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WINTER GROUND OPERATIONS 2022-2023

WYOMING WEATHER MODIFICATION **WIND RIVER & SIERRA MADRE MOUNTAIN RANGES**

Final Operations Summary prepared for the Wyoming Water Development Office

by



Ground-Based Cloud Seeding Operations 2022-2023 Winter Operations Report

For the

Wind River and Sierra Madre Mountain Ranges, Wyoming

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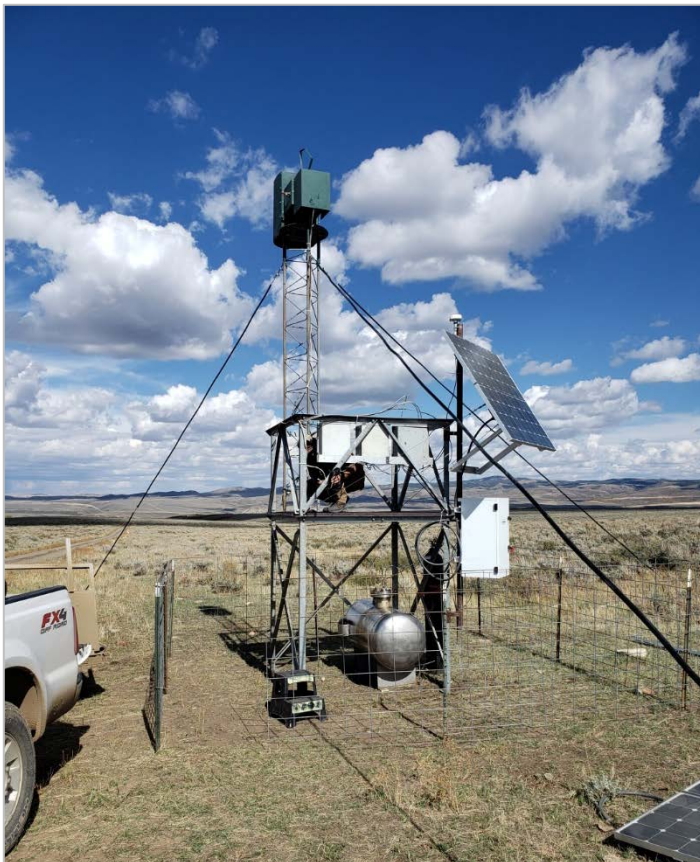
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Cheyenne, WY 82002

NOVEMBER 2023



EXECUTIVE SUMMARY

Funding for cloud seeding operations in the Wind River Range for the winter of 2022-2023 was provided in part by the 2022 Wyoming State Legislature's *Omnibus Water Bill – Construction*. The Wyoming State Legislature has mandated that the funding rate for the State will not exceed 37% of total project costs, leaving 63% of the project costs to be split among other Colorado River Basin water users and other interested parties. Funding partners in support of continued weather modification activities in the Wind River Mountains during the winter of 2022-2023 included the Southern Nevada Water Authority, the Central Arizona Water Conservation District, the Colorado River Board of California - Six Agency Committee, Rocky Mountain Power, and the Green River/Rock Springs/Sweetwater County Joint Powers Water Board.



Ten ground-based ice nucleus generators (ground generators) were employed in the Wind River Range, eight of which were deployed for the eight previous operational seasons. Nine generators were sited on the west, southwest, and southern flanks of the range. The tenth was sited on the southeastern flank, southwest of Lander. Two additional generators were deployed this season in the northwest flank of Sierra Madre Range, west of Saratoga.

The 2022-2023 season became operational on 8 November 2022 and concluded after 22 April 2023. The first seeding event occurred on 9 November 2022.

Figure 1. WMI Technicians assemble the Tullis West (SM10) site in the Sierra Madre Range prior to the 2022-2023 season. Photo by WMI Technician Jeremy Bilben.



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The 2022-2023 weather pattern produced a significant number of seedable storms as compared to the previous season, exceeding even the active storm years of the 2019-2020 and 2020-2021 seasons. Four seeding events occurred in November 2022, seven in December 2022, five in January 2023, eight in February 2023, nine in March 2023, and three in April 2023, bringing the seasonal total to 36 events. Seasonal snowpack (snow water equivalents, or SWE) at project end (April 22) was significantly above the 30-year median at all sites monitored for suspension in the Wind River Range and the Sierra Madre Range. The range-average SWE never reached suspension threshold in the Wind River Range, but on 11 March 2023, did so in the Sierra Madre Range. Seeding operations, both ground-based and airborne, were suspended for the Sierra Madre Range on that date.

The thirty-six storm events accrued 216 hours and 6 minutes during which one or more generators were seeding during the winter. The fewest number of generators that operated during any one storm was one (during one easterly upslope event), and the most, nine.

Similar to recent seasons, the 2022-2023 season featured many shorter-interval storms compared to previous seasons. Of the 36 seeding events, only four lasted for more than ten hours and only one for over twenty. The shorter-interval storms produced good seeding conditions but of shorter duration. Additional and more detailed information is provided in the pages that follow, and the attached appendices.

The total number of “generator hours”, defined as the sum of times each generator was operated during a storm, was 957 hours and 23 minutes. For seeding to have been conducted, the wind direction had to be such that seeding agent released from each specific generator would carry seeding aerosol particles (silver iodide, AgI) upslope into cold but yet-unfrozen clouds at speeds sufficient to ensure that transport would occur. The seeding rate is approximately 25 grams of silver iodide per generator, per hour. The results discussed in this report show a variance in the number of generators used from seeding event to seeding event. This variance is due to situations when the wind direction favored the activation of specific generators. The three other requisite conditions needed to initiate seeding was: the presence of liquid water clouds, suitable cloud temperatures, and the absence of a stable layer which would inhibit the transport of the seeding agent up and over the range. The temperature of the clouds aloft had to be cold enough (-6°C or colder) to ensure that the seeding agent would nucleate ice, thus starting precipitation development. This is discussed in greater detail later in this report.

In the 2022-2023 season, WMI obtained high-resolution weather model information from the National Center for Environmental Prediction (NCEP) and created its own numerical weather prediction (NWP) information from custom-designed Weather Research and Forecasting (WRF) model domains. This information was retrieved and created as quickly as possible leveraging resources from the Amazon Elastic Compute Cloud, providing unique meteorological guidance designed specifically to aid project meteorologists make efficient and successful operational cloud seeding decisions. Hybrid Single-Particle Lagrangian Integrated Trajectory, or HYSPLIT, modeling was also run in real-time from WRF and other publicly available numerical weather prediction models. More about these models are presented in the body of this report.



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As accuracy of numerical models has increased, the need to verify requisite temperature and wind criteria by atmospheric soundings has decreased. For the 2022-2023 season, atmospheric soundings were not conducted. The presence of liquid water clouds over the range was established by the WWDO radiometer sited at the East Fork site, or confidence in model forecasts, coupled with the presence of clouds on satellite and webcams. New satellite products from the GOES-R suite, including day cloud phase and nighttime microphysics, are also used to help assess cloud coverage and composition.



Figure 2. WMI Technicians service the White Acorn (WR03) generator site in the Wind River Range on 24 January 2023. Photo by WMI Technician Michael Paul.



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ACKNOWLEDGMENTS

The 2022-2023 project had multiple partners whom WMI here acknowledges. In addition, the project ran smoothly, effectively, and safely because of the diligence of many people, and we appreciate all of them.

The State of Wyoming, through the Wyoming Water Development Commission (WWDC), contributed 37% of the program costs. Much of the remaining funding was provided by the Colorado River Board of California – Six Agency Committee, the Central Arizona Water Conservation District, and the Southern Nevada Water Authority. Contributions toward project operations were received from Rocky Mountain Power and the Green River/Rock Springs/Sweetwater County Joint Powers Water Board. We appreciate the active participation of these stakeholders very much.

Project guidance and direction on behalf of the State of Wyoming was provided by Program Manager Julie Gondzar and Barry Lawrence of the Wyoming Water Development Office. The WMI ground-based generator crew was comprised of Lead Technician, Michael Paul assisted by Ryan Hudson, and Pat Trujillo. Meteorological services, which included forecasting, weather monitoring (for seeding conditions), and direction of operations were provided primarily by Jason Goehring and Adam Brainard. Numerical weather prediction services and a meteorological web interface for the project was provided by Brainard and Caleb Steele. Additional meteorological support including forecasting services was provided by Sarah-Ellen Calise, Lillie Farrell, and Jeff Ceratto. Bruce Boe, Vice President of Meteorology, provided scientific program oversight.

From the Fargo corporate office, logistical and technical support for the ground-based seeding equipment was provided by Dennis Afseth, Jake Van Ornum and Erin Fischer (Client Services), provided administrative and recordkeeping support, with the assistance of Ramona Adams and Cindy Dobbs.



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1 BACKGROUND AND OVERVIEW

1.1 Background

Atmospheric water transformed to precipitation is one of the primary sources of fresh water in the world. However, a large amount of water present in clouds never is converted into precipitation at the surface. This has prompted scientists and engineers to develop the means to augment water supplies through cloud seeding.

From 2006 through the spring of 2014, cloud seeding operations in the Wind River Range were conducted within the context of the Wyoming Weather Modification Pilot Project (WWMPP; Breed et al. 2014, Rasmussen et al. 2018). Eight of the ten ground-based cloud seeding generators used in that project were funded by the Wyoming State Legislature through the Wyoming Water Development Commission (WWDC). The two additional generators were funded by the Lower Colorado River Basin States.

Though the WWMPP concluded in the spring of 2014, local and regional interest in continuing operations remained. In recognizing this interest, the WWDC obtained legislative support and the funding for a 2014-2015 operational cloud seeding program in the Wind River Range. This interest continues, and operations have continued through this mechanism during subsequent winters. Funding sources are discussed further in Section 1.4.



Figure 3. A view from the Enterprise generator site (WR07) during Fall 2022 pre-season maintenance checks. Photo by WMI technician Jeremy Bilben.



1.2 Scientific Basis

Clouds in the lower troposphere form when, in cooling air, water vapor condenses upon cloud condensation nuclei (CCN), forming cloud droplets. The size of the droplets produced depends on the amount of water vapor present, and the character of the CCN. When the CCN are large or have properties that attract water (such as salt), the resulting droplets will be larger. The formation of cloud droplets happens on a very small scale, as illustrated in Figure 4. About one million (10^6) typical cloud droplets are required to produce a single, one-millimeter (mm) raindrop.

Precipitation forms in two ways. The simpler process involves the collision and coalescence of cloud droplets until the droplet becomes large enough to fall as precipitation. Thus, the initially-tiny cloud droplets grow, becoming drizzle, and with continued growth, rain. This process is known as the *collision-coalescence* or *warm rain* process.

The alternative path to precipitation development is through the formation of ice instead of raindrops, and it is this process that plays a significant role in winter clouds in Wyoming. For ice to exist, the cloud must be colder than 32°F (0°C). However, ice does not form spontaneously at temperatures colder than 32°F (0°C). In the absence of ice nuclei, water can become “supercooled”, meaning the water in the cloud remains in liquid form at temperatures well below zero Celsius. To most persons this is surprising, as we are accustomed to seeing water (at the surface) freeze whenever temperatures fall “below freezing.” Freezing happens at the surface because there are lots of substrates (substances or materials) present that encourage nucleation of the ice phase (freezing), and these substrates are largely absent in the free atmosphere.

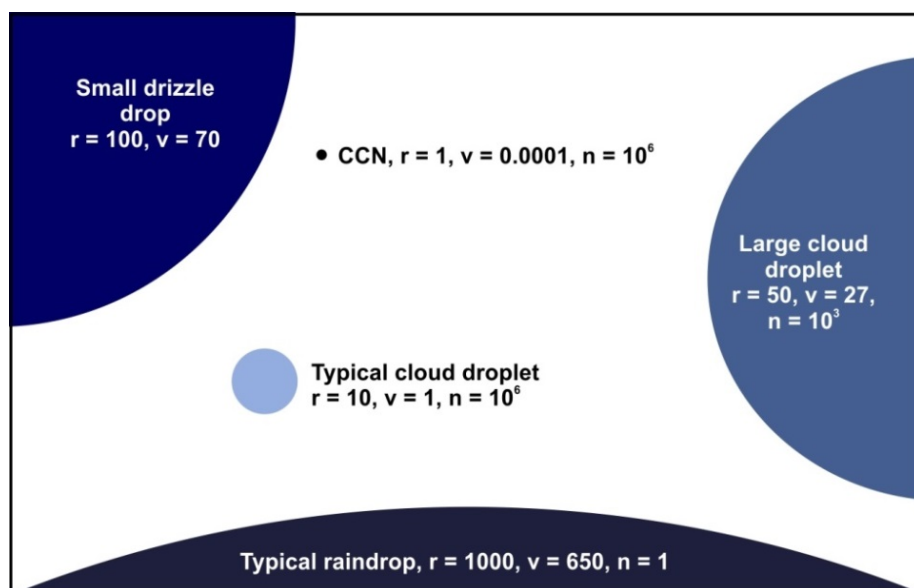


Figure 4. Relative characteristics of particles involved in cloud processes. For each, the radius (r , microns), fall velocity (v , cm per second), and number concentration (n , per liter) are given (after Wallace and Hobbs 1977). The raindrop shown (radius = 1000) is a 2 mm diameter raindrop.

Nature’s solution to the lack of substrates available to encourage the freezing process in clouds comes in the form of tiny particles called *ice nuclei*. Ice nuclei provide microscopic, crystalline “templates” for supercooled liquid water (SLW) to follow and transform to the solid form known as ice. The shape of an ice nucleus plays an important role in determining which atmospheric conditions will be better suited for the formation of ice crystals in clouds.



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Once ice forms in a cloud, the crystals grow quickly. Initially, growth occurs through water vapor deposition directly on the nascent ice particle, producing six-sided crystals. Within five minutes, these tiny ice crystals grow large enough to begin to fall. As they fall, growth by deposition continues, but because the ice crystals are heavier than the nearby SLW droplets they collect them as they fall. Upon contact with the ice crystals, the SLW droplets freeze. As they grow ever larger, the ice crystals may encounter each other and become tangled, forming aggregates known as snowflakes.

When clouds grow colder than about 23°F (-5°C) but do not immediately form ice crystals (very common), they can be treated with silver iodide-based ice nuclei which immediately initiate ice crystal formation, thus starting the ice-phase precipitation process. Ground-based seeding is commonly used in orographic applications, especially when the prevailing wind flow is roughly perpendicular to the mountain range, so that seeding agent is lofted immediately upward into the targeted clouds. This orographic seeding technique was the prime strategy used to seed winter clouds throughout the WWMPP and continued to be the main approach utilized in the Wind River Range during the operational seeding seasons in the winters since.

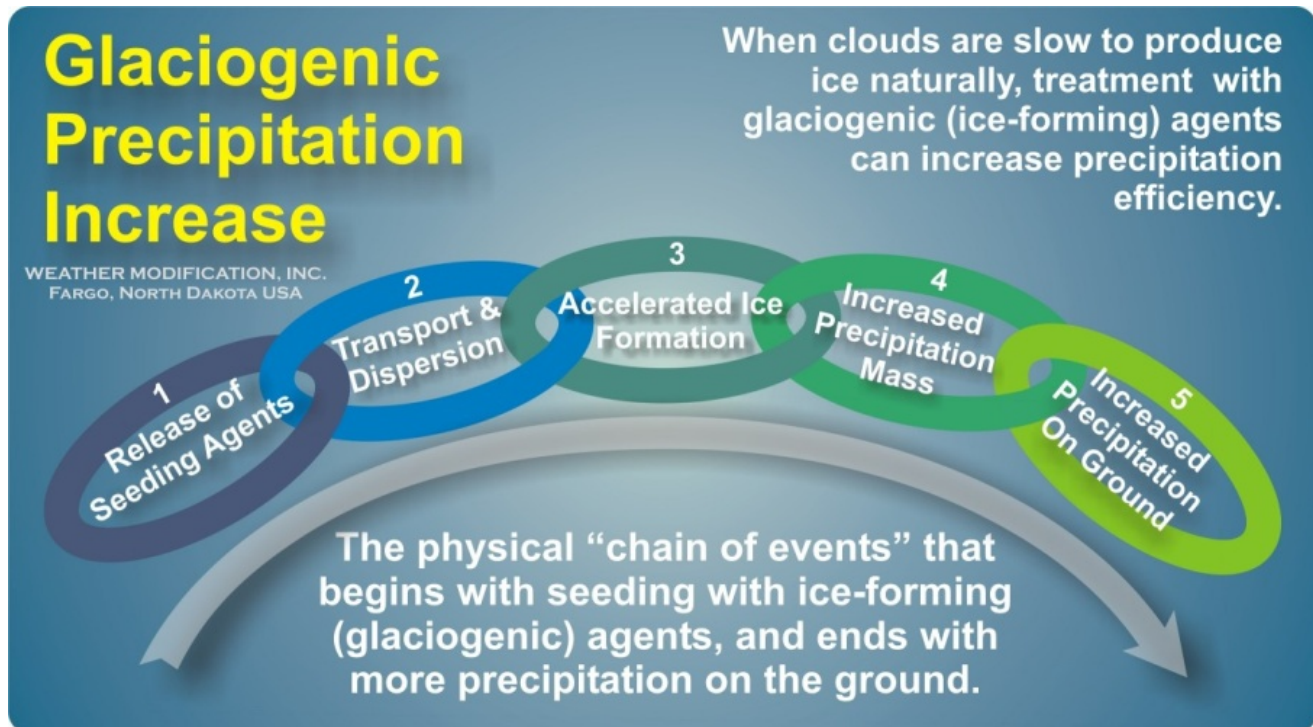


Figure 5. The physical chain-of-events that begins with release of ice-forming seeding agents and culminates with increased precipitation.

