When it Rains, it Pours: Weather Modification Law in the United States and a Proposal for Federal Control

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ABSTRACT

Though weather modification has been used as a strategy to address issues such as drought throughout history, there continues to be a lack of federal regulation addressing weather modification. This Note surveys state regulations on weather modification and examines the current status of how the federal government addresses weather modification. Ultimately, this Note makes the case for why the Department of the Interior should take on the federal regulation of weather modification.
I. INTRODUCTION

In 2023, the American Southwest, a region over 90,000,000 people call home, entered the twenty-third year of its worst megadrought in over a
millennium. As humans pump ever more carbon into the atmosphere, we exacerbate a dire situation. Unfortunately, America’s most vulnerable populations, particularly Native Americans, are facing the brunt of this crisis. Thankfully, with the Inflation Reduction Act (“IRA”), the United States is now on a path to reduce its carbon emissions to fifty to fifty-two percent of peak levels by 2030. However, the Southwest needs to shore up its water supplies much sooner, and there is no guarantee that conditions in the region will improve simply because the United States reduces its carbon

(providing population data for the American Southwest including Arizona, California, Colorado, Nevada, Colorado, New Mexico, Oklahoma, Texas, and Utah).


6. For example, the surface of Lake Mead must sit at least 1,000 feet above sea level for the Hoover Dam to generate electricity for the 1.3 million people it serves. Lake Mead Keeps Dropping, NASA EARTH OBSERVATORY, https://earthobservatory.nasa.gov/images/150111/lake-mead-keeps-dropping [https://perma.cc/2LNW-S49V]; Hoover Dam: Frequently Asked Questions and Answers, U.S. BUREAU OF RECLAMATION, https://www.usbr.gov/lc/hooverdam/faqs/powerfaq.html [https://perma.cc/6BAC-XEHD]. The Southern Nevada Water Authority projects that Lake Mead’s surface will fall below 1,000 feet above sea level in 2025. S. NEV. WATER AUTH., 2023 WATER RESOURCE PLAN 58 fig.4.6 (2023).
emissions. Unfortunately, as climate change worsens, arid conditions will spread out of the Southwest. Most programs to combat drought focus on water conservation, infrastructure improvements, wastewater reclamation, and desalination. While these efforts will certainly help mitigate climate change-driven droughts, each overlooks a critical source of fresh water: clouds themselves.

Bringing clouds into drought mitigation efforts could be possible through cloud seeding, a controversial form of weather modification that uses particles to increase rainfall. By dispersing artificial condensation nuclei, usually silver iodide crystals, into clouds, cloud seeders can stimulate...
precipitation in the form of rain or snow.¹¹ Although some states have considered cloud seeding to combat drought,¹² federal weather modification policy is virtually nonexistent.¹³ Indeed, this country’s landmark piece of federal climate legislation, the IRA, contains no mentions of cloud seeding or weather modification.¹⁴ As a result, state and municipal governments and private individuals must navigate an unclear patchwork of laws.¹⁵

This Note argues that the federal government should take over all cloud seeding and science-based weather modification efforts within the United States and absorb them into a single program run by the Department of the Interior. Such a program would either eliminate the legal obstacles that face other models for weather modification governance or make them significantly easier to manage. Section II of this Note will provide an overview of weather modification science, the history of its use, and the current state of weather modification governance in the United States. Section III will analyze the legal issues facing weather modification programs under the current governing scheme, including the difficulty of assigning liability in cloud seeding tort cases and the question of atmospheric water rights. Section IV will advocate for creating a national weather modification program that will solve the legal issues facing other weather modification regulatory schemes. Finally, Section V will conclude this Note with a summary that emphasizes the benefits of a national weather modification program from a legal and a policy perspective.

¹¹ Clouds form when the air cools below its dew point. Id. at 28. At the dew point, water vapor in the air will condense into millions of tiny water droplets and form into clouds. See id. This process is facilitated by aerosols — tiny particles that float around in the atmosphere and serve as cloud condensation nuclei, which are objects that droplets can easily grow on. See id. at 20–21. When the air is cool enough, these droplets will freeze into ice crystals. Id. at 38–39. Over time, they increase in size until they fall to the ground as rain or snow. Id. at 43–44.


¹³ MacKenzie L. Hertz, It’s Raining, It’s Pouring, Weather Modification Regulation Is Snoring: A Proposal to Fill the Gap in Weather Modification Governance, 96 N.D. L. Rev. 31, 45 (2021) (“Federal regulation of weather modification is negligible and void of any substantive governance.”); see also discussion infra Section II.B.i (discussing federal weather modification policy).


¹⁵ Melissa Currier, Rain, Rain, Don’t Go Away: Cloud Seeding Governance in the United States and A Proposal for Federal Regulation, 48 U. Pac. L. Rev 949, 956 (2017) (“The current governance of cloud seeding in the United States consists of a complex network of primarily state, local, and private agencies.”); see also discussion infra Section II.B.ii (discussing state weather modification regulations).
II. HISTORY AND BACKGROUND

Although cloud seeding sounds like something out of science fiction, it is a well-established technology that has existed for over half a century.\textsuperscript{16} Even before the first real-world cloud seeding experiments in 1946,\textsuperscript{17} the idea of artificial rainmaking generated great public interest, controversy, and even litigation.\textsuperscript{18} However, the difficulty of measuring cloud seeding’s effectiveness and public mistrust over its application has led the federal government to take a hands-off approach to cloud seeding, leaving regulation largely up to the states.\textsuperscript{19}

A. The History of Weather Modification and Weather Modification Law

Humans have sought to control the weather since ancient times.\textsuperscript{20} In the United States, public interest in weather modification can be traced to the rainmakers of the late-1800s, who took advantage of the public’s ignorance and fascination with the many scientific advancements of the era.\textsuperscript{21} Unlike earlier rituals rooted in folklore and mysticism, these rainmakers sought to increase rainfall by altering the atmosphere’s physical properties.\textsuperscript{22} Unfortunately, they were often outright frauds who preyed on desperate farmers looking to survive lengthy droughts.\textsuperscript{23} As such, their efforts also led to some of the earliest weather modification litigation.\textsuperscript{24}

\begin{itemize}
  \item \textsuperscript{16} Dennis, supra note 10, 1–3; Harvey, supra note 12.
  \item \textsuperscript{17} Dennis, supra note 10, at 1.
  \item \textsuperscript{18} See Clark C. Spence, The Cloud Crackers: Moments in the History of Rainmaking, in Agriculture in the West 62, 62–71 (outlining the history of weather modification from early-modern rainmaking to cloud seeding and providing a preview of the controversy involving Charles Mallory Hatfield discussed at length infra).
  \item \textsuperscript{19} Manon Simon, Enhancing the Weather: Governance of Weather Modification Activities in the United States, 46 WM. & MARY ENV’T L. & POL’Y REV. 149, 163 (2021) ("[T]he withdrawal of federal support [for cloud seeding] . . . set the stage for states and private companies to pursue weather-modification operations."); see also discussion infra Section B (discussing the current legal landscape as it pertains to weather modification).
  \item \textsuperscript{20} See generally James George Frazer, The Golden Bough: A Study in Magic and Religion 60–83 (abr. ed. 1922) (outlining the history of rainmaking rituals).
  \item \textsuperscript{21} Spence, supra note 18, at 63.
  \item \textsuperscript{22} Compare id. (outlining popular late nineteenth century rainmaking methods), with Frazer, supra note 20, at 60–83 (providing a history of rainmaking rituals rooted in mysticism practiced around the world).
  \item \textsuperscript{23} Spence, supra note 18, at 63.
  \item \textsuperscript{24} Who Owns the Clouds?, 1 STAN. L. REV. 43, 44 (1948).
\end{itemize}
i. Early Rainmaking Litigation

The 1916 California Superior Court case *Hatfield v. City of San Diego* was the first weather modification lawsuit in U.S. history. Charles M. Hatfield was an early twentieth-century rainmaker who claimed to have developed a method of stimulating rainfall by releasing gaseous chemicals into the atmosphere. In 1915, he approached the San Diego City Council with an offer to use his rainmaking technique to fill the Morena Reservoir, which was dangerously low after a five-year drought, for $10,000. The council accepted the offer, and Hatfield got to work on New Year’s Day in 1916. Ten days later, rains came. San Diego received a then-record 2.5 inches of rainfall in twenty-four hours. A series of storms battered the city for the next two weeks, overflowing the reservoir and creating devastating floods.

After the floods, Hatfield demanded the city pay his fee, claiming to have filled the Morena Reservoir as promised. The city refused, countering that the rain was “an act of God.” Hatfield sued, arguing that “he was responsible for four billion gallons of water in the reservoir and God was responsible for [an] additional ten billion gallons, causing the flood and damage.” The city offered to settle if Hatfield would sign a statement taking full responsibility for the rain and the flood. Hatfield refused, as signing could have left him open to liability for millions of dollars in flood related property damage. The court sided with the city and dismissed the case.

Fittingly, *Hatfield* exemplifies the difficulty of proving causation in modern cloud seeding cases. By holding that the rains were an act of God, the court was, in essence, holding that Hatfield could not prove causation and therefore could not show he had performed under his contract with the

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26. *Id.* at 12.
27. *Id.* at 85–86.
28. *Id.* at 86.
29. *Who Owns the Clouds?, supra* note 24, at 44.
31. *Id.* at 90.
32. *Id.*
33. *Id.* at 90–93.
34. *Id.* at 93.
35. *Id.*
36. *Who Owns the Clouds?, supra* note 24, at 44.
city. Fortunately, unlike Hatfield’s rainmaking methods, cloud seeding is based on sound scientific principles. However, it is difficult to measure how much precipitation cloud seeding produces. Thus, just like Hatfield, cloud seeding plaintiffs have a hard time proving that weather modification caused their injuries.

ii. The Development of Cloud Seeding

In the thirty years that followed Hatfield, scientists discovered the important role condensation nuclei play in precipitation. Armed with this information, in November 1946, General Electric (“GE”) meteorologist and chemist Vincent J. Schaefer “dropped about 1.5 kg of dry ice . . . from a light aircraft into a supercooled lenticular stratocumulus cloud.” Within five minutes, the cloud produced snowflakes that fell 600 meters before evaporating. The following year, Bernard Vonnegut, another GE scientist, discovered that silver iodide crystals, which are cheaper to produce than dry ice, could also serve as artificial cloud condensation nuclei. Within three years of Vonnegut’s discovery, cloud seeding had grown into a nationwide industry.

37. Hatfield needed to prove he filled the reservoir but did not cause flooding so the court would enforce his contract with the city while avoiding liability for flood-related damages. The city’s act of God argument was also an effort to avoid tort liability. See infra Sections II.A–B (analyzing causation and standard of care).
39. Id. at 1173.
40. RONALD B. STANDLER, WEATHER MODIFICATION LAW IN THE USA 5–17 (2006), http://www.rbs2.com/weather.pdf (compiling every cloud seeding court case from 1950 to 2000, some of which indicate that plaintiffs did not successfully prove causation).
43. Vonnegut discovered that silver iodide crystals are the same size and shape as ice crystals at a molecular level. DENNIS, supra note 10, at 2–3. Not only was silver iodide cheaper to produce and deploy than dry ice, but field tests showed that both compounds yielded similar results. Id. at 3. Bernard Vonnegut was the older brother of author Kurt Vonnegut. Wolfgang Saxon, Bernard Vonnegut, 82, Physicist Who Coaxed Rain from the Sky, N.Y. TIMES (Apr. 27, 1997), https://www.nytimes.com/1997/04/27/nyregion/bernard-vonnegut-82-physicist-who-coaxed-rain-from-the-sky.html [https://perma.cc/Z5NS-HEK9].
44. See DENNIS, supra note 10, at 3.
New York City was one of the first major American cities to seed clouds to address a water shortage. In 1950, the city hired meteorologist Wallace E. Howell to seed clouds over the Catskill Watershed, hoping to fill the city’s worryingly low reservoirs. The plan attracted lawsuits even before Howell began seeding. Howell did not start seeding until April, but in February, the owners of a country club in Ulster County filed suit seeking an injunction to stop the seeding. The court ultimately ruled against the club owners, holding that the public’s need for drinking water outweighed any inconvenience increased rain might cause.

Howell began seeding in April 1950, and by June, the city’s reservoirs were overflowing. That did not stop the Sullivan County Board of Supervisors from passing a resolution declaring the city’s cloud seeding efforts a public nuisance. The board also threatened to empanel a grand jury to investigate the program. Despite this, in August, the city renewed Howell’s contract through the end of the year. Although Howell repeatedly emphasized that he did not know if his cloud seeding efforts were having any effect on precipitation, lawsuits against the city continued piling up even after his contract ended. In response, the city commissioned a study to prove that Howell’s cloud seeding efforts had failed. When the city faced another

46. KRISTINE C. HARPER, MAKE IT RAIN: STATE CONTROL OF THE ATMOSPHERE IN TWENTIETH-CENTURY AMERICA 109 (2017) ("Facing a serious water shortage in early 1950, New York City leaders asked Irving Langmuir if cloud seeding could fill their reservoirs.").


