

Chapter - 20

Artificial Rain Making

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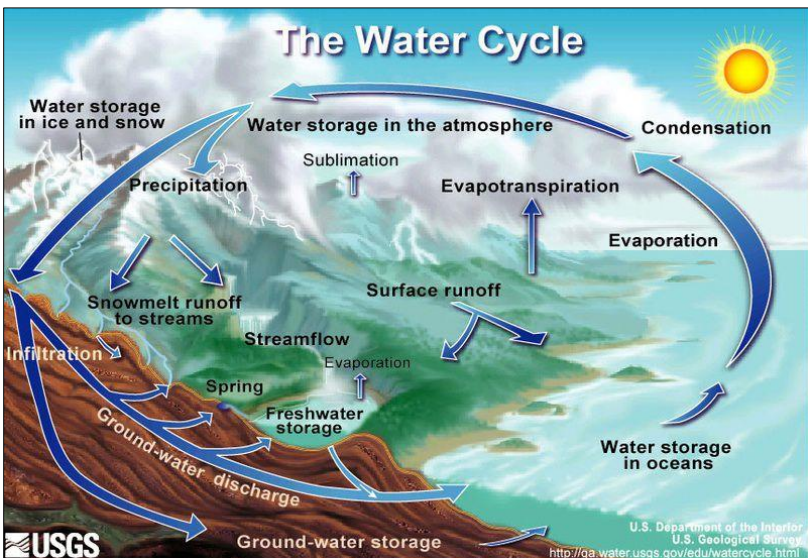
Artificial Rain Making

Abdul Mazeed and Pooja Maurya

Introduction

Rain is liquid water in the form of droplets that have condensed from atmospheric water vapour and then become heavy enough to fall under gravity. Rainfall is responsible for depositing most of the fresh water on the Earth. It provides suitable conditions for many types of ecosystems, as well as water for hydroelectric power plants and crop irrigation. Precipitation of liquid water drops with diameters > 0.5 mm (0.02 inch). On occasions, falling raindrops completely evaporate before reaching the ground. Such streaks of rainfall are called **virgae**.

Water cycle/hydrological cycle



Process

The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere is called as

“Evaporation”. The release of water vapour from plants and soil into the air is called **“Transpiration”**. The transformation of water vapour to liquid water droplets in the air, creating clouds and fog is known as **“Condensation”**. Condensed water vapour that falls to the Earth's surface is known as **“Precipitation”**. Most precipitation occurs as rain, but also includes snow, hail, fog drip and sleet. Water flows vertically through the soil and rocks under the influence of gravity is known as **“Percolation”**.

Failure in water cycle



Precipitation deficiency and Dry season will occur and it greatly increases drought occurrence.

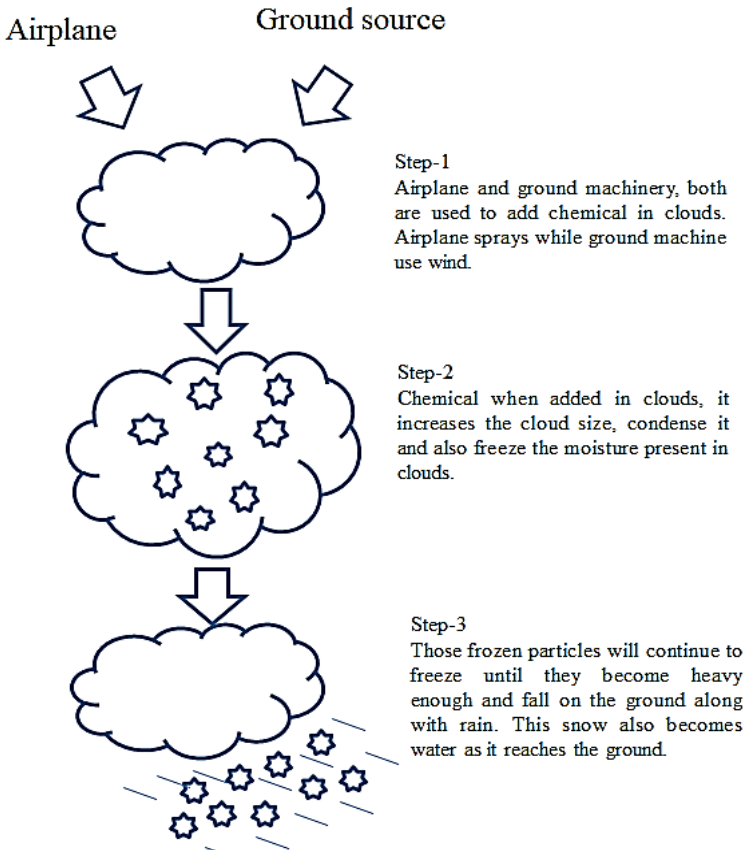
- 1) Destruction of crops
- 2) Forest fires
- 3) Famine caused by crop destruction
- 4) Wildlife destruction
- 5) Hydroelectric plants lose source of power
- 6) Hunger and famine
- 7) Death of farm animal
- 8) Tree destruction and damage
- 9) Diseases caused by lack of clean water like Diarrhoea, Cholera, Typhoid fever and Guinea worm