Given the chain-of-events illustrated in Figure 5, effectiveness of seeding operations depends upon three things:

- The clouds of interest must contain liquid water.
- The cloud temperature at the level where liquid water is present, typically in the neighborhood of 10,000 feet MSL, must be colder than +23°F (-5°C). Natural ice nuclei, such as crystalline soil particles, do not act to form ice crystals until the cloud is much colder, +5°F (-15°C) at the warmest. The AgI seeding agent, by virtue of its crystalline shape being very close to that of ice, begins to form ice crystals much sooner, at about +23°F (-5°C). As a result, precipitation formation within the cloud starts significantly sooner, allowing more time for the ice crystals to grow and transform into snow.
- The wind direction and speed must be such that the seeding agent released from the ground-based generators will be transported up the mountain slope and into the target clouds.

1.3 Operations

The three criteria above were the same as those used in the WWMPP research, except the temperature criterion for seeding during the WWMPP was slightly colder (+17.6°F or -8°C) during the pilot project. The colder temperature threshold was used in the research to ensure that more of the seeding agent would activate in the cloud and produce a stronger seeding signature.



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In operational seeding, the temperature criterion can be met in warmer conditions as long as some of the ice nuclei still produce ice crystals. This being said, it must be noted that the magnitude of the seeding effectiveness will diminish as temperatures warm. Seeding should not occur when temperatures aloft are warmer than +23°F (-5°C). This widening of the temperature window for seeding increases the number of seeding opportunities. Most operational (vs. research) seeding programs use this warmer temperature criterion.

1.4 2022-2023 Program Funding

In addition to the 37% of funding costs provided by the State of Wyoming, funding for the 2022-2023 operations was also provided by the following organizations/agencies.

Southern Nevada Water Authority. The Southern Nevada Water Authority (SNWA) is a cooperative agency formed in 1991 to address Southern Nevada's unique water needs on a regional basis. SNWA officials are charged with managing the region's water resources and providing for Las Vegas Valley residents' and businesses' present and future water needs. With Colorado River water currently representing 90% of SNWA's water supply, the SNWA partners with other Colorado River Basin states to optimize and enhance Colorado River water supplies.

Central Arizona Water Conservation District. The Central Arizona Project (CAP) delivers Colorado River water via a 335-mile aqueduct system to customers in Maricopa, Pinal, and Pima Counties in Arizona, home to 80% of Arizona's population. The CAP diverts more than 1.6 million acre-feet annually, providing water to cities, towns, irrigation districts, Native American communities, and stores water underground for future use during times of drought or shortage. The Central Arizona Water Conservation District manages its Colorado River resources for current and future residents in central Arizona, and continuously seeks collaborative approaches with partners in the Colorado River Basin to protect and augment the water supplies in the Colorado River System.

Colorado River Board of California - Six Agency Committee. The Six Agency Committee was created in 1950 through an agreement among Palo Verde Irrigation District, Coachella Valley Water District, San Diego County Water Authority, Imperial Irrigation District, the Metropolitan Water District of Southern California and the City of Los Angeles Department of Water and Power. The Six Agency Committee provides funding to support actions to safeguard the members' rights and interests in the Colorado River system and for the Colorado River Board of California.

For the 2022-2023 winter season, two other project sponsors continued their support, each having an interest in the water resources within the Green River Basin. Their contributions were modest but meaningful, and very much appreciated. These supporters were: Rocky Mountain Power and the Green River/Rock Spring/Sweetwater County Joint Powers Water Board. Rocky Mountain Power contributed \$3,000 and the Green River/Rock Springs/Sweetwater County Joint Powers Water Board contributed \$5,000.



2 PROJECT PERSONNEL AND FACILITIES

2.1 Personnel

WMI provided an experienced ground-based cloud seeding crew for the 2022-2023 winter season. It consisted of project forecasters who monitored the weather and made the decisions regarding which ground-based generators should be used, and when each should be turned on and off, and the project technicians, who maintained and operated the field units.

2.1.1 Meteorology Team

The meteorology team was led by an experienced team of four, with occasional assistance by two others. Sarah-Ellen Calise and Lillie Farrell were located on-site in Pinedale, WY for the project duration. Adam Brainard operated WMI's numerical weather prediction models and coordinated data collection during the season. Jason Goehring led the forecasting team and was the primary operations meteorologist. Goehring was assisted by Sarah-Ellen Calise and Lillie Farrell. Jeff Ceratto and Caleb Steele participated in forecasting and operations periodically throughout the season.

This was Goehring's eighteenth season of Wyoming seeding operations and forecasting. Brainard has been involved with the Wyoming seeding programs since 2016, providing forecasting, numerical weather prediction services, and web-based information support. Ceratto had four previous seasons of winter experience on the Central Mountain & Upper Snake River Weather Modification Program (sponsored by Idaho Power Company) as a WMI contract meteorologist, and it is his second season with involvement on the Wyoming program. This was Calise's second winter season with WMI, and Farrell's first.

Goehring, Brainard, and Ceratto are all Modification Association Certified Operators. Bruce Boe, WMI Vice President of Meteorology, provided overall management of the meteorology team and is a Weather Modification Association Certified Manager.



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ADAM BRAINARD
CHIEF METEOROLOGIST



JASON GOEHRING
FIELD METEOROLOGIST



SARAH-ELLEN CALISE
FIELD METEOROLOGIST



LILLIE FARREL
FIELD METEOROLOGIST



CALEB STEELE
FIELD METEOROLOGIST



JEFF CERATTO
FIELD METEOROLOGIST

Figure 6. The 2022-2023 Wyoming Winter Meteorology Team.

2.1.2 Technician Team

Three technicians participated in the 2022-2023 operations. On-site technical work was conducted by Mr. Michael Paul, assisted by Mr. Ryan Hudson and Mr. Pat Trujillo for the Wind River Range. Further assistance in the Sierra Madre Range was provided by Logan Adams, Corsin Kerbs, and Brian Roche.

Since maintenance and servicing of generator sites could only occur when storms were not expected, field days were often long, as technicians tried to get to as many sites as possible. Safety guidelines require that no fewer than two technicians travel into the field together, largely in the event of equipment failure (i.e., a snowmobile breaking down or getting badly stuck), but also because two persons are required to complete tasks such as adding seeding solution to a generator. Safety is always of paramount importance, but even more so during heavy-snow winters (such as the 2016-2017 season) when sleds sink more deeply into the always-fresh snow, and avalanche risk may be heightened.



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MICHAEL PAUL
ELECTRONICS TECH



JEREMY BILBEN
ELECTRONICS TECH



RYAN RICHTER
ELECTRONICS TECH

Figure 7. The 2022-2023 Wyoming Technician Team. Not pictured are Ryan Hudson, Pat Trujillo, Logan Adams, Corsin Kerbs, or Brian Roche.

Additional support from WMI headquarters in Fargo, ND was provided by Dennis Afseth, WMI Director of Electronics, and technicians Ryan Richter and Jeremy Bilben. Richter has been providing support for the field program since its inception in 2006. Overall project recordkeeping and reporting was done by Jake Van Ornum and Erin Fischer, Director of Client Services.



ERIN FISCHER
CLIENT SERVICES



BRUCE BOE
VP METEOROLOGY



JAKE VAN ORNUM
CLIENT SERVICES ASSISTANT



DENNIS AFSETH
DIRECTOR OF ELECTRONICS

Figure 8. The 2022-2023 WMI Administrative Support Team.



2.1.3 Pre-Project Ground School

A pre-project ground school was held remotely via GoToMeeting with the flight crew, meteorology team, client, and key WMI staff on 7 November 2022. Attendance was mandatory for WMI project employees. The meeting topics included forecasting, modeling, media protocol, overview of the project, reporting pre- and post-flight, all ground-based cloud seeding operations, and safety. WMI administrators – Bruce Boe, Vice President of Meteorology; Jody Fischer, Vice President of Operations; Erin Fischer, Director of Client Services, and Jake Van Ornum, Client Services Assistant, also attended the kickoff meeting. The meeting allowed both groups to share information which improved communication, program efficiency, and contributed to the overall success of the program.

2.2 Siting of Seeding Equipment

Ground-based units were placed at ten physical locations within the project target area. These sites remain unchanged from those utilized in the WWMPP and the previous operational seeding seasons in the Wind River Range, see Figure 9.

The generator placement was such that individual generators could be activated according to wind direction, and as storms passed and conditions changed. As shown, nine of the ten generator sites wrapped around the western to southwestern side of the mountain range, beginning with the Green River site on the west and ending with the Anderson Ridge site at the extreme southern end. These locations allowed targeting of the range when wind directions were within the southwestern quadrant. The tenth site, Enterprise, allowed targeting when winds were easterly. All sites were on state-owned or private lands. Permissions were established through the Wyoming Office of State Lands and Investments or private memoranda of understanding, accordingly.



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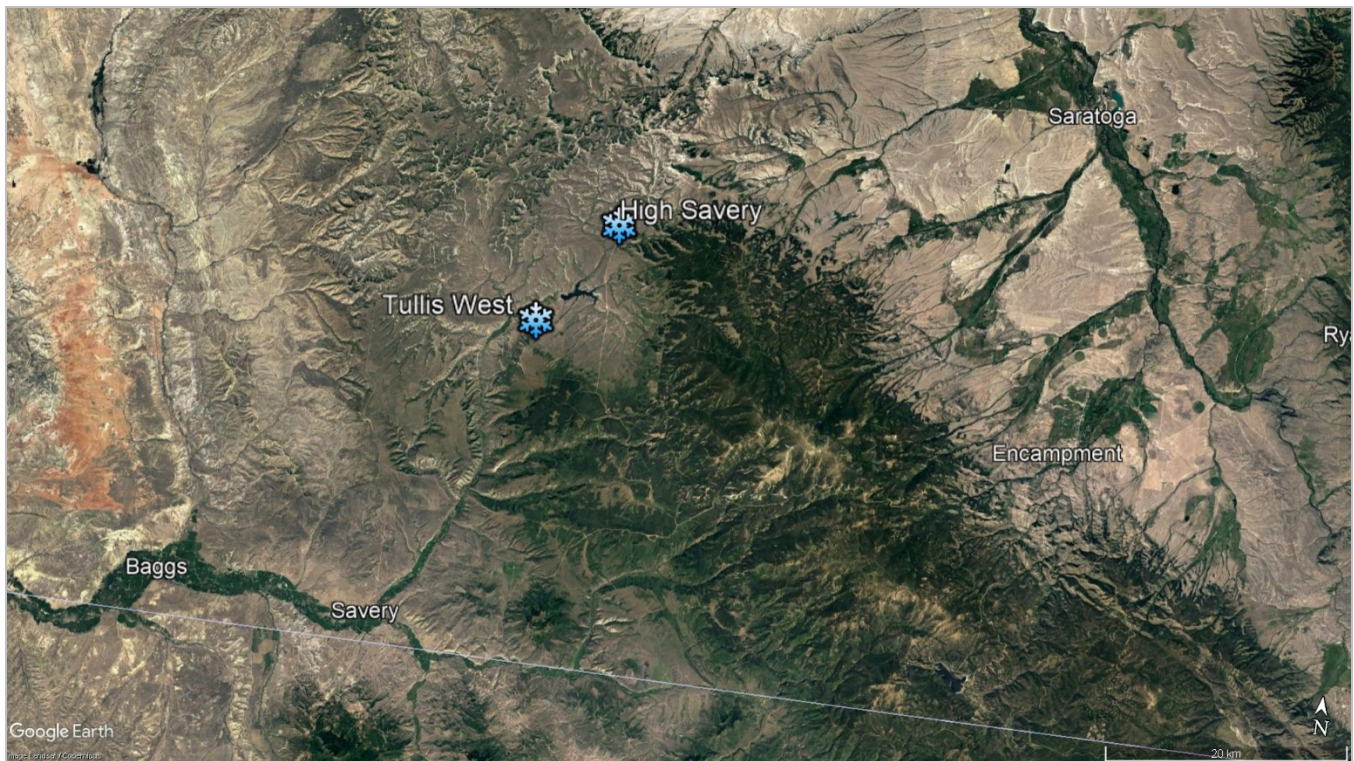


Figure 9 (top) and 10 (bottom). The locations of the ground-based ice nucleus generators in Wind River Range and Sierra Madre Range are indicated by the snow crystal symbols.

2.3 Ice Nucleus Generators

The ice nucleus generators were designed, fabricated, deployed, operated, and serviced by WMI. The primary components are shown in Figure 11.

The Wind River Range generators are entirely independent, controlled via satellite, and powered by batteries charged by solar power. This allowed siting of generators at higher elevations, significantly improving delivery of seeding agent to the clouds. Remotely-controlled generators can be activated and deactivated as weather conditions warrant. This allows seeding agent to be dispersed only when it will be effective. All generator lines and fittings are made of corrosion-resistant stainless steel, to accommodate the high-performance seeding solution.

The generators are robust; designed to function in extreme temperatures, winds, and precipitation.

