

6. Cloud-Seeding in Delhi

Recently, the Delhi government, in collaboration with the Indian Institute of Technology (IIT) Kanpur, conducted cloud-seeding trials to induce rain as part of efforts to reduce the city's air pollution.

Cloud Seeding – Overview

Definition – Cloud seeding is a scientific weather-modification technology to stimulate atmospheric precipitation by dispersing nuclei-forming substances in clouds. Aim is to accelerate natural microphysical cloud processes, not create clouds from scratch.

Core Goal – Enhance rainfall/snowfall. Improve water availability. Support drought relief, agriculture, and hydropower storage. Reduce air pollution and support emergency fire suppression

Scientific Principle

Condensation Nuclei Seeding – Introduces aerosol particles that act as cloud condensation nuclei (CCN) or ice-nucleating particles (INPs).

Water Vapour Dynamics – In supersaturated regions, vapour condenses/freezes around nuclei → droplets/ice crystals grow → fall as precipitation when heavy enough.

Prerequisite – **Cloud presence + adequate moisture** – seeding cannot generate clouds.

Operational Mechanism

Pre-Seeding Analysis – Cloud characteristics studied – moisture, vertical depth, wind shear, temperature gradient, cloud base & top height, radar data. Ideal targets – Cumulus, Cumulonimbus, Stratiform clouds.

Seeding Materials –

Cold clouds – Silver iodide (AgI), Potassium iodide (KI), Dry ice (solid CO_2)

Warm clouds – Sodium chloride (NaCl), hygroscopic salts

Delivery Methods –

Aerial Seeding – Aircraft/drones disperse agents directly into cloud layers – higher precision, best for mesoscale systems.

Ground-based – Ground flares, rockets, portable towers release chemicals that ride updrafts.

Types of Cloud Seeding

Warm Cloud Seeding ($T > 0^\circ\text{C}$) – Salt particles trigger droplet growth via collision-coalescence mechanism.

Cold Cloud Seeding ($T < 0^\circ\text{C}$) – Silver iodide crystals mimic ice lattice → accelerate Bergeron-Findeisen process (ice crystal growth at expense of water droplets).

Applications

Drought Mitigation & Water Security – Supports drinking water reservoirs, irrigation systems, hydroelectric storage.

Agriculture – Enhances soil moisture and monsoon-deficit compensation.

Urban Pollution Control – Artificial rain removes particulate pollutants (PM_{2.5}, soot, dust) – short-term solution.

Forest Fire Suppression – Moistens vegetation, aids firefighting.

Snowpack Enhancement – Boosts winter snow in mountains for spring melt-water (USA, Australia).

Role in India's Pollution Management – Used during Delhi smog episodes to help disperse particulate matter. Helps lower atmospheric stability and temperature inversion effects in winter.

Why Cloud Seeding is Difficult Post-Monsoon (India)

October–December → Dry & Clear Skies (IMD post-monsoon), Weak convection + low humidity
Fewer moisture-laden clouds, Cloud depth typically insufficient for seeding, Strong surface inversion traps pollutants but lacks precipitating systems

Limitations

Cloud Availability Constraint – needs existing moisture-rich clouds

Marginal Booster – average rainfall increase 10–20%

High Cost – aviation, radar, trained teams

Environmental Concerns – Agl accumulation in soil/water

Uncertain Outcomes – influenced by wind, turbulence, atmospheric stability

Ethico-Political Issues – “Weather ownership”, cross-border rainfall diversion debates

India Experience – CAIPEEX Programme

Cloud Aerosol Interaction and Precipitation Enhancement Experiment

Conducted by Ministry of Earth Sciences

Phases – 2009, 2010–11, 2014–15, 2017–19

Major trials – Solapur (Maharashtra) + South Peninsular India

Outcomes – Up to 46% rainfall rise locally; avg ~18% over 100 sq km area. Developed draft guidelines, radar & flight protocols. Strengthened cloud–aerosol science in India

Global Examples

USA – Western states enhance snowpack for water security

China – Largest programme; Olympics 2008 rainfall control

UAE – Continuous seeding for arid-zone water supply

Thailand – Royal Rainmaking Project (since 1955)

Australia – Used in Tasmania for hydropower catchment

Source – <https://timesofindia.indiatimes.com/city/delhi/cloud-seeding-delhi-to-conduct-1st-artificial-rain-trial-today-aircraft-to-take-off-from-kanpur-once-weather-improves/articleshow/124863850.cms>

