OK Water NEWS

# High-Tech "Rainmakers" Visit

## University of North Dakota weather modification team, aircraft visit to study Oklahoma cloud physics

In 1956, a film called "The Rainmaker" premiered in Hollywood. The movie was loosely based on the life of Charles Mallory Hatfield, a Minnesota-born rancher's son, who gained worldwide recognition in the early 1900's as a rainmaker.

The accuracy of the "rainmaker" moniker was debatable, even in that carefree time of American history. Yet if he wasn't what he claimed to be, Hatfield was shrewd enough to persuade the Los Angeles Chamber of Commerce to pay him $1,000 for 'producing' 18 inches of rain during the first four months of 1905. And for eight consecutive years, farmers in the San Joaquin Valley underwrote his expenses to soothe their drought-ravaged crops in that dry region of southern California.

In 1916, prior to the days of flood control structures, the San Diego City Council promised Hatfield $10,000 to fill the city's depleted reservoirs, then refused payment after Hatfield and his brother supposedly induced so much rain that area dams burst, drowning 20 people.

It was the publicity from this feat, or perhaps the ill will of San Diego citizens, which prompted Hatfield to leave California and go worldwide (to Italy and Honduras) with his 'rain attraction and precipitation plant.' His entire rainmaking gear consisted of a wooden tower topped by a square platform from which his secret chemicals were dispensed into the atmosphere.

When Hatfield's 'career' was over, he brazenly claimed 503 successful rainmaking events. But nobody ever knew the actual composition of his secret chemicals. Was his rainmaking plant a crude generator or was Hatfield merely an unscrupulous rogue?

It is such tales of charlatan rainmakers, lightning rod salesmen and Indian medicine men that cause modern weather modification scientists to cringe.

"Many people get a negative impression when they hear the terms **cloud seeding** or **weather modification**. And it is such stories that perpetuate the negative image of weather modification," said Mike Mathis, meteorologist and coordinator of the Weather Modification Program.

The OWRB is mandated by the state legislature to regulate all weather modification activities in Oklahoma through licensing, permitting and reporting. To meet this charge, the Board has adopted regulations to govern and direct rainfall enhancement,

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**From left: UND scientist Mike Poellot, pilot Roger Tilbury and Mike Mathis of the OWRB determine where they will conduct data gathering operations.**

**The highly sophisticated Cessna Citation II is worth approximately $3 million, including all technical equipment.**

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hail prevention and all other weather modification attempts.

The Board's role in state weather modification has received heavy emphasis lately due to three factors: a Congressional write-in to the Bureau of Reclamation budget to support weather modification activities in Oklahoma and Texas, the advent of the rainy season in Oklahoma and the presence of a weather modification data gathering team from the University of North Dakota's Department of Atmospheric Studies.

Scientists and data technicians from UND arrived in late May in a specially instrumented Cessna Citation II jet equipped with sophisticated atmospheric data gathering devices.

"We are extremely fortunate to have a group of this caliber to work with," said Mathis, who coordinated the field data gathering program with the team in late May and early June.

The UND atmospheric science department is one of the best in the nation. They receive considerable financial support from the state of North Dakota, the National Oceanic and Atmospheric Administration (NOAA), the Bureau of Reclamation's Division of Atmospheric Resources Research and others to conduct weather modification and similar atmospheric studies with the Citation.

The plane and its crew, accompanied by a van functioning as a mobile base unit, worked out of OU's Max Westheimer Field in Norman and used weather radar and forecast facilities furnished by the nearby National Severe Storms Laboratory.

According to Mike Poellot, chief scientist and sometimes pilot of the Citation, the crew is gathering cloud information from virtually every section of Oklahoma in order to build a future data base for weather modification activities.

"We are trying to find out just what makes up clouds here—we must know this before we can make it rain," Poellot said.

The UND team—consisting of Poellot, computer programmer Greg Herlache, pilot Roger Tilbury, and co-pilot/technician Ed Dondlinger—termed their mission in Oklahoma "very successful."

"By penetrating cumulus clouds, we hope to gain an understanding of their composition, and more specifically, the different sizes, shapes and types of cloud particles."