Artificial Rain making / cloud seeding

Rainmaking, also known as artificial precipitation, artificial rainfall and pluviculture, is the act of attempting to artificially induce or increase

precipitation, usually to stave off drought. Cloud seeding 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. According to the clouds' different physical properties, this can be done using airplanes or rockets to sow to the clouds with catalysts such as dry ice, silver iodide and salt powder,

- To make clouds rain or increase precipitation
- To remove or mitigate farmland drought
- To increase reservoir irrigation water or water supply capacity
- To increase water levels for power generation.



History

Rainmaking has its roots in 1946 when American scientists Vincent Schaefer and Bernard Vonnegut at General Electric (GE) successfully seeded

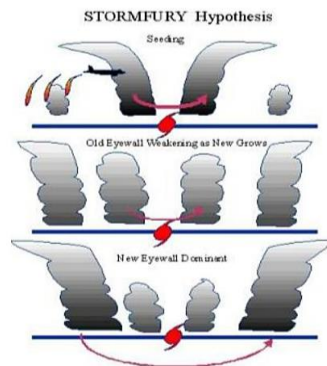
- 1990-2000 witnessed many advances in the airborne instrumentation, radars, flares and software. They got imported to India in new millennium.
- 2003 Karnataka Govt. has initiated cloud seeding with modern gradates like radars and aircrafts Maharashtra Govt. followed a month later.
- 2003-2009 A.P. Govt. has conducted cloud seeding operations perhaps the longest and biggest programme in south East Asia.

Project stormfury

Project Stormfury was a research program for hurricane modification that was active between 1962 and 1983. The Stormfury hypothesis was that seeding the first rain band outside of the eyewall clouds with silver iodide (AgI) would cause super cooled water to turn into ice. The artificially invigorated convection, it was argued, would compete with the convection in the original eye wall, lead to reformation of the eye wall at larger radius, and thus produce a decrease in the maximum wind. Since a hurricane's destructive potential increases rapidly as its maximum wind becomes stronger, a reduction as small as 10% would have been worthwhile. Modification was attempted in four hurricanes on eight different days. On four of these days, the winds decreased by between 10 and 30%. The lack of response on the other days was interpreted to be the result of faulty execution of the experiment or poorly selected subjects.

Revised STORMFURY Hypothesis

- Targeted intense hurricanes with small eyes
- Seed the first rainband outside the eye
- Build a new eyewall around the old
- New eyewall strangles the old



Principle of cloud seeding

In the troposphere, the temperature of the atmosphere descends with altitude. Therefore the clouds in the troposphere are lower in temperature as

they rise in altitude and vice versa. When the temperature of a cloud is **above 0 °C**, the cloud is called a warm cloud when it is **below 0 °C** it is called a cold cloud. Inside a warm cloud, small water drops will become large ones through collision and coalescence, and will finally break the buoyancy of the cloud and fall out of its bottom to become rainfall to the ground. (Spraying water drops, hygroscopic powder or liquid sodium chloride etc.). Inside a cold cloud, ice crystals can also grow to a size where they can break the buoyancy and fall out of the cloud's bottom, and when they pass through a temperature of 0 °C they will melt and become rain drops, also providing the ground with rain. (Use dry ice or silver iodide).

