

Humans Have Intentionally Modified Weather for Military Purposes and Climate Control for Decades

By [Washington's Blog](#)

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Weather modification is a well-known endeavor. For example, governments have been [seeding clouds](#) for decades to create more rain.

And during warfare to create mud to slow the enemy's ability to use roads.

As the Guardian [reported](#) in 2001:

During the Vietnam war, the Americans launched Project Popeye, a secret mission to seed the tops of monsoon clouds and trigger phenomenal downpours that would wash away the Ho Chi Minh Trail used for ferrying supplies.

For five years Vietnam, Cambodia and Laos were sprayed during the monsoons, and military intelligence claimed that rainfall was increased by a third in some places. It only came to an end in March 1971 when [Washington Post] journalist Jack Anderson exposed the project and caused such a public furor that the UN general assembly approved a universal treaty banning environmental warfare.

But the US air force planners recently came up with new proposals to launch new weather weapons. Instead of silver-iodide, the idea is to shower fine particles of heat-absorbing carbon over clouds to trigger localised flooding and bog down troops and their equipment. Lasers on aircraft would also trigger lightning onto enemy aircraft, whilst other lasers could be fired at fog to clear a path over enemy targets on the ground.

Whether or not they work, past experiences tell us to be wary of tampering with the weather. In 1947, meteorologists tried to kill off a dying hurricane out at sea by seeding the clouds. The following day, the hurricane suddenly gathered strength, swung round and hit Savannah, Georgia causing extensive damage. The weather boffins were so rattled by the disaster it was not until August 1969 that they dared try again.

When Hurricane Debbie was 700 miles out at sea, they flew three seeding missions around its eye, where tropical storms are at their most intense, but the results were mixed - with each seeding the hurricane's winds were reduced and each time they picked up again.

Interestingly, U.S. weather modification efforts during the Vietnam war were revealed as part of the Pentagon Papers.

As the Washington Post [reported](#) on July 2, 1972:

Indochina - by the evidence of a long-ignored passage in the Pentagon Papers - has been a test battleground, the site of purposeful rain-making along the Ho Chi Minh trails.

Sen. Claiborne Pell (D-R.I.) is prominent among members of Congress who believe it has become a reality. "There is very little doubt in my mind," he says. Rep. Gilbert Gude (R-Md.) states: "There's no doubt in my mind that it's going on in Vietnam."

"I think there's no doubt rain-making was used in Laos on the trail," says a Senate committee aide well versed in defense affairs.

It is a "successful" pre-1967 use which is documented in the "senator Gravel" version of the Pentagon papers. In late February, 1967, this document discloses the Joint Chiefs of Staff prepared a list of "alternative strategies" for President Johnson.

One, titled "Laos Operations", read:

"Continue at present plus Operation Pop Eye to reduce trafficability along infiltration routes ... authorization required to implement phase of weather modification process previously successfully tested and evaluated in same area. (Italics added)

In 1967 — according to columnist Jack Anderson, who published the first allegation of Indochina rain-making — U.S. forces started secret Project Intermediary Compatriot "to hamper enemy logistics" ... (with) claimed success in creating man-made cloudbursts ... and flooding conditions" along the Ho Chi Minh trails, "making them impassable."

The Post makes clear that cloud-seeding wasn't limited to the Vietnam war theater:

The Defense Department freely reports that it has "field capacities" for making rain. It used them in the Philippines in 1969, in a six-month "precipitation augmentation project" at the Philippines request; in India in 1967, at a similar invitation; over Okinawa and Midway Islands, and in June, July and August, 1971, over drought-stricken Texas, at the urgent request of Gov. Preston Smith.

Navy rain-makers are currently involved in two long-range California programs — one over the Pacific off Santa Barbara, an attempt to increase rainfall over a national forest; the other over the Central Sierras to try to increase the snow-pack for electric utilities that depend on water power.

In 2008, the Denver Post [noted](#) the enormous scope of weather modification projects:

Scientists are monitoring more than 150 weather-modification projects in 40 countries, including at least 60 in the Western United States. The projects include wringing additional snow out of clouds for California hydropower and easing droughts in sub-Saharan Africa.

Most of the current research on this inexact science is being conducted abroad

....

In 2005, the Boston Globe [provided](#) an account of the early discovery of silver iodide as a tool for modifying weather:

In 1946, over Mount Greylock in western Massachusetts, a General Electric research chemist named Vincent Schaefer scattered three pounds of crushed dry ice out of an airplane into a cloud and set off a snow flurry. It was the world's first successful cloud seeding-later that year, the meteorologist Bernard Vonnegut (brother to the novelist) discovered that silver iodide smoke had a similar effect-and weather modification emerged from the realm of con men and eccentrics. Most meteorologists remained skeptical, but by 1951, 10 percent of the United States was under commercial cloud seeding.