48. HARPER, supra note 46, at 111.


50. Slutsky, 97 N.Y.S.2d at 240; see infra Sections II.B.iv.c, II.B.v (discussing Slutsky and its relation to nuisance liability and atmospheric water rights).

51. HARPER, supra note 46, at 112–13 ("Soon the reservoirs were not just full — they were overflowing.").

52. Id. at 113.

53. Id.

54. Id.

55. Id. at 113–14.

56. N.Y. TIMES, City Now Skeptic on Rain-Making; Damage Claims Total $2,138,510, Nov. 5, 1951, at 1, https://www.proquest.com/historical-newspapers/city-now-skeptic-on-rain-making-damage-claims/docview/11192344/se-2 [https://perma.cc/38H3-ZLMN] ("[M]unicipal funds are now being used to make a study to show whether the [city’s cloud seeding program] was a failure . . . .").
water shortage in 1953, it opted against cloud seeding to avoid facing another deluge of lawsuits.\footnote{57}{HARPER, supra note 46, at 114 ("But in 1953, when New York City once again faced a water shortage, the city decided against rainmaking and in favor of conservation . . . .")} In 1954, just four years after New York City’s foray into cloudseeding, a group of twelve Oklahoma citizens became the first jury in U.S. history to hear a case involving cloud seeding.\footnote{58}{STANDLER, supra note 40, at 7 (discussing how Samples v. Irving P. Krick, Inc., Civil Nos. 6212, 6223, 6224 (W.D. Okla. Dec. 22, 1954) was “the first weather modification case . . . to be presented to a jury.”)} In Samples v. Irving P. Krick, Inc., Oklahoma City hired Irving P. Krick, one of the era’s most prominent commercial cloud seeders,\footnote{59}{Krick was chair of the California Institute of Technology meteorology department from 1933 to 1948 but was fired for focusing on commercial forecasting. \textit{Id.} at 7–8.} to seed clouds in the North Canadian River Watershed.\footnote{60}{Ray Jay Davis, \textit{Weather Modification Law Developments}, 27 Okla. L. Rev. 409, 413 (1974) (discussing \textit{Samples} and Krick’s background).} Shortly thereafter, a cloudburst triggered a flood in El Reno, Oklahoma, near Krick’s seeding operation.\footnote{61}{Jack C. Oppenheimer, \textit{The Legal Aspects of Weather Modification}, 1958 Ins. L.J. 314, 319, https://archive.org/details/sim_insurance-law-journal_1958-05_1958_424 [https://perma.cc/L2WZ-KJVR].} A local landowner filed suit, arguing that Krick acted negligently by seeding clouds under the weather conditions that existed at the time of the flood.\footnote{62}{\textit{Id.} at 413.} After both sides presented their case, the jury received the following instructions from the court:

\begin{quote}
[If a] reasonably prudent person, skilled in the science of cloud seeding, either would have or should have known that to seed the clouds at the times and places shown by the evidence to have been seeded by the defendant was dangerous in that it could reasonably have been anticipated that excessive rainfall would result, then the defendant’s seeding . . . would constitute negligence . . . .\footnote{63}{\textit{Id.} at 413.}
\end{quote}

The jury ruled in favor of Krick, holding that the plaintiff did not prove causation.\footnote{64}{\textit{Id.}}

Not only were state and municipal governments interested in taking advantage of this promising new technology, but so were private landowners.\footnote{65}{HARPER, supra note 46, at 109.} As neighboring landowners fought to control the weather for their own ends, lawmakers were “[c]aught flatfooted . . . [and] scrambled to find
a solution."\textsuperscript{66} Congress first sought to regulate cloud seeding in 1951, but military and private interests successfully lobbied against federal regulation.\textsuperscript{67} That left it up to the states to find a solution.\textsuperscript{68} As the 1950s progressed, more and more states began adopting cloud seeding regulations, with over a dozen states enacting some form of regulations by the end of the decade.\textsuperscript{69}

\textit{iii. Cold War Fears Influence Mid-Twentieth Century Federal Policy}

The military applications of weather modification were apparent even before Vincent Schaefer loaded dry ice onto his plane in 1946.\textsuperscript{70} With the Cold War in its infancy, the Department of Defense ("DOD") was eager to weaponize this new technology.\textsuperscript{71} U.S. military leaders even compared cloud seeding to the atomic bomb.\textsuperscript{72} Enthusiasm over cloud seeding’s

\begin{itemize}
  \item Id.\textsuperscript{66}
  \item JAMES RODGER FLEMING, FIXING THE SKY: THE CHECKERED HISTORY OF WEATHER AND CLIMATE CONTROL 173 (2010) ("Senator Clinton P. Anderson . . . proposed federal regulation of rain-making . . . in 1951 . . . The Department of Defense viewed this idea as a threat to its autonomy and categorically opposed [it."]); see also HARPER, supra note 46, at 88–104 (outlining Senator Anderson’s attempts to garner support for the Weather Control Act of 1951 despite other military branches’ disagreement).
  \item See HARPER, supra note 46, at 109–28 (outlining state governments’ attempts to regulate cloud seeding in the mid-twentieth century).
  \item DENNIS, supra note 10, at 1–2.
  \item FLEMING, supra note 67, at 170–72 ("The importance of weather to war and weather science to the military is reflected in the history of military interest in weather and climate control, a long-term relationship that deepened and intensified after World War II.").
  \item Id. at 171.
\end{itemize}
military applications soon bred fears over the technology’s misuse, leading to the federal government’s first attempt to regulate the practice.\footnote{When It Rains, It Pours, supra note 67 (introduced but not enacted).}

In 1951, the Senate introduced a bill to regulate cloud seeding and fund research into the military applications of weather modification.\footnote{Id., supra note 30, at 173. Private cloud seeders also lobbied against the bill.} The DOD saw federal regulations as a threat to its independence and successfully lobbied against the bill.\footnote{Fleming, supra note 67, at 173. Private cloud seeders also lobbied against the bill. Harper, supra note 46, at 94–96.} Public debate over cloud seeding continued, and in 1953 Congress established a national Advisory Committee on Weather Control (“the Committee”), charged with “determining the extent to which the United States should experiment with, engage in, or regulate [weather modification].”\footnote{Act of Aug. 13, 1953, Pub. L. No. 83-256, §§ 2–3, 67 Stat. 426.}

After four years of research, the Committee issued its final report in December 1957.\footnote{Orville, supra note 69, at 583.} Instead of federal regulations, the Committee recommended that the federal government fund further weather modification research through the National Science Foundation (“NSF”).\footnote{Id. at 597.} The Committee made these recommendations despite concluding that existing state statutory and case law could not “prevent cloud seeding under the wrong meteorological conditions or by professionally unqualified or poorly equipped operators.”\footnote{Id. at 597.} Furthermore, the Committee believed that states could not “cope adequately with the physical and legal problems produced by cloud seeding activities conducted relatively close to State and national boundaries.”\footnote{Id. at 597.} However, because state notice and reporting requirements would help generate data for scientific research, the Committee concluded that

\begin{itemize}
  \item By 1957, thirteen states — Arizona, California, Colorado, Louisiana, Massachusetts, Nebraska, Nevada, Oregon, South Dakota, Utah, Washington, Wisconsin, and Wyoming — had enacted cloud seeding regulations of some kind. \textit{Id.} at 595. Nearly all of those states had public notice and reporting requirements for cloud seeders. \textit{Id.} at 596. Ten states — Arizona, California, Colorado, Louisiana, Massachusetts, Nebraska, Oregon South Dakota, Washington, and Wyoming had licensing requirements. \textit{Id.} Arizona, Louisiana, Massachusetts, Nebraska, Oregon, South Dakota, Washington, and Wyoming regulated the methods and conduct of cloud seeders. \textit{Id.} California, Nebraska, Nevada, South Dakota, and Utah authorized municipal governments and state agencies to engage in cloud seeding. \textit{Id.} at 596. Finally, Colorado, Louisiana, Nebraska, South Dakota, and Wyoming had claimed sovereignty over the atmospheric water above their borders. \textit{Id.} at 595. Then as now, there was little case law addressing weather modification. \textit{Id.} at 596.
  \item \textit{Id.} at 597.
\end{itemize}
the “most pressing need is for basic and applied research,” and recommended against federal regulation or governance.  

Cold War fears greatly impacted the Committee’s recommendations. Such anxieties also undoubtedly influenced Congress’s ultimate decision to follow the Committee’s guidance and fund weather modification research through the NSF while eschewing federal regulation. However, as time passed and more federal entities entered the field of scientific research, the NSF’s role in weather modification began to shrink. By 1968, Congress had terminated the NSF’s role as the “central agency in charge of weather modification research and development.” Despite this, federal funding of weather modification research continued until the end of the Vietnam War.

iv. Cloud Seeding in the Vietnam War and Growing Public Opposition

As the Cold War progressed into the 1960s, the United States injected itself into a land war in Asia to prevent Vietnam from becoming the next domino in the region to fall to communism. The U.S. military wanted to use cloud seeding to increase the intensity and duration of the region’s yearly monsoon season and flood supply routes used by the Viet Cong to

81. See id.  
82. Newsweek even quoted Committee chair, retired Navy Captain Howard T. Orville as saying, “If an unfriendly nation gets into a position to control the large-scale weather patterns before we can, the result could even be more disastrous than nuclear warfare.” The Weather Weapon: New Race with the Reds, NEWSWEEK, Jan. 13, 1958, at 54.  
84. See HARPER, supra note 46, at 154.  
85. Simon, supra note 19, at 158.  
86. See id. at 161 (“[F]ederal funding started to decline dramatically after 1978–79 . . . .”).  
87. See, e.g., The United States Enters the War, BRITANNICA, https://www.britannica.com/event/Vietnam-War/The-United-States-enters-the-war [https://perma.cc/2GD5-NBGP] (outlining the factors that led to the United States’ decision to enter the conflict in Vietnam).
render them untraversable. So in 1966, the military initiated Project Popeye, the testing phase of Operation Motorpool, in Laos. The Air Force observed that “seeded clouds grew six to ten times taller and wider within ten minutes of seeding and doubled the precipitation of unseeded clouds.” With the success of Project Popeye, President Johnson initiated Project Intermediary-Compatriot, the operational phase of Operation Motorpool. Between 1967 and 1972, the Air Force conducted over 2,600 seeding runs over Cambodia, Laos, North Vietnam, and South Vietnam.

The public did not learn about Operation Motorpool until 1971, when The Washington Post broke the story, sparking outrage. The Senate held hearings to discuss an international ban on weather modification in war and passed a resolution supporting such a treaty in 1973.

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88. The Southeast Asian Monsoon Belt’s wet season lasts from April to October. HARPER, supra note 46, at 207.
89. FLEMING, supra note 67, at 179.
90. HARPER, supra note 46, at 208. Despite these observations, it is impossible to know how much precipitation Operation Motorpool produced, if it resulted in civilian casualties, or if it damaged civilian infrastructure. Scientists did not discover how to track silver iodide as it turns into precipitation until 2018. See generally French et al., supra note 38.
91. See HARPER, supra note 46, at 218; see FLEMING, supra note 67, at 179.
92. HARPER, supra note 46, at 222, 225; FLEMING, supra note 67, at 180.
94. Prohibiting Military Weather Modification, supra note 93, at 1; S. Res. 71, 93rd Cong. (1973); see also FLEMING, supra note 67, at 183 (“Senator Pell . . . introduced a resolution calling on the U.S. government to negotiate a convention prohibiting the use of environmental or geophysical modification activities as weapons of war.”). Military and executive branch officials denied or downplayed the extent of cloud seeding in Vietnam. Defense Secretary Melvin Laird told the Senate Foreign Relations Committee that the military was not seeding clouds in North Vietnam even though it was still seeding in Cambodia, Laos, and South Vietnam. Id. at 181. In 1974, the Air Force Air Weather Service (“AWS”) published a report stating that AWS personnel had participated in “several non-AWS weather modification projects” but did not mention Operation Motorpool. Id. (discussing the AWS report in depth); HENRY A. CHARY, U.S. AIR FORCE AIR WEATHER SERV., AWS-TR-74-247, A HISTORY OF AIR WEATHER SERVICE WEATHER MODIFICATION 1965–1973 22 (1974),
took the issue to the United Nations, sensing an opportunity to shame its rival, the United States, on the international stage. The resulting treaty, the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (“ENMOD Convention”), was ratified in 1977 and entered into force in the United States in 1980.

