

Rain on Demand: Regulating Weather Modification Throughout the United States

Adriana Vélez-León*

During a severe drought period that lasted approximately five months in 2015, Puerto Ricans endured seventy-two consecutive hours with water cutoffs, intensified forest fires, and a decline in agriculture production that elevated losses to thirteen million dollars.¹ The Puerto Rican government set up water trucks throughout the island that served as an “oasis” in moments where water was shut off.² In times where there were no water trucks in sight, Puerto Ricans resorted to the water in toilet tanks to clean their hands, children took bucket baths, and, in restaurants, plastic cups replaced glass ones.³

In August 2015, the U.S. Drought Monitor⁴ reported that thirty-four of seventy-eight municipalities in Puerto Rico were experiencing extreme drought.⁵ As a result, Puerto Rico’s Aqueduct and Sewer Authority was forced to implement a strict water-rationing plan that commenced in March 2015, and cost the public agency close to twelve million dollars per month.⁶ For approximately 340,000 households and

businesses on the island, about 28% of the island’s total, water was turned off for seventy-two hours and then back on for only twenty-four hours, while others were going without water in forty-eight hour cycles, sending people into desperation and a frenzy of water collection.⁷ Weather modification was the last shot at rain amidst a dire situation in Puerto Rico where water was scarce and with no signs of improvement.

As a result of what has been labeled as one of the worst, if not the worst, drought in Puerto Rico’s history, in July 2015 the Aqueduct and Sewer Authority entered into a three-month contract with Seeding Operations & Atmospheric Research in hopes of creating rain clouds over three of the island’s main water reservoirs.⁸ By the end of the contract, on October 31st, 2015, the water-rationing plan in Puerto Rico ceased and certain rain events, which brought approximately one foot of rainfall, were attributed to the weather modification operations that took place in the island.⁹

As temperatures rise and precipitation decreases, the environmental effects of climate change threaten freshwater supplies across the United States and, as a consequence, droughts are intensified, exemplified by the extreme situations in Puerto Rico and California.¹⁰ Internationally, the United Nations predicts that by 2025, 1.8 billion people will be living in countries with absolute water scarcity,¹¹ and two-

* *Adriana Vélez-León is a 2017 J.D. Candidate at The George Washington University Law School. She received her B.A. in Journalism from the University of Puerto Rico, Río Piedras campus, and is Senior Articles Editor of the George Washington Journal of Energy & Environmental Law. The author would like to thank her family and friends for their constant love and support. She would also like to thank Professor Andrew Satten and Lauren Schaedig for their insight and guidance throughout the Note writing process.*

1. Agencia EFE, *Advierten la Sequía que Afecta a Puerto Rico Puede Ser la Peor de la Historia*, PRIMERA HORA (June 6, 2015, 7:35 PM), <http://www.primerahora.com/noticias/puerto-rico/nota/adviertenlasequiaqueafectaapuertoricopuede-ser-lapeordelahistoria-1089443/>.
2. Lizette Alvarez, *Water Crisis Brings Out Puerto Rico’s Creative Side*, N.Y. TIMES, July 14, 2015, http://www.nytimes.com/2015/07/15/us/in-drought-puerto-rico-rations-water-setting-off-a-collection-frenzy.html?_r=0.
3. *Id.*; see also Chris Bury, *How Puerto Rico Is Coping With the Worst Drought in Decades*, PBS NEWSHOUR (Dec. 29, 2015, 6:30 PM), <http://www.pbs.org/newshour/bb/how-puerto-rico-is-coping-with-the-worst-drought-in-decades/>.
4. The U.S. Drought Monitor is produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. U.S. Drought Monitor, NAT’L DROUGHT MITIGATION CTR., <http://droughtmonitor.unl.edu> (last visited Apr. 2, 2016).
5. Alvarez, *supra* note 2.
6. Maricarmen Rivera, *Vuelve la Siembra de Nubes*, EL VOCERO DE P.R. (Sept. 11, 2015, 4:00 AM), <http://elvocero.com/vuelve-la-siembra-de-nubes/>.

7. Agencia EFE, *supra* note 1.
8. Rivera, *supra* note 6.
9. Harry Rodríguez, *Exitosa Siembra de Nubes en PR*, METRO (Oct. 21, 2015), <http://www.metro.pr/noticias/exitosa-siembra-de-nubes-en-pr/pGxOjuivr4wpWBDRJ9q2/>.
10. Justin Gillis, *California Drought Is Made Worse by Global Warming*, *Scientists Say*, N.Y. TIMES, Aug. 20, 2015, <http://www.nytimes.com/2015/08/21/science/climate-change-intensifies-california-drought-scientists-say.html>.
11. *Water Scarcity Factsheet*, UN-WATER 2014 (May 17, 2013), <http://www.unwater.org/publications/publications-detail/en/c/204294>. The United Nations defines water scarcity as “[t]he point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully.” *International Decade for Action “Water for Life” 2005–2015: Water Scarcity*, UNITED NATIONS, <http://www.un.org/waterforlifedecade/scarcity.shtml> (last updated Nov. 24, 2014). The United Nations further explains that “[w]ater scarcity is a relative concept and can occur at any level of supply or demand[.]” and that “[s]carcity may be a social construct . . . or the consequence of altered supply patterns—stemming from climate change for example.” *Id.*

thirds of the world population could live under water stress conditions.¹² Given this disturbing background, weather modification activities are gaining momentum because of the technology's ability to artificially create rainfall through cloud seeding. Weather modification may be a crucial key in staving off a possible freshwater shortage crisis.

Although weather modification technology has existed for approximately seventy years in the United States,¹³ both state and federal governments' involvement in its regulation has been limited.¹⁴ Most legal control of cloud seeding, if any, in the United States has been carried out at local and state levels. Nevertheless, one of the biggest problems with state regulation of weather modification is that, since weather recognizes no political or territorial boundaries, the effects of weather modification are commonly interstate and, therefore, result in conflicting, varied, and weak state regulations.

Given the interstate effects, discussed *infra* Part III.A, that arise from weather modification activities and the value of water as a commodity, Congress, by the powers vested in it under the Commerce Clause, should enact the National Weather Modification Control Act, a law that will establish comprehensive federal regulation of weather modification activities. This Act will serve to regulate the weather modification field and establish federal standards that the states shall comply with under a program of cooperative federalism.

In advancing this proposal, by way of background, Part I will briefly review what weather modification is, how it functions, and its different benefits. Furthermore, this part will explain some concerns that surround weather modification activities. Part II will focus on the legal development of weather modification in the United States and will address the lack of federal regulation in this field. This part will also detail the different and weak weather modification regulations across the states. Ultimately, this part will broadly illustrate the serious flaws that make current state regulations ineffective to lay the foundation for the argument that the regulatory system of weather modification should no longer be left to the discretion of the states, but should be vested in the federal government. Part III analyzes why weather modification should be regulated on a federal level to minimize the possibility of adverse effects from cloud seeding activities and to avoid interstate legal issues. Part IV will introduce and explain the proposed solution, the National Weather Modifi-

cation Control Act. Furthermore, this part will identify and analyze any challenges and obstacles the proposed Act might confront, highlighting legal obstacles.

I. Overview of Weather Modification, Its Benefits, and Concerns

Weather modification is a complex technology that is not yet well understood by many. The basics of weather modification and its different uses are discussed below. Although a convoluted technology, weather modification provides many different benefits, such as storm suppression and rain augmentation. Nevertheless, as explained further below, this technology is a cause for concern among those who believe weather modification can be used in the future as a new kind of powerful weapon.

A. The Basics of Weather Modification

Despite almost seventy years of use,¹⁵ weather modification is one of the least understood environmental practices currently taking place. Weather modification is a form of atmospheric environmental alteration based on the theory that the introduction of correct amounts of particular "seeding agents" into some types of clouds will alter the precipitation formation process.¹⁶ Specifically, according to a report by the National Science Foundation, weather modification "is taken to mean artificially produced changes in the composition, motion, or dynamics of the atmosphere, whether or not such changes may be predictable, their production deliberate or inadvertent, or their duration transient or permanent."¹⁷

Currently, most weather modification projects are used to either enhance or stop precipitation, or to suppress hail.¹⁸ Other forms of modification include lightning suppression, hurricane diversion, and fog dissipation.¹⁹ The usual technique involved in these types of weather modification projects consist of "seeding clouds" with silver iodide, either by dropping it from planes or launching it from a station on the ground, in order to serve as nuclei around which cloud droplets might form ice crystals.²⁰ These nuclei help the cloud produce precipitation by freezing supercooled liquid water,

12. Water stress refers to "[t]he ability, or lack thereof, to meet human and ecological demand for water. Compared to scarcity, water stress is a more inclusive and broader concept. It considers several physical aspects related to water resources, including water scarcity, but also water quality, environmental flows, and the accessibility of water." Peter Schulte, *Defining Water Scarcity, Water Stress, and Water Risk: It's Not Just Semantics*, PACIFIC INST. (Feb. 4, 2014), <http://pacinst.org/water-definitions/>.

13. James N. Corbridge, Jr. & Raphael J. Moses, *Weather Modification: Law and Administration*, 8 NAT. RESOURCES J. 207, 209–10 (1968).

14. *See id.* at 217–19.

15. In 1946, General Electric had its scientists inject dry ice into a cloud in what is known as the earliest, if not the first, attempt at manipulating the clouds. Corbridge & Moses, *supra* note 13, at 209.

16. Ray J. Davis, *Weather Modification Law Developments*, 27 OKLA. L. REV. 409, 409 (1974) [hereinafter *Weather Modification Law Developments*]; *see also* Ray J. Davis, *Weather Modification Interstate Legal Issues*, 15 IDAHO L. REV. 555, 555 (1978–1979) [hereinafter *Weather Modification Interstate Legal Issues*].