"Intervention in atmospheric and climatic matters on any desired scale" was only decades away, predicted John von Neumann, the mathematician who helped invent and began programming the first electronic computers to model the weather. Over the next 30 years, the federal government spent hundreds of millions of dollars on projects all over the country to increase precipitation, to mitigate hailstorms (an age-old enemy of farmers), and, most successfully, to clear the fog from around airports. Perhaps the era's most ambitious endeavor was Project Stormfury, which sent up airplanes to seed the eye walls of hurricanes with silver iodide to weaken the winds before landfall.

(And see [this discussion](#) by an MIT scientist regarding the use of weather modification to mitigate hurricane damage.)

Moreover, the Post points out that - even in 1972 - weather modification has been tested for other applications as well:

Among patterns that can be predictably" be modified [Robert M. White, the current chief of the National Oceanic and Atmospheric Administration] said, are: cold fog (which can be cleared from airfields) ; cumulus clouds (most common in the tropics - "In Florida," White said, "we have been able almost at will to make them grow explosively"); orographic clouds (moist air moving up over mountains - "At the right temperature you can begin thinking of milking them for water") and hailstorms (which can often be suppressed, according to recent claims by the Russians, who fire silver iodide into them from rockets and artillery).

And - as the Post notes - even in 1972, the government was studying the affect of weather modification on climate:

ARPA Director Stephen J. Lukasik told the Senate Appropriations Committee in March: "Since it now appears highly probable that major world powers have the ability to create modifications of climate that might be seriously detrimental to the security of this country, Nile Blue [a computer simulation] was established in FY 70 to achieve a US capability to (1) evaluate all consequences of of a variety of possible actions ... (2) detect trends in in the global circulation which foretell changes ... and (3) determine if possible , means to counter potentially deleterious climatic changes ..."

"What this means," Lukasik explains, "is learning how much you have to tickle

the atmosphere to perturb the earth's climate. I guess we'd call it a threat assessment."

The Post also quoted high-level scientists warning that enemies could modify weather as a direct form of warfare, for example, by flooding coastal areas where one's enemy resided.

Now, weather modification is so mainstream that Texas [openly discusses](#) its cloud-seeding programs.

And U.S. Senator Kay Bailey Hutchison of Texas [introduced](#) the Weather Modification Research And Technology Transfer Authorization Act in 2004, saying:

Weather modification is the general term that refers to any human attempt to alter the weather.... These efforts have been used in the U.S. for more than 50 years to reduce crop and property damage, optimize useable precipitation during growing seasons and lessen the impact of periodic, often severe droughts.

The weather modification projects in Texas and other States in the U.S. are much more than well considered responses to drought. They are trying to use the latest technological developments in the science to chemically squeeze more precipitation out of clouds. Moisture that is needed to replenish fresh-water supplies in aquifers and reservoirs.

(The bill apparently didn't pass)

There's even a [Journal of Weather Modification](#) (here's a [peek inside](#)).

The Technology Has Advanced Far Beyond Seeding Clouds With Silver Iodide

The technology has advanced a long way since the early 1970s.

For example, the Telegraph [reported](#) yesterday that Abu Dhabi 'creates man-made rainstorms' by "using giant ionisers, shaped like giant lampshades, to generate fields of negatively charged particles, which create cloud formation." "There are many applications," Professor Hartmut Grassl, a former institute director, is [quoted](#) by the *Daily Mail* as saying. "One is getting water into a dry area. Maybe this is a most important point for mankind."

And former [secretary of defense](#) William Cohen [told](#) a conference on terrorism on April 28, 1997 that people can:

Alter the climate ... remotely through the use of electromagnetic waves.

The Use of Sulfur Dioxide to Affect Climate?

[Tom Wigley](#) - senior scientist at the National Center for Atmospheric Research and former director of the Climatic Research Unit at the University of East Anglia and current - has [proposed](#) releasing sulfur dioxide in the upper atmosphere to reflect sunlight and reduce warming. And see [this](#).

Wigley talks about this proposal in a [Discovery channel special](#) on weather modification.

Other scientists have suggested the same thing. See - by way of example only - [this](#), [this](#), [this](#), [this](#), [this](#), [this](#), [this](#), [this](#) and [this](#).

