

## The Weather Makers

## PART 2:

## Cloud Seeding



# Planting Seeds, Growing Snow



**GREEN MACHINE:** A cloud seeding generator (at right) that is operated by the Desert Research Institute, sits on top of Ward Peak at Alpine Meadows. Photo courtesy Desert Research Institute

CLOUD SEEDING MAKES IT SNOW MORE — BUT MAYBE IT'S NOT QUITE THAT SIMPLE

BY DAVE ZOOK

Moonshine Ink

*In part two of the Weather Makers series, where we look at how humans insert their hand in the weather process, Moonshine Ink looks at the practice of cloud seeding, a longstanding practice in the Sierra.*

At the Desert Research Institute's weathermod facility, just north of their main campus in Reno, approximately six cloud seeding generators lay dormant outside of the shop. They consist of a cube-shaped metal box painted camouflage, with a cylindrical apparatus that sits about 15 feet in the air affixed to a tower.

To make them non-dormant, Jeffrey Dean, the principal research technician at the weather modification facility, pushes a couple buttons on a computer. He clicks Connect, then changes a 0 to a 1, and that's it. "I can work from a laptop in Hawaii; all I need is Wi-Fi to get them running," Dean said, looking pleased.

This kicks the generator to life; a silver iodide solution is fed across a propane flame which releases microscopic particles of the chemical silver iodide into the atmosphere. I can't see the plume, but it's there. The one he starts up is a demonstration, but when weather conditions are right,



**INCOMING WEATHER:** As storms roll into Tahoe, scientists at the DRI often release silver iodine into the clouds to boost precipitation. Photo by Sam Okamoto

the DRI does this for the five seeding generators that are placed around western and southern portions of the Tahoe region and the result is an estimated 10 percent more snow squeezed out of the atmosphere.

Many are unaware cloud seeding exists. Its modern practice began in the 1940s in a General Electric laboratory in New York through the research of Bernard Vonnegut (brother of novelist Kurt). California quickly caught on and does more cloud seeding than any

other state, with Sierra Nevada operations starting in the late '70s. Some unfairly affiliate its practice with the alleged chemtrail conspiracy, and some think those buttons Dean pushes simply "makes it snow." The reality is perhaps less sensationalist, though no less important.

What the DRI, an arm of the Nevada System of Higher Education, hopes to do is add that 10 percent increase to the Tahoe Basin snowpack over the winter, with runoff benefitting the Truckee River. They

are funded by the Truckee Meadows Water Authority and the Western Regional Water Commission in Reno.

The nuances of supercooled water, air flow, temperatures, cloud microphysics, and many more variables make it incredibly tough to know exactly what the silver iodide is doing to a particular cloud and how much augmentation is occurring. Plus the head-scratcher of how one can know whether a storm that produced 10 inches of snow would have been nine inches without

the seeding continues to vex scientists.

But a significant body of scientific research shows that cloud seeding can augment precipitation along the order of 5 to 15 percent, which more than justifies the cost for many water managers.

## MODIFY THAT WEATHER

Cloud seeding is most commonly used to boost precipitation, but can also be used to modify other aspects of weather. It is under the umbrella of weather modification, and can include projects such as fog dissipation, storm prevention, hurricane modification, hail mitigation, and more.

The active chemical in cloud seeding is silver iodide. This agent serves as a very small nucleus or seed — 1,000 times smaller than the head of a pin — that allows water vapor to collect on it and form a baby ice crystal. From there the baby ice crystal collects additional water vapor and grows into a fully formed snowflake and falls to the ground. Most natural nuclei are not able to produce ice crystals until the cloud temperature gets below 5 degrees Fahrenheit. Silver iodide ice nuclei can form crystals in clouds at 20

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degrees Fahrenheit, giving a much larger window.

Nuclei come from a wide range of sources, some natural and some not. Sea salt from evaporated ocean water is what is called cloud condensation nuclei and contributes to coastal rainfall. Dust, soot from forest fires, or other microscopic particles serve a similar function. Pollution can create these particles as well, but can actually reduce precipitation as the particles are believed to be too tiny to initiate rain and is considered 'inadvertent seeding.' Silver iodide was selected as the preferred seeding agent as its structure is very similar to that of ice.