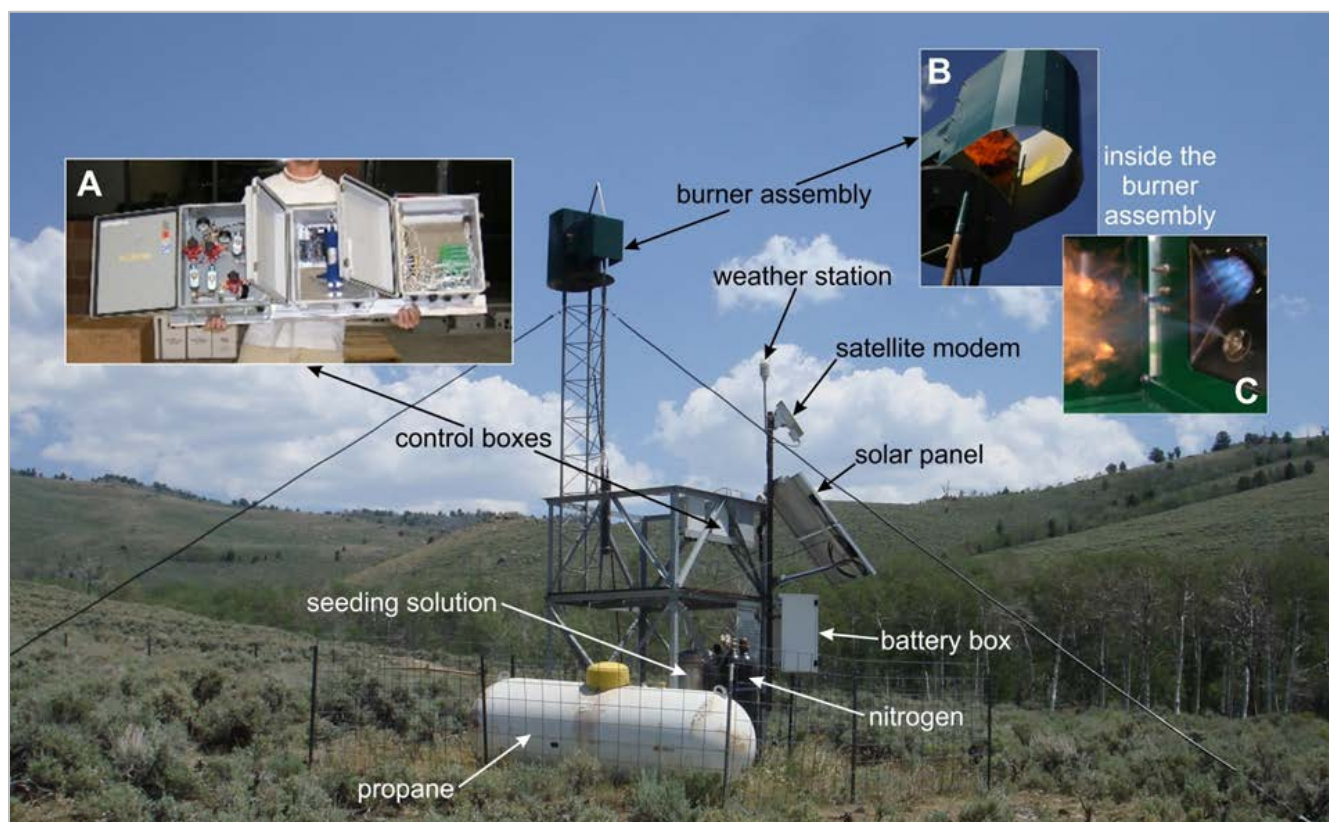


Figure 11. The primary components of the WMI remotely-controlled ground-based ice nucleus generator are illustrated. Inset A, shows the contents of the control boxes. From left to right, these are: solenoids (electronic valves) to turn flows on and off, seeding solution flow rate regulation and measurement, and computer interface with the satellite modem. Inset B, provides a view up and into an ignited generator, and Inset C, shows how the seeding solution is atomized through a nozzle (silver disk, lower right) and into the burning propane (blue flame) and ignited (bright orange flame).

The computer interface used to control the generators is shown in Figure 12. The status of the entire generator system (voltage, pressure, relay (valve) status, and flame temperature) is available for inspection by the technician immediately upon connection to the satellite.



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Clicking the Start Seeding button (lower left on the interface, Figures 12 and 13) automatically sequences the generator start-up. At the generator, a valve will open to allow propane to flow. Ignition of the propane is confirmed on the interface by a rapid increase in indicated flame temperature. When the generator is not burning, the “flame temperature” is that of the ambient air. Once the generator is burning, the seeding solution is atomized by the nozzle and sprayed as an aerosol into the propane flame (Figure 11, Inset C). As the solution burns, particles of silver iodide are transported by the wind into the clouds over the mountains. Several of these steps, such as the flow rate of the seeding agent, can be confirmed by the technician utilizing the WMI remote-controlled ice nucleus generator interface.

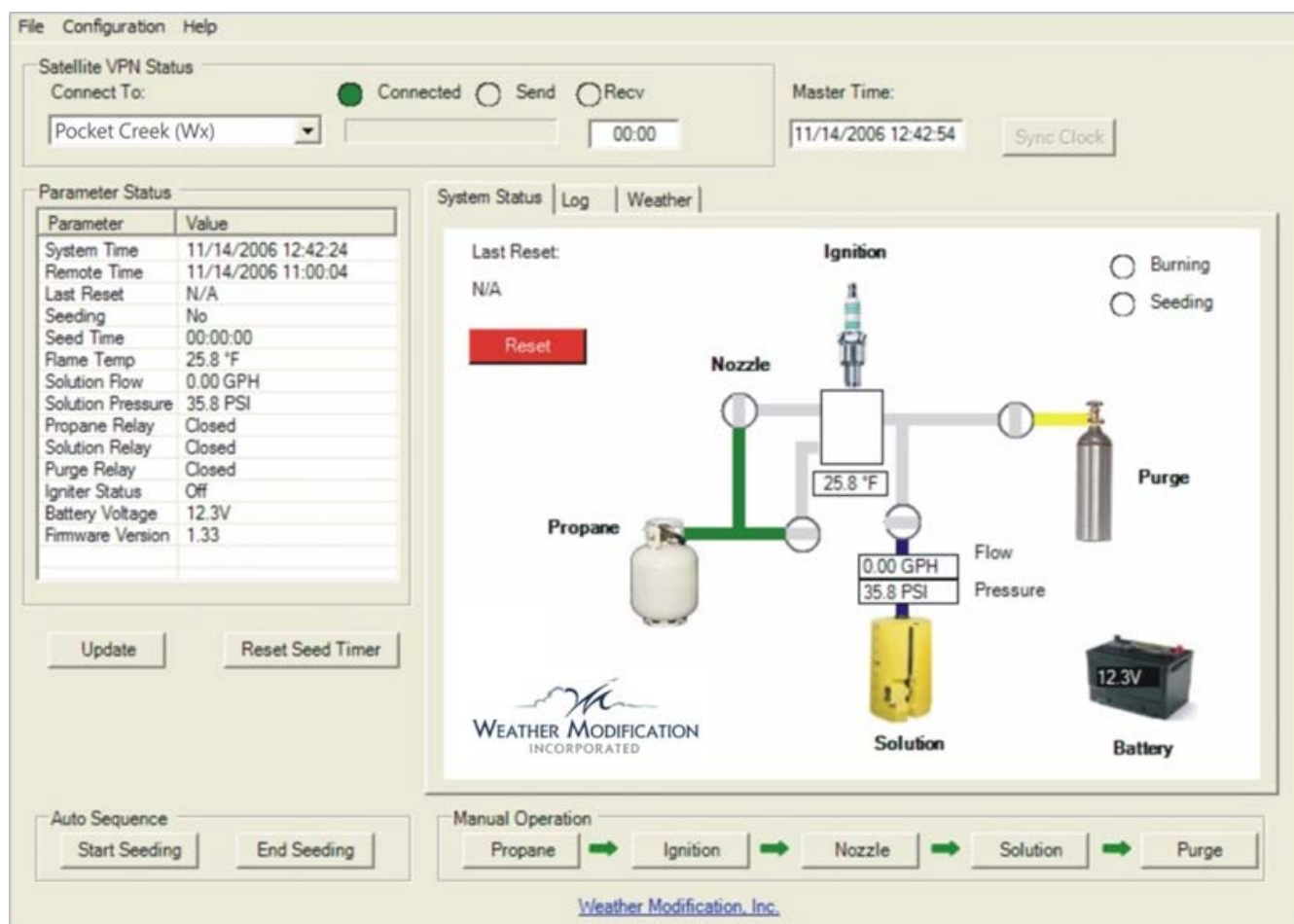


Figure 12. The control interface for the WMI remotely-controlled ground-based ice nucleus generator is shown, after connection is established via satellite, but before the generator is turned on. All flow valves are off, seeding solution flow is zero, but system status is reported.

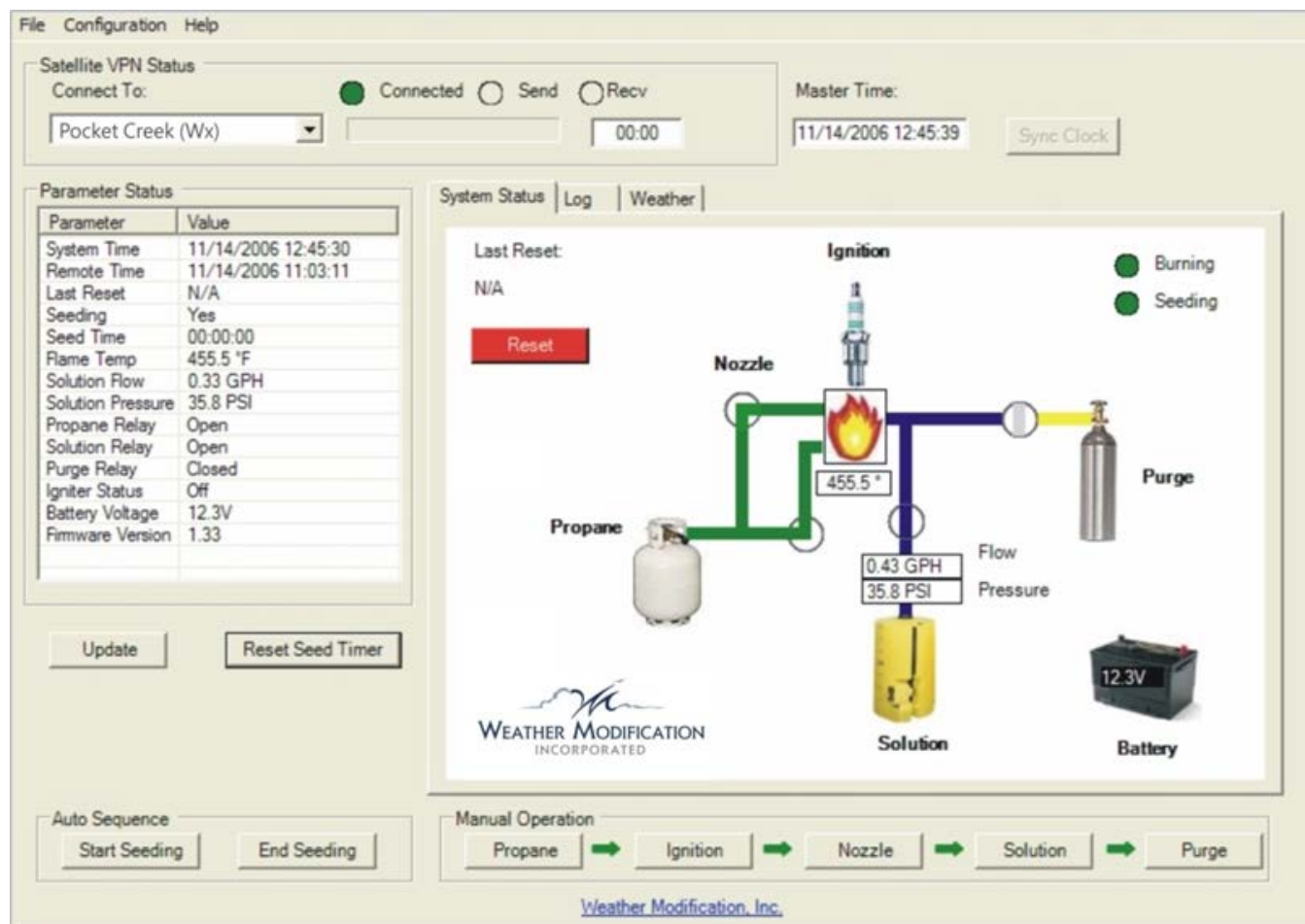


Figure 13. The WMI remote-controlled ice nucleus generator interface is shown, as it appears during seeding operations. Valves are open, the flame is known to be burning, and the seeding solution flow rate is also known. Seeding is certain.

2.4 Seeding Solution

The high-performance seeding solution used on this program was tested at the Colorado State University Cloud Simulation and Aerosol Laboratory by DeMott (1997). These tests determined that colder cloud temperatures produce a bigger yield of active ice nuclei per gram of AgI burned. As shown in Figure 14, the yield increases markedly from -6°C (+21.2°F) to -8°C (+17.6°F), and even more at -10°C (+14°F). At a cloud temperature of -6°C, 3×10^{11} nuclei are active per gram of AgI burned. In more conventional notation, this is 300,000,000,000, or 300 billion.

Most seeding programs in the western United States commonly commence seeding operations at -5 or -6°C. As in the previous five seasons, the 2022-2023 Wind River operations used a temperature criterion of +21°F (-6°C) at 700 hPa, which is about 10,000 feet above sea level, the average elevation of the crestline of the Wind River Range.



It was previously mentioned that this seeding solution is “high-performance”. This means that unlike simpler solutions that produce a simple AgI nucleus, this high-performance solution produces nuclei that contain salt, which enables them to function by the condensation-freezing mechanism. The non-salty, simple AgI nucleus functions by the contact-freezing mechanism. The differences between the two are as follows:

Contact-freezing. For this freezing process to occur, the ice nucleus must contact a supercooled cloud droplet ($\leq -5^{\circ}\text{C}$). The speed at which this type of nucleation occurs depends upon the density of the water droplets in the cloud. Clouds with a lesser liquid water content contain fewer droplets, so it takes much longer for the chance collisions between the AgI nuclei and water droplets to occur, resulting in slower nucleation of the cloud. In clouds with greater liquid water content cloud droplets are plentiful, so nucleation occurs more quickly. After the ice nucleus and supercooled water droplets make contact, the droplets freeze and can continue to grow by other ice-phase growth processes: deposition, accretion, and aggregation.

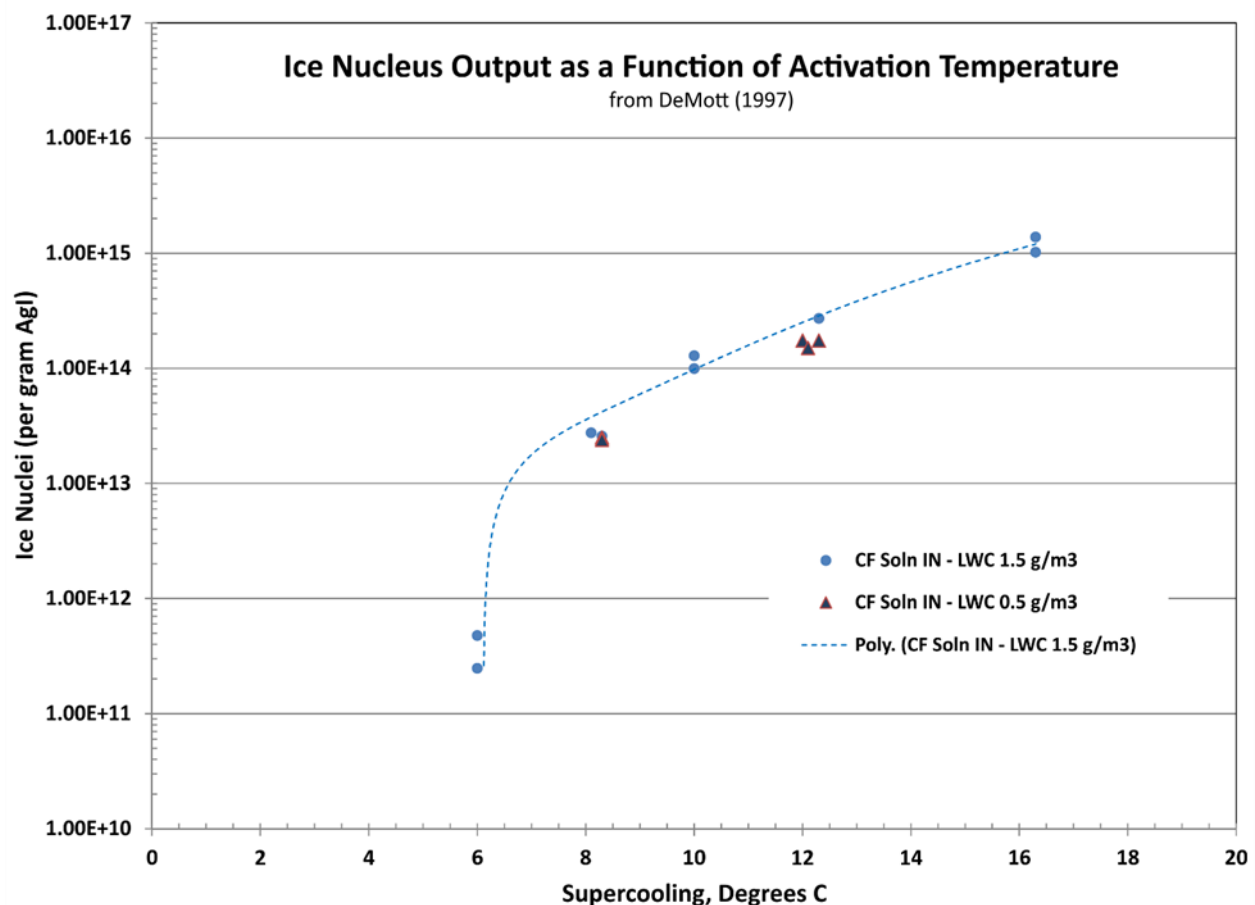


Figure 14. Yield as measured by the number of active ice nuclei per gram of silver iodide (AgI) burned, is shown as a function of temperature (DeMott 1997). These nuclei are comprised of silver iodide, silver chloride, and salt (NaCl).



