering, reducing the likelihood of precipitation, eliminating fog, removing smog and reducing the concentration of suspended PM2.5 particles in the atmospheric air of polluted cities and industrial zones to safe levels that ensure minimal effect on the health of the population.

Electrical ionization of the lower layers of the atmosphere carried out by means of a group of stationary and mobile ion generators (ionizers) controlled from a central control station by means of special programs produces ascending flows of ionized air that contribute to the formation of an area of low atmospheric pressure and initiate the vertical movement of ionized air masses that lead to the breaking of the temperature inversion layer, to the cooling of ionized air masses in the upper layers of the atmosphere and condensation of humidity to form clouds.

This leads to the emergence of descending cooled air masses, their heating in the surface layer of the atmosphere and a decrease in the humidity of heated air masses, which contributes to a decrease in the humidity of clouds and leads to their scattering, the elimination of fog, the removal of smog and a decrease in the concentration of suspended PM2.5 particles in the atmospheric air.

The process of condensation of humidity to form clouds in order to further reduce the humidity of clouds and their scattering requires an additional local “seeding” of the resulting clouds by spraying environmentally friendly reagents, for example, spores of puffball mushrooms (basidiospores) by means of a group of stationary, mobile and

airmobile (aircraft) devices controlled from a central control station by means of certain programs.

In this case, additional centres of condensation of atmospheric humidity are produced, which lead to precipitation, a decrease in humidity of clouds and their scattering.

Thus, in the present invention, the synergy of using the technology of electrical ionization of the lower layers of the atmosphere and the technology of seeding clouds with reagents allows to create conditions for scattering the emerging clouds and reducing the likelihood of cyclonic processes occurring during the monsoon period.

Also, in the present invention, the synergy of using the technology of electrical ionization of the lower layers of the atmosphere and the technology of seeding clouds with reagents allows to create conditions for eliminating fog, removing smog and reducing the concentration of suspended PM2.5 particles in the atmospheric air.

In this case, meteorological data such as air humidity, height of humid air layer, wind speed and direction obtained from satellite systems and weather radars are used.

A system for implementing the above-described methods for reducing climate-related risks associated with weather anomalies includes a group of stationary, mobile and airmobile ion generators (ionizers) for exerting an effect on the lower layers of the atmosphere and a group of stationary, mobile and airmobile devices for seeding the lower layers of the atmosphere with environmentally friendly reagents, with the ability of remote control from a single centre by means of special programs, in accordance with which the area of effect, operating modes of the system, duration, periodicity and intensity of effect are established.

An ion generator (Fig. 1 and 2) consists of an extractor electrode 1, a shielding electrode 3, which are located at the edges, and an emitter corona-forming electrode 2 located between them. The interelectrode distances L1 (between the electrodes 1 and 3), L2 (between the electrodes 1 and 2) and L3 (between the electrodes 2 and 3) are variable.

The stationary ionizers are located at the locations where cyclones/anticyclones are most likely to occur or which are typical for their occurrence, for example at elevations. The mobile ionizers and the devices for seeding clouds are placed on motor vehicles, rail and water vehicles and travel by land and water, depending on meteorological data, such as air humidity, the height of the layer of humid air, wind speed and direction, obtained from satellite systems and weather radars, and the airmobile systems are used in the places inaccessible for mobile devices or at certain altitudes in the air. Thus, the widest coverage of areas and volumes to be exposed to ionizers and devices for seeding clouds is ensured.

Examples of implementation of the claimed invention are as follows.

In the Mangystau region, the Republic of Kazakhstan, demonstration works on the use of a system consisting of 5 stationary ion generators in the form of ILAP-type ionizers located on the territory of the Mangystau region and 2 drones for cloud seeding reagents, which lasted 3 months, were conducted from March to May of year 2022.

In March, the system consisting of 5 stationary ILAP-type ionizers and 2 drones for seeding clouds with reagents was operated in the mode of increasing precipitation at reduced power.

Clouds were seeded 2 times by using 2 drones. Conventional cooking salt and spores of puffball mushrooms (basidiospores) were used as a reagent.

In accordance with official data from observation stations received from the Branch of the RSE Kazgidromet for the Mangystau region, the amount of precipitation in March is given in Table 1.