17. SPECIAL COMM'N ON WEATHER MODIFICATION, WEATHER & CLIMATE MODIFICATION 7 (1965), <https://www.nsf.gov/nsb/publications/1965/nsb1265.pdf>.

18. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.

19. Guive Mirfendereski, *An International Law of Weather Modification*, 2 FLETCHER F. 41, 42 (1978).

20. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555; *see also* W. WATER STATES COUNCIL, *WATER LAWS & POLICIES FOR A SUSTAINABLE FUTURE: A W. STATES' PERSPECTIVE* vii (2008); ZEY LEVIN, *ON THE STATE OF CLOUD*

which are cloud droplets still in liquid form at temperatures colder than thirty-two degrees Fahrenheit.²¹ Often, natural ice nuclei are “[i]nefficient or lacking in sufficient numbers in the atmosphere.”²² Thus, adding more efficient silver iodide nuclei through cloud seeding can increase precipitation production of the cloud.²³ The aim of cloud seeding is to ultimately control both the type and quantity of these ice nuclei in clouds in order to release, or stop precipitation.²⁴

The weather modification process is not as simple as it may seem. It is important to point out that cloud seeding will operate only within *existing* clouds.²⁵ Clouds must already be in the atmosphere in order for any cloud seeding to be done. Weather modification does not “create weather;” rather, it takes existing weather and alters it.²⁶ Therefore, planning ahead of time, and before a serious drought scenario, will be imperative for any potentially successful cloud seeding operation. Moreover, not all clouds are good candidates for cloud seeding. To be successfully seeded, clouds must possess a sustained updraft of moist air, a lack of natural ice, and be significantly cold enough to contain supercooled liquid water.²⁷

Furthermore, cloud seeders must insert an appropriate amount of material into the right sort of cloud, and they must do so at the correct time and place in order to obtain desirable results.²⁸ For example, in order to effectively produce precipitation through cloud seeding, each liter of air needs only one artificial ice nucleus.²⁹ If a cloud is overseeded it becomes glaciated, or made mostly of ice crystals, leaving few supercooled water droplets in the cloud.³⁰ As a result, ice crystals are not able to grow in the cloud and, thus, evaporate dissipating the cloud.³¹ Despite the complexity of this science, different groups of weather modifiers are able to successfully conduct weather modification activities.

Most cloud seeding projects are conducted by a handful of highly specialized commercial firms working under contract for a variety of sponsors.³² The usual sponsors include municipalities, hydroelectric utilities, and agricultural organizations.³³ Municipalities are mostly interested in weather modification projects because of its ability to increase water supplies.³⁴ On the other hand, hydroelec-

tric utilities can generate additional hydroelectric power³⁵ from augmented runoff, which flows into reservoirs, or from enhanced flows in rivers, which have hydroelectric generation facilities.³⁶ Finally, agricultural organizations desire “additional runoff for irrigated agriculture or direct precipitation on crop or range lands during the growing season.”³⁷ Weather modification has provided a variety of benefits to all interested sponsors.

B. Benefits of Weather Modification

The scientific community and private commercial operators have long recognized the advantages of successful weather modification.³⁸ Although weather modification activities are mostly recognized by their rain-augmenting benefits, this science has also proven valuable for numerous other reasons, such as storm suppression. Since weather events can have severe adverse effects on property and economic activity, the gross benefits of successful weather modification activities are, in comparison, very high.³⁹

Although difficult to measure exactly, the operational costs of weather modification activities are small relative to its gross benefits.⁴⁰ For example, “annual losses due to drought are approximately eight billion dollars, which is a higher estimate than for any other natural hazard.”⁴¹ On the other hand, “the cost of a project depends upon the target area size, season and topography, types of seeding to be conducted, needed equipment and personnel, and the length of the desired project period.”⁴² The state of Wyoming conducted the Wyoming Weather Modification Pilot Program (“WWMPP”), from 2005 to 2014, to assess the feasibility of increasing the state’s water supplies through winter cloud seeding.⁴³ At the culmination of the program, based on a potential increase in precipitation from seeded storms of 5-15%, the evidence from statistical, physical, and modeling analysis suggested that cloud seeding was a viable technology to augment existing water supplies in Wyoming.⁴⁴ The estimated annual costs per winter season for a purely operational

SEEDING FOR RAIN ENHANCEMENT 2 (Cypress Inst., 2009), http://www.cyi.ac.cy/system/files/Report_EEWRC_omformat.pdf.

21. *Common Questions and Answers About Cloud Seeding*, N.D. ATMOSPHERIC RES. BD., http://www.swc.state.nd.us/arb/ndcmp/pdfs/q_a.pdf (last visited Apr. 2, 2016).

22. *Id.*

23. *Id.*

24. Virginia Simms, *Making the Rain: Cloud Seeding, the Imminent Freshwater Crisis, and International Law*, 44 INT’L LAW. 915, 918 (2010).

25. BARRY B. COBLE, BENIGN WEATHER MODIFICATION 12 (June 1996); see also Simms, *supra* note 24, at 919.

26. COBLE, *supra* note 25, at 22.

27. *Common Questions and Answers About Cloud Seeding*, *supra* note 21.

28. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.

29. COBLE, *supra* note 25, at 12.

30. *Id.*

31. *Id.*

32. *Frequently Asked Questions (FAQs) Concerning Cloud Seeding Activities Designed to Increase Precipitation*, WEATHER MODIFICATION ASS’N, <http://www.weathermodification.org/faq.php> (last visited Apr. 2, 2016).

33. *Id.*

34. *Id.*

35. Hydroelectric power or hydropower is “using water to power machinery or make electricity.” *How Hydropower Works*, U.S. DEP’T ENERGY: OFF. ENERGY EFFICIENCY & RENEWABLE ENERGY, <http://energy.gov/eere/water/how-hydropower-works> (last visited Apr. 2, 2016).

36. *FAQs Concerning Cloud Seeding Activities Designed to Increase Precipitation*, *supra* note 32.

37. *Id.*

38. See Corbridge & Moses, *supra* note 13, at 208.

39. See Steven T. Sonka, *Economics of Weather Modification: A Review*, 89 ILL. INST. NAT. RESOURCES REP. INVESTIGATION 51 (1979), <http://www.isws.illinois.edu/pubdoc/ri/iswsri-89.pdf>.

40. *See id.*

41. *The Weather Modification Research and Technology Transfer Authorization Act of 2005: Hearing on S. 517 Before the Subcomm. on Sci. & Space & the Subcomm. on Disaster Prevention & Prediction of the S. Comm. on Commerce, Sci., & Transp.*, 109th Cong. 28 (2005) (statement of E. Benjamin Nelson, Sen. from Neb.) [hereinafter *Weather Modification and S. 517*].

42. *Information Resources: Frequently Asked Questions*, WEATHER MODIFICATION INCORPORATED, <http://www.weathermodification.com/resources.php> (last visited Sept. 25, 2016).

43. *The Wyoming Weather Modification Pilot Program: Level II Study*, WYO. WATER DEV. COMMISSION (Dec. 2014), <http://wwdc.state.wy.us/weathermod/WYWeatherModPilotProgramExecSummary.html>.

44. *Id.*

program using remotely controlled ground based generators ranged from \$375,500 to \$526,400.⁴⁵ Thus, the investment in cloud seeding operations, such as the WWMPP, is relatively low when considering benefit-to-cost ratios. For the purposes of this Note, I will discuss the benefits and advantages of precipitation augmentation and hurricane diversion, although my proposed solution will impact all weather modification activities.

I. Benefits of Precipitation Augmentation

Weather modification activities are mostly recognized by the benefits cloud seeding may provide to avert drought.⁴⁶ Economic studies show that precipitation augmentation has the greatest potential economic impact compared to other weather modification activities.⁴⁷ And as these studies have shown, “precipitation augmentation through cloud seeding has enormous potential to help us moderate the adverse . . . economic costs of wide fluctuations in weather and climate.”⁴⁸ Droughts in the United States cause average annual economic losses between six and eight billion dollars.⁴⁹ Weather modification projects help exponentially reduce these losses.⁵⁰

Cloud seeding studies show an increase in rainfall which results in an increase in both free-flowing and stored water supplies.⁵¹ Thus, since only 5-15% of available moisture in clouds naturally reaches the ground as precipitation, rain-augmenting operations could increase U.S. water supplies significantly.⁵² For example, during 2009 and with a \$155,000 budget, the Desert Research Institute (“DRI”) in Nevada, considered leaders in both research and practice of cloud seeding, seeded at Lake Tahoe.⁵³ DRI seeded fifty-six weather events with an estimated increase of about 20,000 acre-feet of snow water or nearly 6.6 billion gallons of water.⁵⁴ From 1997 through 2010, DRI “[h]as augmented snow water an average of about 18,000 acre-feet for the Tahoe-Truckee region.”⁵⁵ This snow water increase is enough to supply approximately 40,000 households with water annually.⁵⁶ From the results of these studies, it is clear that precipitation augmentation is a viable method of addressing drought problems in the United States.