Domestically, the United States enacted its first federal weather modification regulations in 1976. Subsequent attempts to pass federal cloud seeding regulations have failed due to “liability, foreign policy, and national security concerns — that arose in the past.” Before Operation Motorpool, people’s opinions on cloud seeding usually depended on their personal interests. Once the details of the program became public knowledge, cloud seeding became linked with Agent Orange as one of the weapons the United States used to commit atrocities during the Vietnam War. As public support for cloud seeding evaporated, federal funding also dried up. However, with climate change worsening and new evidence showing that cloud seeding produces precipitation, public interest in the technology is on the rise again.


95. FLEMING, supra note 67, at 183.
96. Id. at 184.
100. See, e.g., Orville, supra note 69 (outlining the competing private interests that prevent swift passage of state cloud seeding regulations in the state of Washington).
101. FLEMING, supra note 67, at 182.
102. Congress has not appropriated funds for weather modification research since 2002. Simon, supra note 19, at 163.
B. Current Legal Landscape

Due to its controversial history, cloud seeding is primarily governed by a patchwork of state statutes.\textsuperscript{104} Federal regulation is practically non-existent. What little case law exists comes primarily from lower-level state court rulings, which provide inconsistent guidance for resolving the legal issues cloud seeding presents.\textsuperscript{105} Internationally, cloud seeding is governed by the ENMOD Convention, which has few enforcement mechanisms.\textsuperscript{106} Overall, outside of a few states, cloud seeding remains largely ungoverned in the United States.

i. Federal Policy

Congress has the authority to regulate cloud seeding through the Constitution’s Commerce Clause, which allows Congress to regulate “[c]ommerce with foreign Nations, and among the several States, and with the Indian Tribes.”\textsuperscript{107} The Supreme Court has held that, under the Commerce Clause, Congress may regulate (1) the channels of interstate commerce, including roads, waterways, and airspace, (2) the instrumentalities of interstate commerce, including people and things in the free flow of commerce, and (3) those activities having a substantial relation to, or effect on, interstate commerce.\textsuperscript{108} Not only does cloud seeding have a substantial effect on interstate commerce,\textsuperscript{109} it alters the composition of the air, a key channel of interstate commerce.

\textsuperscript{104} Hertz, supra note 13, at 46.
\textsuperscript{105} STANDLER, supra note 40, at 18.
\textsuperscript{106} See FLEMING, supra note 67, at 184.
\textsuperscript{107} U.S. CONST. art. I, § 8, cl. 3.
\textsuperscript{109} Courts look at the following factors to determine if something has a substantial effect on interstate commerce: (1) the attenuation of the activity’s relationship to commerce; (2) whether the regulation directed at the activity is part of a larger scheme; (3) whether the activity is one traditionally regulated under state police powers; (4) Congressional findings on the activity’s impact on commerce; (5) whether Congress has defined the regulation within a nexus to commerce; (6) the activity’s cumulative effects on commerce; and (7) whether the regulated activity is actually inactivity. See generally id. at 549–631; Nat’l Fed’n of Indep. Bus. v. Sebelius, 567 U.S. 519 (2012). Applying these factors to cloud seeding: (1) weather modification is directly related to interstate commerce weather crosses state lines and agribusinesses need rainwater to grow their crops; (2) the regulation expands on the already in force Weather Modification Policy Act of 1976; (3) less than a majority of states regulate weather modification; (4) Congress has commissioned multiple studies on cloud seeding since its invention; (5) Congress can easily outline the relationship between weather modification and interstate commerce within whatever bill it passes; (6) weather modification has substantial cumulative effects on interstate commerce; and (7) regulations of weather modification do not regulate inactivity.
Despite Congress’s clear authority to regulate cloud seeding, federal cloud seeding policy amounts to very little. The only federal weather modification statute in force, the Weather Modification Policy Act of 1976 ("WMPA"), places few burdens on cloud seeders. Under WMPA, weather modifiers must report their activity to the Department of Commerce ("DOC"). The statute leaves it to DOC to determine the specifics of this reporting requirement. DOC requires weather modifiers to file an initial report specifying the dates, methods, purpose, and geographical region of their activities, ten days prior to engaging in any weather modification.

Additionally, weather modifiers must file an Environmental Impact Statement outlining safety procedures for their projects. Weather modifiers must file a final report no later than forty-five days after completing any project. Violating these reporting requirements can result in a $10,000 fine, and DOC may compel cloud seeders to provide information on their activities by “rule, subpoena, or otherwise.” The WMPA requires DOC to “publish summaries” of the weather modification data it collects “from time to time as [the Secretary] determines.”

Silver iodide is also subject to limited federal regulations. The Environmental Protection Agency ("EPA") classifies silver as a nuisance chemical under its National Secondary Drinking Water Regulations ("NSDWR") and recommends that concentrations of silver in drinking water not exceed 0.1 milligrams per liter of water. In high concentrations, silver can cause skin discoloration or a greying of the whites of the eyes. However, the EPA does not enforce the secondary maximum contaminant levels ("SMCLs") of National Primary Drinking Water Regulations like silver because nuisance

110. Hertz, supra note 13, at 45.
113. 15 C.F.R. § 908.4 (2023). In addition to cloud seeding, activities akin to early modern rainmaking must also be reported to the federal government. These activities include “[u]sing fires or heat sources to influence convective circulation or to evaporate fog,” “[m]odifying the solar radiation exchange of the earth or clouds, through the release of gases, dusts, liquids, or aerosols into the atmosphere,” and “[a]pplying shock waves, sonic energy sources, or other explosive or acoustic sources to the atmosphere.” § 908.3.
114. § 908.4(a)(8).
115. § 908.6.
117. § 330b(a).
118. Simon, supra note 19, at 155–56.
120. Id.
chemicals are not considered hazardous to human health. Rather, the NSDWR serves as a guideline for state and municipal water agencies.

**ii. State Regulations**

Absent federal guidance, states have developed their own weather modification policies, leading to a patchwork system in which the “scope and comprehensiveness of . . . governance varies considerably.” As of 2021, twenty-three states and the U.S. Virgin Islands have cloud seeding regulations on the books. An additional six states and the District of Columbia permit the government to engage in cloud seeding in the event of an emergency without regulating private cloud seeding. Cloud seeding is legal and unregulated in the remaining twenty-one states.

A majority of states with cloud seeding regulations have licensing or permitting requirements. In these states, cloud seeders must satisfy certain competency requirements before receiving authorization to operate, and licensed cloud seeders must file reports on their activities with the state. On top of reporting requirements, seeders in eleven licensure or permit states must provide the public with advanced notice of cloud seeding projects, usually via publication in a local newspaper. Furthermore, seven

121. *Id.*  
122. *Id.* Nuisance chemicals may alter the taste, color, or smell of drinking water, damage water treatment equipment, or produce non-harmful cosmetic physical symptoms in people.  
127. Simon, *supra* note 19, at 164. These reports usually must specify the method of cloud seeding employed, the equipment used, the materials used for seeding and the quantity, names of all project participants, and the times and locations seeding occurred. See, e.g. *Tex. Agric. Code Ann.* § 301.117 (West 2003) (outlining Texas’ reporting requirements).  
licensure or permit states — and one non-license and permitting state — have public participation requirements for cloud seeding projects.\textsuperscript{129} This means the public can participate in the decision making process by which projects are authorized and appeal project authorizations, such as through public hearings or ballot referenda.\textsuperscript{130}

As of 2022, California was the state most actively engaged in cloud seeding, having conducted sixteen cloud seeding projects since 2010.\textsuperscript{131} California passed its first cloud seeding regulations in 1951, authorizing municipal governments, state agencies, and public corporations to pursue weather modification projects.\textsuperscript{132} The law also had licensing, notice, and reporting requirements for private seeders.\textsuperscript{133} In 1978, the state passed new regulations that made the issuance of licenses discretionary, required licensed cloud seeders to receive permits for specific projects, and allowed the public to request hearings on any project.\textsuperscript{134} However, state legislators soon came to see these regulations as needlessly expensive.\textsuperscript{135} In 1984, they passed the California Weather Resources Management Act, effectively deregulating cloud seeding in the state.\textsuperscript{136}

While California is the state most actively engaged in cloud seeding, Texas is the state with the most comprehensive cloud seeding regulations.\textsuperscript{137} Texas’s cloud seeding regulations include licensing, permitting, notice, reporting, and public participation requirements, as well as provisions

\begin{footnotes}
\footnote{129. Simon, \textit{supra} note 19, at 165 tbl.2; see, e.g., \textsc{Wash. Rev. Code Ann.} § 70A.10.090 (West 2020).}
\footnote{130. See Simon, \textit{supra} note 19, at 202.}
\footnote{131. \textit{id.} at 166.}
\footnote{132. \textsc{Cal. Gov’t Code} § 53063 (West 2023).}
\footnote{133. The 1951 law required the Department of Public Works to issue licenses to all cloud seeders for a fee. Act of July 23, 1951, ch. 1677 §§ 3, 4, 6, 1951 Cal. Stat. 3866, 3868 (repealed 1978). Cloud seeders had to publish public notice for projects in a local newspaper and file annual reports with the Department. §§ 9–11.}
\footnote{135. \textit{See Maurice Roos, De Facto Deregulation of Weather Modification in California, 15 J. of Weather Modification} 74, 74 (1983) (“Late in 1981, as a result of the continuing financial pinch on State general fund programs . . . the State administration proposed to make the Weather Resources Management program self supporting . . . .”).}
\footnote{136. The 1984 law eliminated the old licensing and permitting requirements; however, cloud seeders still must comply with notice and reporting requirements. \textit{See Simon, \textit{supra} note 19, at 169–70, 170 n.134.}}
\footnote{137. \textit{id.} at 166, 181.}
\end{footnotes}
governing tort liability. Despite its robust cloud seeding regulations, Texas has not directly funded any cloud seeding projects since 2004. Instead, cloud seeding projects are funded entirely by “underground water conservation districts and other local political subdivisions like county commissions and aquifer authorities.” Currently, there are five permitted cloud seeding projects operating in Texas, each of which has been in operation for over a decade.

iii. International Law

The ENMOD Convention, the only widely adopted multi-lateral treaty related to weather modification, is limited in scope. It does not regulate the general use of cloud seeding and provides no mechanism to resolve disputes between countries related to peaceful cloud seeding. Rather, it only restricts the “military or any hostile use of environmental modification techniques,” such as cloud seeding, that have “widespread, long-lasting or severe effects as a means of destruction, damage or injury to any other State Party.” It only applies “to environmental effects that encompass an area on the scale of several hundred square miles, last for a period of months . . . and involve serious or significant disruption or harm to human life, natural and economic resources, or other assets.”

138. Id. at 165 tbl.2. The Texas Weather Modification Act of 1967 (“TWMA”) contained license and permit requirements, operational regulations, and authorized the state to conduct weather modification research. Texas Weather Modification Act, S.B No. 458, 60th Leg., Reg. Sess. (Tex. 1967). To receive a license, cloud seeders must pay a fee and demonstrate “competence in the field of meteorology.” Tex. Agric. Code Ann § 301.103 (West 2021). Licenses must be renewed yearly. Id. § 301.105. The Advisory Committee on Weather Modification (“ACWM”) reviews licenses and permits on a quarterly basis. 16 Tex. Admin. Code §§ 60.24(c)(27), 79.33(b) (West 2021). To receive a permit, cloud seeders must pay a fee, publish a notice of intention, and carry liability insurance. Tex. Agric. Code Ann § 301.107(a) (West 2003). Permits are renewed every four years. § 301.109(b). The ACWM must hold public hearings if at least twenty-five people who live in an area affected by a request one. § 301.107(b).

139. Simon, supra note 19, at 182.


141. Id.

142. See generally ENMOD, supra note 97.

143. See Virginia Simms, Making the Rain: Cloud Seeding, the Imminent Freshwater Crisis, and International Law, 44 Int’l Law. 915, 930 (2010).


145. Fleming, supra note 67, at 184. In the ENMOD Convention, “widespread” means “encompassing an area on the scale of several hundred square kilometers,” “long-lasting” means “lasting for a period of months, or approximately a season,” and “severe” means “involving serious or significant disruption or harm to human life, natural and economic
violations are not classified as war crimes. However, the treaty does encourage peaceful weather modification.