More History ... and Complicated Issues to Consider for the Future

The above-described Boston Globe article pointed to the complexity of the issues involved in weather modification:

In 2003 the National Academy of Sciences recommended “a coordinated national program” to “conduct a sustained research effort” into weather modification.

Politicians in Western and Southwestern states are funding attempts to tickle more moisture out of the clouds

Last fall, a meteorologist named Ross Hoffman suggested in Scientific American that a network of microwave-beaming satellites could literally take the wind out of hurricanes.

In some of the driest parts of Mexico, a Bedford-based company called Ionogenics is testing a rainmaking apparatus that uses an array of steel poles to ionize the air.

China, a country with widespread cloud seeding, has announced plans to engineer clear weather in Beijing for the 2008 Olympics.

Meanwhile, deepening concern over the possibly cataclysmic effects of climate change has spurred a number of recent proposals, some sketched out in considerable detail, to engineer a measure of counteractive cooling. John Latham, an atmospheric physicist at the National Center for Atmospheric Research in Boulder, Colo., has proposed increasing the reflectivity of the cloud cover by stirring up water vapor from the ocean with a fleet of giant egg-beater-like turbines.

A few years ago, a team led by the late Edward Teller suggested creating a similar effect by launching a million tons of tiny aluminum balloons into the atmosphere.

As our ability to comprehend the weather improves and as the threat of climate change looms larger, some scientists are ready to brave the uncertainty and tangled ethics of tinkering with the skies. . . .

The US military, unsurprisingly, was intrigued by the possibility of a godlike meteorological arsenal. According to Spencer Weart, a physicist and historian of science at the American Institute of Physics, the thinking in the Defense Department was “maybe we’ll give the Russians a real Cold War, or maybe they’ll give us one, so we should be ready.” Pentagon money funded much of the era’s climate research, helping to create the weather models we now use in forecasting. War gamers dreamed up climatological warfare scenarios like laying down a blanket of fog over an airfield or visiting drought upon an enemy’s breadbasket.

But the grandest climate engineering schemes came from the Soviet Union. The most Promethean among them was a late 1950s proposal to dam the Bering Strait and, by pumping water from the Arctic Ocean into the Pacific, draw warm water northward from the Atlantic to melt the polar ice pack, making the Arctic Ocean navigable and warming Siberia. The leading Soviet climatologist, Mikhail I. Budyko, cautioned against it, arguing that the ultimate effects were too difficult to predict (though he himself had played with the idea of warming the Arctic by covering it in soot to decrease its reflectivity). John F. Kennedy, as a presidential candidate, suggested the United States look into collaborating on the project. While the two countries continued desultory discussions of the Bering Strait plan into the 1970s, the American government was by then losing interest in the whole field of weather modification.

In 1972, a government cloud-seeding run in South Dakota was followed by a violent deluge, and more than 200 people were killed in the ensuing flood. Meteorologists disagreed over whether seeding was to blame, but the incident became an ominous symbol for those who saw weather modifiers as latter-day Pandoras. . . . Boyle's caution may be merited, but scientists are better equipped today to understand and manipulate the weather than they were 30 years ago.

Some scientists and engineers, such as Daniel Schrag, director of Harvard's Laboratory for Geochemical Oceanography, point out that, in light of the planet's growing thirst and rising temperature, even Soviet-scale climate modification is attracting real consideration. Boyle, who spoke at a joint MIT-Cambridge University conference on the topic last year, readily concedes, "There are very prominent, serious scientists who are considering these things."

A 1996 Air Force report entitled "Weather as a Force Multiplier: Owning the Weather in 2025," argued that "the tremendous military capabilities that could result from this field are ignored at our own peril."

Even purely peaceful aims would lead to a cascade of seemingly zero-sum conflicts. In the US, cloud seeding has set off several lawsuits in which, for example, downwind farmers have accused a cloud-seeding neighbor of "stealing" their rain. Such issues only grow in complexity along with the scale.

According to Joe Kaplinsky, a technology analyst in London, "To raise these things before the technology has really gotten off the ground is to deprive us of the potential benefits of any technology, because any technology can be misused." "Of course some people will benefit and some people will lose," Kaplinsky says, "but there are social mechanisms for solving disagreements, either through compensation or through democratic debate."

[Here is](#) a copy of the Air Force study "Weather as a Force Multiplier: Owning the Weather in 2025".