2. Storm Control Through Weather Modification

Experiments have shown that weather modification activities may be useful to reduce the destructive impacts of severe storms, such as hurricanes or tornadoes.⁵⁷ In 1961, the National Oceanic and Atmospheric Administration (“NOAA”), along with the Department of Defense and the National Science Foundation seeded Hurricane Esther with silver iodide in an experiment called Project Stormfury, reducing its wind force by 10%.⁵⁸ Approximately eight years later, on August 18, 1969, NOAA once again attempted to weaken a hurricane’s wind force by cloud seeding Hurricane Debbie with silver iodide five times during an eight-hour period.⁵⁹ As a result, winds decreased by 31% between the first seeding and five hours after the fifth seeding.⁶⁰ Nevertheless, the storm re-intensified the following day.⁶¹ On August 20, 1969, once again NOAA seeded Hurricane Debbie, which resulted in a wind speed drop of 15%.⁶² Notwithstanding this ability to weaken hurricanes, the federal government terminated Project Stormfury in 1982 “because NOAA and the Department of Defense could not maintain an operating relationship.”⁶³

Storm suppression through cloud seeding results not only in hurricanes’ wind speed drop, but also in economic benefits. Annually, hurricanes cause substantial financial loss through physical damage and the high cost of precautionary measures.⁶⁴ For example, according to the National Climatic Data Center, damages from Hurricane Katrina in 2005 were estimated at approximately \$105.8 billion in 2010 dollars.⁶⁵ Therefore, suppressing storms and diminishing the level of maximum sustained winds would seem to strongly reduce the detrimental characteristics of the hurricane event and, consequently, lower financial losses that result from hurricanes’ damages.

Although weather modification activities seem to provide a wide range of benefits in different areas, such as storm suppression and freshwater increase, there is skepticism around what some believe could be a powerful technology used as a new kind of weapon.

C. Concerns About Weather Modification

Weather modification is a widely unknown and powerful technology and, as such, has been a cause for concern among those that speculate that it can have health and national security repercussions. Skeptics have voiced concerns regarding weather modification’s use as a new kind of weapon. In the

45. *Id.*

46. Lance D. Wood, *The Status of Weather Modification Activities Under United States and International Law*, 10 NAT. RESOURCES LAW. 367, 373 (1977).

47. See ARNETT S. DENNIS, *WEATHER MODIFICATION BY CLOUD SEEDING* 228 (Acad. Press, 1980).

48. See COMM. ON CLIMATE UNCERTAINTY AND WATER RES. MANAGEMENT ET AL., *MANAGING WATER RESOURCES IN THE WEST UNDER CONDITIONS OF CLIMATE UNCERTAINTY: A PROCEEDINGS* 301 (Nat’l Acad. Press, 1991).

49. Weather Mitigation Research and Development Policy Authorization Act of 2009, S. 601, 111th Cong. (1st Sess. 2009) [hereinafter *Weather Act of 2009*].

50. During the 1980s, “[t]he suppression of hail in the United States alone offers a potential saving of roughly \$500,000,000 per year.” DENNIS, *supra* note 47, at 228; see also *Weather Act of 2009*, *supra* note 49.

51. See *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.

52. U.S. S. SELECT COMM. ON NAT’L WATER RESOURCES, 86th Cong., *WATER RESOURCES ACTIVITIES IN THE U.S.: EVAPO-TRANSPIRATION REDUCTION* (Comm. Print 1960).

53. *DRI Receives Funding to Continue Cloud Seeding Program for 2011*, DESERT RES. INST. (Oct. 20, 2010), <http://www.dri.edu/newsroom/news-releases/3404-dri-receives-funding-to-continue-cloud-seeding-program-for-2011-season>.

54. *Id.*

55. *Id.*

56. *Id.*

57. Wood, *supra* note 46, at 370.

58. *See id.*

59. Ray J. Davis, *State Regulation of Weather Modification*, 12 ARIZ. L. REV. 35, 37 (1970) [hereinafter *State Regulation of Weather Modification*]; see also Wood, *supra* note 46, at 370.

60. *State Regulation of Weather Modification*, *supra* note 59, at 37.

61. *Id.* at 37–38.

62. *Id.* at 38.

63. Wood, *supra* note 46, at 388.

64. See Eric S. Blake et al., *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones From 1851 to 2010 (And Other Frequently Requested Hurricane Facts)*, NAT’L OCEANIC & ATMOSPHERIC ADMIN.: NAT’L HURRICANE CTR. (Aug. 2011), <http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf>.

65. *Id.* at 11.

1990s, the U.S. Air Force commissioned a report on weather modification, which concluded that “[o]ver the course of the next century, the weather will be our most powerful weapon. Weather modification can provide battle space dominance to a degree never before imagined.”⁶⁶

One potential use of weather modification as a weapon is an “unmanned stealth aircraft that could seed clouds above massing troops” in order to “produce localized flooding and create mud, which has been the bane of all of history’s armies.”⁶⁷ For example, from 1966 through 1972, the U.S. military began Project Popeye, a cloud seeding operation designed to flood supply routes used by the North Vietnamese into South Vietnam.⁶⁸ However, in 1977 the U.N. General Assembly, in the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, formally banned using weather modification as a military tool.⁶⁹ President Carter ratified the Convention on December 13, 1979 and it entered into force for the United States on January 17, 1980.⁷⁰

On the other hand, although opposing views exist regarding the danger of cloud seeding operations, some studies indicate, “silver iodide is toxic and can produce harm when used in sufficient quantities and concentrations.”⁷¹ Specifically, environmentalists have voiced concerns about the possible dangerous consequences of injecting silver iodide into clouds since the chemical may break down and add concentrations of silver to the environment.⁷² According to research scientists at the U.S. Geological Survey in Menlo Park, California, “silver is a powerful environmental toxin.”⁷³ Silver has the ability to kill microorganisms “indiscriminately and can wipe out the beneficial ones as well as the pathogenic ones.”⁷⁴ Furthermore, the toxin has a direct effect on the reproduction of certain aquatic invertebrates and fish.⁷⁵

Regarding health hazards to humans, the Environmental Protection Agency (“EPA”) has classified silver as a nuisance chemical, or secondary contaminant, in drinking water.⁷⁶

The EPA states that in concentrations of 0.1 milligrams of substance per liter of water, silver ingestion can cause skin discoloration and a graying of the white part of the eye.⁷⁷

The potential of using weather modification technology as a weapon and its health and environmental dangers adds to the urgency that the federal government should regulate and have centralized control over all weather modification activities in the United States. This way, the U.S. can reap the benefits of this technology while still controlling its use and minimizing any concern of danger.

II. Legal Development of Weather Modification in the United States

A. Weather Modification’s Legal Background

As a result of the first scientifically controlled effort generally recognized as constituting weather modification in 1946, the federal government organized several projects aimed at more thorough research and investigation of weather modification.⁷⁸ Between 1947 and 1952, extensive government-funded tests demonstrated the possibility on a field scale of modifying supercooled clouds to both increase and retard precipitation.⁷⁹

Consequently, legislative models started emerging during what is known as weather modification’s “second phase.”⁸⁰ The Advisory Committee on Weather Control was established, with a fixed duration of five years, by act of Congress on August 13, 1953.⁸¹ The Advisory Committee’s responsibilities dealt primarily with the “evaluation of public and private experiments in weather control for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate activities designed to control weather conditions.”⁸² Subsequent to the statutory termination of the Advisory Committee on Weather Control in 1958, Congress directed the National Science Foundation (“NSF”) to investigate the field of weather modification and passed Public Law 85-510, which designated the NSF as the agency in charge of receiving reports on cloud seeding activities.⁸³ While there was no federal regulatory or operation program established, Congress provided appropriations

66. Simms, *supra* note 24, at 935.

67. *Id.*

68. *Id.*; see also COBLE, *supra* note 25, at 4.

69. Article I of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques sets forth the basic commitment: “Each State Party to this Convention undertakes not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party.” Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques art. 1, *opened for signature* May 18, 1977, 31 U.S.T. 333.

70. *Id.*

71. See Ray J. Davis, *Black Clouds and Silver Iodide: Public Safety and Weather Modification Law*, 23 J. WEATHER MODIFICATION 63 (1991) [hereinafter *Black Clouds and Silver Iodide*]. But see Samantha Young, *Governments Turn to Cloud Seeding to Fight Drought*, U.S. NEWS (Dec. 11, 2009), <http://www.usnews.com/science/articles/2009/12/11/governments-turn-to-cloud-seeding-to-fight-drought> (stating that a study published in 2009 by the Weather Modification Association in the United States revealed that no “environmentally harmful effects” from silver iodide were shown).

72. Simms, *supra* note 24, at 921.

73. Robin Marantz Henig, *Our Silver-Coated Future*, 29 ONEARTH 1, Sept. 1, 2007.

74. *Id.*

75. *Id.*

76. EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for fifteen secondary contaminants.

EPA does not enforce these “secondary maximum contaminant levels.” The standards established only act as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. *Secondary Drinking Water Standards: Guidance for Nuisance Chemicals*, U.S. ENVTL. PROTECTION AGENCY, <https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance- nuisance-chemicals#what-are-secondary> (last visited Apr. 2, 2016).

77. *Id.*

78. See Corbridge & Moses, *supra* note 13, at 210.

79. *Id.*

80. Corbridge & Moses, *supra* note 13, at 210; see also Ray J. Davis, *Four Decades of American Weather Modification Law*, 19 J. WEATHER MODIFICATION 102, 103 (1987) [hereinafter *Four Decades of American Weather Modification Law*].

81. Jack C. Oppenheimer, *The Legal Aspects of Weather*, 1958 INS. L.J. 314, 315 (1958).

82. Pub. L. No. 83-256, § 3, 67 Stat. 559, 559 (1953).

83. Corbridge & Moses, *supra* note 13, at 211; see also *Four Decades of American Weather Modification Law*, *supra* note 80, at 103.

for research⁸⁴ while the states took a leading role as weather modification regulators. States, especially those in arid settings, began to enact weather control regulations.⁸⁵

The “golden years” of weather modification took place during the 1970s when governmental interest and legal development of weather modification technology reached their peak.⁸⁶ On December 18, 1971, Congress enacted 15 U.S.C. § 330 providing for the reporting of weather modification activities to the Secretary of Commerce, who was responsible for the maintenance and publication of such reports.⁸⁷ Currently, NOAA implements the Act.⁸⁸ This is the only act to date that is still in force regarding federal weather modification requirements.