Absent international regulations on peaceful cloud seeding, neighboring countries can enter into bilateral agreements with each other. The United States and Canada have entered into a compact designed to facilitate cooperation with “weather modification activities of mutual interest.” The agreement requires the United States to exchange weather modification data with Canada through the National Oceanographic and Atmospheric Administration (“NOAA”). While the U.S. federal government retains exclusive sovereignty over U.S. airspace, the treaty does not address sovereignty to atmospheric moisture that crosses the United States/Canada border, nor does it address the issue of international tort liability.

iv. Liability

Cloud seeders can be subject to liability via a variety of common law causes of action. In general, plaintiffs in cloud seeding cases seek one of...
two kinds of relief: injunctive relief or monetary damages. While some plaintiffs have successfully obtained injunctive relief, monetary relief has proven elusive to most plaintiffs involved in cloud seeding litigation. Some states shield cloud seeders from certain kinds of liability, while others have expressly opened cloud seeders up to specific causes of action. As of this writing, no court has published an opinion addressing negligent cloud seeding and only a few have addressed atmospheric water rights. As such, most of the legal issues that surround cloud seeding remain unresolved.

a. Negligence and Strict Liability

In most states, plaintiffs seeking to recover damages related to cloud seeding can do so by filing a negligence cause of action. Negligence is the failure to act with reasonable care when one has a duty to do so, and courts hold defendants liable for negligent conduct that causes harm. If an activity is “ultrahazardous” or “abnormally dangerous,” courts will hold people who engage in that activity strictly liable for damages even if they acted

154. Plaintiffs seeking an injunction must show that a cloud seeding project will damage property that cannot be replaced or that monetary damages cannot compensate the plaintiff. STANDLER, supra note 40, at 5.

155. See, e.g., id. at 8 (discussing Auvil Orchard Co., Inc. v. Weather Modification, Inc., Nr. 19268 (Wash. Super. Ct. 1956), where a farmer was granted a temporary injunction against a cloud seeder after flash floods occurred on his farm, but upon hearing expert testimony on appeal, the court held that cloud seeding had not caused the floods and refused to make the injunction permanent). Cf. Slutsky v. City of New York, 97 N.Y.S.2d 238, 240 (N.Y. Sup. Ct. 1950) (denying a temporary injunction against New York City to stop it from cloud seeding because the public’s need for drinking water outweighed the speculative harms posed by cloud seeding).

156. STANDLER, supra note 40, at 5.

157. Id. at 18.

158. Id.; see analysis infra Section III.B–C (analyzing the reasonable standard of care expected of cloud seeders and water rights issues related to cloud seeding).

159. Currier, supra note 15, at 957–58; cf. Hertz, supra note 13, at 42; Simon, supra note 19, at 212.

160. The prima facie elements of a negligence cause of action are duty, breach, causation, and damages. Hertz, supra note 13, at 42 (applying these elements in the case of weather modifier litigants). A duty of reasonable care exists if the defendant’s actions create the risk of harm. RESTATEMENT (THIRD) OF TORTS: PHYSICAL & EMOTIONAL HARM § 7 (AM. L. INST. 2010). Generally, a person breaches their duty if they fail to act as a reasonably prudent person under the circumstances. RESTATEMENT (SECOND) OF TORTS § 283 (AM. L. INST. 1977). Given the esoteric nature of their field, cloud seeders must conform their conduct to that of a reasonably prudent cloud seeder. See id. § 289 cmt. m. (1965) (explaining that when a tortfeasor has greater “attention, perception, memory, knowledge, intelligence, and judgment” than the general public, the standard of care expected of them becomes “that of a reasonable [person] with such superior attributes.”).
with reasonable care.161 However, even if an activity is “abnormally dangerous,” plaintiffs still must prove causation.162 Due to the difficulty of proving how much precipitation cloud seeding produces, causation represents a significant barrier to recovery for plaintiffs in negligence and strict liability cases.163

In the California Superior Court case Adams v. State, a group of plaintiffs sued Pacific Gas & Electric (“PG&E”), a private utility company, and North American Weather Consultants (“NAWC”), a private cloud seeder.164 In the mid-1950s, NAWC managed a cloud seeding project near the Feather River in Northern California under contract with PG&E.165 In December 1955, a devastating storm hit the region.166 The residents of Yuba City, located at the confluence of the Feather and Yuba Rivers, did not evacuate because they were confident in the city’s levies.167 Sadly, the levies broke and the resulting flood killed thirty-seven people.168

The survivors filed suit, claiming that PG&E and NAWC were negligent in the “maintenance and operation” of their silver iodide generators.169 In addition to their negligence claim, the plaintiffs argued that cloud seeding is an “ultrahazardous” activity.170 The defendants argued they could not have caused the flood because they stopped seeding before the storm in

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161. RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST. 1977). Six factors determine whether an activity is abnormally dangerous: (1) whether the activity involves a high degree of risk of harm; (2) the gravity of the potential harm; (3) whether the risk associated with the activity can be eliminated with reasonable care; (4) whether the activity is one of common usage; (5) the appropriateness of the activity to the place where it occurs; and (6) whether the activity’s value to the community outweighs its dangers. Id. § 520. An activity is abnormally dangerous if the first three factors are met, along with one of the final three factors. Id. § 520 cmt. f. No court, as of 2021, has held that cloud seeding is “abnormally dangerous.” Hertz, supra note 13, at 44. North Dakota, Texas, and Wisconsin have statutes declaring that cloud seeding is not “abnormally dangerous.” STANDLER, supra note 40, at 21. Pennsylvania is the only state that applies strict liability to cloud seeders. Hertz, supra note 13, at 51; 3 PA. STAT. AND CONS. STAT. ANN. § 1114 (West 2023).


163. See analysis infra Section III.A (analyzing causation as a barrier to recovery in cloud seeding tort cases).


165. Id. at 693.

166. Id. at 691.

167. Id.

168. Id.; STANDLER, supra note 40, at 10.

169. STANDLER, supra note 40, at 10.

170. Mann, supra note 164, at 695.
response to worsening weather. They also argued that water was not an “ultrahazardous” substance and the state had not categorized any water management techniques as such. The court ruled in favor of the defendants, holding that the plaintiffs had not proven causation. While the court ultimately did not rule on the issue of whether cloud seeding is an “ultrahazardous activity,” its opinion implies that it did not agree with the plaintiffs. The court held that cloud seeding during a storm was not itself evidence that cloud seeding caused any harm. Additionally, scholars that have examined the court's holding have found that liability would require proof that the defendant acted without reasonable care. The question of whether cloud seeding is “abnormally dangerous” remains unresolved.

b. Trespass

Theoretically, any precipitation, artificial nucleation particles, or aircraft which passes above or falls onto privately owned land as the result of cloud seeding could render a cloud seeder liable to the landowner for trespass. In practice, however, the trespass cause of action affords landowners little opportunity for relief, in part because they can only claim title to the airspace immediately above, or “superadjacent,” to their land. Historically, under the ad coelem doctrine, landowners claimed title to all the airspace above their land up to the “periphery of the universe.” However, as the Supreme Court explained in United States v. Causby, the ad coelem doctrine is incompatible with the modern world. The Causbys owned chicken coops near a military airstrip used to train pilots during WWII. The planes flew so low that the noise scared many of their chickens to death. The Causbys sued the government, arguing the flights constituted

171. See id. at 694, 705 (providing background of facts and defendant’s legal argument).
172. Id. at 709.
173. Id.
174. Id.
175. Id.
176. Id.
177. Hertz, supra note 13, at 38.
178. Id.
180. Id. at 260–61.
181. Id. at 260.
182. See id. at 258–59.
183. Id. at 259.
a taking under the Fifth Amendment and trespass under the *ad coeleum* doctrine.\(^{184}\)

While the *Causby* Court did not rule on trespass, it rejected the *ad coeleum* doctrine because otherwise “every transcontinental flight would subject the operator to countless trespass suits.”\(^{185}\) However, the Court held that landowners do have rights to the “superadjacent” airspace above their land, that is, “as much of the space above the ground as the [property owner] can occupy or use in connection with the land.”\(^{186}\) Everything above this “superadjacent” airspace is public airspace.\(^{187}\) Because the military frequently flew its aircraft at low altitudes beneath public airspace during the training runs in *Causby*, the Court held that such flights constituted a taking under the Fifth Amendment and ruled in favor of the Causbys.\(^{188}\)

The Federal Aviation Administration (“FAA”) has set the floor of publicly navigable airspace at 500 feet above any “person, vessel, vehicle, or structure” in non-congested areas and 1,000 feet in congested areas.\(^{189}\) Cloud seeding projects are unlikely to operate under this elevation,\(^{190}\) therefore the majority of flights by cloud seeing airfraft constitute would not constitute trespass.\(^{191}\) Additionally, while causing projectiles to enter on or into privately owned land or airspace can constitute trespass,\(^{192}\) most jurisdictions hold that such projectiles must be visible to the naked eye, and cloud seeding particles are not.\(^{193}\) In theory, cloud seeders could be held liable simply by causing unwanted rain to fall on private land because intrusions of water constitute trespass.\(^{194}\) However, the difficulty in proving causation means it is unlikely that precipitation alone could form the basis of a trespass claim.\(^{195}\)

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\(^{184}\) *Causby* v. United States, 60 F. Supp. 751, 756 (Ct. Cl. 1945), rev’d, 328 U.S. 256 (1946).

\(^{185}\) *Causby*, 328 U.S. at 261.

\(^{186}\) *Id.* at 264–65.

\(^{187}\) *Id.* at 260–61.

\(^{188}\) *Id.* at 266–67; see also discussion infra Section II.B.d.d (discussing the Fifth Amendment Takings Clause).

\(^{189}\) 14 C.F.R. § 91.119(c) (2024).

\(^{190}\) Most rain producing clouds form at 2,000 feet above ground level or higher. See *Cloud, Nat’l Geographic: Educ.*, https://education.nationalgeographic.org/resource/cloud [https://perma.cc/3WAR-VK5H].

\(^{191}\) See Hertz, *supra* note 13, at 39.

\(^{192}\) RESTATEMENT (SECOND) OF TORTS § 158 cmt. i (AM. L. INST. 1965).

\(^{193}\) Hertz, *supra* note 13, at 39.

\(^{194}\) See *Restatement (Second) of Torts* § 158 cmt. i, illus. 3 (AM. L. INST. 1965).

\(^{195}\) See analysis infra Section III.A (analyzing causation as a barrier to recovery in cloud seeding tort cases).
c. Public and Private Nuisance

Unlike trespass, which is a physical invasion of land, a private nuisance is conduct which unreasonably interferes with a landowner’s use and enjoyment of their land.\(^{196}\) Courts will hold a defendant liable for creating a private nuisance if the gravity of the harm suffered by the plaintiff outweighs the utility of the defendant’s conduct.\(^{197}\) While case law is sparse, it seems unlikely that courts will hold that the harm potentially caused by cloud seeding outweighs its utility.

In the 1950 case *Slutsky v. City of New York*, the owners of an upstate New York country club sought a preliminary injunction against New York City to stop it from cloud seeding in the Catskills watershed.\(^{198}\) The plaintiffs argued that increased rainfall would harm their business because resort attendance was dependent on the region’s mild climate.\(^{199}\) Although *Slutsky* was not a private nuisance action, the court held that the public’s need for drinking water outweighed the “purely speculative” harm cloud seeding could cause the plaintiff and denied the injunction.\(^{200}\) Similarly, eighteen years later, a Pennsylvania court held that cloud seeding does not constitute a nuisance because the public interest outweighs a landowner’s right to atmospheric moisture in *Pennsylvania Natural Weather Association v. Blue Ridge Weather Modification Association*.\(^{201}\)

Public nuisance differs from private nuisance in that public nuisance does not deal with the use of private land.\(^{202}\) Instead, a public nuisance “is an unreasonable interference with a right common to the general

\(^{196}\) *Restatement (Second) of Torts* § 821D cmt. d (Am. L. Inst. 1979).

\(^{197}\) *Id.* § 826. In determining the gravity of the harm suffered, courts look at (1) the extent of the harm; (2) the character of the harm; (3) “the social value that the law attaches to the type of use or enjoyment” impaired by the defendant’s conduct; (4) the suitability of the impaired use or enjoyment to the locality; and (5) the burden avoiding the harm places on the plaintiff. *Id.* § 827. To determine the utility of the defendant’s conduct, courts examine (1) the social value attached to the conduct; (2) the suitability of the conduct to the locality; and (3) “the impracticability of preventing or avoiding” the plaintiff’s harm. *Id.* § 828.

\(^{198}\) *Slutsky* v. City of New York, 97 N.Y.S.2d 238, 239 (N.Y. Sup. Ct. 1950); see discussion *infra* Section II.A.ii and discussion *supra* Section II.B.v (discussing *Slutsky* and New York City’s cloud seeding program and atmospheric water rights issues).

\(^{199}\) *Slutsky*, 97 N.Y.S.2d at 239.