Table 1. Total precipitation for March, mm

Observation station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Aktau	25.1	4.7	3.7	2.2	57.3	44.3	13.1	8.8	2.1	1.2	27.1

Akkudyk	23.6	4.3	0.4	14.4	17.4	10.6	42.5	29.5	1.1	4	3.9
Zhanaozen	17.9	6.9	4.7	1.9	96.6	10.7	10.7	36	8.7	0.1	9.2
Kyzan	16.0	3.5	6.2	12.9	50.1	36.6	8.8	6.2	5.4	4.8	33.8
Tuschybek	29.4	4.8	2.9	6.4	44.8	41.3	7.8	10.4	4.4	2.5	21.4
Sai-Utes	53.7	12.5	9.2	4.4	64.3	13.2	20	22.2	13.5	1.2	7.9
Opornaia	14.3	4.3	5.8	2.8	32.7	11	12.8	7.5	3.9	-	14.1
Beineu	25.7	25.7	12.9	12.7	29.5	8.8	18.6	32.7	8.7	7.1	27.5
Sam	33.2	23.9	2.1	14.7	42.4	14.2	17.2	47.2	2.6	11.3	43.7
Kulaly	5	5	4.7	9.6	20.6	21.2	5.3	-	8.2	2.3	12.3
Fort-Shevchenko	3.8	3.2	1.5	8.8	29.1	47.3	7.7	0	3.5	3.3	20.1

The average increase in precipitation for March was about 24 %.

In April, the system consisting of 5 stationary ILAP-type ionizers and 2 drones for seeding clouds with reagents was operated in the mode of scattering convective clouds and removing smog.

Clouds were seeded 1 time by using 2 drones. Conventional cooking salt and spores of puffball mushrooms (basidiospores) were used as a reagent.

In accordance with official data from observation stations received from the Branch of the RSE Kazgidromet for the Mangystau region, the amount of precipitation in April is given in Table 2.

Table 2. Total precipitation for April, mm

Observation station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Aktau	1.2	15.3	5.5	3172	67.9	9.2	15.7	36.6	9.0	0	0
Akkudyk	1.2	7.0	9.3	60.5	31.1	9.7	5.8	36.2	13.9	0	0
Zhanaozen	2.5	17.5	29.2	41	105.7	38.7	3.8	24.1	17.1	0.1	1.4
Kyzan	0	6.6	0	38.6	39.2	3.8	9.3	36.2	21.3	2.1	0
Tuschybek	6.4	24.6	4.7	40.6	59.9	10.7	8.7	35.4	20.1	-	2.4
Sai-Utes	0	15.2	2.3	16.6	32.6	1.2	3.4	17.2	13.5	0	0.4
Opornaia	0.4	4.7	11.2	21.2	25.8	1.6	4.0	39.1	33.8	0	0.9
Beineu	0	17.3	8.1	33.3	36	0	6.5	23.8	26	2.7	2.4
Sam	1.7	37.5	4.1	21.3	33.7	1.3	3.1	36.3	34.2	1.3	3.1
Kulaly	0	5	3.3	19.6	7.6	-	4.3	18.4	2.3	1.1	2.3
Fort-Shevchenko	0.3	4.2	1.6	39.1	25.7	-	0	33.2	4.3	-	2.2

Most of the convective clouds were scattered and almost no precipitation was observed during April. Visually, no smog was observed in the atmospheric air in the area of the observation stations.

During the first week, from May 1 to May 7, the system consisting of 5 stationary ILAP-type ionizers and 2 drones for seeding clouds with reagents was operated in the mode of increasing precipitation at increased power.

Clouds were seeded 3 times by using 2 drones. Conventional cooking salt and spores of puffball mushrooms (basidiospores) were used as a reagent.

On May 7 and May 8, the cyclonic processes led to heavy rains, which were observed during the 2nd week of May. The average increase in precipitation for the 2nd week of May was about 75%.

During the third week, the system consisting of 5 stationary ILAP-type ionizers and 2 drones for seeding clouds with reagents was operated in the mode of reducing precipitation.

Clouds were seeded 1 time by using 2 drones. Conventional cooking salt and spores of puffball mushrooms (basidiospores) were used as a reagent.

During the third and fourth weeks of May, the cyclonic processes weakened, and the amount of precipitation decreased and precipitation completely stopped at the end of the 4th week.

In accordance with official data from observation stations received from the Branch of the RSE Kazgidromet for the Mangystau region, the amount of precipitation in April is given in Table 3.

Table 3. Total precipitation for May, mm

Weather station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Aktau	1.7	0.3	13.4	13.7	13.5	40.4	0.0	3.0	22.0	8.4	52.8
Akkudyk	2.7	3.3	-	17.3	20.4	50.7	-	16.9	2.5	1.0	3.4
Zhanaozen	3.4	10	0.3	7.5	7.5	76.4	-	87.7	33.1	2.5	12.0
Kyzan	4.3	0.4	0.8	28	14.6	4.7	-	24.6	21.2	9.4	68.1
Tuschybek	10.3	40.4	10.4	16.9	37.6	44.1	-	34.5	23.9	7.4	71.2
Sai-Utes	2.8	3.2	1.4	11	28.5	16.4	-	5.6	12.2	0.9	9.6

Opornaia	4.2	0	4.6	26.2	59.3	13.2	1.2	16	23.4	0.4	8.1
Beineu	5.8	5.7	0	11.2	36.5	6.9	0	4.6	17.8	0.0	32.1
Sam	5	1.5	3.8	12.4	33	14.2	0.4	13.9	6.5	2.9	66.3
Kulaly	-	1.5	3.3	8.1	12.6	0.6	-	5.2	5.2	3.5	4.4
Fort-Shevchenko	4	0	15.3	16.3	5.5	1.7	0	3.2	21.2	2.2	18.7

Claims

1. A method for reducing climate-related risks associated with weather anomalies by increasing the amount of precipitation, including disruption of anticyclonic circulation through the effect of vertically ascending flows of ionized air on the lower layers of the atmosphere in the zone of anticyclone, characterized in that the clouds are additionally seeded with environmentally friendly reagents in the zone of anticyclone.