The promise of the “golden years” dwindled later during the 1980s.⁸⁹ Governmental cloud seeding financial support withered mostly because of budget cuts in this particular field.⁹⁰ Congressional weather modification research and funding declined, as did the enactment of states’ weather modification laws.⁹¹

Although cloud seeding regulation seemingly slowed down, weather modification activities have not ceased. Currently, the number of private and state-funded weather modification projects has jumped by nearly a third during the last decade and a half.⁹² The numbers regarding cloud seeding operations continue to rise: sixty-one projects in nine states were reported in 2010, thirteen more than in 1998.⁹³ Nevertheless, the only type of federal control all these operations are submitted to is the requirements of 15 U.S.C. § 330. The broad and ambiguous requirements of the Act, which may take place even after the weather modification operation has culminated,⁹⁴ do not provide the type of regulation required to address the effects of weather modification activities in the United States.

B. Lack of Federal Weather Modification Regulation

Given the present failure of states to actively regulate weather modification activities, one might anticipate that legislators at the federal level would have filled this regulatory void given that this is an interstate activity. Nevertheless, up to the present, “Congress and federal agencies have been primar-

ily concerned with investigating and coordinating weather modification, rather than with regulating it.”⁹⁵

1. Weather Modification Activities Federal Reporting Requirement

As previously mentioned, the only federal regulation of weather modification is 15 U.S.C. § 330, which imposes a mere reporting obligation of weather modification activities with a maximum \$10,000 fine for those who knowingly and willfully violate this requirement.⁹⁶ The Act provides that all weather modification activities are subject to initial recording and submission of reports⁹⁷ to the NOAA.⁹⁸ However, the Secretary of Commerce may require that said reports be submitted to him before, during, or after any weather modification activity or attempt.⁹⁹ Moreover, after the Secretary has received initial notification of a planned weather modification activity, he may waive some of the subsequent reporting requirements.¹⁰⁰

Activities of federal agencies and their contractors, employees, or agents, however, are exempted from the reporting requirements of the Act.¹⁰¹ The Act applies only to an “individual, a corporation, company, association, firm, partnership, society, joint stock company, any State or local government or any agency thereof, or any other organization, whether commercial or nonprofit.”¹⁰²

Although this Act can be seen as an initial step towards federal regulation of weather modification, it falls short of providing the governmental machinery for coordination and regulation of weather modification activities. It provides no standards, requirements or guidelines for coordination and planning, or regulation and licensing of weather modification activities.¹⁰³

2. Weather Modification Regulation on Federally Designated Wilderness Areas

Aside from 15 U.S.C. § 330, federal regulation of weather modification exists only on federally designated wilderness area.¹⁰⁴ The U.S. Forest Services (“USFS”) and Bureau of

84. By the late 1970s, annual federal funding for cloud seeding projects reached \$20 million. Simms, *supra* note 24, at 927.

85. See *Four Decades of American Weather Modification Law*, *supra* note 80, at 104.

86. *Id.*

87. 15 U.S.C. § 330 (2012); see also Peter E. Graf, *Weather Modification: The Need for a National Policy*, 3 GOLDEN GATE U. L. REV. 343, 356 (1973).

88. 15 C.F.R. § 908 (2016).

89. *Four Decades of American Weather Modification Law*, *supra* note 80, at 105.

90. “[T]he basic consideration during the present weather modification decade has been economic. Regulation costs money; de-regulation is the rage. Budgets are tight; weather modification lacks the political constituency to be protected from budget-makers’ axes. The money tree has borne less fruit.” *Id.*

91. *Id.*

92. See Simms, *supra* note 24, at 927.

93. AGRIC. DEF. COAL., *A Summary of Weather Modification Activities Reported in 2010* (2010), http://www.agriculturedefensecoalition.org/sites/default/files/file/weather/450WV_2010_NOAA_Final_Listing_of_Weather_Modification_Programs_Spreadsheet_10WXMOD5.pdf.

94. 15 U.S.C. § 330(a) (2012).

95. Corbridge & Moses, *supra* note 13, at 219.

96. See 15 U.S.C. § 330(a), (d).

97. Weather modifiers must submit to NOAA information such as: (1) project or activity designation; (2) dates of project; (3) purpose of project or activity; (4) name, address, and phone number for the project sponsor and operator; (5) location and size of target and control areas; (6) a description of the weather modification apparatus, modification agents, and the techniques to be used; and (7) name, address, and phone number of the responsible individual from whom log books and records may be obtained. 15 C.F.R. § 908.4 (2016).

98. See 15 U.S.C. § 330(a).

99. *Id.*

100. “No person may engage, or attempt to engage, in any weather modification activity in the United States unless he submits to the Secretary such reports with respect thereto, in such form and containing such information, as the Secretary may by rule prescribe.” *Id.* (emphasis added).

101. Graf, *supra* note 87, at 356; see also Wood, *supra* note 46, at 374.

102. 15 U.S.C. § 330(2).

103. See Graf, *supra* note 87, at 357–58.

104. Wilderness is defined by the Wilderness Act of 1964 as “[a]n area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.” Furthermore, wilderness is defined as

Land Management (“BLM”) have specific policies to regulate weather modification activities in wilderness area.¹⁰⁵

According to USFS regulation, long-term weather modification programs “that produce, during any part of successive years, a repeated or prolonged change in the weather directly affecting wilderness areas,” are not permitted.¹⁰⁶ However, “[s]hort-term weather modification activities that produce only occasional, incidental, temporary, or transitory changes in the weather with carryover ground effects that last only a few days beyond the actual cloud-seeding period may be permitted.”¹⁰⁷ To carry out weather modification activities over wilderness areas administered by USFS, operators must satisfy certain criteria and obtain a permit.¹⁰⁸

On the other hand, BLM policy for weather modification over wilderness largely mirrors that of USFS. State directors are required to gather the necessary information about the proposed activity and make recommendations to the Director of the BLM on any activity or application for weather modification operations.¹⁰⁹ The Director then determines whether to approve weather modification operations affecting wilderness.¹¹⁰ As with USFS, applications for weather modification affecting BLM wilderness areas must meet certain criteria.¹¹¹

C. Weather Modification State Regulation

The most recent information collected through the reporting requirements established in 15 U.S.C. § 330 revealed that there were sixty-one cloud seeding projects in nine states carried out in 2010 and thirty-two cloud seeding projects carried out in the same nine states in 2011. These weather modification projects are currently subject to the particular regulatory requirements established by each state legislature.¹¹² These state laws range widely in scope from laws

that favor said activities by providing taxing authority for weather modification districts to laws that are so restrictive they practically constitute an effective ban on weather modification activities.¹¹³ This has resulted in a patchwork of state regulation across the U.S. that ranges from very stringent to lax requirements.

I. Varied Weather Modification Regulation Across the States

A survey of all state statutes reveals that thirty-three states,¹¹⁴ the District of Columbia, Puerto Rico, and the Virgin Islands have had or currently have weather modification regulation to some degree. The remaining seventeen states have opted to not adopt weather modification regulations for, what scholars believe to be, three main reasons. First, the uncertainties surrounding the consequences of a relatively new and powerful technology such as weather modification have led to some skepticism among states.¹¹⁵ Second, there is a lack of federal government funds that can help with the implementation of weather modification programs in the states.¹¹⁶ Lastly, states have banned “weather modification on the theory that rain falling prematurely is rain stolen from the location where it would otherwise naturally fall.”¹¹⁷ This “robbing Peter to pay Paul” theory, however, has been dispelled because clouds continually regenerate and release only a portion of their moisture when it rains, which means weather modification operations cannot eliminate all the moisture from a cloud and cannot “steal” rain from an area a cloud is ultimately traveling towards.¹¹⁸

The states that have enacted regulation regarding weather modification have done so in various and particular ways which have resulted in a broad difference in scope among the different acts. Some states require only reporting of weather modification activities, others require some form of licensing, but with no standards or criteria of competence, while other states like Oklahoma¹¹⁹ are more stringent and require a showing of financial responsibility in case of liability, which might result from said activities.¹²⁰ The following two sub-

“[a]n area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable, (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation, (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.” 16 U.S.C. § 1131 (2012).

105. See WESTERN WATER STATES COUNCIL, *supra* note 20, at viI.

106. U.S. FOREST SERV., FOREST SERVICE MANUAL § 2323.45 (2007).

107. *Id.*

108. The USFS may approve wilderness area as a target area for weather modification operations when: (1) the weather modifier provides scientific evidence that the activities will not produce substantial, permanent changes; (2) the proposal includes no feature that will “visibly alter” or “impact the wilderness environment;” and (3) the proposal is not likely to “reduce the value of wilderness for recreation, scenic, scientific, educational, conservation, or historical use.” U.S. FOREST SERV., *supra* note 106.

109. See BUREAU OF LAND MGMT., BLM MANUAL § 8560.36 (1983).

110. *See id.*

111. The criteria that must be satisfied are: “(a) [t]he proponent can provide reasonable, scientifically supportable assurance that the activities will not produce permanent, substantial changes in natural conditions; [and] (b) [t]he proposal does not include any features that might reasonably be expected to produce conditions incompatible in appearance with the wilderness environment or reduce its value for recreation, scenic, scientific, education, conservation, or historical use.” *Id.*; cf. U.S. FOREST SERV., *supra* note 106.

112. See Graf, *supra* note 87, at 359–60.

113. See DENNIS, *supra* note 47, at 242.

114. These states include Alaska, Arizona, California, Colorado, Florida, Texas, Pennsylvania, Oklahoma, Kansas, Wisconsin, North Dakota, Utah, New Mexico, Louisiana, Oregon, Idaho, Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Montana, Nebraska, Nevada, New Hampshire, Rhode Island, South Dakota, Tennessee, Virginia, Washington, West Virginia, and Wyoming.