\(^{200}\) *Id.* at 240.


\(^{202}\) *Restatement (Second) of Torts* § 821B cmt. h (Am. L. Inst. 1979).
Such a right is one enjoyed by all members of the public. An interference with a public right is unreasonable if it is the result of negligent, reckless, intentional, or abnormally dangerous conduct. To recover in an action for public nuisance, a plaintiff must experience a different kind of harm than that suffered by the general public. However, so far, no one has ever filed a public nuisance claim against a cloud seeder.

**d. Government Liability**

Under the doctrine of sovereign immunity, the government is immune from suit unless it consents to be sued. The federal government consents to being held liable for tort damages via the Federal Torts Claims Act ("FTCA"), including those related to weather modification. The FTCA serves as "a limited waiver of [the federal government’s] sovereign immunity" from "claims that exist under state tort law." Section 2680 of the FTCA, which contains an exhaustive list of exceptions to the act’s sovereign immunity waiver, does not list weather modification or cloud seeding, meaning the federal government can be liable for damages related to such activities. Ten states have taken a different approach to sovereign immunity when it comes to cloud seeding and have shielded themselves from liability for the activities of private cloud seeders via statute.

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203. Id. § 821B(1).
204. For example, an obstruction which blocks an entire highway constitutes a public nuisance, but one which only blocks vehicles taller than nine feet does not. Id. § 821B cmt. g.
205. Id. § 821B cmt. e.
206. Id. § 821C(1).
207. See STANDLER, supra note 40, at 5–17 (summarizing, in 2006, every documented weather modification court case in the United States since the invention of cloud seeding).
   1. Against the United States; 2. for money damages; 3. for injury to or loss of property, or personal injury or death; 4. caused by a federal employee’s negligent or wrongful act or mission; 5. while acting within the scope of his office or employment; 6. under circumstances where the United States, if a private person, would be liable to the plaintiff in accordance with the law of the place where the act or omission occurred.

210. CONTINO & KUERSTEN, supra note 209, at 5–6 (emphasis in original).
While the federal government itself may be sued under the FTCA, federal employees may not.\textsuperscript{213} The protection from personal immunity granted to federal employees by the FTCA does not extend to independent contractors working under contract with the federal government.\textsuperscript{214} However, in the 1940 case \textit{Yearsley v. W.A. Ross Construction Co.}, the Supreme Court held that sovereign immunity can extend to independent contractors in some circumstances.\textsuperscript{215} In \textit{Yearsley}, landowners in Nebraska sued a company that built dikes on the Missouri River under contract with the federal government.\textsuperscript{216} The landowners alleged that the company had used “large boats with paddles and pumps to produce artificial erosion, [and] had washed away part of [their] land.”\textsuperscript{217} The court ruled against the landowners, holding that when Congress validly confers authority to carry out a project upon an independent contractor, “there is no liability on the part of the contractor in executing [Congress’s] will.”\textsuperscript{218} However, independent contractors can be held liable if they exceed their authority or if “it was not validly conferred.”\textsuperscript{219}

Even when courts cannot hold the government liable in tort, they can hold the government liable for taking property under the Fifth Amendment’s Taking Clause, which states that no “private property [shall] be taken for public use, without just compensation.”\textsuperscript{220} Although no one has initiated a takings case against a government run cloud seeding program,\textsuperscript{221} the

\begin{itemize}
    \item \textsuperscript{213} 28 U.S.C. § 2679(b)(1) (2023) (“Any other civil action or proceeding for money damages arising out of or relating to the same subject matter against the employee or the employee’s estate is precluded without regard to when the act or omission occurred.”). For purposes of the FTCA, the term “employee of the government” includes: [O]fficers or employees of any federal agency, members of the military or naval forces of the United States, members of the National Guard while engaged in training or duty . . . and persons acting on behalf of a federal agency in an official capacity, temporarily or permanently in the service of the United States, whether with or without compensation . . . . Id. § 2671 (2023).
    \item \textsuperscript{214} Under the FTCA, the United States retains sovereign immunity for torts committed by independent contractors acting under contract with the federal government. In such cases, the independent contractor is the only party subject to liability. \textsc{Contino & Kuersten}, \textit{supra} note 209, at 8–9.
    \item \textsuperscript{215} \textit{Yearsley v. W.A. Ross Constr. Co.}, 309 U.S. 18, 20–21 (1940).
    \item \textsuperscript{216} \textit{Id.} at 19.
    \item \textsuperscript{217} \textit{Id.}
    \item \textsuperscript{218} \textit{Id.} at 20–21.
    \item \textsuperscript{219} \textit{Id.} at 21.
    \item \textsuperscript{220} U.S. \textsc{Const.} amend. V.
    \item \textsuperscript{221} First Eng. Evangelical Lutheran Church of Glendale v. L.A. Cnty., 482 U.S. 304 (1987). \textit{First English} is the closest the Supreme Court has come to addressing the Takings Clause in a case dealing with cloud seeding. In \textit{First English}, Los Angeles County enacted an interim ordinance prohibiting the construction in certain flood plain areas after a flood
\end{itemize}
Supreme Court has dealt with many cases involving flooding. In such cases, the Court “has consistently distinguished between flooding cases involving a permanent physical occupation, on the one hand, and cases involving a more temporary invasion, or government action outside the owner’s property that causes consequential damages within, on the other.” Only the former constitutes a taking.

Thus, if a government cloud seeding program briefly causes unwanted rain or snow to fall on someone’s property, that would not constitute a taking. However, a government cloud seeding program could trigger a taking if it causes a flood which permanently renders someone’s private land inaccessible. Furthermore, while the issue of private ownership of atmospheric water remains unresolved, a long-term government cloud seeding project which continually disrupts an otherwise reliable weather system might also be a taking.

v. Atmospheric Water Rights

States have well-established systems for governing private surface and groundwater rights. Since the invention of cloud seeding, legal scholars...
have attempted to apply these water rights schemes to atmospheric water by analogy, but no consensus has emerged. However, such analysis assumes landowners have property rights to atmospheric water, which is far from certain.

Six states have claimed sovereignty over all atmospheric moisture above their borders, either via statute or constitutionally. Courts in New York, Pennsylvania, and Texas have addressed the issue of private landowners’ rights to atmospheric moisture, and each have arrived at different conclusions. In Slutsky v. City of New York, the court stated in dicta that private property owners “clearly have no vested property rights in the clouds or the moisture therein.” The court did not cite any legal or scholarly authorities to support its conclusion, nor did it discuss property rights in its opinion. Instead, the court seemingly based its conclusion on equitable and public

adopted a hybrid model, which combines elements of both systems. Although both surface and groundwater are part of the same hydrological cycle, the law treats them differently. The states have adopted five models for governing groundwater rights: (1) under the “absolute dominion rule,” landowners have the right to use as much groundwater as they are able to extract, irrespective of all other concerns; (2) the “reasonable use rule,” requires a landowner to put whatever groundwater they extract “to a reasonable use on the overlying tract of land”; (3) under the “correlative rights doctrine,” the amount of groundwater a landowner may extract from an aquifer is proportional to the size of their plot of land in relation to the size of the aquifer; (4) the “Restatement rule,” allows landowners to extract a reasonable share of groundwater so long as they do not lower the water table or harm surface bodies of water; and finally, (5) many western states utilize the “prior appropriation doctrine,” and allow landowners to divert groundwater for beneficial uses on a first-come-first-served basis.

230. Simon, supra note 19 at 211 (“Scholars attempted to use legal analogies to regulate cloud seeding, but traditional structures of proprietary rights have appeared inadequate to address weather modification issues.”). California treats precipitation produced by cloud seeding as though it were of natural origin once it hits the ground; however, that is different from rights to atmospheric water itself. Cal. Water Code § 401 (West 2023).

231. Chen, supra note 124, at 82–84.

232. Id. at 82–83.


234. Id. at 239.

policy concerns, given that it weighed public and private interests in denying the plaintiff’s injunction.\textsuperscript{236}

Texas courts, on the other hand, have held that landowners do have rights to atmospheric water. Similar to \textit{Slutsky}, the case \textit{Southwest Weather Research, Inc. v. Jones} dealt with claimants who sought a preliminary injunction against an entity, this time a corporation, engaging in weather modification.\textsuperscript{237} Although the Texas Supreme Court did not directly rule on the property rights issue, it did affirm the appellate court’s ruling.\textsuperscript{238} The appeals court had previously affirmed the injunction, holding that landowners are “entitled to such precipitation as Nature deigns to bestow” and are therefore are entitled “to such rainfall as may come from clouds over [their] own property that Nature . . . may provide.”\textsuperscript{239} Citing to \textit{Causby}, the appeals court reasoned that, landowners are “entitled to protection against improper or unreasonable use” of the airspace over their land.\textsuperscript{240}

A decade after \textit{Jones}, Pennsylvania courts arrived at a middle ground between the Texas and New York approaches to the issue.\textsuperscript{241} In \textit{Pennsylvania Natural Weather Association v. Blue Ridge Weather Modification Association}, the Pennsylvania Court of Common Pleas held that landowners have a “property right in the moisture in the clouds and the right to receive that moisture in its natural form subject to such weather modification activities as shall be carried out by governmental authorities in the public, as opposed to private, interest.”\textsuperscript{242} Under this framework, landowners can assert their atmospheric water rights against other landowners but not the government itself. Unfortunately, as with most of the legal issues cloud seeding presents, a lack of case law means no consensus has emerged regarding atmospheric water rights.

\section*{III. ANALYSIS}

Cloud seeding can easily provoke disputes between neighbors, be they private landowners or sovereign political entities. Such disputes present

\begin{itemize}
\item \textsuperscript{236} See Special Comm’n, supra note 235 (“[The Slutsky] decision appears to have been based not upon rules about property and water rights but rather upon principles of equity and public policy . . ..”).
\item \textsuperscript{237} \textit{Sw. Weather Rsch., Inc. v. Jones}, 327 S.W.2d 417, 419 (Tex. 1959).
\item \textsuperscript{239} \textit{Duncan}, 319 S.W.2d at 945; \textit{Rounsaville}, 320 S.W.2d at 216.
\item \textsuperscript{240} \textit{Duncan}, 319 S.W.2d at 944–45; \textit{Rounsaville}, 320 S.W.2d at 216.
\item \textsuperscript{241} Chen, supra note 124, at 84.
\end{itemize}
several legal issues. First and foremost, the difficulty in analyzing the impact of individual instances of cloud seeding means that causation is a significant barrier to recovery in tort claims. Additionally, it is nearly impossible for courts to determine the standard of care expected of cloud seeders due to the esoteric and technical nature of the field. Beyond tort law issues, there is the issue of atmospheric water rights. Thanks to a lack of case law or federal guidance, these issues remain unresolved.

A. Causation is a Barrier to Recovery for Plaintiffs in Tort Cases

Because causation is an important element in many causes of action, it has been a persistent barrier to recovery for plaintiffs who believe they have been harmed by cloud seeding. The issue first showed up in 1916, in Hatfield v. City of San Diego, when the California Superior Court held that the rains which brought devastating floods to San Diego were an act of God, not the product of Charles Hatfield’s rainmaking efforts. In nearly every cloud seeding case since then, the presiding court held that the plaintiff did not prove causation.

Fortunately for plaintiffs, the burden of proof in civil cases is such that they need not prove that cloud seeding caused their harm with absolute certainty to prevail. Plaintiffs only need to convince the fact finder that cloud seeding more likely than not contributed to their harm, as opposed to proving causation with 100% certainty. However, juries and judges are generally not experts in meteorology or statistical analysis and will likely have a difficult time understanding the complicated evidence necessary to prove causation in such cases.

Scientists are close to being able to differentiate natural precipitation from that caused by cloud seeding; however, currently, there is no

244. See analysis infra Section III.B.
245. See generally Who Owns the Clouds?, supra note 24, at 46–63 (discussing different theories of atmospheric water rights).
246. STANDLER, supra note 40, at 18; Simon, supra note 19, at 164.
247. Currier, supra note 15, at 958; see also discussion supra Section II.B.iv.a.
248. Donaldson, supra note 25, at 93; Who Owns the Clouds?, supra note 24, at 44; see also discussion supra Section II.A.i (discussing the Hatfield case).
249. See supra notes 58–64, 155–156, 164–176 and accompanying text (for further discussion of cloud seeding cases).
250. STANDLER, supra note 40, at 26.
251. Id.
252. Id.
253. See Making it Snow: A Brief History and Review of the Science Behind Cloud-Seeding, DESERT RSCH. INST. (Mar. 15, 2023), https://www.dri.edu/making-it-
practical means of measuring how much precipitation each cloud seeding project produces. Historically, scientists have compared precipitation from seeded and unseeded storms in the same region to estimate a cloud seeding project’s effectiveness. However, defense attorneys are likely to object to such evidence and demand that evidence be restricted to the specific clouds seeded in a given case. Accordingly, causation remains a significant barrier to relief for plaintiffs in cloud seeding cases.