The American Institute of Physics - the organization mentioned in the Boston Globe article -

[provides](#) an interesting overview of the history of weather modification:

From 1945 into the 1970s, much effort went into studies of weather modification. American entrepreneurs tried cloud-seeding to enhance local rainfall, Russian scientists offered fabulous schemes of planetary engineering, and military agencies secretly explored “climatological warfare.”

In the mid 1970s ... Research turned instead to controversial “geoengineering” schemes for interventions that might restrain global warming if it started to become unbearable.

At the close of the Second World War, a few American scientists brought up a troublesome idea. If it were true, as some claimed, that humans were inadvertently changing their local weather by cutting down forests and emitting pollution, why not try to modify the weather on purpose? For generations there had been proposals for rainmaking, based on folklore like the story that cannonades from big battles brought rain.

Now top experts began to take the question seriously.... At the end of 1945 a brilliant mathematician, John von Neumann, called other leading scientists to a meeting in Princeton, where they agreed that modifying weather deliberately might be possible. They expected that could make a great difference in the next war. Soviet harvests, for example, might be ruined by creating a drought. Some scientists suspected that alongside the race with the Soviet Union for ever more terrible nuclear weapons, they were entering an equally fateful race to control the weather. As the Cold War got underway, U.S. military agencies devoted significant funds to research on what came to be called “climatological warfare.”

In 1953 a President’s Advisory Committee on Weather Control was established to pursue the idea. In 1958, the U.S. Congress acted directly to fund expanded rainmaking research. Large-scale experimentation was also underway, less openly, in the Soviet Union.

Military agencies in the U.S. (and presumably in the Soviet Union) supported research not only on cloud seeding but on other ways that injecting materials into the atmosphere might alter weather. Although much of this was buried in secrecy, the public learned that climatological warfare might become possible. In a 1955 Fortune magazine article, von Neumann himself explained that “Microscopic layers of colored matter spread on an icy surface, or in the atmosphere above one, could inhibit the reflection-radiation process, melt the ice, and change the local climate.” The effects could be far-reaching, even world-wide. “What power over our environment, over all nature, is implied!” he exclaimed. Von Neumann foresaw “forms of climatic warfare as yet unimagined,” perhaps more dangerous than nuclear war itself. He hoped it would force humanity to take a new, global approach to its political problems.

Around 1956, Soviet engineers began to speculate that they might be able to throw a dam across the Bering Strait and pump water from the Arctic Ocean into the Pacific. This would draw warm water up from the Atlantic. Their aim was to eliminate the ice pack, make the Arctic Ocean navigable, and warm up

Siberia. The idea attracted some notice in the United States — presidential candidate John F. Kennedy remarked that the idea was worth exploring as a joint project with the Soviets, and the discussion continued into the 1970s.

Beginning around 1961, Budyko and other scientists speculated about how humanity might alter the global climate by strewing dark dust or soot across the Arctic snow and ice. The soot would lower the albedo (reflection of sunlight), and the air would get warmer. Spreading so much dust year after year would be prohibitively expensive. But according to a well-known theory, warmer air should melt some snow and sea-ice and thus expose the dark underlying soil and ocean water, which would absorb sunlight and bring on more warming. So once dust destroyed the reflective cover, it might not reform.

A 1972 U.S. government rain-making operation in South Dakota was followed by a disastrous flood, and came under attack in a class-action lawsuit.

Already back in 1965, a Presidential advisory panel had suggested that if greenhouse effect warming by carbon dioxide gas ever became a problem, the government might take countervailing steps. The panel did not consider curbing the use of fossil fuels. They had in mind geoengineering schemes — spreading something across the ocean waters to reflect more sunlight, perhaps, or sowing particles high in the atmosphere to encourage the formation of reflective clouds. Some back-of-the-envelope arithmetic suggested such steps were feasible, and indeed could cost less than many government programs. In 1974, Budyko calculated that if global warming ever became a serious threat, we could counter it with just a few airplane flights a day in the stratosphere, burning sulfur to make aerosols that would reflect sunlight away.

For a few years in the early 1970s, new evidence and arguments led many scientists to suspect that the greatest climate risk was not warming, but cooling. A new ice age seemed to be approaching as part of the natural glacial cycle, perhaps hastened by human pollution that blocked sunlight. Technological optimists suggested ways to counter this threat too. We might spread soot from cargo aircraft to darken the Arctic snows, or even shatter the Arctic ice pack with “clean” thermonuclear explosions. [For background, see [this](#) and [this](#).]

The bitter fighting among communities over cloud-seeding would be as nothing compared with conflicts over attempts to engineer global climate. Moreover, as Budyko and Western scientists alike warned, scientists could not predict the consequences of such engineering efforts. We might forestall global warming only to find we had triggered a new ice age.