115. “[T]he uncertainties of an infant science such as weather modification may lead to critical variations between anticipated and actual results.” Corbridge & Moses, *supra* note 13, at 209.

116. See COBLE, *supra* note 25, at 17–18.

117. Simms, *supra* note 24, at 927.

118. Amanda Little, *Weather on Demand: Making It Rain Is Now a Global Business*, BLOOMBERG BUSINESSWEEK (Oct. 28, 2015), <http://www.bloomberg.com/features/2015-cloud-seeding-india/>.

119. The state of Oklahoma requires that “proof of financial responsibility shall be furnished by an applicant by his showing, to the satisfaction of the director, his ability to respond in damages for liability which might reasonably be attached to or result from his weather modification and control activities in connection with the operation for which he seeks a permit.” 82 OKLA. STAT. tit. 82, § 1087.14 (2015).

120. See Graf, *supra* note 87, at 359–60.

sections highlight the vast difference between state regulations concerning weather modification.

a. North Dakota

On one hand, states like North Dakota have enacted detailed regulatory weather modification statutes.¹²¹ As part of North Dakota's weather modification efforts, it currently has a statewide operational cloud seeding program called North Dakota Cloud Modification Project.¹²² In North Dakota, "no person may engage in weather modification activities without both a professional weather modification license . . . and a weather modification permit. . . ."¹²³ In determining whether to issue a license, North Dakota sets forth a series of rigorous requirements, such as a minimum of one year of field experience in the management and control of weather modification operations or research, proof of financial responsibility, and an explanation of whether a weather modification operational permit issued to the applicant in any jurisdiction has ever been suspended or revoked or whether there has been refusal to renew a permit by any jurisdiction.¹²⁴ After a license has been effectively issued, North Dakota retains authority over weather modification activities by having the power to revoke or suspend any license for different reasons, such as incompetency, dishonest practice, or failure to comply with any of the provisions or rules prescribed by the North Dakota legislature.¹²⁵

b. Idaho

On the other hand, states with more relaxed weather modification statutes, such as the state of Idaho, concern licensing requirements that are essentially mere registration provisions which only require a cloud seeder to list their alleged qualifications, but no one has the responsibility to verify whether they are competent, honest, and solvent. For example, the weather modification statute of Idaho purports on its face only to require registration of producers of artificial rainfall with the state Department of Agriculture.¹²⁶ Registration only requires the "name of the person, association, or corporation, its residence, or principal place of business in the state of Idaho and the general nature of the business to be conducted."¹²⁷ However, the statute does not impose penalties on those who do not comply with it. Thus, if there are no consequences for noncompliance, the state's Department of Agriculture is in a disadvantaged position to enforce the required registration requirements. In fact, in 1978, Idaho's

Department of Agriculture regarded "[i]tself as unable to enforce registration because the statute carries no penalties."¹²⁸

Although states, like Idaho, have no robust weather modification regulation, countries around the world are currently extensively regulating weather modification technology. Unlike the United States, other countries' governments, such as China, have spent huge amounts of money to regulate this technology, apply the different techniques, and ultimately reap their benefits.

D. China's Weather Modification Activities and Regulation

According to the World Meteorological Organization, weather modification programs, primarily involving cloud seeding activities aimed at enhancing precipitation or mitigating hail fall, exist in more than approximately fifty-two countries.¹²⁹ One of these countries includes China, which has the most "extensive weather modification program in the world, with more than 35,000 people working in cloud seeding programs across the country."¹³⁰ The Chinese government has enacted regulations promoting weather modification cooperation between provinces and regions.¹³¹ Also, the government funds a greatly expanded weather modification research and operations program at \$100 million per year, in addition to training over 1,500 new weather modification scientists.¹³² China's cloud seeding weapons include approximately 6,781 artillery guns and 4,110 rocket launchers.¹³³ In 2004, the Chinese government reported it eased drought by employing "[a]ircraft, rockets, artillery shells, meteorological balloons and mountain-top-based devices . . . to scatter silver iodide particles into gathering clouds to induce precipitation in the form of rain or snow over the city."¹³⁴

One of the biggest cloud seeding operations in China took place in Beijing in 2008 months before the Summer Olympics took over the Chinese city.¹³⁵ In preparation for the Olympic games, Beijing officials set up cloud seeding stations where "peasants don military fatigues and helmets and squat behind anti-aircraft guns and rocket launchers blasting the sky with silver iodide, hoping to shock rain from the clouds."¹³⁶ Beijing officials planned to have these stations ready and, if rain threatened either the opening or closing ceremonies, they would "seed threatening clouds [using rocket launchers] outside the city . . . and cause them to release their rain before it reaches the capital."¹³⁷

128. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 561–62.

129. Little, *supra* note 118.

130. Rocky Barker, *Modifying Weather: Cloud Seeding Has Some New Believers*, U.S. NEWS (Nov. 19, 2009, 2:49 PM), <http://www.usnews.com/science/articles/2009/11/19/modifying-weather-cloud-seeding-has-some-new-believers>.

131. See Simms, *supra* note 24, at 923.

132. *Weather Modification and S. 517*, *supra* note 41.

133. Stephen Wade, *Rain Out: China Aims to Control Olympics Weather*, USA TODAY (Feb. 29, 2008), http://usatoday30.usatoday.com/weather/research/2008-02-29-china-weather_N.htm.

134. *Cloud Seeding Eases Drought*, CHINA INTERNET INFO. CTR. (July 26, 2004), <http://www.china.org.cn/english/China/102176.htm>.

135. Wade, *supra* note 133.

136. *Id.*

137. *Id.*

121. See N.D. CENT. CODE § 61-04.1 (2015); see also N.D. CENT. CODE § 89-07-02 (2014).

122. *The North Dakota Cloud Modification Project*, N.D. ST. GOV'T: ST. WATER COMM'N & OFF. ST. ENGINEER, <http://www.swc.nd.gov/arb/ndcmp/> (last visited Sept. 23, 2016).

123. N.D. CENT. CODE § 61-04.1-11 (2015).

124. N.D. ADMIN. CODE §§ 89-07-02-07 to -14 (2014).

125. N.D. CENT. CODE § 61-04.1-15 (2015).

126. IDAHO CODE ANN. §§ 22-3201 to -3202 (2015).

127. *Id.* § 22-3201.

Despite this arguable success in China's Olympic games preparation, the United States' federal government still has not resorted to effectively control weather modification in order to reap all the benefits that stem from this technology. There seems to be a paradox here where the federal government is not willing to spend funds to promote weather modification technologies and enact regulations, yet other countries are willing to spend huge amounts of funds to apply these techniques and reap their benefits.

III. Need for Weather Modification Regulation on a Federal Level

Weather modification activities are prone to interstate legal issues or adverse effects without any effective accountability by the federal government. Nevertheless, a federal interest exists if any weather modification activity in the United States could have effects beyond one state's border, or would affect federal lands or activities.¹³⁸ Thus, the federal government needs to take action and regulate weather modification across the United States in order to minimize the possibility of adverse effects or issues, addressed below, from cloud seeding activities and to avoid interstate legal issues.

Present capabilities in the science of weather modification suggest that the need for comprehensive regulation at a national level is imperative.¹³⁹ As global warming takes an exponential toll on fresh water supplies and weather patterns,¹⁴⁰ the science of weather modification, and the implied issues that result thereof, is effectively taking a dominant role in attempting to alleviate environmental effects that result from climate change.¹⁴¹ Therefore, the federal government must resolve current issues and difficulties presented by weather modification in order to ensure its expansion while safeguarding weather modification operators and those who may be affected by the activities.

A. Interstate Impact and Legal Issues

The weather knows no territorial or political boundaries and, thus, its effects and impacts travel across states' borders resulting in multijurisdictional consequences. These issues could arise, for example, when an individual or government causes extra rain, which then floods a neighboring state's field.¹⁴²

During the mid-1970s, a precipitation alteration project operated in Idaho and neighboring states gave rise to interstate legal issues.¹⁴³ Washington state's legislature was considering a bill to appropriate funds for drought relief cloud seeding activities.¹⁴⁴ Nevertheless, Idaho Attorney General Wayne Kidwell protested the bill and threatened to file a suit

in the U.S. Supreme Court seeking an injunction to stop the cloud seeding.¹⁴⁵ Attorney General Kidwell's concern was based upon the belief that weather modification not only has an impact upon the target areas selected for cloud seeding, but can also have an adverse effect upon downwind areas such as the Idaho panhandle.¹⁴⁶ Fortunately, in this case, Idaho Governor John Evans opted for a different approach and proposed regional interstate coordination of cloud seeding efforts.¹⁴⁷

Attorney General Kidwell voiced a common concern between adjoining states from where a weather modification operation is taking place.¹⁴⁸ Thus, weather modification should be federally regulated to minimize the possibility of adverse effects in downwind areas as well as in target areas. Furthermore, Congress should enact comprehensive regulation resolving or clearing liability issues and questions and multi-state impacts that arise from weather modification activities.

B. Uniform Safety Standards

As discussed above,¹⁴⁹ the use of silver iodide may present a health and environmental hazard "when used in sufficient quantities and concentrations."¹⁵⁰ A trial court judge in *Pennsylvania Natural Weather Ass'n v. Blue Ridge Weather Modification Ass'n*, noted that various seeding agents "are poisonous" and concluded that "possible harm can result from uncontrolled and unregulated weather modification activities."¹⁵¹ Given the uncertain nature of this science there exist concerns over the long-term consequences of injecting silver iodide into clouds in order to manipulate the weather.¹⁵²

Substantial risk upon "land, people, health safety, property, or the environment" has always been of sufficient importance to Congress as to call for legislative action.¹⁵³ Thus, Congress needs to step in and regulate weather modification activities nationwide and establish consistent and minimum standards of care in order to ensure or minimize any risk to public health, safety, and welfare that could result from unregulated cloud seeding operations.