B. What is the Reasonable Standard of Care for Cloud Seeders?

In fault-based tort claims, the plaintiff must prove that the defendant failed to adhere to a certain level of care. Ordinarily, people have a duty to act as a reasonably prudent person under the circumstances if their actions create the risk of harm. However, cloud seeding is still a relatively esoteric technology that requires advanced scientific knowledge to truly understand. Some states even require cloud seeders to have advanced degrees in physics or meteorology, or to have a certain number of years of practical cloud seeding experience, just to qualify for a license. Thus, cloud seeders are expected to act as a reasonably prudent cloud seeder with the same level of knowledge and expertise would under the same circumstances. Unfortunately, judges and juries are almost universally lay people when it comes to the fields of advanced atmospheric physics,

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254. See French et al., supra note 38, at 1168.
255. STANDLER, supra note 40, at 26–27.
256. See id. at 27–28 (suggesting that defense attorneys would do well to downplay the efficacy of their clients’ cloud seeding projects in order to ensure causation remains in issue).
258. See supra note 160 and accompanying text (discussing the prima facie elements of negligence and the standard for breach of duty).
259. Id.
260. See generally DENNIS, supra note 10, at 78–81.
261. See, e.g., WASH. REV. CODE ANN. § 70A.10.080 (West 2023).
262. See supra note 160 (discussing the prima facie elements of negligence and the standard of care expected of tortfeasors with advanced knowledge or skills).
meteorology, and statistical analysis. As such, it is extremely difficult for them to determine whether a cloud seeder operated with “reasonable care.”

This issue first became apparent in *Samples v. Irving P. Krick, Inc.* The *Samples* jury instructions explained that a reasonably prudent cloud seeder should know that seeding clouds under certain weather conditions is “dangerous in that it [can] reasonably [be] anticipated that excessive rainfall [will] result.” However, later commentators have noted that “so little is known about weather modification that it might seem to some persons unreasonable to expect a jury to decide whether a cloud seeder was negligent or careful in particular weather situations.” Just as with causation, the public and the legal profession’s lack of familiarity with cloud seeding science makes it nearly impossible to prove when cloud seeders fail to act with reasonable care.

C. Rights to Clouds and Atmospheric Water

Outside of tort law, cloud seeding presents a number of unresolved issues within the realm of property rights. If property owners can claim ownership over clouds or atmospheric water, they may be able to claim that cloud seeding constitutes trespass or private nuisance even if no rain or nucleation particles ever enter onto their property. Beyond private landowners, cloud seeding programs could lead to disputes between neighboring polities who have claimed sovereignty over atmospheric water that passes over their borders.

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263. E.g., Mann, supra note 164, at 698–99 (showing the defendant’s attorney in *Adams v. State*, No. 10112 (Cal. Super. Ct. April 6, 1964) lamented the prospect of presenting complicated scientific evidence to a jury pool comprised almost entirely of women, for whom it was extraordinarily uncommon to be trained in meteorology or weather modification, and men with backgrounds as grocery store clerks or in meat packing While such comments reflect the sexism prevalent in mid-twentieth century American society, it is very unlikely that any jury pool would have had an easier time understanding the highly technical evidence in the case.); *See also* Standler, supra note 40, at 12.

264. Simon, supra note 19, at 212.

265. See Standler, supra note 40, at 7 (diving into *Samples v. Irving P. Krick, Inc.*, Civil Nos. 6212, 6223, 6224 (W.D. Okla. Dec. 22, 1954), which was a jury rather than a bench trial).

266. Oppenheimer, supra note 63, at 319.


268. See Restatement (Second) of Torts § 158 cmt. i (Am. L. Inst. 1965).

269. See, e.g., Currier, supra note 15, at 960 (“As cloud seeding becomes more reliable and widely recognized as an additional water resource, federal regulation is a clear step toward preventing potential disputes between the states.”).
i. **Who Owns Clouds?**

Before addressing the issue of who owns the water in clouds, it must first be established who owns clouds themselves. At common law, one of the primary ways a person can convert unowned objects into chattel property is by occupation. Occupation requires a person to exercise “an act of control or dominance over the object” with the intent to “appropriate the object to [their] own use.” Certain objects, however, were deemed beyond occupancy because they could not be brought under physical control. According to William Blackstone, “[a] man can have no absolute permanent property in [fire, light, air, and water] as he may in the earth and land; since these are of a vague and fugitive nature . . . .”

Clouds are clearly of the same “vague and fugitive nature” as the air they float in. They appear spontaneously and dissipate just as quickly. Protean and ephemeral, they move, grow, shrink, transform, split apart, and merge back together with the natural turbulence of the air. Suppose someone were to devise a way by which they could envelop and contain a cloud within some kind of container. The mere act of doing so would alter the physical properties of the air so much the dew point would change, causing the cloud to either vanish or precipitate out as liquid water. Therefore, it is unlikely that someone could claim ownership over a cloud via occupation.

Although air cannot be occupied, landowners do have claim to the superadjacent airspace above their land, as the Supreme Court held in *Causby*. In the years since *Causby*, the FAA has set the floor of publicly navigable airspace at 500 feet above any person, vessel, vehicle, or structure in non-congested areas and 1,000 feet in congested areas. The base of most rain clouds, such as nimbostratus and cumulonimbus clouds, generally

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270. See *Who Owns The Clouds?,* supra note 24, at 49-50 (“Although ‘clouds’ have been treated as a unit up to this point, the water which makes up the clouds must be separately considered.”) (indicating that the issue of who owns clouds themselves and who owns the water within clouds are two separate legal issues.).

271. See *Pierson v. Post,* 3 Cai. R. 175 (N.Y. Sup. Ct. 1805) (“[P]roperty in [wild] animals is acquired by occupancy only.”).

272. *Who Owns The Clouds?,* supra note 24, at 47.

273. *Id.*

274. 2 *WILLIAM BLACKSTONE, COMMENTARIES ON THE LAWS OF ENGLAND* (Lonang Inst., 2003).

275. *Who Owns The Clouds?,* supra note 24, at 48 (“Applying Blackstone’s test, the ‘vague and fugitive nature’ of a cloud prevented occupancy.”).

276. See generally *DENNIS,* supra note 10, at 28–38 (outlining the physics of cloud formation).


278. 14 C.F.R. § 91.119(c) (2024).
sit between 2,000 and 6,500 feet above ground level, well above the FAA’s limits. For these reasons, real property owners in congested areas have no claim to clouds 1,000 feet above their property or higher, and those in uncongested areas have no claim to clouds that are 500 feet or higher. While it is likely that they do have property rights over those rare clouds which sit under public airspace, such ownership does not automatically translate to ownership over the water within such clouds.

ii. **Who Owns the Water in Clouds?**

The extent to which private landowners can claim rights over atmospheric water that passes over their land, if at all, remains an open question. In the absence of definitive legal authority, scholars have fallen into two camps. The first contends that private landowners have a claim of ownership over atmospheric water, either by virtue of their ownership of the underlying land or through “natural rights.” The second camp rejects private ownership of atmospheric water. Under this framework, atmospheric water is either *res communes* — public property owned in common by all — or *res nullius* — owned by no one.

If private landowners can claim rights to atmospheric water, states need to develop a framework for governing competing private atmospheric water rights claims. Unfortunately, existing schemes for governing surface and groundwater rights do not neatly apply to atmospheric water by analogy. For one, the average landowner has no practical means of capturing...

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280. *Who Owns The Clouds?,* supra note 24, at 49 (describing the water within clouds as “common property”).
281. See, e.g., Simon, supra note 19, at 212 (concluding that “after more than fifty years of legal research, ownership of weather resources remains a challenge.”). Some states, such as California, have statutes declaring that atmospheric water “caused to fall” by cloud seeding is the same as natural precipitation when it comes to water rights. *Cal. Water Code* § 401 (West 2024). However, by their plain language, such statutes only apply once water has converted from atmospheric water into surface water. They do not address the rights landowners have over water still in the atmosphere.
282. Chen, supra note 124, at 68.
283. *Id.*; Simms, supra note 143, at 929 (“If traditionally property rights extend to the sky, then clouds would belong to the owners of the land below.”); *Who Owns the Clouds?,* supra note 24, at 51–58 (discussing rights to atmospheric water derived from a land owners “natural rights” to their land. “Natural rights” refers to rights which “protect the landowner’s use of his land in its natural condition” and are not related to the concept of natural law.).
284. Chen, supra note 124, at 68.
285. *Id.*
286. See Simon, supra note 19, at 211 (“Scholars attempted to use legal analogies to regulate cloud seeding, but traditional structures of proprietary rights have appeared inadequate to address weather modification issues.”).
atmospheric water, unlike surface or well water.\footnote{Landowners can set up rainwater capture systems on their property, where permitted by law. E.g., Cal. Water Code §§ 10570–74 (West 2024). However, these systems do not actually capture atmospheric water. Instead, they capture and store rain at the moment it becomes surface water by otherwise natural processes. P.E. Cabot et al., Rainwater Collection in Colorado – 6.707: Quick Facts, Colo. State Univ.: Extension, https://extension.colostate.edu/topic-areas/natural-resources/rainwater-collection-colorado-6-707/ [https://perma.cc/287J-J66F] (explaining the process of rainwater harvesting, or collection, which involves “capturing, storing and directing rainwater runoff [commonly from roof gutter downspouts] and putting it to use”).} Cloud seeding requires a level of advanced scientific knowledge that the vast majority of people do not have.\footnote{See generally Dennis, supra note 10 (providing a doctoral level breakdown of the science of cloud seeding).} Unlike surface and groundwater, clouds and atmospheric water are not confined to established channels and aquifers. While it is true that some weather patterns are reliable,\footnote{For instance, the northern hemisphere’s polar jet stream reliably blows eastward across the Atlantic Ocean. The Jet Stream, NOAA, (Sept. 20, 2023), https://www.noaa.gov/jetstream/global/jet-stream#:~:text=Within%20jet%20streams%2C%20the%20winds,between%20hot%20and%20cold%20air [https://perma.cc/5266-XV9C]. In doing so, it picks up heat and moisture brought up from the equator by the gulf stream, an ocean current which brings warm water from the Caribbean up the east coast of North America and to the North Atlantic. What Is the Gulf Stream?, SciJinks, https://scijinks.gov/gulf-stream/ [https://perma.cc/2VTQ-K3WU]. The jet stream, in turn, brings warm air to Europe, making the climate there milder than it otherwise would be.} individual weather events are still somewhat random in their appearance, duration, and intensity.\footnote{For illustrative purposes, suppose a state were to apply a “prior appropriation” system to atmospheric water. Determining which landowner has seniority over atmospheric water would be exceedingly difficult. If applied to each individual storm, landowners would be forced to rush to the border of their state in order to be the first property owner to appropriate water from a storm system forecast to pass over their land. This could be solved with a permitting system, however, that would still lead to a system in which landowners can overpower competing claims over atmospheric water simply by having been first in line when the permitting system was launched.} Additionally, climate change could have the effect of disrupting previously reliable weather patterns.\footnote{See, e.g., Climate Change Indicators: Weather and Climate, Env’t Prot. Agency, (July 26, 2023), https://www.epa.gov/climate-indicators/weather-climate [https://perma.cc/L3WK-K2MR] (“Rising global average temperature is associated with widespread changes in weather patterns.”).} However, even if existing laws governing surface and groundwater do not apply to atmospheric water by analogy, that does not mean landowners do not have a claim of ownership over atmospheric wa-
iii. Competing Sovereignty Claims

Whether or not private property owners can claim ownership over atmospheric water, state governments can claim sovereignty over atmospheric water over their borders. Mountain ranges, with their high elevations and year-round low temperatures, are ideal locations for cloud seeding projects. They also make excellent natural borders between states and countries. As such, a great deal of cloud seeding activity takes place along state lines, especially in mountainous western states. Under the current system, each state has an equal sovereignty claim to atmospheric water over their borders. For cloud seeding projects located firmly within the interior of a state, this is not an issue. However, in mountainous border regions, it is.

Although cloud seeding has not yet resulted in a sovereignty dispute between states, it is not difficult to imagine a scenario in which two or more states come into conflict over cloud seeding. As they have with surface and groundwater, neighboring states can form compacts with each other governing the appropriation of atmospheric water between them. Unfortunately, atmospheric water is of a fundamentally different character than surface or groundwater. Devising a system by which multiple states could reliably apportion and monitor their extraction of atmospheric water via cloud seeding would be exceedingly difficult, especially since there is currently no reliable way to measure how much precipitation cloud seeding produces.