Condensation-freezing. Nuclei of this type attract water vapor and immediately form water droplets, eliminating the requirement for collisions between ice nuclei and cloud droplets. Freezing results as soon as the droplets containing these nuclei cool to at least -5°C. Unlike the contact-freezing process, the speed at which this type of nucleation occurs does not depend upon the density of the water in the cloud. As soon as freezing occurs, the new ice particle can grow by other ice-phase growth processes.

The nucleation advantage of the more complex solution used in the Wind River operations is considerable, especially in clouds having lesser liquid water. The sole disadvantage of the complex seeding solution is that, containing salt, it is more corrosive than the simpler solution. Using the more complex seeding solution requires generators designed to burn it. The generators must be equipped with corrosion-resistant stainless-steel tanks, lines, and fittings to avoid operational failure, and require more frequent maintenance.

2.6 Shop and Site Servicing



Throughout the season, WMI maintained a shop in Pinedale that provided storage and served as a staging area for generator service. The shop housed WMI's 4x4 truck, ATV, snowmobiles, trailer, spare generator parts, trouble-shooting equipment, and replacement nitrogen tanks.

Figure 15. The WMI technician crew performs a maintenance check of generator WR03 (High Savery). Photo by WMI technician Michael Paul.



3 FORECASTING AND OPERATIONAL DECISION-MAKING

3.1 Meteorological Data Sources

The bulk of the weather information used for forecasting and weather monitoring was obtained from the Internet. Among these sites were those of RAP Real-Time Weather, the National Center for Environmental Prediction (NCEP), the College of DuPage, Pivotal Weather, and the University of Wyoming. While many of the web-based weather products (i.e., National Weather Service (NWS) products) were publicly available, some data sources were project-specific. WMI also implemented an operational numerical model for the project; this is discussed in detail later in this section.

3.1.1 Radiometer

The WWDO radiometer was deployed at the East Fork generator site for the 2022-2023 season. The unit was operated at a 10° elevation angle over the Wind River Range, where the measurements indicated if liquid water was present.



Figure 16. Adam Brainard performs maintenance on the WMI radiometer during the 2022-2023 winter season. Photo by WMI Technician Michael Paul.

3.2 Numerical Weather Prediction

3.2.1 WRF Modeling

For the 2022-2023 season, WMI operated a variable nested limited area domain of the Weather Research and Forecasting (WRF) model. During quiet weather periods, an inner high-resolution nest covering both this ground-based generator program and the Wyoming-Aerial project was used. When weather was more active, and operations were either possible or ongoing (aka IOP mode), individual nests for the two programs were



implemented. The high-resolution inner nest(s), whose boundaries are shown with a thick black border(s) on the plots below, was initialized from the High-Resolution Rapid Refresh (HRRR) model, and was given the North American Model (NAM) forecast for boundary conditions at 3-hour intervals. The outer domain grid spacing was 9 km and the inner higher-resolution nest grid spacing was 3 km during quiet periods, 9km and 1.8km in IOP mode. The model was routinely run twice per day, with a 60-hour forecast duration for the 12 UTC model cycle and a 72-hour forecast duration for the 00 UTC model cycle. When IOP mode was activated, shorter model integrations from 06 and 18 UTC initial condition datasets were also executed. Information provided by these customized WRF runs provided very specific tools that greatly improved targeting and effectiveness of seeding, such as the explicit forecasting of supercooled water content over the flight tracks, and winds/temps aloft at a high spatiotemporal resolution.

Many graphical outputs were developed specifically to aid cloud seeding decision-making. A few examples of the more unique or meteorologist-favorite products are shown in the following figures. Figure 17 shows forecast integrated cloud water colder than -5°C over the Wind River Range.

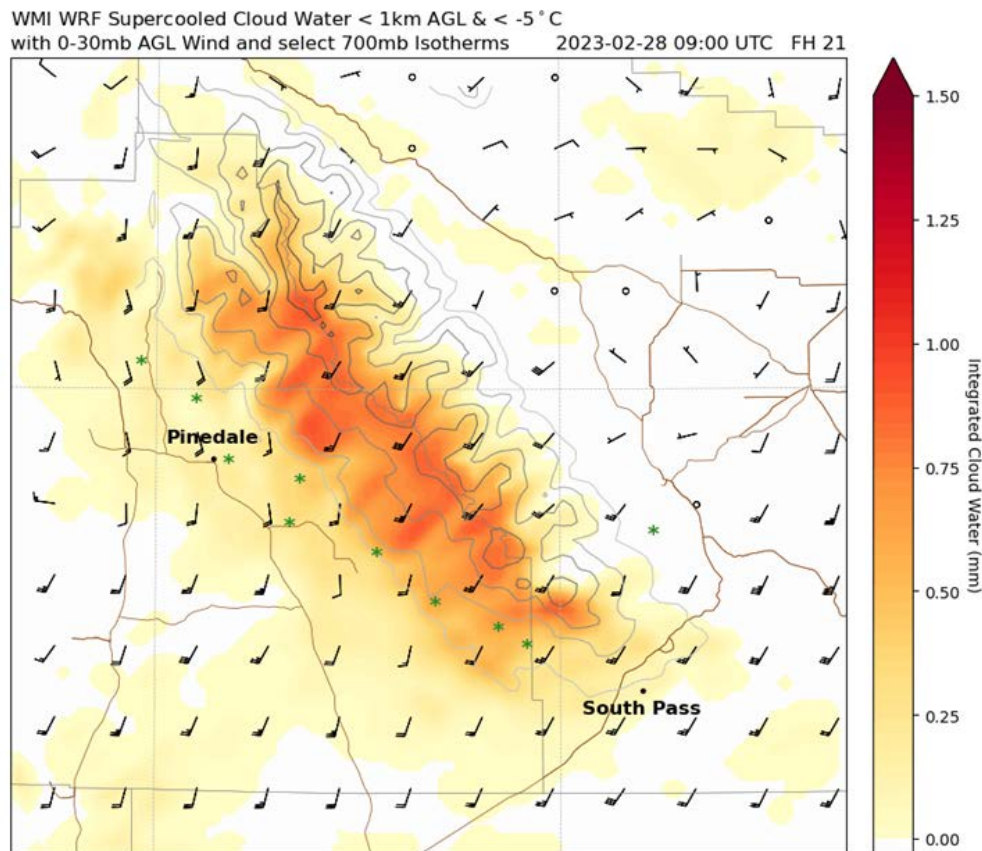


Figure 17. Near surface wind barbs are shown with integrated cloud water on this panel from the WMI WRF model, valid on 28 February 2023, at 09:00 UTC. Since the liquid water shown is only that which is found at -5°C and colder, it is supercooled sufficiently for seeding. The WMI WRF was initialized and run as often as every six hours; plots such as this were produced every hour. Contours show model terrain elevation at 1,000 ft intervals beginning at 8,000 ft. Small green asterisk symbols denote the location of a project ground generator.



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Though knowing the SLW distribution shown in Figure 16 is very helpful in determining which of the 10 ground-based generators should be activated, it is also very helpful to know the vertical distribution of SLW and cloud ice, as well as the height of the -10°C isotherm. This information was available to the project meteorologists in the form of vertical cross-sections (Figure 17).

The meteorologist could examine the evolution of SLW and cloud ice along four different cross sections. One was along the southwest side of the Continental Divide, northwest to southeast. Another was from the Green River generator site, approximately perpendicular to the orientation of the Wind River Mountains. A third was from the Pocket Creek generator site, perpendicular to the range, and the fourth was west-to-east through the central portion of the range.

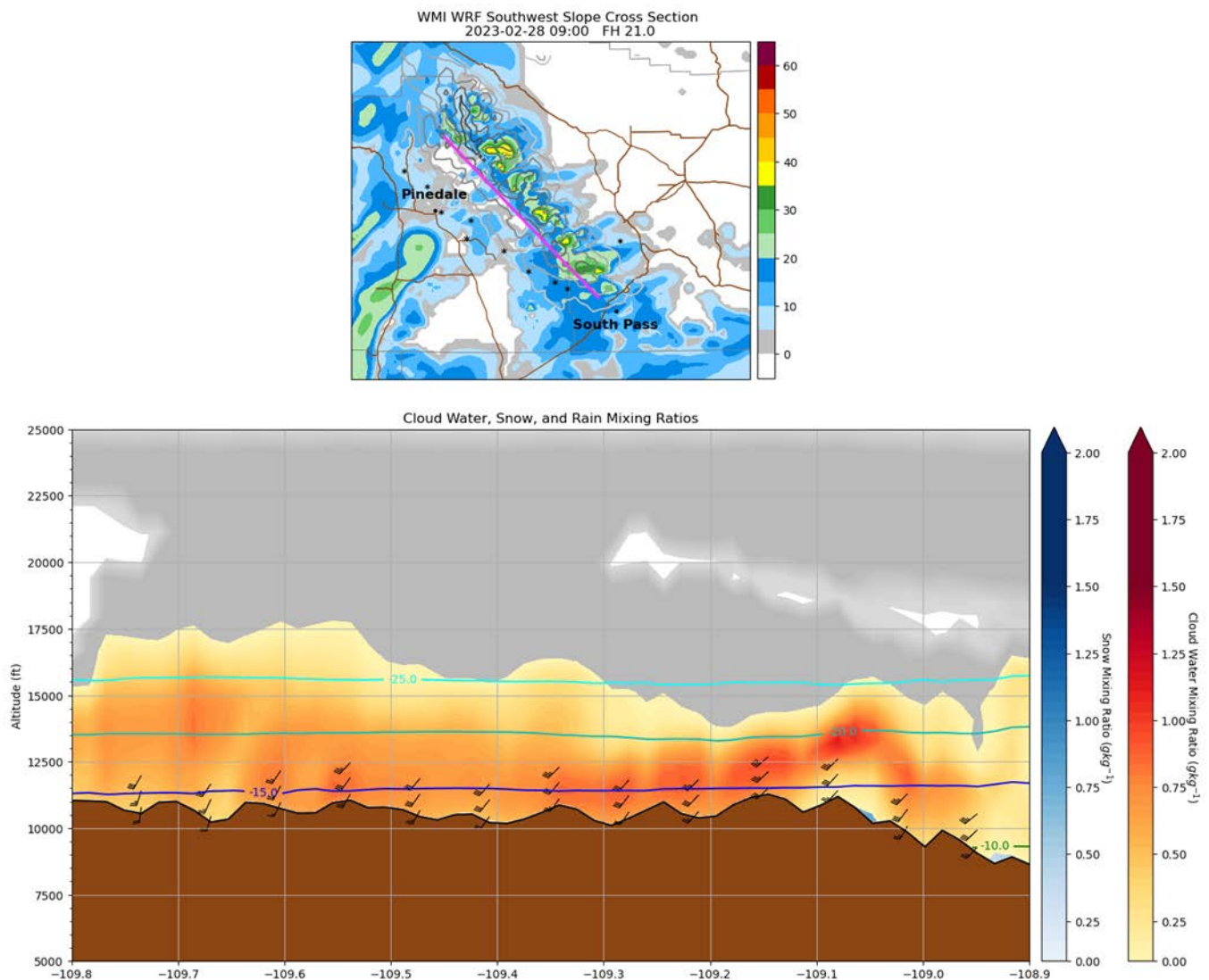


Figure 18. Vertical cross section from northwest to southeast near and west of the continental divide. Cross section line shown in pink on the forecast composite reflectivity plot on the top half of the image. The plot represents 09:00 UTC on 28 February 2023. See text for interpretation and discussion.



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The example shown in Figure 18 for 28 February 2023 is the cross section southwest of the continental divide. In the lower panel, a substantial region of cloud water is predicted. Note that the region lies entirely above the -5°C isotherm, so the liquid water is supercooled—perfect for seeding. The position is also very favorable, being to the left (upwind) of the range. This allowed the seeding agent to initiate the development of ice—and thus precipitation—in time for it to fall on the target. Plot priority is given to cloud water over snow, so some areas of predicted snow are not visible. Spatial maps and cross sections were animated in 1-hour time steps, providing a crucial understanding of expected storm evolution.

Thermodynamic stability throughout the Wind River domain was made part of the suite of products created during the WMI WRF model runs. The meteorologists also considered Froude Number to determine if the plume(s) would go over the range or be blocked by it, as well as the model vertical velocity field at the lowest vertical level (Figure 19).

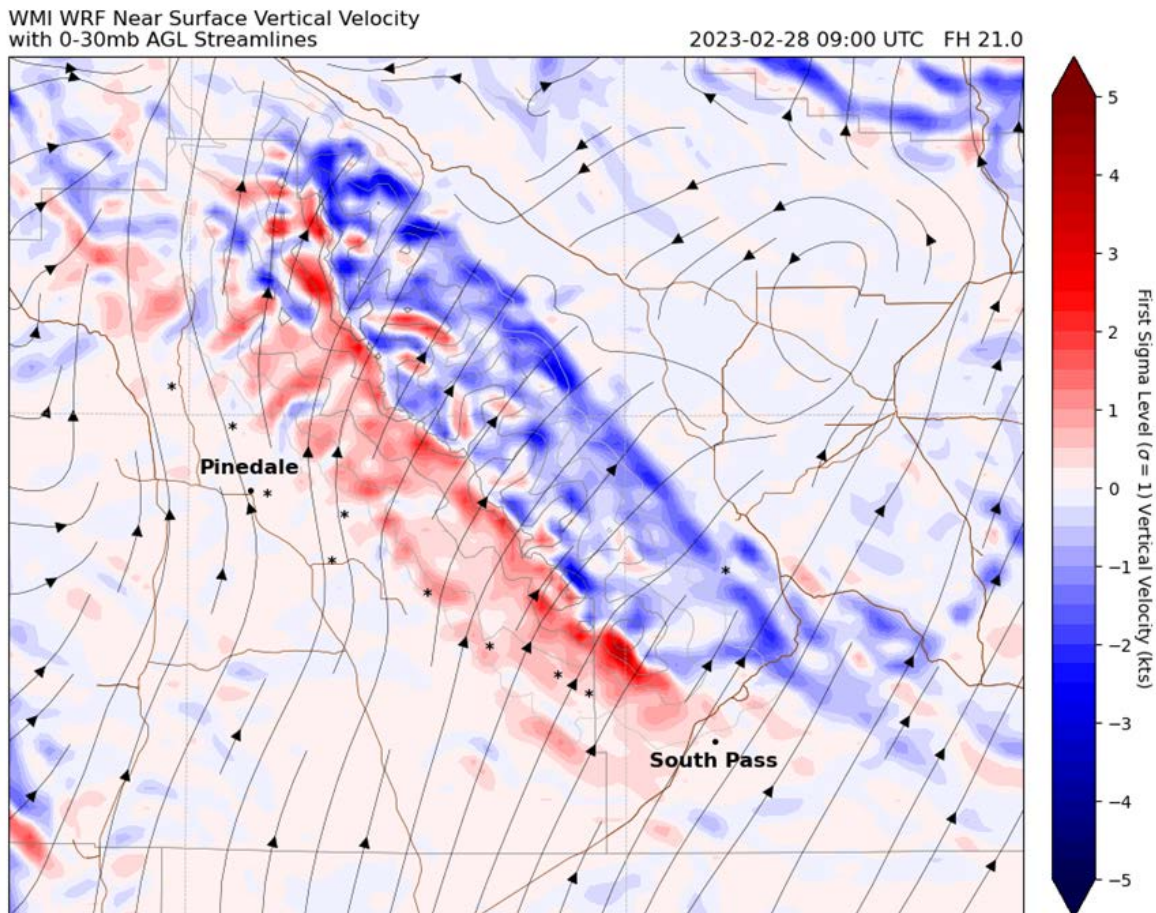


Figure 19. This product, also designed specifically for winter orographic seeding, shows the near surface vertical velocity along with streamlines of the near surface (average 0-30 mb AGL) wind. Here, ascending air is shown in red, with descending air in blue. This plot helps illuminate when sufficient upslope winds exist to transport seeding materials from ground generators up into the target area. This plot shows favorable seeding conditions for many of the western Wind River ground generators.



