

A photograph of a snowy forest. The trees are heavily laden with snow, and the ground is also covered. The scene is a winter landscape with evergreen trees.

# Cloud Seeding

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# History

- In Kurt Vonnegut's 1963 novel titled "Cat's Cradle" a young scientist has in his possession an ice crystal that has the power to freeze any liquid that comes into contact with it. This non fiction satire is loosely based around Vonnegut's brother Bernard Vonnegut an atmospheric scientist who discovered the ability of Silver Iodide as an ice nuclei catalyst.

# Cloud Seeding is...

- a process that uses a product such as Silver Iodide or dry ice released into the environment, mostly mountainous regions that constantly create clouds, to augment the amount of water in the air to create precipitation or suppress fog and hail.

# 2 main types

**dynamic-** is more commonly used for warm latitude clouds that are more capable of releasing latent heat to add the freezing process of the ice nuclei in clouds.

**static seeding-** involves cumulus clouds traveling west to east through mountain ranges that are picking up water and other microscopic particles like soil, dust, smoke, that then are cooled because of the high altitudes. As the water or condensation nuclei cool more, ice nuclei form and grow bigger. Introducing certain chemicals such as Silver Iodide helps the condensation nuclei to freeze thus forming more ice nuclei. This is more common in areas like Colorado

# Factors

Specific storm systems are needed to create the ideal conditions for precipitation. From a mesoscale system the warmer less dense air is pushed above the colder dense air. Over a mountain range when pushed up enough the warm air that is filled with moisture should reach an optimum cooling point of between -9 to 14 degrees Celsius. This is the ideal temperature window for ice nuclei to form and drop as precipitation. Other variables include the horizontal and vertical distribution of clouds plus the lifetime of those clouds. Winds can form suddenly and blow clouds away from the targeted area. Some experiments show effectiveness when location for generators were chosen assuming a mean wind direction and no wind change, but due to insufficient knowledge about wind flow systems in cloud liquid water (CLW) regions data can show positive or negative effects.

# Costs for Vail

According to [www.vail.com](http://www.vail.com) there are 5289 acres of skiable terrain, not including the resort and surrounding town. So the reported costs for the 2005 season was about “\$165,000 using 17 cloud seeding generators” noted by Larry Hjermstad, manager for a Durango-based Western Weather Consultants, whose company supplied Vail Resorts with the cloud seeding generators. This comes out to be about \$31.20 per an acre.

# Implications

“Essentially we cannot tell the difference between a snowflake that has come from a silver iodide crystal and a snowflake from a natural ice crystal”-Larry Hjernstad

Although there might be an increase in precipitation from tests, the tested snowfall might not even test positive for Silver Iodide in targeted areas, data is hard to quantify, making cloud seeding an arguable technique.

Producing more snow in a warmer climate has many different outcomes in feedback loops that tie in snowmelt, warming temperatures, Pine Beetles, ice-albedo relations, and disrupting these could have more of an effect than anyone could imagine just like the burning of fossil fuels has shown.

# In the future...

- Geoengineerists have been working to inject aerosols into the stratosphere to control tropospheric pollution. This warm cloud seeding technique would enhance cloud albedo. There are negative and positive effects to this in that acid rain can be created and the sulfur cycle would be disturbed, but increased cloud coverage would permit cooler temperatures.
- Another proposal by climatologists at the National Center for Atmospheric Research for controlled climate cooling would be to seed low maritime oceanic clouds with seawater particles that would act as condensation nuclei, activate more precipitation which would then further increase cloud albedo and longevity.



# Works Cited

I own all of these photographs

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