Seeding of clouds

Warm clouds

- 1) Water drop Technique
- 2) Common salt technique

Cold clouds

- 1) Dry ice seeding
- 2) Silver iodide seeding

Cold clouds - dry ice seeding

Dry ice (solid carbon-dioxide) has certain specific features. It remains as it is at -80 °C 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.

Cold clouds-silver iodide seeding

Minute crystals of silver iodide produced in the form of smoke acts as efficient ice-farming nuclei at temperatures below -5°C. Silver iodide is the most effective nucleating substance because its atomic arrangement is similar to that of ice. When these nuclei are produced from the ground generators, these particles are fine enough to diffuse with air currents. 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

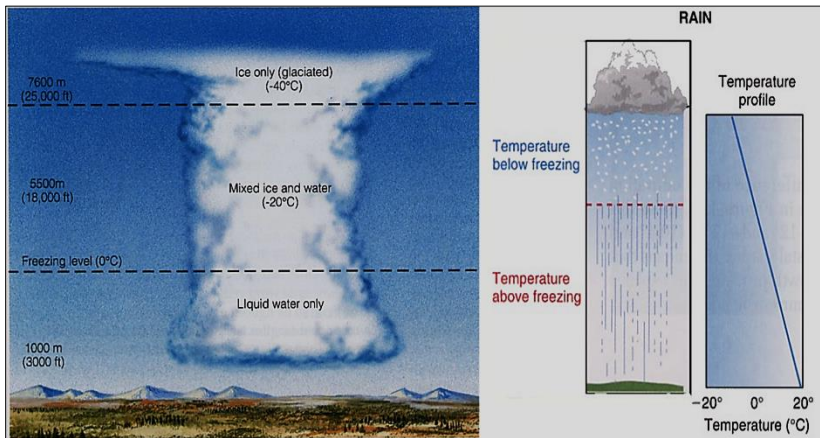
long way and decay under the sun light. The appropriate procedure for seeding cold clouds would be to release silver iodide smoke into super cooled cloud from an aircraft. In seeding cold clouds silver iodide technique is more useful than dry ice techniques, because very much less of silver iodide is required per cloud.

Warm clouds-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 μm are sprayed from aircraft at the rate of 30 gallons per seeding on warm clouds.

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.



Types of artificial rain making methods

Mainly there are 3 methods to produce artificial rainfall, they are

- 1) Cloud seeding method-
 - i) Static cloud seeding.
 - ii) Ground generator seeding.

iii) Rocket cloud seeding.

2) Cloud buster

3) Bioprecipitation

Static cloud seeding

In this the army planes or aircrafts are used for seeding.

Planes used in this process

- Hawker 400.
- Beech craft king air B350.
- Bombardier Lear jet 35A.
- Piper.
- Cessna 340.

The aircraft that contain rain making chemicals can be directly fired into clouds. Those rain making chemicals are usually shot from a largely pressurized canister into the base of the clouds which normally hangs above the top of the mountain to cluster up and to rain on the mountain.



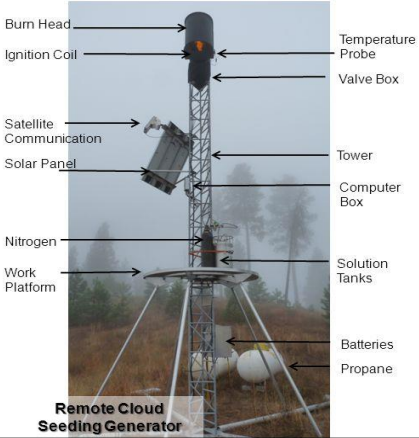
Ground generator seeding

This method is same as static cloud seeding, but aircrafts are replaced by ground generator. There are two types of ground-based generators

