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Weather Modification by Cloud seeding Technique (Artificial Rain Making)

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Abstract
Cloud seeding involves the use of water-absorbent materials to encourage the formation of clouds and rain so that there could be increased crop production in areas where there's little water. Cloud seeding is one of the tools to mitigate the effects of drought. It is defined as a process in which the precipitation is encouraged by injecting artificial condensation nuclei through aircrafts or suitable mechanism to induce rain from rain bearing cloud. The various aspects of cloud seeding are discussed in this study.

Keywords: Cloud seeding; Snowfall; Precipitation; Clouds; Fog; Silver Iodide; Dry ice.

Introduction

If water availability in different countries is considered from 1950 it is found that the water availability per person per year is gradually decreasing from the year 1950 and the deficit is getting more and more in African and Asian countries due to the rapid population growth, urbanisation and industrialisation during the recent decades. The water availability is assumed to be the river run-off formed in the territory of a given region and summed up with half the inflow of the river from outside. As the population increases the water consumption also rises and the value of specific water availability in a state gets gradually reduced. The water availability for selected countries shows a great unevenness in the distribution of water per capita per year in different countries. For instance Canada has the greatest water availability of about 175,000 cubic meters per capita per annum in the year 2000 but the densely populated countries of Asia, South Europe and Africa get only a moderate quantity of 1200 to 5000 cubic meters per year. But in North Africa and Arabia the water availability is about 200 to 300 cubic meters per person per year but availability at less than 2000 cubic meter per person per year is "low" while less than 1000 cubic meters is "catastrophically low" and consequently such low availability of water unavoidably possess a serious threat to public health, industrial and agricultural development besides causing damage to the environmental assets of a nation. About one-third of the earth's population have very low or catastrophically low levels of water supply and this situation will deteriorate year after year. Scientists warn that by the year 2025 most of the nations have to face very serious water scarcity problems with low and catastrophically low water supplies. More than one-third of the population may face "catastrophically low" fresh water supplies of less than 1000 cubic meters per person per year. However high levels of water availability will be experienced by the people in North Europe, Canada, Alaska, South America, Central Africa, Siberia and the Far East. Hence most of the countries have to plan for water conservation measures including cloud seeding to tap the abundant sky water in the clouds for protecting public health and promoting economic growth, industrial development and sustainable environment. In fact the intellectuals of China are working to solve the problems of water scarcity, suppress the damage due to hail storms and are reducing the summer temperature by cloud seeding to save electrical power used for air conditioning and thereby improving the water availability for agriculture and economic prosperity of the nation. It is high time that the scientists, the bureaucrats and the political leaders of India should learn from the experiences of China and

Texas on how cloud seeding operations can be used to promote public health, economic growth and prosperity of India.

Benefits of cloud seeding

Increasing Precipitation

The most common application of cloud seeding is to increase precipitation, possible with both warm and cold clouds. There are two primary methods employed to stimulate precipitation. One, hygroscopic seeding, affects warm cloud processes. The other, glaciogenic seeding initiates cold cloud processes.

Though occasionally both techniques may be helpful, in most cases one can be utilized more effectively than the other. In addition, either technology can be applied from the surface (ground-based) or from an aircraft. Weather Modification, Inc. can help you decide which method will be most effective.

Augmenting Snowfall

Glaciogenic seeding can also be used to increase precipitation from stratiform and orographic clouds. In such cases, seeding may be accomplished through either ground-based or airborne modes. By increasing snowpack and resultant spring runoff, subsequent water supplies for hydropower are increased. In addition to alleviating the need for alternative costly power supplies, cloud seeding increases the water availability for municipal, recreational, and environmental interests.

Enhancing Rainfall

Efforts to increase rainfall during the warm seasons are typically aimed at convective clouds. While it is theoretically possible to seed such clouds using ground-based equipment, targeting from aircraft is much more efficient and accurate. It is usually possible to affect the cloud through releases of a seeding agent in sub-cloud updrafts, or by dropping the seeding agents directly into the upper regions of the clouds.

Warm season glaciogenic seeding is typically applied to treat supercooled cumulus congestus clouds, either by releasing the ice-forming (nucleating) seeding agent in the updraft beneath the actively-growing cumulus, or by dropping the nucleating agent directly into the supercooled cloud top. The seeding agents can produce ice at significantly warmer temperatures than the natural process. This is how glaciogenic seeding gives the treated cloud a head start in producing precipitation.