Clouds consist mostly of water vapor which is critical in their formation. If the air cools enough, water vapor condenses into large cloud droplets which collect around tiny, lighter-than-air particles called **cloud condensation nuclei**. These particles consist of dust, smoke, salt, soil or other materials upon which condensation may begin. At higher altitudes and colder temperatures, these same particles freeze on contact with **ice-forming nuclei**. Usually, cloud moisture is present in both forms—cloud droplets and ice crystals.

When atmospheric conditions are unstable, cloud particles are carried upward by vertical air movement, or updrafts. As a result, large rain-producing cumulus clouds often form. The taller a cumulus cloud grows, the more water it stores and the more likely it is to produce rain. As water droplets rise, coalesce and grow, some become heavy enough to fall as raindrops. Such dynamic clouds are often primary candidates for seeding and, hopefully, for producing additional rain.

Weather modification efforts began in earnest shortly after World War II. In recent years, the science has enjoyed worldwide popularity. The Soviet Union seeds clouds through the use of rockets which shoot seeding agents high into the atmosphere. In Oklahoma, three types of cloud seeding methods have been used since seeding efforts began here in 1952:

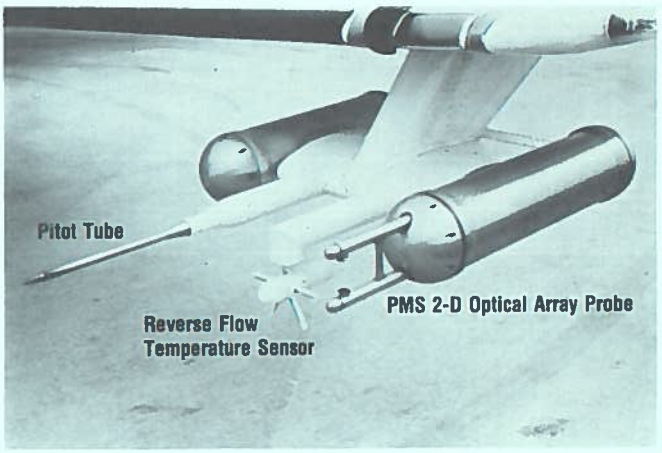
- Ground-based generators which release silver iodide into the atmosphere upwind of air current updrafts.
- Aircraft seeding using the direct injection of silver iodide and dry ice into upper cloud levels which have a temperature at or below freezing.
- Aircraft seeding using the injection of urea or other large particles into lower cloud levels at temperatures above freezing.

Despite apparent success with ground-based generators, some experts consider them to be too inconsistent in delivering the seeding materials to seedable clouds. Many believe that the use of airplanes—such as the Citation—is much more precise. Depending upon cloud and atmospheric conditions, seeding aircraft may deliver seeding agents above cloud tops, below cloud bases or through critical cloud levels.

"Different cloud seeding agents are used depending on whether the seeding area of the cloud is above or below freezing," Poellot explained. "In the seeding of 'warm' clouds, salt or urea particles are often introduced—these substances are able to draw water vapor readily from the air, thus causing the cloud droplets to grow larger and faster. 'Cold' cloud seeding injects silver iodide or dry ice, which causes droplets to freeze and become ice crystals."

Although the UND team's purpose for traveling to Oklahoma was simply for weather modification background studies, they often assist cloud seeding operations.

"When we seed, we are not trying to create more clouds; we are simply trying to give a boost to the ones already there," Poellot said. "The purpose of our studies in Oklahoma is to answer questions vital to enhancing rain, such as: how much liquid water does a



cloud contain and how efficiently is this water being used up?"

The Citation usually carries a crew of three or four. It takes two to fly the aircraft while a scientist and/or a data technician are needed to operate the jet's sophisticated equipment and enter cloud data into the computer.

Among the plane's advanced measurement devices, perhaps the most interesting are the three 'optical particle measurement probes' which measure cloud particles.

"The Citation has three separate lasers emanating from probes on the jet's wings," Poellot said. "The PMS 2-D probe on the left wing can transmit a two-dimensional picture of small cloud particles to the computer screen. The PMS 1-D on the right wing measures the larger cloud particles but gives only a one-dimensional picture of them. The third laser, called the Forward Scattering Spectrometer Probe, provides information on the size and number of cloud droplets. Together, these probes can tell the weather modification operator if a cloud is 'seedable,' and if so, how and when it should be seeded.

