The rainmakers

By George Pendle

For more than 60 years, humans have been trying to change the weather. But does cloud seeding really work?

Bob Simpson was just seven years old when the weather first tried to kill him. It was 1919 when a hurricane hit Corpus Christi, Texas, and his family home was swamped beneath surging storm waters. His father told him to cling to him as he swam out of the submerged house. For the rest of his life, Simpson would try to get his own back on the weather.

Now, at the age of 99, Simpson can lay claim to being the grand old man of American meteorology. As the founder of the National Hurricane Research Project in 1955, he flew into the eye of hurricanes in unarmoured planes. That’s his name on the Saffir-Simpson hurricane scale, by which hurricane strength is classed from category one (“large branches of trees will snap”) to category five (“total roof failure and wall collapse”). But it was through his appointment in 1962 as the first director of Project Stormfury, the US government’s two-decade-long quest to subdue hurricanes, that Simpson partook in his most intriguing endeavour, as the man who oversaw the boom and bust of the American dream to change the weather.

Today, weather modification is seen as a sort of quasi science, located at the indistinct crossroads of
meteorology, cloud physics and atmospheric research and hampered by a lack of evidence. But in a world of rapidly changing weather patterns, drought-plagued farmers continue to demand its implementation and scientists across the world continue to investigate it.

There are currently more than 150 legitimate weather-modification programmes taking place in 37 countries, according to the National Center for Atmospheric Research (NCAR) in Colorado. Most of these are state-backed initiatives, often involving private American companies in consulting roles. Some are single season programmes that cost tens of thousands of dollars, others multi-year projects that run into the millions. In India, Thailand, Mexico, the UAE, the Philippines and especially in China, people aren’t just talking about the weather, they’re actually trying to do something about it.

The urge to change the weather has existed for as long as humans have been subject to it. Just like our ancestors, we seek to increase rain for irrigation and drinking water and decrease hail to protect our crops. It was Plutarch who first suggested a quasi-scientific basis for changing the weather when he noted that the noise of a great battle produced rain by mimicking the sound of thunder. This idea was still being practised as late as the 19th century, when the US government sanctioned rainmaking experiments that consisted of appending explosives to balloons and kites. Such spectacular, if ineffectual, displays led to the field of weather modification becoming the preserve of conmen. The reason that it was not consigned to the same cabinet of curiosity as alchemy and astrology is largely due to one man: the Nobel Prize-winning chemist, Irving Langmuir.

In 1946, Langmuir and his assistant, Vincent Schaefer, had fashioned a cloud chamber out of a freezer in a General Electric laboratory in Schenectady, New York. They had been studying why clouds at temperatures below freezing didn’t always produce snow and were now creating their own “supercooled” clouds using the water vapour on their breath. On a particularly hot, humid day when the freezer was struggling to keep cool, Schaefer dropped in a piece of dry ice (solid carbon dioxide) to help cool it down. When he subsequently breathed into the freezer, the cloud created by the water vapour on his breath instantaneously turned into millions of tiny ice crystals. The serendipitous addition of dry ice had somehow managed to shock the cloud into producing snow.

The injection of chemicals into clouds to stimulate precipitation became known as cloud seeding. Following field experiments, the GE annual report for 1947 predicted it would produce “inestimable benefits for mankind”. The world lapped up the good news and a new industry was born with companies from Australia to New Mexico offering to seed clouds at a moment’s notice.

There are three things one should know about clouds. First, they’re lazy. A single cumulus cloud may hold millions of tonnes of water, but it often won’t part with a single drop of precipitation. Even when clouds do produce rain or snow, they usually give up less than 30 per cent of their moisture. The aim of cloud seeding is to make them more efficient. Second, clouds are dirty, forming when water vapour condenses on dust,
smoke or salt particles. Third, clouds are gullible. Silver iodide has largely superseded dry ice as a seeding agent. It mimics the hexagonal lattice structure of ice and tricks the cloud’s water vapour into condensing around it, after which it falls as snow or rain.

Cloud seeding’s fortunes have always risen and fallen with the barometer. When it is raining, nobody thinks twice about it. When there is a drought, people clamour for its use. Following the devastating hurricane season of 1954, the National Hurricane Research Project was created, with Simpson as its first director. But it was the creation of Project Stormfury a few years later that saw the US government making a concerted effort to weaken hurricanes through seeding.

While cloud seeding sought to bring out the best in underachieving clouds, hurricanes need no help in fulfilling their potential. An average hurricane releases the energy equivalent of 500,000 atomic bombs in one day. What cloud seeding hoped to do was calm them down. It was believed that if a storm was bombarded with dry ice, the supercooled water in its highest regions would freeze and fall as rain, causing the hurricane to expend some of its considerable energy. It was Langmuir and Scahefer’s experiment, but on a much bigger scale.