When clouds do not grow tall and cold enough to produce precipitation through the Bergeron process, it may be possible to stimulate precipitation growth by seeding these warm clouds with hygroscopic seeding agents. This approach can be quite successful through stimulation of the warm cloud precipitation processes. Hygroscopic seeding is normally done from aircraft flying in the sub-cloud updrafts, in order to affect the initial cloud droplet development which occurs in this zone.

Mitigating Hail Damage

Cloud seeding can be used as a tool to help mitigate hail damage and protect crop yields, homes and other property, thus reducing the economic harm from disastrous storm damage. Since hail is itself ice that is produced only by vigorous convective clouds, it is certain that such clouds are cold enough to be amenable to glaciogenic seeding techniques. Hail develops when excess supercooled liquid water develops within strong updrafts. However, if the excess might be induced to freeze into large numbers of small particles rather than much smaller numbers of large particles, the ice that does precipitate may melt during its transit through the warm sub-cloud layer, or if it doesn't it will reach the surface as much smaller, less-damaging, ice.

Dispersing Fog

Another useful application for cloud seeding is the treatment of ground-based clouds, also known as fog. Supercooled fogs, comprised of water droplets at temperatures cold enough to permit ice development, can easily be cleared by glaciogenic seeding. This can be done either from the ground or from airborne application. Your choice between the two will depend on characteristics such as local infrastructure, topography, and wind.

Methods of cloud seeding

The seeding of clouds is broadly classified into two catagories Viz warm cloud seeding and dry cloud seeding.

Seeding of warm clouds

The term warm rain was coined by the scientists who found that the rain in tropical countries often fell from clouds whose temperature throughout the clouds was warmer than the freezing level of 0^0C or 32^0F. This can be achieved by two ways:

Water drop Technique

Coalescence process is mainly responsible for growth of rain drops in warm cloud. The basic assumption is that the presence of comparatively large water droplets is necessary to initiate the coalescence process. So, water droplets or large hygroscopic nuclei are introduced in to the cloud. Water drops of 25 mm are sprayed from aircraft at the rate of 30 gallons per seeding on warm clouds.

Common salt technique

Common salt is a suitable seeding material for seeding warm clouds. It is used either in the form of 10 per cent solution or solid. A mixture of salt and soap avoid practical problems. The spraying is done by power sprayers and air compressors or even from ground generators. The balloon burst technique is also beneficial. In this case gunpowder and sodium chloride are arranged to explode near cloud base dispersing salt particles.

Seeding of cold clouds

The cold rain occurs in clouds whose temperature in all or part is colder than the freezing level of 0^0C or 32^0F. This can be achieved by two ways:

Dry ice seeding

Dry ice (solid carbon-dioxide) has certain specific features. It remains as it is at -80^oC and evaporates, but does not melt. Dry ice is heavy and falls rapidly from top of cloud and has no persistent effects due to cloud seeding. Aircrafts are commonly used for cloud seeding with dry ice. Aircraft flies across the top of a cloud and 0.5 – 1.0 cm dry ice pellets are released in a steady stream. While falling through the cloud a sheet of ice crystals is formed. From these ice crystals rain occurs. This method is not economical as 250 kg of dry ice is required for seeding one cloud. To carry the heavy dry ice over the top of clouds special aircrafts are required, which is an expensive process.

Silver Iodide seeding

Minute crystals of silver iodide produced in the form of smoke acts as efficient ice-farming nuclei at temperatures below –5 degree C. When these nuclei are produced from the ground generators, these particles are fine enough to diffuse with air currents. Silver iodide is the most effective nucleating substance because; its atomic arrangement is similar to that of ice. The time for silver iodide smoke released from ground generator to reach the super cooled clouds was offer some hours, during which it would draft a long way and decay under the sun light. The appropriate procedure for seeding cold clouds would be to release silver iodide smoke into super cooled cloud from an aircraft. In seeding cold clouds silver iodide

technique is more useful than dry ice techniques, because, very much less of silver iodide is required per cloud. There is no necessity to fly to the top of the cloud, if area to be covered is large.

Conclusion:-

Cloud seeding technique has a great potential in weather modification as well as it can be used as a tool to avert natural disasters like draughts, problems resulting from excessive precipitation and can help solve the problem of water scarcity to a great extent.

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