The aircraft also contains a rather obtrusive-looking boom which extends horizontally from the nose. The gust probe at the end of the structure is instrumental in measuring vertical air movement, according to Poellot.

"We are constantly looking for clouds with a good updraft because they are the ones that make excellent seeding candidates. If there is little or no updraft or if the updraft is dying, then the cloud will soon dissipate."

Atmospheric conditions fluctuate so rapidly that seeding operators may have only minutes to seed a cloud. The cloud must be in the precise stage of development for seeding agents to create the desired effect. Therefore, Poellot said, nighttime seeding is sometimes required.

Separating what effects man produces artificially and what nature would have done has caused the most headaches for scientists.

"The whole key to weather modification is accurate measurement of success. Unfortunately, that is absolutely the hardest thing to determine," Poellot lamented. "You just cannot predict what a cloud is going to do."

In addition to the enhancement of rainfall, weather modification may also be used for the mitigation of severe, damaging weather events.

"We have had some success with hail prevention, mitigation of hurricane winds, adjustment of snowfall and even in the prevention of severe lightning strikes," Poellot said.

Mathis added that there have also been some recent advances in seeding agents. Lab technicians have developed silver iodide agents which freeze faster, thus allowing cloud particles to grow larger more quickly. There have also been some successful lab experiments using a mixture of silver iodide and sodium chloride—or table salt.

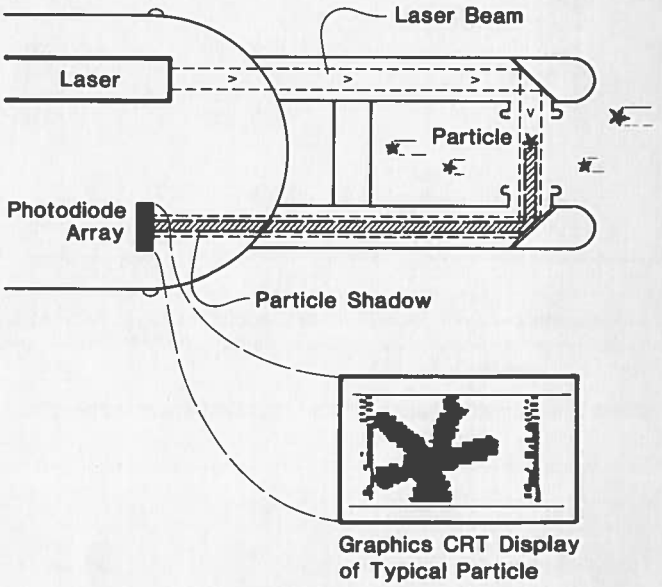
Another recent development is a tracer gas (sulfur hexafluoride) which has been used in North Dakota to track the movement of seeding materials. with aircraft and radar. Mathis said that a similar program may be implemented in Oklahoma next year.

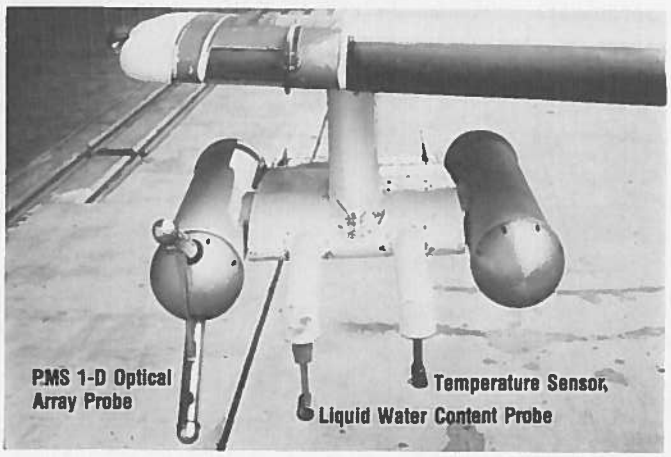
Mathis pointed out that cooperation between the states and the federal government is a key to the future of the science.