2. A method for reducing climate-related risks associated with weather anomalies by reducing the amount of precipitation, including weakening cyclonic circulation through the effect of vertically ascending flows of ionized air on the lower layers of the atmosphere in the zone of developed or developing cyclone, characterized in that the clouds are additionally seeded with environmentally friendly reagents in the zone of developed or developing cyclone.

3. A method for reducing climate-related risks associated with weather anomalies by eliminating fog, smog and reducing the concentration of suspended PM2.5 particles in the atmospheric air, including disruption of anticyclonic circulation through the effect of vertically ascending flows of ionized air on the lower layers of the atmosphere, characterized in that local seedings of the formed clouds are additionally carried out by spraying environmentally friendly reagents.

4. The method according to claims 1–3, wherein spores of puffball mushrooms (basidiospores) can be used as environmentally friendly reagents.

5. A system for implementing the method of claims 1–3, comprising one or a group of ion generators for producing an ascending flow of ionized air, having an emitter corona-forming electrode, an extractor electrode and a shielding electrode, characterized in that the ion generators are configured to change the configuration of electrodes and interelectrode distances, wherein they are placed on stationary, mobile and airmobile platforms forming a group for exerting an effect on the lower layers of the atmosphere with ionized radiation, wherein the system further comprises a group of stationary, mobile and airmobile devices for seeding the lower layers of the

atmosphere with environmentally friendly reagents, which are combined into a single network, with the ability of remote control from a single centre by means of special programs, in accordance with which the area of effect, operating modes of the system, duration, periodicity and intensity of effect are established.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

A01G 15/00(2006.01)i; **G01W 1/00**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A01G 15/00(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: weather, precipitation, anticyclonic circulation, ionized air, ion generator, mushroom, spore, fog, smog, cyclonic circulation, mobile, air mobile

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1652423 A1 (PROTOPOPOV, VADIM ANATOLEVICH et al.) 03 May 2006 (2006-05-03) paragraphs [0001]-[0003], [0013]-[0019], [0022]-[0033]; and figs. 1-4	1,3-5
A		2
Y	HASSETT, MARIBETH O. et al., Mushrooms as rainmakers: how spores act as nuclei for raindrops, PLoS ONE, 2015, Vol. 10, Issue No. 10, Article No. e0140407, Internal pages 1-10 (Published on 2015.10.28) abstract; internal pages 2-8; and figs. 2, 7, 8	1,3-5
Y	RU 2098942 C1 (PESTOV, DMITRIJ ALEKSANDROVICH) 20 December 1997 page 3, left column, lines 1-7, right column, lines 10-66; and figs. 1, 2	3
Y	US 2016-0165813 A1 (THE BOEING COMPANY) 16 June 2016 (2016-06-16) paragraphs [0011], [0015], [0017]-[0022], [0024], [0025]; and figs. 2, 3, 5	5
A	RU 2321870 C2 (PROTOPOPOV, VADIM ANATOLEVICH et al.) 10 April 2008 page 4, lines 2-6; and page 6, lines 20-34	1-5

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2024	**13 May 2024**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2024/051090

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011-0049257 A1 (BOLOGUROV, SERGEY et al.) 03 March 2011 (2011-03-03) the whole document	1-5

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2024/051090

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
EP 1652423 A1	03 May 2006	AU 2004-257560 A1	27 January 2005
		CA 2530409 A1	27 January 2005
		EP 1652423 A4	11 August 2010
		RU 2233578 C2	10 August 2004
		WO 2005-006844 A1	27 January 2005
RU 2098942 C1	20 December 1997	None	
US 2016-0165813 A1	16 June 2016	US 10314249 B2	11 June 2019
RU 2321870 C2	10 April 2008	RU 2006-114994 A	10 January 2008
US 2011-0049257 A1	03 March 2011	CN 102137591 A	27 July 2011
		EP 2273868 A1	19 January 2011
		IL 208479 A	30 December 2010
		JP 2011-516074 A	26 May 2011
		JP 5559144 B2	23 July 2014
		RU 2373693 C1	27 November 2009
		US 8988847 B2	24 March 2015
		WO 2009-125264 A1	15 October 2009