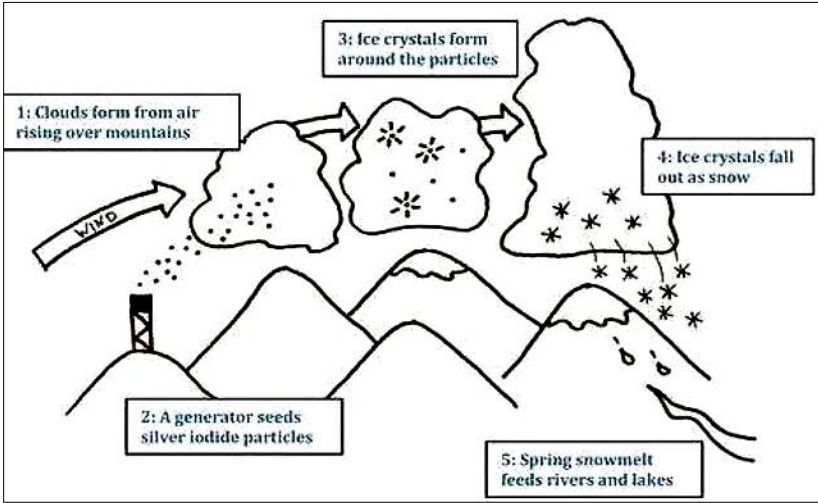
- Remote Controlled Ground-Based Generators
- Manual Ground-Based Generators.

These solution-burning ice nuclei generators are most often used to seed orographic clouds in areas of rugged topography.

Generator Types



Manual Cloud Seeding Generator



How cold cloud seeding works

Since its discovery in the late 1940s, cloud seeding has proven effective at changing cloud structure and producing ice crystals that fall as snow or rain, although quantifying the amount of additional precipitation can be difficult.

1 Clouds form from air rising over mountains.

4 Droplets of supercooled water attach to the particles forming ice crystals.

2 In the air, planes accurately disperse silver iodide into clouds.

3 On the ground, generators spray silver iodide solution into a propane burner. The heat column transports the seeding particles into the cloud's water vapor.

5 If it is cold enough, ice crystals fall out as snow.

6 The enhanced snowpack melts in spring, feeding rivers and lakes.

The right conditions

Ground-based generators rely on prevailing winds to disperse seeding material on target. Clouds must contain supercooled water for effective seeding.

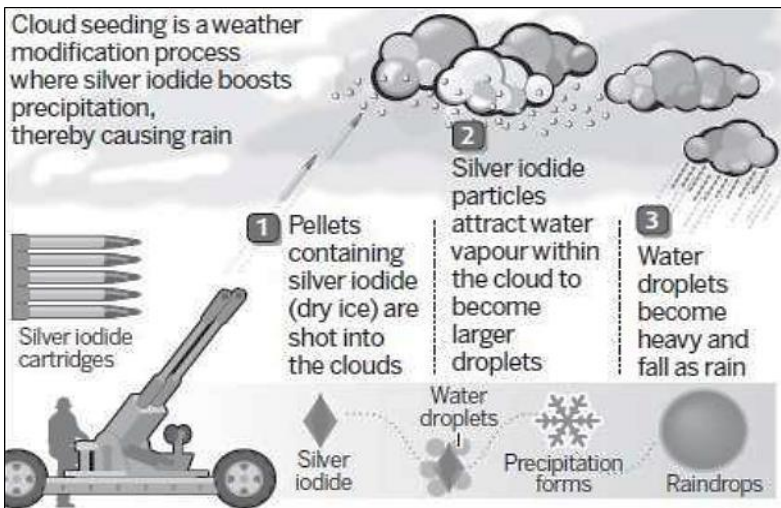
Sources: Desert Research Institute, North American Weather Consultants, Inc.

Alan Kenaga/Capital Press

Rocket cloud seeding

The rockets are aimed at cloud seeding by using silver iodide in rain-bearing clouds, resulting in the showers. A bunch of rockets has to be fired within minutes, aiming at the eye of the clouds to yield the precipitation reaction to induce rainfall. Once the rockets are fired, rain is expected within 50 minutes. This technology is much cheaper than using airplanes for the job. It has a success ratio of 80% as against 40% ratio in the static seeding method.

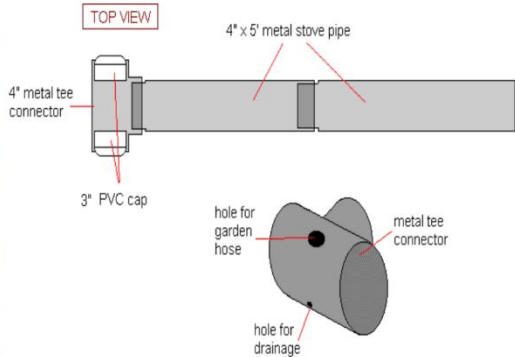




Cloud buster

A cloud buster is a pseudoscientific device designed by Austrian psychoanalyst Wilhelm Reich (1897-1957), which Reich said cloud produce rain by manipulating what he called "orgone energy" present in the atmosphere. The cloud buster was intended to be used in a way similar to a lightning rod focusing it on a location in the sky and grounding it in some material that was presumed to absorb organ, such as a body of water would draw the orgone energy out of the atmosphere, causing the formation of clouds and rain. Reich conducted dozens of experiments with the cloud buster, calling the research "Cosmic orgone engineering".