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Finally, meteograms show a snapshot of upcoming weather conditions at a fixed point in space. Several different types of meteograms are produced for a number of locations in the target area, but a particularly useful one is the Mid Atmosphere Conditions plot shown below (Figure 20). This plot illustrates the progression of 500 hPa and 700 hPa temperature through the 48-hour forecast window shown here, along with 700 hPa relative humidity, precipitable water, and 700 hPa wind. In this example, modest warming is predicted to occur the night of March 31, with near-saturated conditions at 700 hPa and winds shifting from northwest to southwest by the morning of April 1. Seeding occurred from midday April 1 into the overnight hours when winds pivoted further to the northwest and orographic cloud coverage diminished.

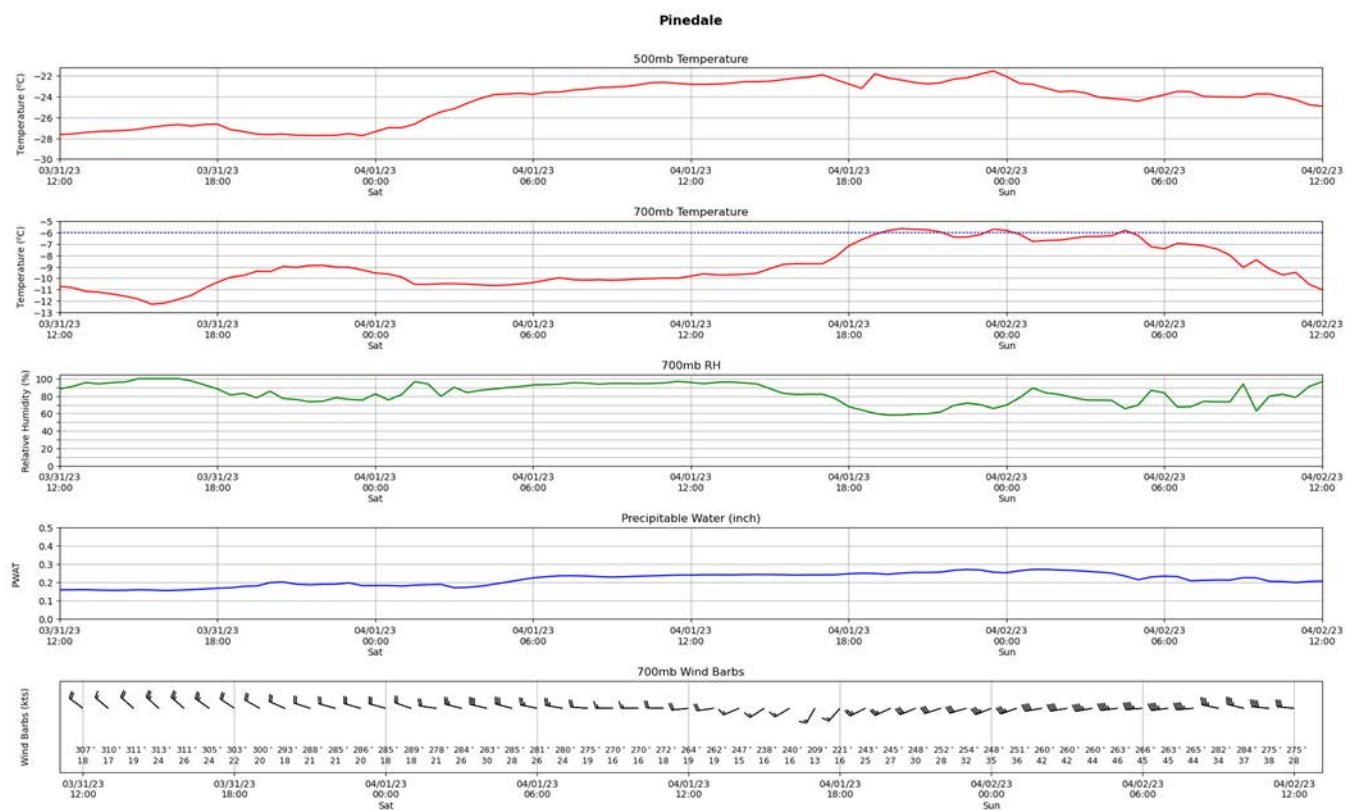


Figure 20. A meteogram illustrating the progression of key atmospheric variables (mid and low-level temperature, moisture, and low-level wind) in Pinedale. In this example, from the 12 UTC run on March 31, sufficiently cool temperatures, high low-level moisture, and improving wind direction (becoming more perpendicular to the range) gave meteorologists and ground technicians an early warning a favorable period for seeding operations may develop. Additional information and commentary is provided in the text above.



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3.2.2 HYSPLIT Modeling

During the 2022-2023 season, WMI ran the Hybrid Single-Point Lagrangian Integrated Trajectory (HYSPLIT) plume dispersion model to establish a better idea of seeding agent plume behavior. The process was automated, performed with each update of the WRF, providing a complete record of predicted plume trajectories for the season. These HYSPLIT plots were output in one-hour increments, with each plot showing forecast locations of plume centerline (the most-dense portions of the plumes) for four hours. A series of such plots is provided as Figure 21, for the 14 April 2022 seeding event. In the plots, each hour is shown by a “dot” on the plume centerline.

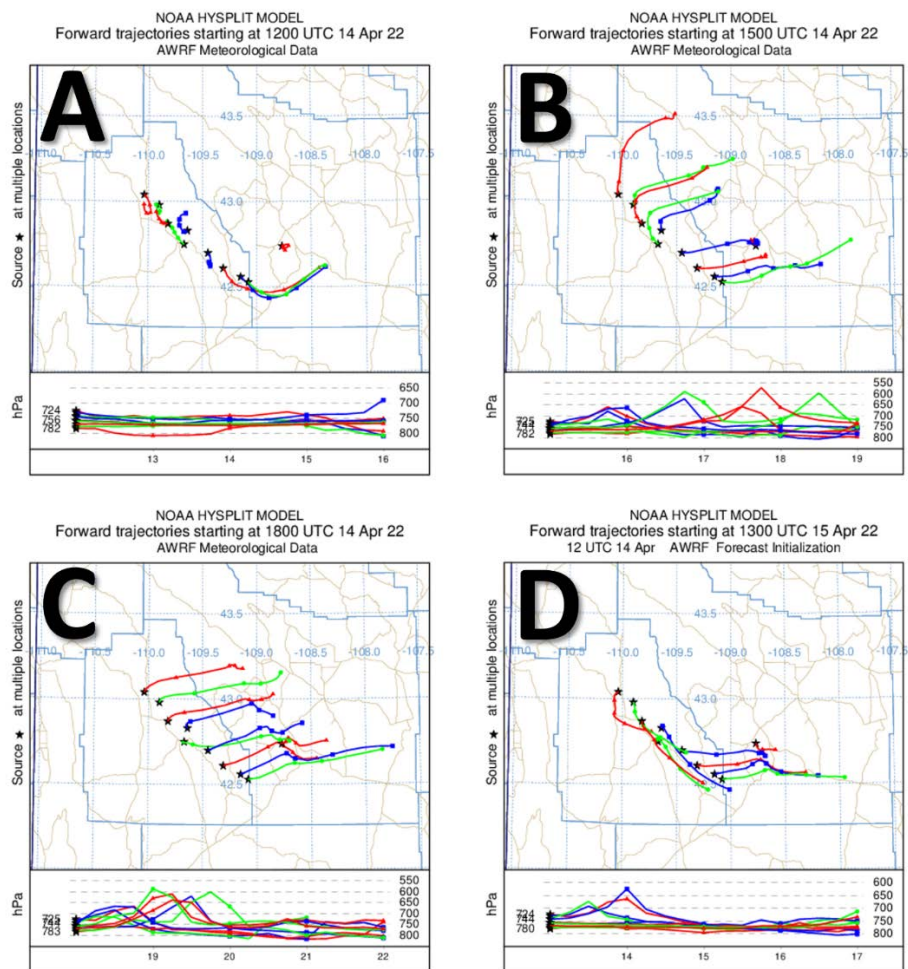


Figure 21. The evolution of the centers of plume trajectories is shown for the seeding event on 14 April 2021. Times (UTC) are as follows: (A) 12:00 April 14th, (B) 15:00 April 14th, (C) 18:00 April 14th, and (D) 13:00 April 15th. Before the seeding began (A), most plumes were projected to remain beneath a stable layer of air, with only a couple ground generators forecast to flow indirectly over the Wind River Mountains after a period of a couple hours. In (B) instability has increased and winds have strengthened such that trajectories from several ground generators all travel directly over the crest, however lower elevation sites such as Green River and East Fork continue to indicate initial movement of a seeding plume would not lift over the range. By 18:00 UTC (C), flow and instability have improved enough that all western ground generators indicate favorable lifting over the target range. By (D) at 13:00 UTC (April 15th), a cold front has shifted low level winds to the northwest, and all seeding opportunities ceased. Cloud conditions had deteriorated prior to this time, and seeding was no longer in progress.



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3.3 Timetables and Routines

If seeding was not underway at dawn, the following daily routine ensued.

WMI furnished a daily “first glance” update that provided an outlook into the probability of seeding operations taking place that day. This very simple form, sent to all project personnel, provided an early look at the weather expected each day. Four time periods were specified, from issuance until noon, from noon until sunset, from sunset until midnight, and from midnight until dawn the next day. The probability of seeding operations occurring in each of these time periods was rated by the forecaster as no chance, unlikely, possible, or probable. Technicians used this outlook to help inform equipment operation and maintenance decisions. In instances when seeding operations were already active in the morning, the “first glance” outlook would still be issued, reflecting the status of current operations.

The “first glance” update was followed by a much more detailed forecast and weather briefing, typically disseminated to the WWDO and all funding partners by late morning via email. These daily briefings included a summary of the preceding day’s weather and seeding activities, a summary of the current synoptic-scale weather pattern, and conditions likely to exist for the next 24 hours in the Wind River Range. Oftentimes weather conditions would vary sufficiently during the day that evening forecast updates were warranted and provided. The Orographic Day Category (ODC), shown in Table 1, numerically categorized the probability of seeding operations occurring.



PROBABILITY OF SEEDABLE CONDITIONS			
Until Noon WR SM	Noon to Sunset	Sunset to Midnight	Midnight to Dawn
☐ ☒ NO CHANCE	☐ ☒ NO CHANCE	☒ ☐ NO CHANCE	☒ ☐ NO CHANCE
☐ ☐ UNLIKELY	☐ ☐ UNLIKELY	☐ ☐ UNLIKELY	☐ ☒ UNLIKELY
☐ ☐ POSSIBLE	☐ ☐ POSSIBLE	☐ ☒ POSSIBLE	☐ ☐ POSSIBLE
☒ ☐ PROBABLE	☒ ☐ PROBABLE	☐ ☐ PROBABLE	☐ ☐ PROBABLE

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Figure 22. First glance outlook issued for 8 February 2023.



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	SYNOPSIS																																									
	The upper level winds over WY are switching from SW to northerly today as a jet comes into western WY tonight. A mid level trough and strong PVA has been making its way into WY from the NW this morning and will continue moving through the state to the SE throughout the day. Low level moisture had started increasing in the WR before sunrise and will continue through the afternoon before waning throughout the evening and night. Meanwhile, the SM will have increasing moisture this afternoon with waves of moisture continue to pass through until tomorrow afternoon. After this system moves away, it looks to be dry until late Monday.																																									
FORECAST																																										
Low, orographic cloud had developed over the range last night with favorable seeding conditions gradually developing throughout the morning. This will be fairly short-lived as the wind will be switching to NW this afternoon and looks to be no longer favorable for proper plume transport by mid afternoon. The clouds will be breaking up in the late afternoon, but there will be scattered showers around through the middle of the night. Some low clouds will exist over the northern slopes into tomorrow morning before clearing. Only periods of high and mid level clouds are expected the rest of the week and weekend. Low clouds have started forming over the SM this morning and will continue expanding this afternoon with light snowfall from mid afternoon to mid evening. The wind is SW and not favorable for seeding this afternoon. Around sunset it will become westerly and then north this evening. This looks to provide a short window for seeding as the trajectories go over the range with a small amount of SLW and light snowfall. By mid evening, the clouds become broken. Snowfall with some SLW will begin again during the night and go until midday tomorrow, but the wind looks to be too northerly and not quite right for seeding. The clouds will be thinning tomorrow afternoon and clear by sunset.																																										
ACTION:	WR: seeding started at 1539Z, expected to end between 21Z and 22Z. SM: chance for seeding between 00Z and 02Z.																																									
Day 2 Outlook ODC: 0																																										
<table border="1"><thead><tr><th colspan="3">WRF MODEL SOUNDING</th><th>YESTERDAY'S WEATHER</th><th>Observed ODC: 0</th></tr></thead><tbody><tr><td>PNA</td><td>21Z, 8 February</td><td>High Savery</td><td>Pinedale: 32/12 Rock Springs: 29/17 Lander: 26/10 South Pass: 32/18 Dixon: 27/0</td><td></td></tr><tr><td>N/A</td><td>0 °C level</td><td>N/A</td><td rowspan="5">After mid level clouds moved out of the WR in the morning the sky was clear until the evening. High and mid level clouds moved in before midnight with low clouds forming over the range during the night. Snowfall didn't begin until around sunrise. The SM had shallow low clouds linger through the daytime. Snowfall map showed up to 1 inch accumulation but most of that occurred in the early morning and the wind was not favorable for seeding at any point during the day. The clouds diminished in the evening and it was clear until a band of mid level clouds moved in Wednesday morning. No seeding occurred.</td><td></td></tr><tr><td>N/A</td><td>-5 °C level</td><td>7.7 kft</td><td></td></tr><tr><td>8.5 kft</td><td>-10 °C level</td><td>8.6 kft</td><td></td></tr><tr><td>12.6 kft</td><td>-20 °C level</td><td>14.7 kft</td><td></td></tr><tr><td>0.13 inches</td><td>Precipitable Water</td><td>0.16 inches</td><td></td></tr><tr><td>-13.4°C</td><td>700 mb T</td><td>-10.6°C</td><td></td><td></td></tr><tr><td>300@25 kts</td><td>700 mb wind</td><td>275@25 kts</td><td></td><td></td></tr></tbody></table>		WRF MODEL SOUNDING			YESTERDAY'S WEATHER	Observed ODC: 0	PNA	21Z, 8 February	High Savery	Pinedale: 32/12 Rock Springs: 29/17 Lander: 26/10 South Pass: 32/18 Dixon: 27/0		N/A	0 °C level	N/A	After mid level clouds moved out of the WR in the morning the sky was clear until the evening. High and mid level clouds moved in before midnight with low clouds forming over the range during the night. Snowfall didn't begin until around sunrise. The SM had shallow low clouds linger through the daytime. Snowfall map showed up to 1 inch accumulation but most of that occurred in the early morning and the wind was not favorable for seeding at any point during the day. The clouds diminished in the evening and it was clear until a band of mid level clouds moved in Wednesday morning. No seeding occurred.		N/A	-5 °C level	7.7 kft		8.5 kft	-10 °C level	8.6 kft		12.6 kft	-20 °C level	14.7 kft		0.13 inches	Precipitable Water	0.16 inches		-13.4°C	700 mb T	-10.6°C			300@25 kts	700 mb wind	275@25 kts		
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VER 1.6, 11-2022

Figure 23. WMI forecast sheet from 8 February 2023; all forecasts were submitted to the client and the client's distribution list via email daily.



The seeding criteria were straightforward. First, 700 hPa temperature, meaning the temperature near the cloud elevation (about 10,000 feet), had to be equal to, or less than -6°C ($+21.2^{\circ}\text{F}$). Secondly, there had to be SLW present in the clouds. Finally, wind speeds needed to be strong enough to transport seeding agent from the generator upward into the mountains. Wind direction was also considered, as it helped inform which generators would be activated.

The first criterion, temperature, was determined by consulting the most recent prognostic numerical modeling runs.

The presence of SLW was informed by GOES-16 satellite products such as day cloud phase and nighttime microphysics, and by real-time data from the radiometer (Figure 16) located near Pinedale, WY. The wind speed and direction were obtained from the numerical models.