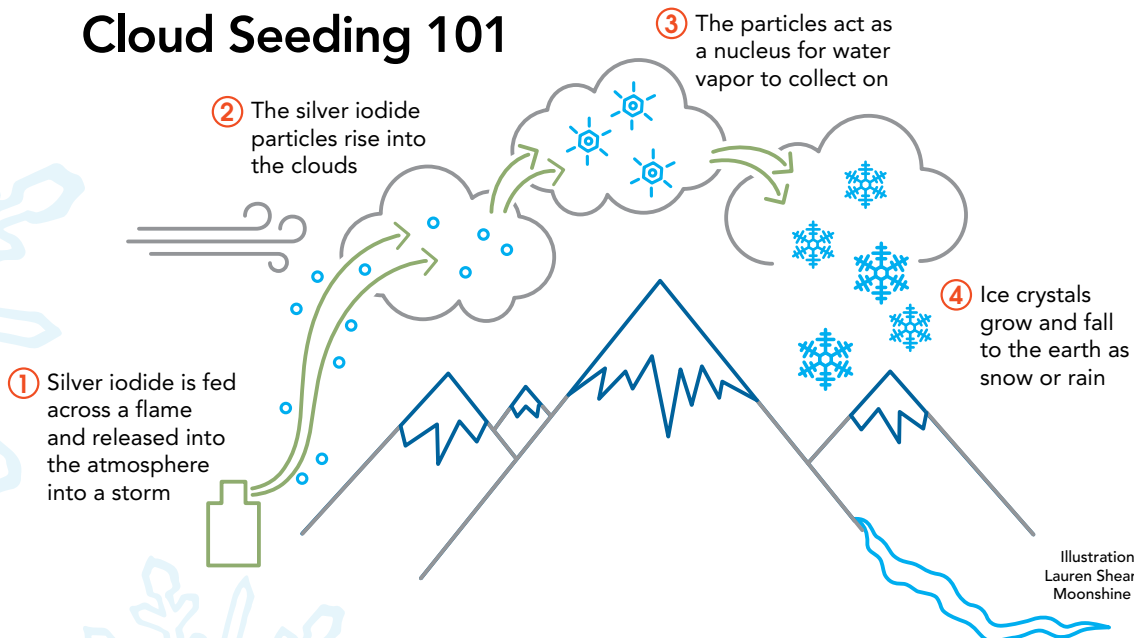
Seeding is done via aerial or ground-based operations, with the DRI utilizing the latter, though aerial operations have been used in the past in the Sierra. Skiers at Alpine Meadows may have noticed the apparatus that resembles a clunky green metal cube with a black smokestack atop Ward Peak near the top of Summit lift. This is one of DRI's five seeding units in their Sierra operations.

## SNOW FOR THE SLOPES

Skiers and riders in Tahoe are likely reaping the rewards of slightly more snow from the DRI's efforts, as many of the resorts and backcountry zones in Tahoe are well within their target area.

"Ski areas are benefitting from our programs but we aren't targeting them" said Frank McDonough, an assistant research scientist with the division of atmospheric science at the DRI. "We would be interested in discussing cloud seeding with ski areas and we could tune our operations to specifically target them." He

## Cloud Seeding 101



said the resorts of Northstar California Resort, Mt. Rose Ski Tahoe, Diamond Peak, and Heavenly Mountain Resort are best positioned to receive the potential 10 percent boost.

The seeding is believed to take about 20 to 30 minutes to release any augmented precipitation, which usually means a few miles distance from the generators. So, for example, the generator on Alpine Meadows couldn't augment snow for Alpine itself, but could receive a boost from the seeders that are positioned farther west.

A handful of Colorado resorts already believe in seeding enough to pay for it. In 2010 a program was started that directly targeted the ski resorts of Keystone Ski Resort, Breckenridge Ski Resort, and Arapahoe Basin Ski & Snowboard Area, and the DRI has operations that target Winter Park and Telluride Ski Resorts.

## AIRBORNE CHEMICALS - OH MY!

Through cloud seeding, the DRI releases chemicals into the atmosphere that are then returned to the watershed, with the intended target area of the Tahoe Basin, and has been doing so for over 35 years.

The DRI uses about 25 grams of silver iodide per hour per generator and can use up to 14 pounds per year per generator, depending on usage. A study found that three metric tons of the chemical were released for seeding purposes in the U.S. in 1978, an amount estimated to be similar to today's levels.

Additionally, it has been well documented that silver in some forms can be toxic to certain organisms, according to the Weather Modification Association, a Utah-based weather modification organization.

But local environmental and governmental groups have virtually nothing to say on the

practice. The Tahoe Regional Planning Agency has never been involved in review or permitting of the process, the League to Save Lake Tahoe had no comments to make on cloud seeding, and the Sierra Club has no official stance on the practice, according to representatives from the respective groups.

Cloud seeding operators would likely explain this by citing the body of studies that all point to silver iodide having a negligible effect on the environment. The Weather Modification Association cites more than 15 different studies since the '60s that reached that conclusion, discussed in a report it issued on environmental impacts of seeding in 2009.