C. Lack of State Funding

One of the obstacles to weather modification at the state level has been the financing and funding of weather modification activities.¹⁵⁴ "The States have small amounts of money and personnel to administer and enforce their regulations," and

145. See *id.*

146. See *id.*

147. See *id.*

148. See N.D. Atmospheric Res. Bd. v. Bd. of Nat. Res. & Conservation, 1992 Mont. Dist. LEXIS 60 (Mont. Dist. Ct. 1992) (upholding North Dakota's cloud seeding project despite allegations that it would have potential adverse effects in the state of Montana).

149. See *supra* Part I.

150. See *Black Clouds and Silver Iodide*, *supra* note 71, at 63.

151. Pa. Nat. Weather Ass'n v. Blue Ridge Weather Modification Ass'n, 44 Pa. D. & C.2d 749, 761 (Pa. C.P. 1968).

152. See Simms, *supra* note 24, at 921.

153. *Black Clouds and Silver Iodide*, *supra* note 71, at 64.

154. See Oppenheimer, *supra* note 81, at 317.

138. See Wood, *supra* note 46, at 390.

139. See Corbridge & Moses, *supra* note 13, at 225.

140. See Alex Morales, *Global Warming Seen Taking Toll on Economy, Health, Crops*, BLOOMBERG, Nov. 4, 2013, <http://www.bloomberg.com/news/articles/2013-11-04/global-warming-seen-taking-toll-on-economy-health-crops>.

141. See Simms, *supra* note 24, at 918.

142. See *id.* at 933.

143. See *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.

144. See *id.* at 556.

their weather modification activities are usually conducted as an incident to other conservation, water resources, or agricultural programs.¹⁵⁵ State officials have noted that the absence of explicit legal authority to the states renders improbable for states to appropriate general funds or levy taxes to finance weather modification activities.¹⁵⁶ Nevertheless, in the past, different states have shown interest in cooperating with the federal government and obtaining federal funding for the weather modification efforts in their respective states.¹⁵⁷ Thus, funds provided by the federal government acting in conjunction with the states would likely spark weather modification regulation.

As Congressman John Jacob Rhodes, Jr. stated in 1982, “the potential societal benefits of weather modification are too great for us to ignore or to pursue it in piecemeal fashion. We need a better sense of national strategy.”¹⁵⁸ This is why there is a pressing need for federal action and national regulation of weather modification activities in order to minimize any of the adverse effects or issues, detailed above, that may arise from such operations, while still enjoying its benefits.

IV. Enactment of the National Weather Modification Control Act

To address the under-regulation of weather modification, Congress should enact, through its Commerce Clause power, what I have titled the National Weather Modification Control Act (“NWMCA”), which shall be implemented through a program of cooperative federalism between the states and the federal government.

A. Congress’ Power Under the Commerce Clause

Among the powers granted to Congress by the Constitution is the authority “to regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes.”¹⁵⁹ This authority, under what is known as the Commerce Clause, is the basis for most environmental federal statutes enacted by Congress beginning in the 1970s to protect public health and the environment, including the Clean Air Act (“CAA”) and the Clean Water Act (“CWA”).¹⁶⁰ These acts and the Supreme Court’s decisions involving the scope of governmental authority to regulate the use of natural resources have been the result of, what commentators call, the “Environmental Commerce Clause.”¹⁶¹ Under the “Environmental Commerce Clause,” Congress possesses overarching authority over the states to federally regulate the use of

natural environment that has interstate effects or a direct effect on interstate commerce.¹⁶²

In enacting the major environmental statutes, Congress broadly construed its Commerce Clause powers reaching practically any matter of national concern.¹⁶³ For example, the Endangered Species Act (“ESA”) allows the listing and protection of species that have no readily apparent connection to interstate commerce, and it purports to impose restrictions on conduct that harms listed species regardless of whether that conduct is commercial in nature.¹⁶⁴ The ESA thus prohibits any person to “take,” meaning “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct,” any member of an endangered species, without requiring proof of an interstate commercial nexus.¹⁶⁵ This prohibition has even been broadly defined to extend to “habitat modification” that harms a listed plant or animal.¹⁶⁶ Commerce Clause challenges to the ESA have been consistently rejected in lower federal courts and, so far, the Supreme Court has not granted certiorari in any of these cases.¹⁶⁷

In light of this liberal construction of the Commerce Clause, a court is likely to find that weather modification activities undoubtedly have interstate effects and can thus be regulated by the Commerce Clause. For example, weather modification activities alter the composition of the atmosphere resulting in rain augmentation in one area to the possible detriment of another, may cause extra rain, which can then flood a neighboring state, or may cause adverse effects in downwind areas as well as in target areas.

Furthermore, despite a longstanding understanding of the right of states to protect their natural resources, the U.S. Supreme Court has invalidated the only state water law that has come before it in a challenge under the dormant Commerce Clause.¹⁶⁸ In *Sporhase v. Nebraska*, the Supreme Court invalidated a provision of Nebraska law that restricted the out-of-state transport of groundwater withdrawn from any well in Nebraska.¹⁶⁹ In reaching its conclusion, the Court explicitly held that “water is an article of commerce” subject to federal regulation.¹⁷⁰ The legacy of *Sporhase* retains precedential value for the premise that “state water resources are articles of commerce, potentially subject to federal regulation.”¹⁷¹ This holding preserves the federal prerogative to regulate inter-

155. *Id.*

156. *Id.*

157. See *Weather Modification Law Developments*, *supra* note 16, at 418; see also Oppenheimer, *supra* note 81, at 317.

158. Stanley A. Changnon, Jr. & W. Henry Lambright, *The Rise and Fall of Weather Modification Policy*, 19 J. WEATHER MODIFICATION 1, 10 (1987).

159. U.S. CONST. art. I, § 8, cl. 3.

160. See Christine A. Klein, *The Environmental Commerce Clause*, 27 HARV. ENVTL. L. REV. 1 (2003).

161. *Id.*

162. *Id.*

163. Timothy S. Bishop et al., *Do Federal Environmental Laws Regulate Commerce?*, 17 NAT. RESOURCES & ENV’T 7, 54 (2002).

164. *Id.*

165. 16 U.S.C. § 1532(19) (2012).

166. *Babbitt v. Sweet Home Chapter of Communities for a Great Or.*, 515 U.S. 687, 697 (1995).

167. Bishop et al., *supra* note 163, at 54; Greg Stohr, *Endangered Species Act Survives Challenge at U.S. High Court*, BLOOMBERG (Oct. 31, 2011), <http://www.bloomberg.com/news/articles/2011-10-31/endangered-species-act-survives-challenge-at-u-s-high-court> (“The high court hasn’t taken up a commerce clause case since Chief Justice John Roberts took his seat in 2005.”).

168. See *Sporhase v. Nebraska*, 458 U.S. 941 (1982). The dormant Commerce Clause doctrine “has long been understood to have a ‘negative’ aspect that denies the States the power unjustifiably to discriminate against or burden the interstate flow of articles of commerce.” Klein, *supra* note 160, at 2.

169. See *Sporhase*, 458 U.S. at 954.

170. See *id.* at 943–54.

171. Klein, *supra* note 160, at 46.

state commerce and transient natural resources like water, and, furthermore, provides the necessary authority Congress requires to enact the NWMCA.

B. NWMCA's Implementation Through a Program of Cooperative Federalism

Execution of the NWMCA would demand coordination and collaboration between both the federal and state governments through a program of cooperative federalism, which has been implemented in environmental federal acts such as the CWA, as discussed below. Cooperative federalism is a system under which the federal and state governments share some degree of regulatory authority.¹⁷² Where Congress has the authority to regulate private activity under the Commerce Clause, the courts have recognized that it may offer the states the choice of regulating that activity in accordance with federal standards or having the state law preempted by federal regulation.¹⁷³ Thus, state implementation of a federal act is subject to federal approval and oversight with states expressly authorized to establish more stringent standards if they so desire.¹⁷⁴

In order to carry out the NWMCA, the states and federal government will need to join in a cooperative federalism partnership where states implement the federal regulatory program. In this way, Congress will be able to regulate weather modification activities at a national level while also leaving the states with the option of implementing their own regulatory program and tailoring it to meet their particular local needs.

I. Why Cooperative Federalism?

In any federal-state collaboration, the federal government is usually seen as the “dominant partner . . . but because the Constitution reserved to states all powers that were not explicitly” given to the federal government, and because federal resources are limited, the federal government often heavily relies on state involvement and cooperation to achieve a nationwide environmental goal.¹⁷⁵ Cooperative federalism should be adopted because it strikes the proper balance between state and federal power, with the state government being a main participant. In addition, given the great geographical diversity of the United States and the consequent variation in natural and/or atmospheric conditions, the states likely have better insight than the federal government into the particular needs of each state with respect to weather modification. Also, states can be more responsive to the different consequences resulting from weather modification

operations within their jurisdictions.¹⁷⁶ Therefore, if the federal government managed the NWMCA on their own, it would likely be cost prohibitive and greatly inefficient given the vastly different landscapes, weather conditions, and environmental issues in each state.

Furthermore, this model provides a way for states to be accountable for their weather modification regulations and activities. Under a model of cooperative federalism, if a state does not cooperate or meet the NWMCA's established federal minimum standards and requirements it can be subject to penalties, such as losing federal funds.¹⁷⁷ Conditioning the receipt of federal funds on state adoption of weather modification plans acceptable to federal authorities will stimulate greater state efforts to address the current under-regulation of weather modification activities.