When all three conditions were satisfied, seeding was initiated by the meteorologist and the generator technician. The meteorologist would communicate to the technician which generators should be activated, when, and for how long. The length of time a generator was activated depended upon how long weather conditions remained favorable. Once seeding was initiated, the meteorologist would begin tracking the real-time weather conditions that would impact seeding duration. If wind direction changed, some generators could be deactivated while others would be turned on. When favorable weather conditions ended, the technician would be directed to shut down all remaining active generators.

Orographic Day Category

ODC	Seeding	Meteorological Description
-3	No	Clear skies, or clear with isolated upper-level cloudiness.
-2	No	Occasionally clear, with cirrus, cirrostratus; or altostratus with bases above
-1	No	Limited coverage or short-lived orographic clouds, not enough temporal or spatial extent to warrant seeding activities.
0	Possible	Some orographic clouds/stratus over mountain tops. SLW/Winds/Temps marginal or uncertain. Operations possible, but not likely.
+1	Yes	Orographic clouds and/or stratus deck enshrouding mountain tops, Supercooled Liquid Water/Winds/Temps favorable for seeding.
+2	Yes	Persistent orographic clouds and/or stratiform cloud deck enshrouding mountain tops, Supercooled Liquid Water/Winds/Temps favorable for extended seeding operations.

Table 1. The Orographic Day Category.



4 OPERATIONS

4.1 2022-2023 Season

Project operations began on 8 November 2022, with forecasts and full data collection activities. The first seeding opportunity occurred immediately on 9 November 2022 with six generators being operated. During the season, seeding opportunities were observed on thirty-six occasions, as enumerated in Table 2.

November had four seeding events, December, seven; January, five; February, eight; March, nine; and April, three. Table 3 summarizes operations by month and provides season totals. In total, 27.02 kg of seeding agent were released. Generators were operated for a total of 216:06 hours during the season, accruing a total of 957:23 generator hours. [Generator hours are calculated by summing the number of hours each generator was operated. For example, six generators operated for five hours yields thirty generator hours.] This season was the first year of operations for the Sierra Madre generators. In total, they contributed 29:22 of the total generator hours and dispensed 0.74 kg of seeding agent.

The twenty-two seeding events that utilized more than one generator were all quality opportunities that used three to nine generators and were of 3 or more hours in duration. Four events were ten hours or longer, and one exceeded thirty hours.



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2022-2023 List of Seeding Events

Date	Number of Generators Utilized	Length of Seeding (hours)	Total Generator Hours	AgI Released this date (kg)	AgI Monthly Total (kg)	Generator Hours	Total Duration of Seeding
11/9/2022	8	7:47	27:42	0.737	3.661	126:21	28:18
11/13/2022	1	3:41	3:41	0.109			
11/15/2022	2	2:44	3:45	0.132			
11/28/2022	9	14:06	91:13	2.682			
12/2/2022	5	7:04	34:01	0.873	6.893	259:29	47:12
12/5/2022	4	6:00	21:52	0.621			
12/9/2022	5	7:26	34:03	0.849			
12/22/2022	9	12:24	100:40	2.715			
12/22/2022	1	2:14	2:14	0.047			
12/27/2022	5	4:48	23:24	0.612			
12/31/2022	6	7:16	43:15	1.175			
1/4/2023	0	0:00	0:00	0.000	0.959	33:45	18:26
1/5/2023	3	5:41	9:06	0.248			
1/10/2023	4	4:51	16:45	0.461			
1/24/2023	1	2:33	2:33	0.071			
1/25/2023	1	5:21	5:21	0.179			
2/5/2023	3	3:48	11:24	0.370	7.353	252:20	65:55
2/6/2023	1	4:13	4:13	0.075			
2/8/2023	9	5:47	42:43	1.297			
2/9/2023	2	2:31	4:49	0.130			
2/19/2023	1	1:40	1:40	0.026			
2/27/2023	9	35:08	137:26	4.035			
2/28/2023	6	8:01	45:18	1.338			
2/28/2023	1	4:47	4:47	0.082	4.750	168:48	37:00
3/3/2023	6	4:31	26:19	0.816			
3/5/2023	2	2:19	4:27	0.130			
3/13/2023	2	2:05	3:00	0.091			
3/15/2023	8	5:15	34:49	0.923			
3/20/2023	4	8:35	27:12	0.697			
3/21/2023	4	4:08	14:26	0.396			
3/22/2023	9	2:42	22:24	0.601			
3/30/2023	4	3:58	15:37	0.508			
3/31/2023	6	3:27	20:34	0.588			

TABLE CONTINUED ON NEXT PAGE



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4/1/2023	9	12:03	85:38	2.565	3.406	116:40	19:15
4/2/2023	8	3:15	15:17	0.408			
4/19/2023	4	3:57	15:45	0.433			
Seasons	31 Events	216:06	957:23	27.022	27.022	957:23	216:06

Table 2. 2022-2023 List of Seeding Events. Wind River Range seeding events are highlighted in blue and Sierra Madre Range in orange.

The generator performance for the season was lower than usual at 84.6% functionality. Much of this is attributable to the new sites in the Sierra Madre Range, the timely access to which proved difficult to access due to the heavy snowfall. Steps have been taken to ensure improved performance in the 2023-2024 season.

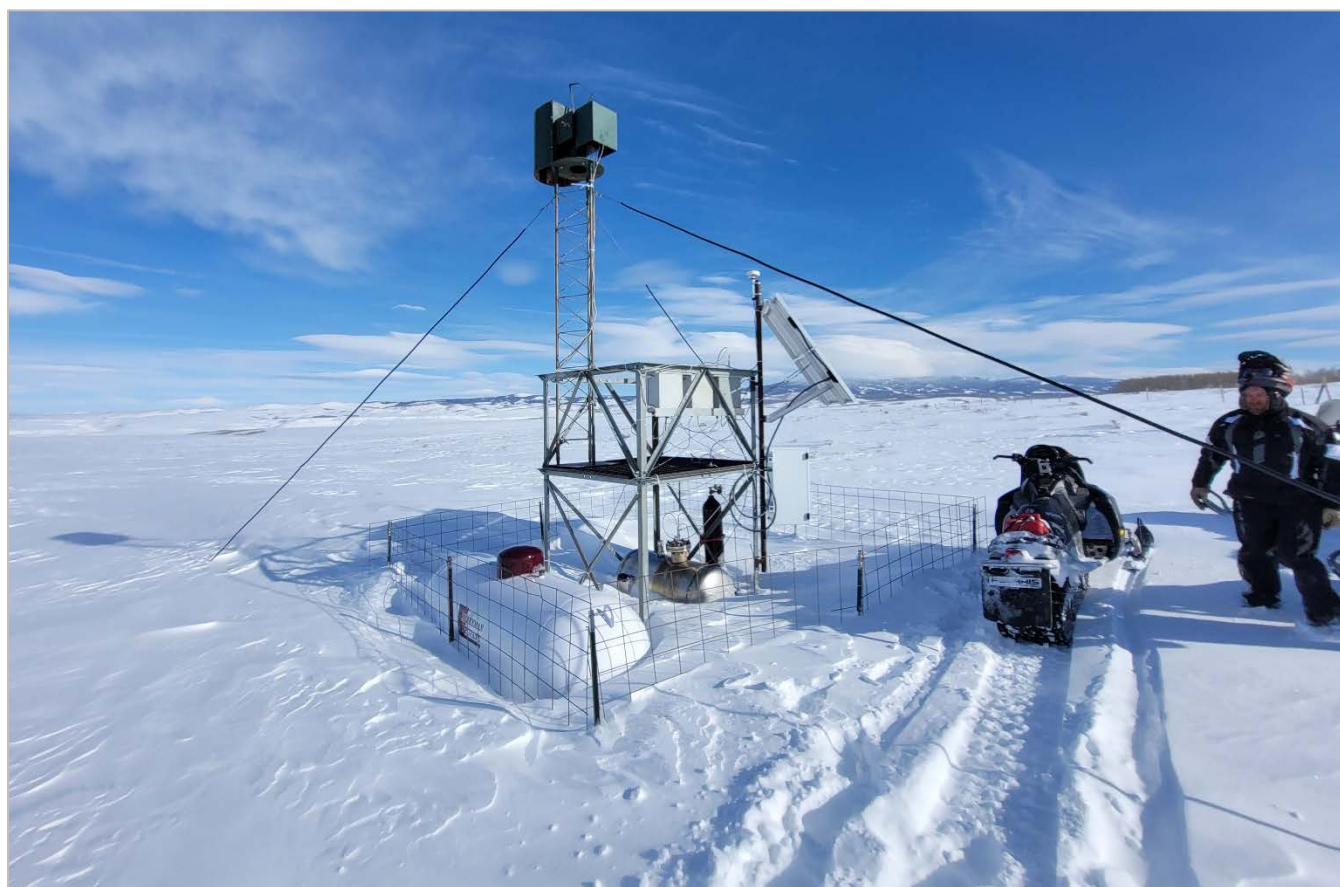


Figure 24. WMI technicians visit the Tullis West site in the Sierra Madre range to fix an ignition issue on 8 January 2023. Compare the white propane tank with burgundy cover with Figure 25. Photo by WMI Technician Michael Paul.

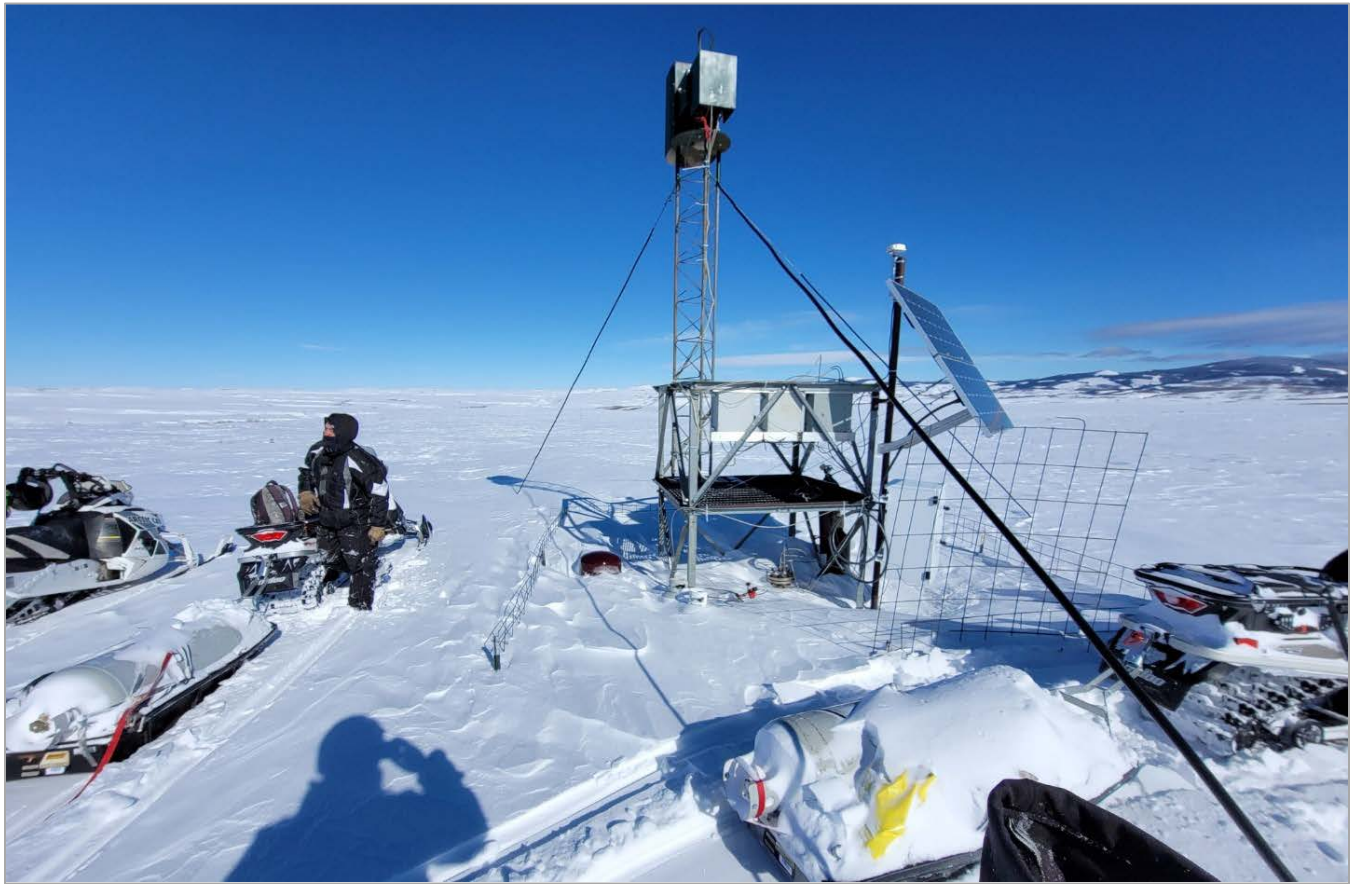


Figure 25. WMI technicians revisit the Tullis West site later in the season, notice the propane tank is no longer visible as it was in Figure 24. Photo by WMI Technician Michael Paul.

Table 4 shows the activity of each of the twelve generators on a case-by-case basis. Each seeding event has two rows, the top indicates whether each generator was requested (REQ), and the bottom whether the generator ran (RAN). Ideally, every time a generator was requested it would run for the entire duration of the event. If a generator was requested to operate, a “Yes”, “No”, or “Partial” comment would be denoted in the appropriate (RAN) row.

As Table 4 shows, the problems were scattered among the generators. Each generator encountered some problems from time to time with the exception of Enterprise which was run only once during the season.



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Ice Nucleus Generator Operations 2022-2023 Season

Wind River Range		WR01 Big Sandy	WR02 Block & Tackle	WR03 White Acom	WR07 Enterprise	WR09 Boulder Lake	WR10 East Fork	WR12 Pocket Creek	WR13 Green River	WR14 Willow Lake	WR16 Highland	SM10 Tullis West	SM11 High Savery	#Ggens Called	#Ggens Active
20221109	WRR0181	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	PARTIAL	PARTIAL	NO	NO	PARTIAL	PARTIAL	NO	PARTIAL	YES	NO	NO		2.75
20221113	WRR0182	REQ	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO		1
20221115	SMR0001	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	2	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	PARTIAL		1.25
20221128	WRR0183	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	PARTIAL	YES	YES	NO	YES	PARTIAL	PARTIAL	YES	YES	PARTIAL	NO	NO	7
20221202	WRR0184	REQ	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO	5	
		RAN	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO		5
20221205	WRR0185	REQ	YES	YES	NO	NO	YES	NO	YES	NO	NO	NO	NO	4	
		RAN	YES	YES	NO	NO	YES	NO	YES	NO	NO	NO	NO		4
20221209	WRR0186	REQ	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO	5	
		RAN	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO		5
20221222	WRR0187	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO		9
20221222	SMR0002	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1
20221227	WRR0188	REQ	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES	NO	5	
		RAN	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES	NO		5
20221231	WRR0189	REQ	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO	6	
		RAN	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO		6
20230104	SMR0003	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		0
20230105	WRR0190	REQ	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	3	
		RAN	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO		3
20230110	WRR0191	REQ	YES	YES	YES	NO	NO	NO	YES	NO	NO	NO	NO	4	
		RAN	YES	YES	YES	NO	NO	NO	YES	NO	NO	NO	NO		4
20230124	SMR0004	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1
20230125	SMR0005	REQ	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	2	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1
20230205	WRR0192	REQ	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	3	
		RAN	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO		3
20230206	SMR0006	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1



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20230208	WRR0193	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO		9
20230209	SMR0007	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	2	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES		2
20230219	SMR0008	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1
20230227	WRR0194	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	NO	NO	YES	NO	PARTIAL	PARTIAL	YES	YES	YES	YES	NO	NO		5.75
20230228	WRR0195	REQ	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO	NO	6	
		RAN	NO	NO	NO	NO	YES	YES	PARTIAL	YES	YES	YES	NO	NO		5.5
20230228	SMR0009	REQ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO		1
20230303	WRR0196	REQ	NO	NO	YES	NO	YES	YES	NO	YES	YES	YES	NO	NO	6	
		RAN	NO	NO	YES	NO	YES	YES	NO	YES	YES	YES	NO	NO		6
20230305	WRR0197	REQ	NO	NO	YES	NO	YES	NO	NO	YES	YES	NO	NO	NO	4	
		RAN	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	NO		2
20230313	WRR0198	REQ	NO	NO	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	4	
		RAN	NO	NO	NO	NO	PARTIAL	NO	NO	NO	NO	YES	NO	NO		1.25
20230315	WRR0199	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO	NO		8
20230320	WRR0200	REQ	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO	NO	5	
		RAN	YES	YES	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO		3
20230321	WRR0201	REQ	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO	NO	5	
		RAN	PARTIAL	YES	YES	NO	YES	NO	NO	NO	NO	NO	NO	NO		3.25
20230322	WRR0202	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	YES	YES	PARTIAL	NO	YES	YES	YES	YES	YES	YES	NO	NO		8.25
20230330	WRR0203	REQ	YES	YES	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	4	
		RAN	YES	YES	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO		4
20230331	WRR0204	REQ	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO	NO	6	
		RAN	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO	NO		6
20230401	WRR0205	REQ	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	9	
		RAN	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO	NO		8
20230402	WRR0206	REQ	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES	NO	NO	8	
		RAN	YES	YES	YES	NO	YES	YES	YES	PARTIAL	NO	YES	NO	NO		7.5
20230419	WRR0207	REQ	NO	NO	NO	NO	YES	NO	NO	YES	YES	YES	NO	NO	4	
		RAN	NO	NO	NO	NO	YES	NO	NO	YES	YES	YES	NO	NO		4
ZULU DATES ONLY													TOTALS		172	145.5
PARTIAL = > 25% of Expected Runtime														RUN =	84.6%	
														FAIL =	15.4%	

Table 3. Ice nucleus generator operations are shown for each of the thirty-six seeding events during the 2022-2023 season.