Principle

In principle, a cloud buster of newer design consists of several long copper tubes which are mounted in a parallel way. At one end the tubes are directed to the sky, at the other end they are fixed to a container in which a two-component adhesive or polyester resin is mixed with iron or aluminium scrap. This substance is called organite.

Bioprecipitation

Bioprecipitation is the concept of rain-making bacteria (*Pseudomonas* and *Xanthomonas*) and was proposed by David Sands from Montana State University, 1983. The formation of ice in clouds is required for snow and most rainfall. Dust and soot particles can serve as ice nuclei, but biological ice nuclei are capable of catalyzing freezing at much warmer temperatures. The ice-nucleating bacteria currently known are mostly plant pathogens. Recent research suggests that bacteria may be present in clouds as part of an evolved process of dispersal.



Fig 1: Bioprecipitation Cycle.

Advantages of Cloud Seeding

This technique is used to produce the clouds and bring rain to the drought prone areas for better rain and boosting crop yield. It is also used to reduce the size of hailstones where hail stones precipitate in large size. It is also used on some airports to reduce fog which has always been a cause of mishaps on airports. This technique is used to clear the air in the fields during matches or concerts. Where there is rain, there is farm produce. Farms that yield better can help the local economy and feed the people (and even animals). Cloud seeding can greatly improve the living conditions in dry, arid places. Rain is important for keeping the area hydrated and fertile for growing crops and other plants.

Disadvantages of cloud seeding

Chemicals used in cloud seeding can potentially damage the environment and Silver iodine may cause “iodism”, a type of iodine poisoning where the patient exhibits running nose, headache, skin rash, anemia, and diarrhea, among others. It is very expensive to produce artificial rain. If not regulated or controlled properly, cloud seeding may cause undesirable if not altogether destructive weather conditions such as flooding, storms, hail risks, etc. The cloud seeding may Difficult to operate. The chemicals which are used in these methods may cause residual injuries to humans and mammals. It may be Difficult to aim targets.

Countries in which Cloud Seeding is being done

USA: In USA cloud seeding is done on major scale to overcome the problems like drought. USA spent total of \$15 million per year. As it turns to be very expensive for the country side farmers to water their lands. So they pay government 5\$ per acre to use this cloud seeding phenomenon. This also reduces the amount of fog and thunderstorms but increases the amount of precipitation.

Russia: Military pilots are being used to seed the clouds because of the Chernobyl incident.

India: Indian government just spent 62 to 89 crore Indian rupees on cloud seeding experiments over the last six years. The experiment has been turned into practice by the Tamil Nadu government and Karnataka states to increase the rainfall in drought affected areas.

Kuwait: To counter drought and to increase the amount of rainfall, Kuwait is working on its cloud seeding program with the help of local Environmental Public Authority.

Africa: In Mali and Nigeria, cloud seeding is done on a national scale as they are drought affected regions.

China: China is the biggest country to have largest cloud seeding experimental program in the world. In china cloud seeding is being done way back from the time of Emperor Yu in 2150 BC. China spent \$150 million on a single regional cloud seeding program.

Conclusion

After an extensive research we have a wider knowledge of this artificial rain making methods, learnt useful information about different type mechanical and biological methods to produce rainfall. It is basically a weather modification technique. These methods mainly works for precipitation and although it used for to reduce the pollution and also for weather modifications. These having the minor disadvantages, but there eliminated using proper materials and having giving training to the operator to reduce the mistakes and lot of capital cost and maintenance cost and thus cannot be adopted by backward countries. Artificial rain making methods help to increase the green life and oxygen and decreasing the pollution. Thus these methods plays major role in reducing drought and increasing the quantity of drinking water in future.

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