These missions were not for the faint-hearted. Sometimes, up to 10 aircraft would fly into the extremely turbulent eyewall of a hurricane. Here the pilots would wrestle with their controls as the scientists frantically dropped silver iodide bombs and flares while photographing and filming any changes they thought they had caused, all the while measuring the windspeed. “It wasn’t too bad,” says Simpson casually. “Not really. You’re too busy recording what’s going on to be scared.” He was accompanied by his wife, Joanne, the first woman ever to get a PhD in meteorology.

Results were initially inconclusive. There were just too many variables to ascertain whether cloud seeding actually weakened a hurricane. However, it remained one of the best experiments for observing how the turbulent weather system worked, and the US government was happy to spend some $20m a year on weather modification programmes.

Then in 1963, one of the deadliest hurricanes in recorded history — Hurricane Flora — lingered for four days over Cuba causing thousands of deaths. This prompted Fidel
Castro to accuse the US of waging weather warfare against him. Mexico soon followed suit, claiming Stormfury had caused a protracted drought by stealing its rain. Although the scientists of Stormfury were certain they were not the cause of either event, they lacked the data to prove it.

“Suddenly we couldn’t seed within so many miles of Cuba,” recalls Simpson, “we couldn’t seed within so many miles of Mexico. I was out several times on planes ready to run a seeding expedition when my boss called me to say, ‘You’re too close to this place or that place, and, no matter what happens, they’ll blame us for it.’” He shakes his head. “As soon as politics get into it, forget it!”

His fears came true with the release of the Pentagon papers in 1971, which showed cloud seeding had been practised in the Vietnam war in an attempt to flood the Ho Chi Minh Trail and hamper enemy movement. The military was forced to cut its funding for weather research. Stormfury suffered further when it was discovered hurricanes actually held very little of the supercooled water that was necessary for cloud seeding to function. The programme blew itself out in 1983, and soon after that all US government involvement with weather modification ended.

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The weather has stayed on everybody’s minds. According to numbers released by the Organisation for Economic Co-operation and Development, the number of severe floods, droughts and storms has dramatically increased worldwide over the past three decades. Of equal concern is the assessment compiled in October last year by America’s National Intelligence Agency (NIA), which predicted “water-related state conflict” would threaten countries worldwide.

The weather is getting worse, water is becoming scarcer, and according to the NIA’s report, “no big breakthroughs” in water technology are set to appear over the next decade to help mitigate these problems. Cloud seeding is not mentioned once. This is because of a fundamental problem at its heart: how do you know what a cloud or hurricane would have done if you hadn’t seeded it? “It’s the Achilles heel of weather modification,” says Michael Garstang, a South African meteorologist and emeritus research professor of environmental sciences at the University of Virginia. “We cannot predict – with accuracy – what would have happened if we had not interfered.”

After a lifetime spent studying the atmosphere, Garstang was the chair of a 2003 National Research Council report entitled “Critical Issues in Weather Modification”. Chief among these issues was the difficulty cloud seeders have in providing scientific proof. The result was a picture of a science caught in a catch-22 situation. “The inability to provide acceptable proof damages the credibility of the entire field,” read the paper, “resulting in diminished scientific effort to address problems whose solutions would almost certainly lead to better evaluations.” The conclusion of the paper was cautiously optimistic, after all, as Garstang points out: “If we accept global warming as human
induced, we are accepting weather modification.” However, it called for more disciplined research to shore up the shaky foundations of the science.

This report caused a split in the small but passionate cloud-seeding community between the research side, characterised by university men such as Garstang and the operational side, represented by private businesses.

... Gary Walker is an avuncular Texan and the president-elect of the Weather Modification Association, founded in 1951 to encourage the “augmentation of rain and snow, and suppression of hail and fog”. A former state representative, Walker also runs Soar, a small weather-modification business. It is one of many companies west of the Mississippi that make up what is now a multimillion-dollar industry offering increased rainfall to local water boards, power companies and farmers. These businesses send up small single- and twin-engine aircraft into clouds where they release silver iodide, or other seeding material, from flares mounted on the wings. “We’d still say new research needs to be done no question,” Walker says. “We don’t have all the answers. But we have enough answers to know that modifying the weather to our advantage is a very good potential for our world.” Belief in cloud seeding is so strong in Texas that local tax districts pay for it.

But there are also concerns. “People say we’re robbing Peter to pay Paul,” says Walker. “Someone downstream from one of our projects says we’re getting their rain and then it doesn’t rain on them.” Walker and the cloud-seeding community strongly refute this claim. They say that although rainfall is increased by seeding, it is barely enough to
even put a dent in the massive potential amount of precipitation held in clouds. Indeed, fewer than a dozen court cases have been brought against cloud-seeding companies since 1950 and none has yielded any findings of liability. In many cases, the cloud seeders’ best defence lies in their science’s greatest weakness – how, after all, can an inconclusive science be conclusively to blame for anything?