4.2 Comparisons with Previous Seasons

Comparisons of the nine seasons of operational cloud seeding are provided in Tables 5 and 6. In Table 5, the lengths of seeding operations in each month are provided. Each season was different. In terms of actual number of hours with seeding operations, the 2015-2016 season tops the list. However, when one compares the total hours of seeding conducted each season (Table 6), the 2016-2017 season was far above the others, 400 hours more than the 2015-2016 season with a close second belonging to 2021-2022. Least active was the 2018-2019 season, in part due to budget constraints that precluded operations in November and April. The 2022-2023 season ended with snowpack values significantly above the thirty-year medians, but near-normal total hours during which seeding occurred.

Hours of Seeding - 2014-2023 Winter Seasons

	<i>Nov</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>Season</i>
2014-2015	10:13	83:45	24:08	36:47	25:21	20:12	200:26
2015-2016	41:28	66:07	49:56	60:30	62:00	9:54	289:55
2016-2017	NA	120:22	63:12	58:53*	SUSP	NA	242:27
2017-2018	NA	49:37**	23:24	57:25	62:06	NA	192:54
2018-2019	NA	11:15	26:46	121:47	6:07	NA	165:55
2019-2020	22:10	40:03	77:59	29:07	56:23	18:57	244:29
2020-2021	19:31	39:18	27:37	85:37	48:13	17:51	262:07
2021-2022	4:24	112:49	25:18	18:42	17:17	44:00	222:30
2022-2023	28:18	47:12	18:26	65:55	37:00	19:15	216:06
Mean	21:00	65:06	37:25	59:28	39:18	25:41	226:18
*Project was suspended on February 11 th , 2017.							
**Project started on December 9 th , 2017, not December 1 st .							

Table 4. Hour of seeding conducted over the project's nine winter seasons (2014-2023).

December and February were the most active months, logging 259:29 and 252:20 generator hours, respectively. This is a little less than the average which is about 300 hours. The least active month was January, during which just 33:45 hours of generator time were logged. This is the lowest recorded in January of the project's still-young history. Overall, the total time seeding was about two hundred hours less than the nine-season mean, but hours of seeding were only ten hours less than the mean.



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Hours of Ice Nucleus Generator Operation - 2014-2023 Winter Seasons.

	<i>Nov</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>Season</i>
2014-2015	71:43	377:52	125:51	36:47	219:54	20:12	852:19
2015-2016	86:21	375:03	328:57	180:56	191:31	9:54	1172:42
2016-2017	NA	815:05	396:22	406:57*	SUSP	NA	1618:24
2017-2018	NA	304:53**	156:06	397:31	373:04	NA	1231:34
2018-2019	NA	39:49	159:48	745:21	6:07	NA	951:05
2019-2020	45:33	152:42	375:41	157:06	189:59	78:09	999:10
2020-2021	78:07	153:41	128:03	548:42	107:25	41:51	1057:49
2021-2022	18:32	731:39	159:28	119:40	103:25	239:29	1372:13
2022-2023	126:21	259:29	33:45	252:20	168:48	116:40	957:23
Mean	71:06	363:10	207:06	304:47	170:01	84:22	1134:44
*Project was suspended on February 11th, 2017.							
**Project started on December 9th, 2017, not December 1st.							

Table 5. Hours of ice nucleus generator operation over the project's nine winter seasons (2014-2023).

Meteorological support of operational seeding in the Wind River Mountains continues to improve, specifically through continued development and refinement of numerical modeling products specifically tailored to assist winter orographic cloud seeding. With these tools, we are now more selective and accurate in our operational decision-making. We are also more responsive to shorter-term opportunities, and to changing conditions as storms pass.



5 GENERATOR ADDITIONS

Two ground-based ice nucleus generators were added to the 2022-2023 program, both on the western slopes of the Sierra Madre Range (see again, Figure 9). These sites, Tullis West and High Savery, were sites previously used in the Wyoming Weather Modification Pilot Project, located on state lands.

The sites were installed and readied for operation prior to the season. However, the unusually heavy snowfall made access via county roads difficult, as travel by truck to any point relatively near either generator proved impossible, necessitating the use of sleds (snowmobiles) for many miles.

Weather patterns did favor either generator, and the season total use was significantly less than what was suggested during the Pilot Project. We believe that the 2022-2023 winter was anomalous, and the subsequent years will afford increased opportunities.

6 OUTREACH

Whenever possible, WMI likes to be receptive to requests to educate those showing an interest in our field efforts. In each recent season, WMI has done a “weather talk” to some local students and teachers, explained a little bit about the seeding project, and done a demonstration weather balloon launch.

This season a tour of the High Savery ground-based generator site occurred on 28 June 2023. A bus transported several guests of the WWDO as part of the Wyoming Water Associations meeting in Saratoga. Michael Paul, WMI technician, was on hand to give a brief demonstration of the unit and Ms. Julie Gondzar, WWDO Project Manager gave a short presentation on cloud seeding operations in the State of Wyoming.

It is important to WMI to be receptive to requests to educate those showing an interest in our weather modification efforts. WMI looks forward to continuing these activities.



7 SUMMARY

Operations were successfully conducted as planned for the 2022-2023 season with thirty-six seeding events in total. The 2022-2023 season became operational on 8 November 2022 and concluded after 22 April 2023. The first seeding event occurred on 9 November 2022. The 2022-2023 weather pattern was plenty active this season, but it did not hold the longevity as previous seasons.

Seasonal snowpack (snow water equivalents, or SWE) at project end (22 April 2023) was significantly above normal at all the Wind River SNOTEL sites monitored as part of the suspension criteria, but never quite high enough to trigger suspension. Such was not the case in the Sierra Madre, however, as snowpack in that Range exceeded the maximum allowable on 11 March, and ground-based and aerial seeded ceased for that range on that date.

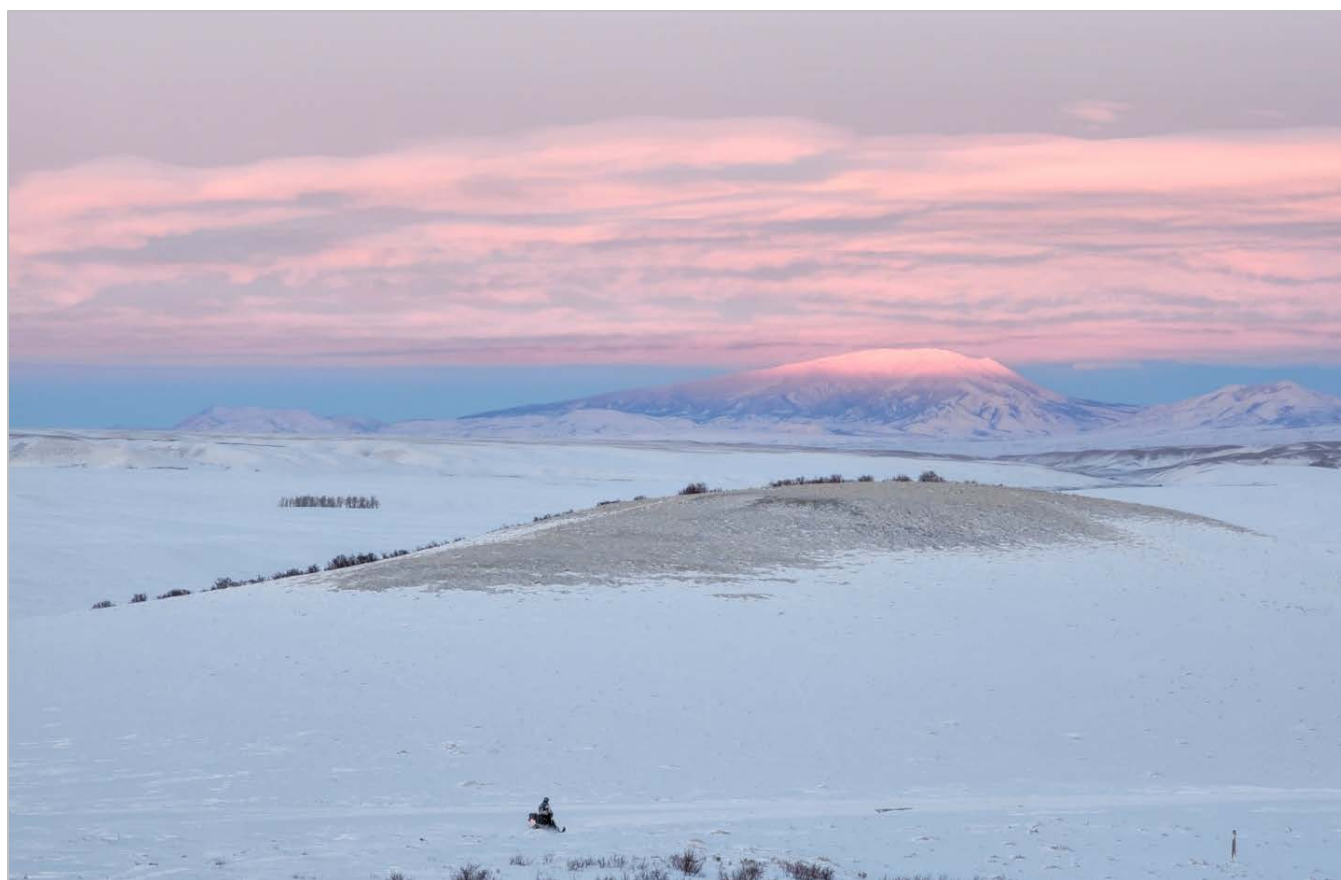


Figure 26. The generator field team returns home as the sun sets after completing servicing at the Tullis West Site (SM10). Photo by WMI Technician Michael Paul.

Though a lack of snowfall for an extended period might have resulted in the range-wide SWE falling below the suspension criteria again. The snow did not abate, and the suspension remained in effect for the program duration. The WWDO issued a press release on the subject on 20 March 2023.



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The thirty-six seeded storm events lasted a total of 216:06 hours, during which one or more generators were seeding. The total number of “generator hours”, defined as the sum of the length each generator was operated during each storm, was 957:23 hours. The seeding rate was approximately 25 grams of silver iodide per generator, per hour, throughout the season.

As the accuracy of the WMI prognostic numerical modeling efforts has improved, the need to verify requisite temperate and wind criteria by atmospheric soundings has decreased. For the 2022-2023 season, atmospheric soundings were not conducted. The presence of liquid water clouds over the range in each case continued to be established by the WWDO radiometer sited at the East Fork site, or the numerical weather prediction (NWP), coupled with the presence of clouds on satellite and webcams.



8 LIST OF TERMS AND ACRONYMS

Accretion	See <i>riming</i> .
Aerosol	A system in which particles, either solid or liquid, are dispersed in within a gas, usually air.
Ag	The chemical notation for silver.
AgI	See <i>silver iodide</i> .
Aggregation	The process of clumping together of snow crystals following collision as they fall, to form snowflakes.
AGL	Above ground level
ASCE	American Society of Civil Engineers
ATV	All-terrain vehicle
BTAC	Bridger-Teton Avalanche Center
CAP	Central Arizona Project, run by the Central Arizona Water Conservation District. The Central Arizona Project delivers Colorado River water via a 335-mile aqueduct system to customers in Maricopa, Pinal, and Pima Counties in Arizona, home to 80% of Arizona's population.
CCN	Cloud condensation nucleus
CSU	Colorado State University
GPS	Global Positioning System
Glaciogenic seeding	Cloud seeding with ice-forming aerosols
Ground generator	See <i>ice nucleus generator</i> .
hPa	Hectopascal, equivalent to one millibar (mb), the common unit used to measure atmospheric pressure. Pressure decreases as altitude increases; standard sea level pressure is 1,013.25 hPa, 850 hPa equates to approximately 5,000 feet (1,500 m) elevation, and 700 hPa, about 10,000 feet (3,000 m) above mean sea level.
HRRR	High-resolution, Rapid-Refresh numerical model. This model runs every three hours and produces predictions in one-hour increments, but only for the next 12 hours.
Ice nucleus	Any particle that serves as a nucleus leading to the formation of ice crystals, without regard to the particular physical processes involved in the nucleation.
Ice nucleus generator	The remotely-controlled machines that burn a silver iodide solution to produce the ice nuclei that “seed” clouds containing <i>supercooled liquid water</i> .
IN	See <i>ice nucleus</i> .
mb	Millibar, same as hectopascal (<i>hPa</i>)



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MOU	Memorandum of Understanding
MSL	Elevation above mean sea level
NaCl	The chemical notation for sodium chloride, common table salt
NAM	North American Model. A model run four times daily by the National Weather Service. This model produces output in 3-hour increments for the 72 hours following initialization (the start of each run). This model is not customized for the Wind River Range, and produces no graphics designed for cloud seeding operations, unlike the WMI WRF.
NCAR	National Center for Atmospheric Research, Boulder, CO
NCEP	National Centers for Environmental Prediction, a set of NOAA research centers.
NOAA	National Oceanic and Atmospheric Administration, U.S. Department of Commerce
NRCS	Natural Resource Conservation Service, an agency of the U.S. Department of Agriculture
NWP	Numerical weather prediction (forecasts generated by computer models)
NWS	National Weather Service, U.S. Department of Commerce
ODC	Orographic Day Category, used to summarize the expected chance of seeding on each day. For details, see Table 1.
OSLI	Office of State Lands and Investments
PNA	The airport and meteorological station identifier for Pinedale, Wyoming.
Precipitation efficiency	Expressed as a percentage, the ratio of the quantity of precipitation produced by a cloud to the total water condensate produced by the cloud.
Radiometer	A passive (non-transmitting) instrument that measures liquid water and water vapor in the atmosphere.
Rawinsonde	Commonly called a <i>weather balloon</i> , the rawinsonde is a small package of weather instruments carried aloft by balloon. Vertical profiles of temperature, humidity, and winds are obtained as a function of pressure.
Riming	The growth of an ice particle by the collision with <i>supercooled</i> cloud droplets that freeze wholly or partially upon contact.
RIW	The airport and meteorological station identifier for Riverton, Wyoming.
SCCD	Sublette County Conservation District, Pinedale, WY
Silver iodide	An inorganic chemical compound, AgI, that has a crystalline structure (symmetry, lattice spacing) similar to ice and a very low solubility in water and can be easily generated as an aerosol.
SLW	See <i>supercooled liquid water</i> .