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292. See supra note 231 and accompanying text.
293. Cloud seeding works well in supercooled air — air that is below freezing and contains lots of uncrystallized water droplets. French et al., supra note 38, at 1168–69. With their high elevation, not only are mountainous regions good locations to find supercooled clouds, but they are ideal locations to install ground-based silver iodide generators. See generally, Thomas O. Mazzetti et al., Potential for Ground-Based Glaciogenic Cloud Seeding Over Mountains in the Interior Western United States and Anticipated Changes in a Warmer Climate, 60 J. APPLIED METEOROLOGY & CLIMATOLOGY 1245, 1245–46 (2021).
294. For instance, in 2011, there were at least two active cloud seeding projects in operation in California along its border with Nevada. Simon, supra note 19, at 168 fig.1 (map showing the geographical locations of active cloud seeding projects in the state of California in 2011).
295. See supra note 231 and accompanying text (providing an overview of the states that have declared sovereignty over atmospheric water).
296. See Hertz, supra note 13, at 53 ("[W]ether modification effects have the potential to cross state lines . . . .").
297. Id.; Currier, supra note 15, at 963.
299. See id. at 964.
300. French et al., supra note 38, at 1168.
Just as neighboring states may come into conflict over weather modification programs, so too might states come into conflict with Native American Tribes, which are considered sovereign nations by the United States and “are entitled to certain water rights.” At the time of this writing, the right of Native American Tribes to either “maintain existing natural precipitation patterns,” or to engage in cloud seeding at a tribal level, has yet to be litigated.  

D. Disadvantages of State Based and Mixed Federalism Regulation Models

Two recent proposals for resolving the legal issues surrounding cloud seeding have sought to either expand the existing state-dominated framework with more robust state-level regulations or to convert to a mixed federalism model in which the federal government regulates cloud seeding and coordinates state-level cloud seeding efforts. Unfortunately, neither of these models adequately addresses the legal issues around cloud seeding. In her article It’s Raining, It’s Pouring, Weather Modification Regulation Is Snoring: A Proposal to Fill the Gap in Weather Modification Governance, legal scholar MacKenzie L. Hertz argues that state legislatures are most well equipped to address the issues present in current cloud seeding law. She addresses the issue of causation by proposing a burden shifting system based on the National Vaccine Injury Compensation Program (“NVICP”), under which the victims of weather modification related injuries would “enjoy a presumption of causation.”

Because there is currently no reliable way to determine how much precipitation cloud seeding produces, Hertz’s burden shifting framework creates a presumption that is impossible to rebut. Thus, while her proposal keeps causation from being a barrier to recovery for plaintiffs, it makes it a

303. Compare Hertz, supra note 13, at 44 (advocating for robust state based cloud seeding regulations), with Currier, supra note 15, at 950 (advocating for a mixed-federalism approach to weather modification governance).
304. Hertz, supra note 13, at 52–53.
305. Id. at 56–59.
306. See French et al., supra note 38, at 1168.
guarantee of liability for defendants. Similar to NVICP, which requires vaccine injury cases to be handled by a special master who is an expert in vaccine injury litigation, Hertz’s proposal requires each cloud seeding case to be handled by a special master who is an expert in cloud seeding litigation.307 However, medical malpractice is a well-established legal field with a large pool of experts who could serve as special masters, unlike weather modification law. Most notably, Hertz provides no mechanism for resolving conflicts between states or groups of states in weather modification compacts.308 Nor does Hertz address the issue of Tribal sovereignty.309

Instead of a state-dominated framework, Melissa Currier proposed a mixed federalism model for cloud seeding governance in her law review comment Rain, Rain, Don’t Go Away: Cloud Seeding Governance in the United States and A Proposal for Federal Regulation.310 Under this model, the federal government would develop national weather modification regulations that would apply to all fifty states and create an agency that would help coordinate state level cloud seeding efforts.311 While this model provides for uniformity and interstate cooperation, it largely leaves the issue of tort liability to the states and does not address the issues around proving causation or private ownership of atmospheric water.312 A complete federal takeover of weather modification fills in the holes that these alternative proposals leave uncovered.

307. Hertz, supra note 13, at 58.
308. Hertz argues that thus far, no states have come into conflict over cloud seeding and have the option of entering interstate compacts with each other. Id. at 53. While this is true, it does not account for the potential for future conflict, or conflict between two groups of states which have entered into separate compacts.
310. See generally Currier, supra note 15, at 950.
311. See id. at 950–51.
312. See id. at 966 (“If the federal government decided to preempt the area of weather modification, states should still have the ability to determine whether cloud seeders operating in their state are to be held strictly liable for their torts.”).
IV. PROPOSED SOLUTION: FEDERAL CONTROL OF WEATHER MODIFICATION

Individual states have been left to figure out how best to regulate cloud seeding within their borders, absent guidance from federal regulations, well-established common law principles specifically related to weather modification, or a widely accepted model code.\textsuperscript{313} The result is a patchwork system in which only a handful of states meaningfully regulate cloud seeding and even less actively engage in it.\textsuperscript{314} As climate change worsens, interest in cloud seeding and weather modification has increased.\textsuperscript{315} If this trend continues, the current system of cloud seeding governance is simply unsustainable. Disputes will inevitably arise between cloud seeders, governments, businesses, and individuals, leading to mountains of litigation with no guarantee that courts will be able to resolve the pressing legal issues facing cloud seeding effectively.\textsuperscript{316}

A. Main Components of a Federal Weather Modification Program

By bringing all weather modification efforts under federal control, including existing cloud seeding programs, the federal government can effectively sidestep nearly all of the legal issues present under the current legal framework.\textsuperscript{317} Congress can assert federal control over all weather modification efforts in the United States under the Commerce Clause,\textsuperscript{318} the

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{313} See discussion \textit{supra} Section II.B (examining the current weather modification legal landscape).
\item \textsuperscript{314} See discussion \textit{supra} Section II.B.ii (exploring state weather modification regulations).
\item \textsuperscript{315} See \textit{supra} note 103 and accompanying text.
\item \textsuperscript{316} Mountains of litigation does not necessarily mean dozens of individual lawsuits. In the case, \textit{Adams v. State}, No. 10112 (Cal. Super. Ct. April 6, 1964), it took six years to litigate — including five years of pleadings and discovery, twenty-six days of pretrial motions hearings, and a five-month long trial. \textit{Standler, supra} note 40, at 10–11. The court did not hand down its final decision until nine years after the deadly flood that sparked the litigation. See Mann, \textit{supra} note 164, at 690 (stating that the flood occurred in 1955 and that the lawsuit concluded in 1964, a difference of nine years).
\item \textsuperscript{317} See analysis \textit{supra} Section III (describing the legal issues present under current weather modification law).
\item \textsuperscript{318} The Commerce Clause allows Congress to regulate “commerce with foreign Nations, and among the several States, and with the Indian Tribes.” U.S. \textit{CONST.} art. I, § 8, cl. 3. Congress may regulate the channels of interstate commerce, including roads, waterways, and airspace, the instrumentalities of interstate commerce, including people and things in the free flow of commerce, and activities having a substantial relation to, or effect on, interstate commerce. United States v. Lopez, 514 U.S. 549, 558–59 (1995). Altering the weather undoubtedly has a substantial effect on interstate commerce, and cloud seeding directly alters the composition of the air, one of the channels of interstate commerce. See \textit{supra} note
\end{itemize}
\end{footnotesize}
General Welfare Clause,319 the Necessary and Proper Clause,320 and the Supremacy Clause.321 Therefore, Rather than simply applying uniform federal regulations to existing state-level cloud seeding efforts, the federal government should, through an act of Congress, absorb all existing cloud seeding programs into a single National Weather Modification Service (“NWMS”) within the Department of the Interior (“DOI”).322 Doing so would not only eliminate the potential of interstate conflicts over cloud seeding, but would also eliminate related to tort liability through sovereign immunity.

i. The DOI Takes Over U.S. Weather Modification Efforts

The DOI is well situated to administer a federal weather modification program as it currently manages the United States’ natural resources,
federal public lands and minerals, national parks, western water resources, 
and federal trust responsibilities to Native American Tribes and Alaskan 
natives.\textsuperscript{323} It also oversees multiple sub agencies, including the Bureau of 
Indian Affairs and the Bureau of Reclamation, which manage water and hy-
drologic power resources in all of the states west of the 100th Parallel.\textsuperscript{324} 
Thus, an assertion of federal control over weather modification would entail 
absorbing all weather modification activity in the United States into a single 
NWMS within the DOI.

The NWMS would be run by a committee modeled after the Weather 
("WMA").\textsuperscript{325} The WMA called for the creation of a Weather Mitigation 
Research Office authorized to "coordinate studies and provide grants to uni-
versities, state agencies, and nonprofit organizations to explore methods to 
reduce the impact of severe weather."\textsuperscript{326} However, unlike the WMA, the 
NWMS would be a fully funded agency that directly engages in cloud seed-
ning for the public benefit.

\textit{ii. An Assertion of Federal Sovereignty Over Atmospheric Water}

A federal claim of sovereignty over atmospheric moisture within U.S. 
airspace eliminates the possibility of interstate conflict over rainwater rights 
and helps to bolster an argument in court that cloud seeding does not con-
stitute a taking under the Fifth Amendment.\textsuperscript{327} The federal government has 
already asserted its sovereignty over U.S. airspace,\textsuperscript{328} which almost certainly

\begin{itemize}
\item \textsuperscript{323} Interior Department, U.S. FED. REG., https://www.federalregister.gov/agencies/in-
terior-department [https://perma.cc/B9PK-SUZT]; About Interior, U.S. DEP'T OF THE INTERIOR, 
https://www.doi.gov/about [https://perma.cc/9S4P-8YVW].
\item \textsuperscript{325} John D. Rockefeller, Committee on Commerce, Science, and Transportation, Weather 
\item \textsuperscript{326} Id. at 3. The Working Groups under the WMA have been comprised of two repre-
sentatives from states actively engaged in cloud seeding, two members from the National 
Center for Atmospheric Research within the National Science Foundation, one member each 
from NASA, the American Meteorological Society, the National Academy of Sciences, NOAA, 
and the Department of Agriculture, and one weather modification expert from a university 
or other higher education institution. Id. at 5. The NWMS administrative committee should 
be similarly structured. However, since states would no longer cloud seed after the creation 
of the NWMS, those seats should be reserved for representatives of states west of the 
Ninety-Eighth Parallel, who would hold them for two years on a rotating basis. See discussion 
supra note 8 (establishing the significance of the Ninety-Eighth Parallel).
\item \textsuperscript{327} See discussion supra Section II.B.iv.d.
\item \textsuperscript{328} 49 U.S.C. § 40103(a).
\end{itemize}
extends to atmospheric water. However, to avoid confusion, Congress should explicitly assert exclusive federal sovereignty over atmospheric water within U.S. airspace. Combined with the Supremacy Clause, a Congressional assertion of sovereignty over atmospheric water will supersede any claim that state or municipal governments may have to such resources.

Asserting federal sovereignty over atmospheric water would facilitate cooperation with Native American tribes on weather modification activities. Currently, the Bureau of Indian Affairs, a subagency within the DOI, “works with tribes and individual American Indians and Alaska Natives in the management of their trust lands, assets, and resources.” After asserting federal sovereignty over atmospheric water, the NWMS could coordinate with the Bureau of Indian Affairs to ensure its weather modification activities respect tribal sovereignty.

iii. Sovereign Immunity for Weather Modification

The creation of an NWMS solves most of the legal issues facing current weather modification governance through sovereign immunity. Under the FTCA, the federal government is not immune to suit for damages arising from any cloud seeding or weather modification activities it may conduct. However, Congress can easily amend the list of exceptions to the FTCA’s waiver of sovereign immunity to include activities related to weather modification and weather control. This, in turn, would render the issues related to proving causation or establishing the reasonable standard of care for cloud seeders completely moot.

Currently, state and local governments that wish to engage in cloud seeding often enter into contracts with private cloud seeding companies.

329. See United States v. Causby, 383 U.S. 256, 264 (1946) (describing airspace as akin to a public highway); 14 C.F.R. § 91.191(c) (2024). If the government can determine the floor of publicly navigable airspace without infringing on state sovereignty, it is likely the government can claim sovereignty over atmospheric water within public airspace.