Another argument claims seeding is not cost effective. Walker again rebuts this: “It’s a much cheaper production of new water when you get additional water out of a cloud than it is for desalinisation. And in many cases where I live in the Texas panhandle, we don’t have that ocean or sea or gulf that provides that salt water to desalinate in the first place.” He estimates desalinisation costs about $1,000 to provide an acre-foot of water (i.e. to cover an acre of ground in a foot of water) compared with cloud seeding’s $1-$10 per acre-foot cost. Many practitioners believe that while cloud seeding does not have the 95 per cent statistical certainty that scientists demand, there is enough proof it works – and enough demand for it – to take a more holistic view. Cloud seeding may not work every time, says Walker, but it seems to work more often than not. Isn’t that enough?

Not according to James Rodger Fleming, a historian of science and former research meteorologist, whose book *Fixing the Sky* charts the history of weather modification. He regards both cloud seeding practitioners and their clients in a slightly more jaundiced light. “They’re not sure if their efforts are effective, but they’re too afraid to stop!”

In 2010, the US government’s Accountability Office estimated that $100.9m of federal money had been spent the previous year on research into geoengineering projects designed to ameliorate the inadvertent effects of man on the earth’s climate (i.e. global warming). The enthusiasm with which such projects are greeted is matched only by their staggering impracticality. (One example is the National Academy of Sciences’ 1991 proposal to install 50,000 mirrors, each 40 sq miles in size, in orbit to reflect incoming sunlight away from Earth.) During the same period the amount of government money spent on research into intentional local weather change was nil.

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Yet as the US has cut all government ties with the science it invented, many foreign governments have picked up the dream. These range from Thailand’s Bureau of Royal Rainmaking, which is overseen by King Bhumibol Adulyadej, who personally holds several cloud seeding patents, to the quasi-militaristic ventures in China.

Indeed China has made cloud seeding one of the cornerstones of its most recent five-year plan, laying out a scheme to increase rainfall across the country by 10 per cent and reduce losses caused by weather disasters from 3 per cent of GDP to 1 per cent. Before the 2008 Beijing Olympics, the Chinese government announced it would not rain during the Games thanks to its weather-modification bureau. They proved correct, although
many thought this had little to do with cloud seeding. “They were just bloody lucky,” says Garstang. “It was a stupid prediction to make because they had no [scientific] basis to rest it on.”

Nevertheless, China is more willing than any other country to invest in the science, creating what amounts to a cloud seeding army. Nearly 40,000 field operators equipped with about 7,000 anti-aircraft cannons and 5,000 truck mounted rocket launchers allegedly stand ready to fire rockets laden with silver iodide into any unsuspecting cloud that drifts overhead. “Some of it I have my doubts about,” says Roelof Bruintjes, head of the weather modification programme at NCAR, who has advised China on its research programmes. “The technologies they use are dating back to the 1970s. But now they’re pursuing better evaluation methods, new technologies, trying to understand what is happening.”

Yet as investigations into cloud seeding increase around the world, the greatest hope can perhaps be found much closer to its original home. In Wyoming, a project that has been running for seven years, funded by the state to the tune of $11m, looks set to lay to rest the uncertainty that has persistently dogged cloud seeding. The aim of the project is to increase the snowpack on two of Wyoming’s mountain ranges and produce more spring and summer runoff for water supplies. With 16 ground-based generators belching silver iodide smoke directly into the mountain clouds, the project is being scrutinised not only by the private weather company performing the cloud seeding, but also by scientists from NCAR and the Desert Research Institute in Nevada.

The Wyoming programme’s greatest innovation is the fact that it is a blind, randomised experiment. Two closely correlated mountain ranges are being seeded at random many hundreds of times, but only if conditions are deemed suitable for seeding in both. The hope is that this will finally answer what would have happened to a cloud if it had, and had not, been seeded.

Dan Breed, an NCAR scientist attached to the scheme says with the world-weariness of his tribe, “I don’t care if the snowfall increases or decreases. My real goal is to make sure that we have enough data to say something definitive about the experiment. We don’t want to spend all this money and say, ‘Gee, it’s inconclusive.’ We want to be able
to draw conclusions, scientifically based conclusions, from it.” The programme has two more years to run but is already drawing attention. In May, one of the scientists involved received an award from the National Institutes for Water Resources, suggesting that the US government is shaking off its antipathy to the science. Ultimately, it just might prove to be the “big breakthrough” in water technology the NIA report had hoped for.

Despite all the updrafts and downdrafts that have buffeted him over his years in cloud seeding, when Bob Simpson is asked whether he thinks it will eventually be accepted as a proper science he is strident in his answer. “I don’t think there’s any question about it. I think it will. And I’m for it.” He smiles. “I’m a believer.”

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