The studies suggest that seeding is not environmentally harmful due to the extremely low amounts of the chemical that seeding adds to the environment. Additionally, silver iodide

is insoluble, so it does not dissolve in water sources.

If fresh, unseeded snow was collected and tested, it would contain around three to five parts per trillion of silver. With successful seeding, that snow would show increases to around 10 to 20 parts per trillion. But since most silver is added to the environment by the decay of rocks, if one looked at the levels in soil and streams, they would be in the parts per million, 100,000 times higher than anything found via seeded snow, McDonough explained.

## NOT A SILVER (IODIDE) BULLET, BUT SOMETHING

What no cloud seeding proponent would ever suggest is that it will solve the drought. Its effectiveness is markedly reduced in droughts, in fact, as seeding only happens when already existing storms are approaching. If it's clear skies, there is a zero percent chance seeding will help.

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## THE MOTHER OF ALL CLOUD SEEDING OPERATIONS

For the 2008 Beijing Olympic opening ceremonies, China wanted clear skies. Really badly. Organizers dispersed a whole lot of silver iodide for "rain dispersal" — a technique used to bring down precipitation away from a certain location. They went ballistic on the clouds, launching 1,100 silver iodide-releasing rockets from 21 sites, according to the British newspaper *The Independent*. China's total arsenal of cloud-seeding weapons include 6,781 artillery guns and 4,110 rocket launchers, which uses seeding for a variety of applications. It may have even worked, as Beijing enjoyed clear skies for the ceremonies, while the nearby Baoding City reported four inches of rain.

>>> “We can only seed in certain conditions, and the last few winters have been short on ‘seedable’ storms. Adding 10 percent to a 30 percent [of average] winter doesn’t get us to normal, but it is something,” McDonough said.

Most water managers, and perhaps citizens as well, would agree that an additional 10 percent of water in our reservoirs — and maybe under our skis — is significant.

Based on the 10 percent figure, the DRI estimates their programs add about 14,000 acre-feet (the amount of water needed to fill one acre with one foot of water) of water per year on average to the watershed, which is about 4.5 billion gallons of water. In 2014, the DRI reported its seeding operations had added 18.2 billion gallons to the Truckee since 1980.

And the cost is low compared to other water management methods. The DRI puts the cost of seeding at \$10 to \$20 per acre foot. Some operators do put the numbers higher, and into the low hundreds of dollars per acre foot, but it is still far cheaper, comparatively.

An independent analysis of ocean water desalination put its cost at \$2,000 to \$3,000 per acre foot, based on a 2014 study by James Fryer, an environmental scientist. The study also found that water recycling typically costs between \$300 and \$1,300 per acre-foot.

**WHY NOT MORE?**

So is cloud seeding a proven science that brings down more snow that is also cheap and environmentally sound? If so, why are water managers and politicians in the West not jumping on it?

The main issue seems to be the ‘proven’ component, as giving bulletproof evidence of how much precipitation seeding can add remains elusive. The largest cloud seeding study to date, an eight-year, \$10 million study — was released in March 2015 by the University of Wyoming. The results were indeed inline with previous studies — showing a potential increase in precipitation between 5 and 15 percent — but the devil was in the details, and the world’s curiosity was not sated.

The 5 to 15 percent figure only applied to precipitation from storms that had the proper seeding conditions, and the



**MODIFYING THE MODIFIERS:** Jesse Juchtzer of the DRI works on one a cloud seeding generator outside the DRI’s manufacturing shop in Stead, Nev. Photo by Dave Zook/Moonshine Ink

initial findings had the number around 3 percent, according to the executive summary of the study.

“We learned a lot from the Wyoming study, but what it didn’t do was come up with definitive proof. It came up with acceptable results, but proof is incredibly difficult to show given the nature of cloud seeding,” said Hans Ahlness, who was involved in the study, and is the president of the Weather Modification Association.

The DRI carries out a variety of studies to better understand the impact of cloud seeding. They analyze the snowpack in the targeted areas for silver iodide levels, as well as study the structure of snowflakes. Usually, the crystal structure from cloud seeded snowflakes is different from that of natural flakes, and these studies help the DRI better understand the process and refine techniques.

Nevertheless, overall interest is increasing, largely due to the University of Wyoming study and the drought. The DRI is doing research into the possibility of using drones to more accurately disperse silver iodide, and may extend drone usage into the Tahoe area in the future.

“As long-term freshwater supplies continue to be stretched with an increasing population, cloud seeding will become an increased fixture in water management,” said Don Griffith, president of North American Weather Consultants, a private weather modification company based in Utah.

To learn more, visit [dri.edu](http://dri.edu) (P)

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