Such worries revived the U.S. military’s interest in artificial climate change on a global scale. A group at the RAND corporation, a defense think tank near Los Angeles, had been working with a computer climate model that originated at the University of California, Los Angeles.

The RAND group had to scramble to find support elsewhere. They turned to the Advanced Research Projects Agency of the Department of Defense.

When a National Academy of Sciences panel convened in 1991 to catalog the options, the members got into a long and serious debate over whether to include the grand “geoengineering” ideas. Might hopes of a future fix just encourage people to avoid the work of restricting greenhouse gas emissions? The panel reluctantly voted to include every idea, so that preparations could start in case the climate deteriorated so badly that radical steps would be the lesser evil. Their fundamental problem was the one that had bedeviled climate science from the start — if you pushed on this intricate system, nobody could say for sure what the final consequences might be.

What About Contrails?

The Environmental Protection Agency [notes](#) in a report entitled “Aircraft Contrails Factsheet”:

Persistent contrails can last for hours while growing to several kilometers in width and 200 to 400 meters in height.



Figure 2. Photograph of two contrail types. The contrail extending across the image is an evolving persistent contrail. Shown just above it is a short-lived contrail. Short-lived contrails evaporate soon after being formed due to low atmospheric humidity conditions. The persistent contrail shown here was formed at a lower altitude where higher humidity was present (Photos: J. Holecek, NOAA Aeronomy Laboratory, Boulder, CO.)



Figure 3. Persistent contrails and contrails evolving and spreading into cirrus clouds. Here, the humidity of the atmosphere is high, and the contrail ice particles continue to grow by taking up water from the surrounding atmosphere. **These contrails extend for large distances and may last for hours.** On other days when atmospheric humidity is lower, the same aircraft passages might have left few or even no contrails. (Photo: L. Chang, Office of Atmospheric Programs, U.S. EPA.)



Figure 5. Satellite photograph showing an example of contrails covering central Europe on May 4, 1995. The average cover in a photograph is estimated by using a computer to recognize and measure individual contrails over geographical regions of known size. Photograph from the National Oceanic and Atmospheric Administration (NOAA)-12 AVHRR satellite and processed by DLR (adapted from Mannstein et al., 1999). (Reproduced with permission of DLR.)

Persistent contrails are of interest to scientists because they increase the cloudiness of the atmosphere. The increase happens in two ways. First, persistent contrails are line-shaped clouds that would not have formed in the atmosphere without the passage of an aircraft. Secondly, persistent contrails often evolve and spread into extensive cirrus cloud cover that is indistinguishable from naturally occurring cloudiness (See Figure 3). At present, it is unknown how much of this more extensive cloudiness would have occurred without the passage of an aircraft. Not enough is known about how natural clouds form in the atmosphere to answer this question. Changes in cloudiness are important because clouds help control the temperature of the Earth's atmosphere. Changes in cloudiness resulting from human activities are important because they might contribute to long-term changes in the Earth's climate. Many other human activities also have the potential of contributing to climate change. Our climate involves important parameters such as air temperature, weather patterns, and rainfall. Changes in climate may have important impacts on natural resources and human health. Contrails' possible climate effects are one component of aviation's expected overall climate effect.

Persistent line-shaped contrails are estimated to cover, on average, about 0.1 percent of the Earth's surface

It is clear that persistent jet contrails can affect weather and climate. I have no idea whether persistent jet contrails are an unintentional affect of airplanes interacting with the environment, or an intentional attempt to affect the weather.

The articles quoted in the first part of this essay provide support for the possibility that at least some of the affects might be intentional. And as a 2008 international workshop on weather modification [noted](#):

It has been well established that successful implementation of Cloud Seeding resulting in precipitation enhancement has significant positive beneficial impact in managing the issue of global warming and climate change....

German television network [RTL](#) purportedly [alleges](#) that the German government has admitted testing persistent jet contrails for military purposes - as a high-tech form of "chaff" to disrupt enemy radar.

The EPA attributes formation of persistent jet contrails to altitude and humidity, as well as trace impurities such as sulfur contained in jet fuel. On the other hand, some [claim](#) that very high concentrations of chemicals like barium and sulfur have been found in groundwater after the incidence of persistent jet contrails increased. And see [this](#).

But whether or not persistent jet contrails are intentionally being created to affect climate or for military purposes or are an unintentional byproduct of flying a modern airplane is beyond the scope of this essay.

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