2. CWA's Cooperative Federalism Framework

The principle of cooperative federalism underlies several of the major environmental statutes that Congress enacted in the 1970s. One of these federal environmental statutes includes the CWA, which, given its success, will serve as a foundation for the NWMCA. For the CWA, Congress allocated varying levels of regulatory and enforcement responsibility to the states, in recognition of the states' roles as the traditional protectors of local lands and waters and the geographical differences between states.¹⁷⁸ Congress anticipated “a partnership between the States and the federal Government, animated by a shared objective: to ‘restore and maintain the chemical, physical, and biological integrity of the nation's waters.’”¹⁷⁹ Congress made federal funds available to states contingent upon the creation of a regulatory scheme that is at least as stringent as the federal minimum standards, although states may tailor water quality criteria to local needs, enforce their own administrative rules, and implement their own pollutant discharge elimination systems.¹⁸⁰ A major innovation in the amended 1972 CWA was the establishment of a national permit program, the Section 402 National Pollutant Discharge Elimination System (“NPDES”), to control water pollution and the monitoring and reporting requirements that form the basis of effective enforcement.¹⁸¹ Congress imposed industry-wide, nationally-uniform, minimum standards, but preserved state autonomy by providing that states operate the federal permit program through delegated authority from EPA.¹⁸² After EPA approves a state's program, the state issues permits with EPA retaining limited oversight authority.¹⁸³ In most cases, the owner of a facility applies to

176. Donald Frenzen, *Weather Modification: Law and Policy*, 12 B.C. L. REV. 503, 513 (1971).

177. See Percival, *supra* note 174, at 1166; see also *New York*, 505 U.S. at 167.

178. See Clean Water Act of 1972, 33 U.S.C. § 1251 (2012).

179. *Arkansas v. Oklahoma*, 503 U.S. 91, 101 (1992) (quoting 33 U.S.C. § 1251).

180. See 33 U.S.C. §§ 1251–1887; see also Sweeney & Armstrong, *supra* note 175, at 3.

181. See 33 U.S.C. §§ 1311(b)(2), 1342.

182. Percival, *supra* note 174, at 1162.

183. See 33 U.S.C. §§ 1312(a), 1342(d); see also 40 C.F.R. §§ 122.44(d), 123.44 (2015).

172. See, e.g., Robert L. Fischman, *Cooperative Federalism and Natural Resources Law*, 14 N.Y.U. ENVTL. L.J. 179, 187–88 (2005).

173. See *New York v. United States*, 505 U.S. 144, 167–68 (1992).

174. See Robert Percival, *Environmental Federalism: Historical Roots and Contemporary Models*, 54 MD. L. REV. 1141, 1175 (1995).

175. Katie M. Sweeney & Sherrie A. Armstrong, *Cooperative Federalism in Environmental Laws: A Growing Role for Industry*, AMERICAN B. ASS'N. SEC. ENV'T, ENERGY, & RESOURCES FALL CONF. 1, 2 (Oct. 9–12, 2013).

either the EPA or a state permitting authority for its own NPDES permit, and the permit writer evaluates facility-specific information to determine the appropriate permit terms and conditions.¹⁸⁴

Furthermore, under the CWA's system of cooperative federalism, states have primary responsibility to establish, periodically review, and revise state water quality standards.¹⁸⁵ Congress gave EPA a secondary role where it reviews new or revised state water quality standards to determine whether they satisfy the CWA's requirements.¹⁸⁶ If necessary, EPA recommends changes and, if the state fails to comply, only then does the CWA allow EPA to promulgate water quality standards for the state.¹⁸⁷ As previously mentioned, given the regulatory success of this Act, the design of the proposed NWMCA will mirror different regulatory aspects of the CWA.

C. The Design of the NWMCA

Congressional enactment of the NWMCA will require the development of a well-delineated national permit program to control and regulate the use of weather modification, the allocation of varying levels of regulatory and enforcement powers to the states, and coordination and collaboration among NOAA and the states in implementing the Act. To achieve the objectives of the NWMCA, the Act embodies the concept that *all* weather modification activities are unlawful, unless specifically authorized by a permit, which is the Act's principal enforcement tool.

I. National Permit Program

The defining feature of the NWMCA is the development of a national permit program, similar to the NPDES permit program of the CWA,¹⁸⁸ which will serve as a mechanism for regulating and enforcing federally-mandated national weather modification standards. As stated above and further explained below, this permit program will be carried out through a cooperative federalism partnership between the states and the federal government, in which, through delegation of federal authority, states will have the power to issue NWMCA permits to those who engage in weather modification activities within their jurisdiction. This way the permit program acknowledges the inherently state specific differences and requirements to ensure nationwide attainment of weather modification standards.

As stated above, the NWMCA permit obligations will apply exclusively to all weather modification activities, such as storm suppression, precipitation augmentation, hurricane diversion, and so forth. Thus, the scope of obligations under the permit program covers any person, company, firm, corporation, municipality, association, partnership, and/or

commission that artificially alters or produces changes in the composition or behavior of the atmosphere in the United States, including all territories and the District of Columbia.

a. National Objective of the NWMCA

Before the issuance of any NWMCA permit, weather modifiers must meet the minimum federal standard: "It is the national policy that emitting chemicals or materials into the atmosphere with the purpose of artificially altering or producing changes in weather patterns shall not negatively impact the human and natural environment." In order to carry out the policy set forth in this Act, the emission of chemicals and materials into the atmosphere in toxic amounts shall be prohibited¹⁸⁹ and the use of weather modification must seek to attain the widest range of beneficial uses of the atmosphere without environmental degradation, risk to public health or safety, or other undesirable consequences.

In order to achieve the Act's national goal, all weather modifiers shall obtain a NWMCA permit and meet the following requirements: (1) proof of competence; (2) completion of a registration form of all weather modification activities; (3) completion of a financial form; and (4) public notice.

b. Obligations and Requirements Under the NWMCA Permit Program

Before launching a weather modification activity, any person, company, firm, corporation, municipality, association, partnership, and/or commission must obtain governmental consent in the form of a NWMCA permit. Those applicants who demonstrate that they have met the established federal standard will obtain a permit to engage in said activities and must continue to comply with the mandates and requirements set throughout the Act for the duration of their weather modification activities. Although certain specifics of the Act, such as the amount and concentration of silver iodide permitted in the atmosphere, will need to be determined after further research and collaboration with scientists in the field, states' representatives, pertinent federal agencies, and public citizens, the general framework of the Act is detailed below.

i. Proof of Competence

Currently, unless a specific state requires otherwise, the only mandated requirement to engage in weather modification is a reporting obligation to NOAA.¹⁹⁰ Therefore, essentially anyone who has the required equipment can engage in such activities even though they may not have the necessary expertise or experience to effectively engage in safe and adequate operations. Nevertheless, proof of competence in this field is particularly important given the wide range of effects that can result from weather modification activities;

184. Jeffrey M. Gaba, *Generally Illegal: NPDES General Permits Under the Clean Water Act*, 31 HARV. ENVTL. L. REV. 409, 410 (2007).

185. See 33 U.S.C. § 1313.

186. See *id.* § 1313(c)(3).

187. See *id.* § 1313(c).

188. See *id.* § 1342.

189. This is similar to the CWA's national goal "[t]hat the discharge of toxic pollutants in toxic amounts be prohibited." *Id.* § 1251(a)(3).

190. See 15 U.S.C. § 330 (2012).

“at the least, incompetent cloud seeding can prevent rain despite an attempt to cause it, or make worse existing flood conditions, or augment precipitation outside rather than inside the target area.”¹⁹¹

Thus, under the proposed permit program, in order to obtain a permit, applicants must first establish and produce proof of competency and ethical weather modification operations. Similar to North Dakota’s requirements when considering whether to issue a weather modification license,¹⁹² the applicant must provide proof of field experience in the responsible and efficient management and control of weather modification operations. In order to prove competence an applicant must have: (1) a minimum of two years of field experience in weather modification operations; and (2) a degree in engineering, physical sciences, atmospheric science, or meteorology.¹⁹³ Furthermore, like many other professions, in order to maintain a permit, weather modifiers will have a continuing education requirement given that technology advances and changes, as do weather patterns. In addition to proof of competence, an applicant would be required to complete two forms: a registration form and a financial form.

ii. Registration of Activities and Financial Resources

No national administration of weather modification will be possible unless the principal enforcers of the Act, discussed below, are aware of all the activity in the field. Thus, all weather modifiers who obtain a permit must consequently register and maintain a complete record of all their weather modification activities and submit periodic reports to NOAA, or the pertinent state department, after completion of any operation. The submission of reports will vary on a case-by-case basis, given that each operation will likely vary in length. Thus, for shorter-length operations, monthly reports would suffice, whereas for longer operations, quarterly submissions (every three months) would be required. Nevertheless, every record should at least contain: (1) the location of the weather modification operation and any geographic area that may be affected; (2) the date or dates when the activity is to be carried out; (3) the purpose of the activity; (4) the equipment and method utilized in such activities; and (5) the chemical nature and quantities of the materials emitted into the atmosphere for the purposes of weather modification.