330. U.S. CONST. art. VI, cl. 2.


332. See analysis supra Section III.C.iii (analyzing competing sovereignty claims over atmospheric water).

333. See discussion supra Section II.B.iv.d.


335. See discussion supra Sections III.A–B (analyzing causation and reasonable standard of care).

336. See, e.g., Simon, supra note 19, at 172 (“Most [cloud seeding] projects [in California], however, are sponsored by local public entities . . . which contract with private operators to run their cloud-seeding activities.”).
Replacing state and local governments with the federal government in this equation does nothing to address the issue of tort liability related to cloud seeding under the current FTCA framework. In such a scenario, private cloud seeding companies would be independent contractors working for the federal government, and thus potentially subject to personal liability for harms they may cause.

Congress can solve this problem in one of two ways: by banning private cloud seeding or by extending sovereign immunity to independent contractors engaged in weather modification projects for the federal government. By banning private cloud seeding and creating the NWMS, anyone engaged in cloud seeding in the United States would, by definition, have to be an employee of the federal government. As such, they would be immune from personal liability for any actions they take within the scope of their employment. Alternatively, pursuant to *Yearsley v. W.A. Ross Construction Co.*, Congress could ban all private cloud seeding unless conducted under contract with the NWMS and extend sovereign immunity to those contractors.

Whichever path Congress takes, it should also declare that engaging in cloud seeding without the authorization of the federal government constitutes negligence per se. Doing so eliminates the need for courts to determine the standard of care expected of cloud seeders, since the violation of

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337. See *supra* note 214 and accompanying text.
338. See *supra* note 213 and accompanying text (discussing immunity for contractors).
339. In this scenario, banning private weather modification would go hand in hand with creating a NWMS. Congress would authorize the DOI to initiate a Fifth Amendment taking of any weather modification equipment in the country to bring it under the direct ownership of the NWMS. See discussion *supra* Section d. The cost of such a taking would represent a small fraction of the overall federal budget, which was $6.8 trillion in 2021. *The Federal Budget in Fiscal Year 2021: An Infographic*, CONG. BUDGET OFF. (Sept. 20, 2022), https://www.cbo.gov/publication/58268 [https://perma.cc/A5SH-EXY8]. As of 2011, there were fourteen private weather modification companies operating in the United States. Hoospool, *supra* note 322. Globally, the entire cloud seeding industry was worth less than $125 million in 2021. *Allied Market Research, supra* note 322. Any academic weather modification research projects ongoing at the time of the ban on private weather modification would continue unimpeded — only the equipment used for research would change title.
340. See *Yearsley v. W.A. Ross Constr. Co.*, 390 U.S. 18, 20–21 (1940) (holding that sovereign immunity extends to independent contractors acting within the scope of validly conferred Congressional authority); see also discussion *supra* Section II.B.iv.d (analyzing sovereign immunity). Although both solutions are likely to result in litigation, litigation resulting from a ban on private cloud seeding would likely focus on the Fifth Amendment Taking, see discussion *supra* note 339, while litigation resulting from an extension of sovereign immunity to federal contractors engaged in cloud seeding would likely focus on sovereign immunity.
341. See discussion *supra* note 153 (examining negligence per se).
the statute itself would constitute a breach of duty.\textsuperscript{342} Congress should go further and implement a burden shifting framework for cases arising from cloud seeding conducted without the authorization of the NWMS, under which illegal cloud seeding creates a rebuttable presumption of causation. Doing so would effectively eliminate causation as a barrier to recovery for plaintiffs injured by weather modification efforts conducted in violation of federal law.\textsuperscript{343}

\textbf{iv. Congress Should Assert and Courts Should Hold That Private Claims to Atmospheric Water Are Subordinate to the Public Interest}

Congress and federal courts should follow the lead set by \textit{Pennsylvania Natural Weather Association v. Blue Ridge Weather Modification Association} and declare that any rights landowners have to atmospheric water is subordinate to the public interest.\textsuperscript{344} Doing so would recognize landowners’ rights to utilize the superadjacent airspace above their land,\textsuperscript{345} while recognizing the public’s obvious interest in maintaining the nation’s atmospheric water resources. Thus, government cloud seeding efforts would not constitute a Fifth Amendment taking unless they resulted in a flood that permanently prevented a landowner from using their land. Additionally, plaintiffs could sue illegal private cloud seeding operations for trespass, public nuisance, and private nuisance, with the protection of a rebuttable presumption of causation. Such an approach to atmospheric water rights is in sync with \textit{Causby}. Following California’s model, Congress should also declare that any precipitation caused by cloud seeding will be treated as though it were the result of natural forces once it hits the ground,\textsuperscript{346} so as not to disrupt

\begin{itemize}
  \item \textsuperscript{342} In a negligence per se action, the violation of the statute is analogous to the duty and breach elements of the negligence cause of action — the tortfeasor had a duty to comply with the statute and breached that duty by violating it. See discussion supra notes 153, 160 (discussing negligence and negligence per se). Thus, in a negligence per se action, there is no need to evaluate whether the tortfeasor acted as a reasonably prudent person under the circumstances. See discussion supra Section III.B.
  \item \textsuperscript{343} See discussion supra Section III.A.
  \item \textsuperscript{344} Pa. Nat. Weather Ass’n v. Blue Ridge Weather Modification Ass’n, 44 Pa. D. & C.2d 749, 763 (Pa. Ct. Com. Pl. 1968) (holding that atmospheric moisture is common property and that private landowners’ interest in rainwater is subject to public weather modification efforts).
  \item \textsuperscript{345} United States v. Causby, 328 U.S. 256, 266 (1946); see also supra Section II.B.iv.b (discussing \textit{Causby} and how property owners have a right to superadjacent airspace).
  \item \textsuperscript{346} See \textit{Cal. Water Code} § 401 (2023) (“[A]tmospheric water . . . which is caused to fall by weather [modification] shall, for the purpose of water rights determinations, be considered as if it occurred [naturally].”).
\end{itemize}
existing systems for managing surface and groundwater rights.\textsuperscript{347} That way, any surface or groundwater created as the result of cloud seeding would be subject to the same rights regime as all other surface and groundwater in any given state.\textsuperscript{348}

\textbf{v. Weather Modification Insurance and Federal Assistance for Weather Modification Injuries}

Although applying sovereign immunity to weather modification eliminates the issue of assigning tort liability for cloud seeding injuries, it does not eliminate the risks associated with cloud seeding. The federal government is fallible and there are still many unknowns when it comes to the effects of weather modification.\textsuperscript{349} Without the option of pursuing their claims in court, plaintiffs harmed by weather modification need an alternative means of being made whole. To solve this problem, Congress should take advantage of two tools at its disposal: its power to regulate insurance companies and its control over federal disaster relief funding.\textsuperscript{350}

Similar to the requirement that health insurance companies provide coverage to patients with preexisting conditions under the Affordable Care Act ("ACA"),\textsuperscript{351} Congress should require insurance companies to provide

\begin{itemize}
  \item \textsuperscript{347} See discussion \textit{supra} note 229 (differentiating between surface and groundwater rights).
  \item \textsuperscript{348} \textit{Id.}
  \item \textsuperscript{349} Although scientists are able to track silver iodide as it turns into precipitation, they are still a long way away from reliably measuring exactly how much precipitation cloud seeding produces every time someone engages in the practice. French et al., \textit{supra} note 38, at 1168. Even if cloud seeding on average only produces modest increases in precipitation, it is not hard to imagine a scenario where even a slight increase in rainfall means the difference between a reservoir overflowing or not.
  \item \textsuperscript{350} Congress’s power to regulate insurance companies derives from the Constitution’s Commerce Clause. U.S. Const. art. I, § 8, cl. 3; \textit{see also supra} notes 107–109 and accompanying text (analyzing Congress’s power to regulate weather modification pursuant to the Commerce Clause). Its power to control federal disaster relief funds derives from the Appropriations Clause. U.S. Const. art. I, § 9, cl. 7 ("No Money shall be drawn from the Treasury, but in Consequence of Appropriations made by Law. . . .").
  \item \textsuperscript{351} 42 U.S.C. § 300gg-3(a) provides that “[a] group health plan and a health insurance issuer offering group or individual health insurance coverage may not impose any preexisting condition exclusion with respect to such plan or coverage.” The ACA has withstood many constitutional challenges in court, most famously in \textit{National Federation of Independent Business v. Sebelius}, in which the Supreme Court upheld a provision requiring Americans to purchase health insurance or pay a yearly tax. 567 U.S. 519, 574 (2012) ("[T]he] requirement that certain individuals pay a financial penalty for not obtaining health insurance may reasonably be characterized as a tax. Because the Constitution permits such a tax, it is not our role to forbid it. . . ."). However, the constitutionality of § 300gg-3(a) itself has not been challenged and falls squarely within Congress’s Commerce Clause powers. U.S. Const. art. I, § 8, cl. 3; \textit{see}
\end{itemize}
coverage to any customers who reside in geographical areas covered by weather modification projects. As with the ACA, Congress should appropriate funds to subsidize weather-modification-related insurance claims and forbid insurance companies from charging more for policies within weather modification project zones.\textsuperscript{352}

In addition to these insurance related provisions, Congress should appropriate funds to the Federal Emergency Management Agency specifically to provide relief to those harmed by weather modification projects.\textsuperscript{353} These funds should be earmarked to compensate individuals who do not have insurance policies covering their property and to provide additional compensation for anyone whose injuries exceed their coverage limits. Since the existence of the NWMS will likely cause many people to blame all weather-related inconveniences on weather modification,\textsuperscript{354} these provisions will help create public trust and good will for the program.

B. Additional Provisions to Ensure Public Trust

Since the invention of cloud seeding, the primary obstacles standing in the way of robust federal weather modification policy have been political.\textsuperscript{355} After the Vietnam War, many Americans came to see any attempts by the government to alter the weather as sinister.\textsuperscript{356} Additionally, the difficulty of proving how much precipitation cloud seeding produces has provided perfect cover to politicians looking for ways to trim government spending.\textsuperscript{357}

To overcome these hurdles and ensure public trust in the idea of a federal weather modification program, any legislation that creates such a program must have the following components: (1) extensive funding for weather modification research, both to develop more effective weather

discussion supra notes 107–109 and accompanying text (analyzing Congress’s power to regulate weather modification).

352. Under the ACA, the federal government subsidizes health insurance policies for lower income individuals in the form of a tax credit. See 26 U.S.C. § 36B(a).

353. 42 U.S.C. §§ 5174, 5193 (2018) (authorizing the President to provide direct assistance to individuals and households harmed by a major disaster and limiting the total amount of federal funds appropriated for emergency assistance).

354. See, e.g., HARPER, supra note 46, at 113 (“No one had proof that [New York City’s 1950s cloud seeding program] changed the weather, and in its absence people would have grumbled about the inopportune rain or complained about the forecast, but cloud seeding led to the default assumption that it caused undesirable weather, wet or dry.”).

355. See discussion supra Section II.A.

356. See discussion supra Section II.A.iv (discussing the Vietnam War and public opinion on cloud seeding).

357. See supra note 102 and accompanying text; Simon, supra note 19, at 163.
modification tools and to be able to accurately measure the effectiveness of cloud seeding and other weather modification techniques; (2) funding for an ongoing educational campaign designed to inform the public about weather modification, cloud seeding, and its effects; (3) a commitment to transparency, including notice and reporting requirements and unlimited public access to all NWMS weather modification data;\(^3\) (4) opportunities for the public to voice their concerns with new or ongoing weather modification projects to committee members by way of regular public hearings in effected areas; and (5) a mechanism by which the public can petition the NMWS to start or terminate specific weather modification projects.

V. CONCLUSION

For nearly all of recorded history, humans have tried to assert their will over the weather. In 1946, Vincent J. Schaefer loaded a bucket of dry ice onto an airplane and made that dream a reality. Unfortunately, the government’s initial enthusiasm for Schaefer’s invention soon gave way to military and political concerns, leaving the United States without any federal weather modification policy for over seven decades. A handful of states have sought to fill the gap but have been unable to resolve many the legal issues that cloud seeding presents. With climate change worsening, tens of millions of people in the American Southwest, who have already experienced the region’s worst megadrought in over a millennium, face an uncertain future. It is therefore imperative that the United States use every tool at its disposal to maximize its water supplies. That is why the federal government should absorb all weather modification efforts under a single agency within the DOI. Doing so not only eliminates all of the legal issues that have plagued cloud seeding and weather modification for decades but ensures that America utilizes its atmospheric water resources for maximum public benefit.

\(^3\) Under the WMPA, cloud seeders are already required to report the dates, methods, purpose, and geographical region of their activities to the DOC, and the Secretary of Commerce is required to publish periodic summaries of these reports. 15 C.F.R. § 908.4 (2022); id. § 908.12; id. § 330b; see also discussion supra Section II.B.i. Under the new scheme, the public would have direct access to this data through monthly or quarterly reports produced by the NWMS, as well as on NWMS’s website.