"In the past, we have worked closely with Texas and the Bureau of Reclamation through the exchange of weather modification data. But in order to expand this cooperation, we must have a state commitment along with federal backing to successfully and fully implement a weather modification program in this region."

Mathis added that Congressman Wes Watkins has been instrumental, along with Congressmen from Texas, in acquiring funds from the Bureau of Reclamation to keep the weather modification program alive and growing.

"But to keep this funding going, it




**ABOVE: This two-dimensional probe uses a laser light source falling on a row of photo sensors to illuminate cloud particles in the airstream. When a particle passes through the sample volume, it casts a shadow on the sensors which detect the presence and size of the particle. Its shadow is then recorded on the photodiode array.**

**FAR LEFT: Instruments on the left wing measure atmospheric temperature and aircraft speed as well as gauge small ice particles present in the atmosphere.**

**LEFT: The right wing bears a cloud water content probe, a temperature sensor and a second laser probe (similar to the one on the left wing) which measures larger ice particles.**

*Clouds, continued from page 3*

will be necessary to improve the public perception of weather modification. Maintaining responsible cloud seeding programs should eventually stifle the negative image associated

"In the meantime, we will continue to study past and present weather modification projects to learn from their successes and failures," Mathis said. "It is the responsibility of project sponsors to measure the effects of a seeding program and to make that information available to the public.

A national weather modification program may be several years away from becoming a reality. Until then, "rainmakers" will be watching the skies ready to help man deal with nature's unpredictable and sometimes cruel weather tendencies.

**ACTIVE CONSERVATION STORAGE IN SELECTED OKLAHOMA LAKES AND RESERVOIRS AS OF JUNE 30, 1986**

| PLANNING REGION LAKE/RESERVOIR | CONSERVATION STORAGE (AF) | PERCENT OF CAPACITY |
|---|---|---|
| SOUTHEAST | | |
| Atoka | 121,731 | 98.5 |
| Broken Bow | 914,697 | 99.6 |
| Pine Creek | 77,700 | 100.0 |
| Hugo | 157,600 | 100.0 |
| CENTRAL | | |
| Thunderbird | 105,925 | 100.0 |
| Hefner | 73,051 | 96.9 |
| Overholser | 15,935 | 100.0 |
| Draper | 77,128 | 77.1 |
| SOUTH CENTRAL | | |
| Arbuckle | 62,571 | 100.0 |
| Texoma | 2,637,700 | 100.0 |
| Waurika | 203,100 | 100.0 |
| SOUTHWEST | | |
| Altus | 64,536 | 48.5 |
| Fort Cobb | 78,423 | 100.0 |
| Foss | 135,388 | 55.5[2] |
| Tom Steed | 75,523 | 84.8 |
| EAST CENTRAL | | |
| Eufaula | 2,329,700 | 100.0 |
| Tenkiller | 627,500 | 100.0 |
| Wister | 27,100 | 100.0 |
| Sardis | 302,500 | 100.0 |
| NORTHEAST | | |
| Eucha | 79,567 | 100.0 |
| Grand | 1,324,120 | 88.7 |
| Oologah | 544,240 | 100.0 |
| Hulah | 30,594 | 100.0 |
| Fort Gibson | 365,200 | 100.0 |
| Heyburn | 6,600 | 100.0 |
| Birch | 19,200 | 100.0 |
| Hudson | 200,300 | 100.0 |
| Spavinaw | 30,000 | 100.0 |
| Copan | 43,400 | 100.0 |
| Skiatook | ——— | ———[1] |
| NORTH CENTRAL | | |
| Kaw | 428,600 | 100.0 |
| Keystone | 616,000 | 100.0 |
| NORTHWEST | | |
| Canton | 97,500 | 100.0 |
| Optima | 3,000 | ———[1] |
| Fort Supply | 13,900 | 100.0 |
| Great Salt Plains | 31,400 | 100.0 |
| **STATE TOTALS** | **11,918,429.00** | **94.4[3]** |

1. In initial filling stage
2. Temporarily lowered for maintenance
3. Conservation storage for Lake Optima not included in state total

Data courtesy of U.S. Army Corps of Engineers, Bureau of Reclamation, Oklahoma City Water Resources Department, and City of Tulsa Water Superintendent's Office.

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