Regarding the financial form required, applicants for a NWMCA permit must demonstrate financial resources adequate to correct and compensate damages that may be assessed against them due to project activities.¹⁹⁴ Financial

assurance rules act as an important complement to liability insurance, assuring cost internalization by responsible parties for damages caused by weather modification activities that injure the public health and safety or that cause property or natural resource damages.¹⁹⁵

iii. Procedural Requirements

Currently some states that regulate weather modification activities require public notice as a condition precedent to launching a weather modification operation.¹⁹⁶ Such procedural requirement is an important provision of the NWMCA, so that those near the target area of a weather modification operation can raise any safety concerns to NOAA before it decides whether to issue or not a permit. Therefore, before the issuance of any NWMCA permit, the permitting authority must provide public notice of the draft permit, allow at least thirty days for the public to comment, and grant hearings if requested by interested parties, such as residents near the affected areas.¹⁹⁷

2. Enforcement by NOAA and the States

Effective execution of the NWMCA will demand collaboration and coordination among NOAA, the lead federal agency, and the states. Under the NWMCA, as with most cooperative federalism statutes, NOAA’s jurisdiction will be broad, particularly regarding establishment of weather modification national standards. In order to assure a centralized control of weather modification operations throughout the U.S., NOAA, which is currently the only federal agency implementing a weather modification regulation, will play a central and principal role in setting and enforcing the Act’s requirements. Nevertheless, similar to the CWA,¹⁹⁸ the Act embodies a federal-state partnership in which NOAA and the states share authority to implement and enforce the Act. NOAA sets the federal minimum requirements, and states carry out the day-to-day activities of implementation and enforcement, through active monitoring, to assure compli-

195. James Boyd, *Financial Responsibility for Environmental Obligations: An Analysis of Environmental Bonding and Assurance Rules*, L. & ECON. ENVTL. POL’Y 1 (2002).

196. For example, the state of Florida requires that “the licensee shall cause the notice of intention to be published at least once a week for [two] consecutive weeks in a newspaper having general circulation and published within any county wherein the operation is to be conducted and in which the affected area is located, or if the operation is to be conducted in more than one county or if the affected area is located in more than one county or is located in a county other than the one in which the operation is to be conducted, then such notice shall be published in like manner in a newspaper having a general circulation and published within each of such counties. . . .” FLA. STAT. § 403.361 (2015).

197. The CWA imposes similar public notice and comment procedural obligations on the issuance of NPDES permits. The statute requires that the permits be issued “after an opportunity for a public hearing” and further provides that “permit applications” and the permits themselves be made available to the public for at least thirty days. 33 U.S.C. §§ 1342(a)(1), (j) (2012); see also 40 C.F.R. § 124.10(b)(1) (2015). Public hearings may be requested, but the permitting authority is required to hold such a hearing only if there is a “significant degree of public interest” or when “such a hearing might clarify one or more issues involved in the permit decision.” 40 C.F.R. § 124.12(a)(1)–(2).

198. See Claudia Copeland, *Clean Water Act: A Summary of the Law*, CONG. RES. SERV. (Apr. 23, 2010).

191. Wood, *supra* note 46, at 390.

192. See N.D. ADMIN. CODE §§ 89-07-02-07 to -14 (2014).

193. These requirements are similar to the minimum qualifications required by the Weather Modification Association in order to grant a person a certification as a Weather Modification Operator. See *Certification*, WEATHER MODIFICATION ASS’N, <http://www.weathermodification.org/certifications.php> (last visited Sept. 25, 2016).

194. Most U.S. environmental laws make polluters liable for damages caused by commercial activities that injure the public health and safety or that cause property or natural resource damage. See *Black Clouds and Silver Iodide*, *supra* note 71, at 64.

ance with requirements and standards. Furthermore, states are empowered, by the use of its authority to make reasonable rules and regulations, to fill in the gaps not covered by the basic federal regulatory standards or even implement stricter requirements. Nonetheless, NOAA may find it necessary to step in from time to time if a particular state is not carrying its duties and responsibilities under the Act. Under such circumstances, NOAA, as the lead federal agency, has the power to issue or deny a permit, or to enforce penalties as required.

In order to effectively enforce the NWMCA, all those who disobey the conditions and requirements of the permit program will be in noncompliance and violation of the NWMCA and thus, shall be subject to penalties. Although NOAA and each state government will likely enjoy significant discretion in pursuing enforcement and assessing penalties, violators of the Act can expect, at a minimum, fines at least equal to any economic benefit they achieved or any harm caused to other parties by disobeying the NWMCA. Bad faith, previous noncompliance, and violations that significantly affect human health and the environment will likely increase the ultimate penalty.¹⁹⁹ For the ultimate penalty, violators can expect to have their NWMCA permit stripped away entirely. All enforcement proceedings shall be the responsibility of the states with NOAA stepping in if the particular state does not take any action against the violator of the Act.

Furthermore, in order to keep both federal and state governments in check, the NWMCA, like the CWA,²⁰⁰ must include a citizen suit provision that authorizes private citizens to bring enforcement actions against persons violating the Act. Citizens may seek injunctive relief to enforce the federal standard or requirements and, if successful in litigation, an award of civil penalties.

Even though the NWMCA will serve the important function of regulating weather modification throughout the U.S., the novelty of this proposal will likely present significant political and policy challenges, and opposition by those who are leery about the technology's effectiveness.

D. *Counterarguments: Obstacles and Challenges to the NWMCA*

As expected with any novel proposed legislation, the NWMCA will most likely face opposition and challenges against it. As previously stated, most federal environmental laws rely in some degree upon the states for their implementation.²⁰¹ Nevertheless, states are not always willing to coop-

erate.²⁰² Considering the quasi-sovereign interest states have in protecting local water, it is likely that the states will raise significant opposition to the NWMCA.

Notwithstanding state opposition, "the federal government now plays the dominant role in environmental protection policy in the United States."²⁰³ As presented throughout this Note, legal precedent supports the premise that the federal government has a legitimate interest in regulating environmental affairs under the Commerce Clause, particularly for a transient natural resource such as the water that falls from cloud seeding.²⁰⁴ A federal interest exists in weather modification activities in the United States that have effects beyond one state's borders. Thus, as weather modification activities become increasingly frequent and widespread across the United States, a federal regulation, like the NWMCA, could help assure that weather modifiers perform competently and properly document and report all their operations to a central administrative federal agency, and that interstate and federal interests, such as public health and safety, are protected. Congress has usually sought to use federal regulation to guarantee a minimum level of environmental protection to citizens regardless of their location.²⁰⁵ This guarantees citizens that no matter where they are located in the United States, they can "travel freely without encountering unreasonable risks to their health or welfare from environmental conditions."²⁰⁶

Another challenge revolves around the perceived uncertainty of weather modification's effects. The novelty of weather modification technology and "the limited fund of knowledge concerning weather and its modification"²⁰⁷ may provoke opposition from those who doubt the technology's effectiveness. Nonetheless, with the advancement of technology, scientific uncertainty is now less of a concern.²⁰⁸ Recent improvements in the techniques of seeding agents, observational technology, cloud models, and in physical understanding of cloud processes permit ever more detailed design and targeting of weather modification activities and more accurate specification of the range of anticipated responses and effects.²⁰⁹ These improvements are evinced by the effective use of cloud seeding operations in more than approximately fifty-two countries, such as China.²¹⁰

Although the introduction of the Act will face opposition, these challenges can likely be addressed in favor of Congress and the enactment of the NWMCA. Given current pressing issues, such as climate change and a possible freshwater crisis, now would be an effective time to enact the NWMCA.

(1998).

202. *Id.*

203. Percival, *supra* note 174, at 1146.

204. *See Sporhase v. Nebraska*, 458 U.S. 941, 941 (1982).

205. Percival, *supra* note 174, at 1171.

206. *Id.* at 1172.

207. Frenzen, *supra* note 176, at 514.

208. "Although doubters may remain, it is now widely agreed that the techniques of weather control have reached a level where substantial results may be anticipated. . . ." Corbridge. & Moses, *supra* note 13, at 208.

209. *See Planned Weather Modification Through Cloud Seeding*, AM. METEOROLOGICAL SOC'Y (Nov. 2, 2010), <https://www2.ametsoc.org/ams/index.cfm/about-ams/ams-statements/statements-of-the-ams-in-force/planned-weather-modification-through-cloud-seeding/>.

210. Little, *supra* note 118.

199. For example, in determining the amount of the civil penalty for CWA violations, "[t]he court shall consider the seriousness of the violation or violations, the economic benefit (if any) resulting from the violation, any history of such violations, any good-faith efforts to comply with the applicable requirements, the economic impact of the penalty on the violator, and such other matters as justice may require." 33 U.S.C. § 1319(d).

200. The CWA authorizes any citizen having an interest which is or may be adversely affected to commence a civil action on his own behalf against any person to enforce the Act. *Id.* § 1365(a)(1).

201. *See* Jonathan H. Adler, *The Green Aspects of Printz: The Revival of Federalism and Its Implications for Environmental Law*, 6 GEO. MASON L. REV. 573, 574

V. Conclusion

The confluence of factors including climate change and a practically inevitable freshwater crisis is a warning to political leaders in the United States to take action regarding weather modification regulation. The western part of the United States, specifically the state of California, and its territories, such as Puerto Rico, have already felt the effects of intensified and persistent droughts, and scientists point to “future dry spells” worsening as temperatures continue to rise.²¹¹

With such pressing concerns across the U.S., weather modification, particularly cloud seeding, is gaining momentum as it is being more frequently used as a technology to help stave off water scarcity issues. Nevertheless, stagnated and weak state regulations across the United States do not take into account the issues and effects that this technology

may have across states’ borders. Furthermore, there is no centralized governmental control of such a powerful technology, which has already been used in the past as a weapon in military affairs.

For such reasons, Congress needs to act and, by the powers vested in it, enact the NWMCA, which will establish comprehensive federal regulation of weather modification activities. Such a national plan, with a lead agency, and a strong coordinated federal-state partnership will provide the necessary tools for national regulation and control of weather modification operations, while reaping its benefits, such as freshwater augmentation and storm suppression. Given the critical environmental impacts of climate change felt in the United States, the time is ripe for Congress to act and enact the NWMCA.

211. Gillis, *supra* note 10.