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SNOTEL	Sites instrumented, operated, and maintained by the <i>NRCS</i> , to measure precipitation, <i>SWE</i> and other related parameters in the mountains.
SNWA	Southern Nevada Water Authority, a cooperative agency formed in 1991 to address Southern Nevada's unique water needs on a regional basis.
Supercooled liquid water	Liquid water at a temperature below the freezing point.
SWE	Snow water equivalent, the water content of snow, commonly expressed in depth (inches)
UTC	Universal Time Coordinates, the standard time used by aviation and meteorological reporting worldwide. UTC time is six hours ahead of Mountain Daylight Time, and seven hours ahead of Mountain Standard Time.
WMI	Weather Modification International, the business name of Weather Modification LLC, Fargo, North Dakota
WRDS	The Wyoming Water Resources Data System. This organization serves as a repository for all water-related information in the State of Wyoming and is located on the University of Wyoming campus in Laramie, WY.
WRF	Weather Research and Forecasting model, a means of numerical weather prediction.
WSEO	Wyoming State Engineer's Office, the regulatory agency for cloud seeding in the State of Wyoming. Cheyenne, WY.
WWDC	Wyoming Water Development Commission, Cheyenne, WY
WWDO	Wyoming Water Development Office, the administrative team serving under the direction of the Wyoming Water Development Commission. Cheyenne, WY.
WWMPP	Wyoming Weather Modification Pilot Program, conducted from 2005-2014 to evaluate the potential for cloud seeding in the Medicine Bow, Sierra Madre, and Wind River Ranges of Wyoming.



9 REFERENCES

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Appendix A. Daily Operations Summaries

08 November 2022, Tuesday	
<p>In the Wind River range, mostly cloudy skies with a mix of snow and rain were observed in the valley. SWE accumulation was around 1" at higher elevations. Temperatures were too warm for seeding.</p> <p>In the Sierra Madre range, skies were mostly clear the entire forecast period. No precipitation or seedable conditions were observed.</p> <p>Max/Min temperatures Pinedale: 36/27 Rock Springs: 53/41 Lander: 59/24 Dixon: 60/32 Observed ODC: 0</p>	No ground-based seeding was conducted.
09 November 2022, Wednesday	
<p>In the Wind River range, continued snowfall over the range throughout most of the period. SWE accumulations of around 0.5-0.75" were observed. The temperature cooled enough during the morning for seeding to occur until the low-level flow turned northwesterly around sunset.</p> <p>In the Sierra Madre range, skies were mostly clear until snow showers began in the afternoon. Snow continued to fall through the night. Snotel observations showed SWE accumulations of around 0.5" across the range. SW flow inhibited seeding opportunities.</p> <p>Max/Min temperatures Pinedale: 39/21 Rock Springs: 48/21 Lander: 27/16 Dixon: 56/26 Observed ODC: +2</p>	<p>Seeding event WRR0181 began at 0937 MST on 11/09/2022.</p> <p>WRR0181 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 0937 (11/09) to 1724 (11/09) MST 1637 (11/09) to 0024 (11/10) UTC Duration: 27:42 Total Time Seeding Material: 12.12 gallons (692.25 grams)</p>
10 November 2022, Thursday	
<p>Shallow low clouds over the WR in the morning, slowly diminished throughout the afternoon and evening. Mid level clouds moved through during the late afternoon and evening. The sky then cleared overnight. Snowfall map showed 1 to 2 inches accumulation on the range.</p> <p>The SM had shallow, low cloud coverage throughout the period, but the wind flow was not right for seeding operations and cloud thickness wasn't sufficient. Only a dusting of snowfall occurred.</p>	No ground-based seeding was conducted.



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Max/Min temperatures Pinedale: 23/16 Rock Springs: 25/14 Lander: 26/13 Dixon: 32/18 Observed ODC: -1	
11 November 2022, Friday	
<p>Clear skies were seen across the WR during the day and into the night, before thin upper-level clouds moved into the area during the early AM hours. No SLW, precip, or seeding activity. Low but sparse clouds lingered over the SM into the early afternoon before skies cleared late in the day. Thin, upper-level clouds moved into the area late in the forecast period. No seeding.</p> <p>Max/Min temperatures Pinedale: 28/3 Rock Springs: 26/7 Lander: 34/13 Dixon: 26/11 Observed ODC: -1</p>	No ground-based seeding was conducted.
12 November 2022, Saturday	
<p>Thin upper-level clouds were present through both the Wind River and Sierra Madre ranges. Overnight, clouds thickened as elevated warm air advection moved across Wyoming ahead of a low that moved into the Great Basin. These clouds did not reach low enough to obscure the peaks of the range.</p> <p>Max/Min temperatures Pinedale: 30/3 Rock Springs: 28/13 Lander: 36/18 Dixon: 36/10 Observed ODC: -2</p>	No ground-based seeding was conducted.
13 November 2022, Sunday	
<p>Clear skies over the WR until low clouds started forming on the north slopes in the middle of the afternoon and expanded throughout the late afternoon. Seeding occurred for a few hours while the wind flow was favorable, but it became unfavorable in the early evening. The low clouds diminished during the evening with only a few low clouds left by morning. Snowfall map showed 0.5 to 1.5 inch accumulation on the northern slopes.</p> <p>The SM had short lived periods of low clouds during the daytime and evening with light snowfall that amounted to less</p>	<p>Seeding event WRR0182 began at 1553 MST on 11/13/2022.</p> <p>WRR0182 Summary: Generators: WR07. Time: 1553 (11/13) to 1934 (11/13) MST 2253 (11/13) to 0234 (11/14) UTC Duration: 3:41 Total Time Seeding Material: 1.79 gallons (86 grams)</p>



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<p>than 1 inch. Thin mid level clouds moved through during the night.</p> <p>Max/Min temperatures Pinedale: 32/3 Rock Springs: 33/9 Lander: 38/16 Dixon: 37/10 Observed ODC: +1</p>	
14 November 2022, Monday	
<p>Broken low cloud coverage developed over the WR region in the early afternoon with areas of light snowfall and persisted into the mid evening hours. The wind was not favorable for seeding operations. There were only a few clouds during the night. Snowfall map showed mostly 0.5 to 3 inch accumulation with a small area over 5.</p> <p>Widespread clouds spread over the SM region by mid afternoon, lasting through the evening. Shallow low clouds lingered during the night with unfavorable wind flow. Snowfall map showed around 1 inch on the range.</p> <p>Max/Min temperatures Pinedale: 30/9 Rock Springs: 30/11 Lander: 35/12 Dixon: 30/9 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
15 November 2022, Tuesday	
<p>In the Wind River range, skies were clear before becoming overcast in the afternoon. Winds were out of the northwest and gusty in the afternoon and evening before becoming light and variable overnight.</p> <p>In the Sierra Madre range, low clouds thickened during the morning with favorable seeding conditions for a few hours. The clouds weakened by mid day and then began to clear the rest of the afternoon.</p> <p>Max/Min temperatures Pinedale: 30/9 Rock Springs: 26/11 Lander: 31/10 Dixon: 27/5 Observed ODC: +1</p>	<p>Seeding event SMR0001 began at 0947 MST on 11/15/2022.</p> <p>SMR0001 Summary: Generators: SM01, SM02. Time: 0947 (11/15) to 1234 (11/15) MST 1647 (11/15) to 1934 (11/15) UTC Duration: 2:44 Total Time Seeding Material: 2.17 gallons (93.75 grams)</p>
16 November 2022, Wednesday	



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<p>In the Wind River range, high cirrus clouds were observed in the morning. Orographic clouds formed in the mountains in the afternoon along with some lowmid level clouds. Some snow showers occurred as well. The wind was not favorable for seeding operations.</p> <p>In the Sierra Madre range, snow showers occurred in the morning. Skies became mostly clear with some high cirrus clouds and some orographic clouds over higher elevations by the late morning. The wind was not favorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 32/5 Rock Springs: 31/17 Lander: 38/20 Dixon: 30/11 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
17 November 2022, Thursday	
<p>Broken cloud cover with some pockets of blue sky developed over the WR region during the early morning hours. Light snowfall started in the late afternoon and continued through the overnight hours. The wind remained unfavorable for seeding operations. Snowfall map showed around 0.15-0.2 inches of accumulation across the range. The east side of the range towards the valley got around 3 inches.</p> <p>Widespread cloud cover with some broken areas over the SM started in the early morning hours. On and off light snowfall started in the early afternoon and continued through the evening. Broken cloud cover occurred overnight before clearing out in the morning. The wind remained unfavorable for seeding operations. Snowfall map showed around 0.2 inches of accumulation.</p> <p>Max/Min temperatures Pinedale: 25/10 Rock Springs: 23/7 Lander: 18/10 Dixon: 26/15 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
18 November 2022, Friday	
<p>The WR saw mostly blue skies with the occasional orographic cloud over the range during the afternoon. High level cloud cover moved into the area through the evening and into the overnight hours before clearing out in the morning. There were some light snow showers over the range with the snowfall map showing around 0.4 inches.</p>	<p>No ground-based seeding was conducted.</p>



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<p>The SM saw blue skies with no clouds. This continued throughout the day and into the overnight hours. No precipitation occurred.</p> <p>Max/Min temperatures Pinedale: 18/-6 Rock Springs: 15/-3 Lander: 20/1 Dixon: 20/-6 Observed ODC: -1</p>	
<p>19 November 2022, Saturday</p>	
<p>The WR saw clear blue skies during the morning. Some high-level clouds started to move in during the afternoon but cleared out by the evening. Clear skies continued through the overnight hours into the morning. No precipitation occurred. The SM saw blue skies with no clouds during the morning. This continued throughout the day with some isolated high-level clouds during the afternoon. These cleared out by the evening and stayed clear through the overnight hours. No precipitation occurred.</p> <p>Max/Min temperatures Pinedale: 23/-9 Rock Springs: 22/1 Lander: 30/4 Dixon: 28/-1 Observed ODC: -3</p>	<p>No ground-based seeding was conducted.</p>
<p>20 November 2022, Sunday</p>	
<p>Clear skies across WY except for isolated upper level clouds passing through during the night.</p> <p>Max/Min temperatures Pinedale: 37/-4 Rock Springs: 37/9 Lander: 37/7 Dixon: 37/0 Observed ODC: -3</p>	<p>No ground-based seeding was conducted.</p>
<p>21 November 2022, Monday</p>	
<p>High clouds spread across the area during the daytime with some thicker mid level clouds forming over the WR in the late afternoon. Those clouds disappeared in the mid evening and the high clouds cleared overnight.</p> <p>Max/Min temperatures Pinedale: 41/1</p>	<p>No ground-based seeding was conducted.</p>



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Rock Springs: 39/15 Lander: 38/10 Dixon: 38/7 Observed ODC: -2	
22 November 2022, Tuesday	
<p>The WR region had clear skies during the daytime. High and mid level clouds moved in by the late evening with low clouds coming a little after midnight. A band of snowfall occurred with a cold front during the night, but the wind was not favorable for seeding operations. By sunrise, there were only scattered low clouds over the range. Snowfall map showed less than 0.5 inch accumulation.</p> <p>The SM region had areas of high clouds during the afternoon and then high clouds until just before sunrise. The cold front with light snowfall entered the region a little before sunrise and moved through during the morning. The wind was not right for seeding.</p> <p>Max/Min temperatures Pinedale: 39/5 Rock Springs: 40/15 Lander: 47/15 Dixon: 40/8 Observed ODC: 0</p>	No ground-based seeding was conducted.
23 November 2022, Wednesday	
<p>In the Wind River range, skies were mostly clear at times with low level, orographic clouds periodically. Some orographic snow showers occurred but were not consistent.</p> <p>In the Sierra Madre range, low level clouds were observed throughout the day. Snow fell through the afternoon and evening, but the wind was not favorable for seeding operations. Around 1.75 inches of snow accumulation were observed in the eastern Sierra Madre peaks while closer to an inch of snow accumulated in the western peaks.</p> <p>Max/Min temperatures Pinedale: 34/16 Rock Springs: 33/22 Lander: 42/21 Dixon: 35/10 Observed ODC: 0</p>	No ground-based seeding was conducted.
24 November 2022, Thursday	
<p>In the Wind River range, skies were clear throughout the day. A few high cirrus clouds were observed periodically.</p>	No ground-based seeding was conducted.



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<p>In the Sierra Madre range, mostly cloudy skies were observed before becoming mostly clear in the late morning. A few low-level clouds occurred throughout the day before completely clearing overnight.</p> <p>Max/Min temperatures Pinedale: 36/9 Rock Springs: 35/16 Lander: 43/21 Dixon: 36/18 Observed ODC: -1</p>	
<p>25 November 2022, Friday</p>	
<p>In the Wind River range, skies were clear throughout the day with periods of high cirrus clouds. Low level clouds pushed in around sunset and stuck around overnight.</p> <p>In the Sierra Madre range, clear skies were observed throughout the day besides a few high cirrus clouds that moved in around sunset. Some cirrus and low-level clouds occurred overnight.</p> <p>Max/Min temperatures Pinedale: 43/9 Rock Springs: 42/17 Lander: 44/19 Dixon: 40/11 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>26 November 2022, Saturday</p>	
<p>In the Wind River range, skies were overcast throughout the day. Some clouds cleared out around sunset. Snow showers were observed mainly in the afternoon with NW wind flow.</p> <p>In the Sierra Madre range, high cirrus clouds were observed in the morning becoming overcast in the afternoon. Snow showers were observed in the evening while the wind was unfavorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 32/14 Rock Springs: 35/26 Lander: 37/27 Dixon: 40/14 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>27 November 2022, Sunday</p>	
<p>In the Wind River range, mostly cloudy skies became overcast in the afternoon with snow showers. Continuous snowfall with favorable seeding conditions developed after sunset and</p>	<p>Seeding event WRR0183 began at 1859 MST on 11/27/2022.</p>



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<p>persisted through the night. SLW diminished Monday morning, ending seeding operations.</p> <p>In the Sierra Madre range, mostly cloudy to overcast skies were observed with some orographic snow showers, but the wind was not favorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 30/12 Rock Springs: 33/19 Lander: 38/13 Dixon: 33/24 Observed ODC: +2</p>	<p>WRR0183 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 1859 (11/27) to 0906 (11/28) MST 0159 (11/28) to 1606 (11/28) UTC Duration: 14:07, 91:13 Total Time Seeding Material: 54.67 gallons (2280.75 grams)</p>
<p>28 November 2022, Monday</p>	
<p>In the Wind River range, overcast skies were observed through the morning and afternoon, becoming mostly cloudy by the evening. Orographic snow showers occurred throughout the day.</p> <p>In the Sierra Madre range, mostly cloudy to overcast skies were observed with some orographic snow showers.</p> <p>Max/Min temperatures Pinedale: 27/10 Rock Springs: 32/15 Lander: 33/15 Dixon: 35/21 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>29 November 2022, Tuesday</p>	
<p>In the Wind River range, orographic snow showers occurred in the morning. Skies became mostly clear in the afternoon with some orographic clouds forming over the mountains. Skies became overcast overnight.</p> <p>In the Sierra Madre range, snow showers and overcast skies were observed through the afternoon. Skies became partly cloudy with some orographic snow showers in the mid-afternoon.</p> <p>Max/Min temperatures Pinedale: 19/-8 Rock Springs: 18/7 Lander: 18/2 Dixon: 21/4 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>30 November 2022, Wednesday</p>	
<p>In the Wind River range, orographic snow showers occurred in the morning and continued through the afternoon. The wind</p>	<p>No ground-based seeding was conducted.</p>



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<p>was not quite favorable for seeding operations. Skies became mostly clear in the afternoon with some orographic clouds continuing over the mountains. Skies became overcast overnight. Accumulations in the range were around 3 inches. In the Sierra Madre range, mid and low-level clouds filtered out throughout the afternoon. High-level clouds moved in place over the evening before clearing out through the overnight hours. There was some early morning snow showers will accumulations up to 2 inches down the range.</p> <p>Max/Min temperatures Pinedale: 27/-13 Rock Springs: 27/7 Lander: 14/-1 Dixon: 34/14 Observed ODC: 0</p>	
01 December 2022, Thursday	
<p>In the Wind River range, orographic snow showers occurred in the morning and continued through the night. Favorable seeding conditions developed around sunset. Seeding continued throughout the evening and ended at 8Z as SLW started to decrease. Accumulations in the range were around 11 inches in the northern half of the range and 10 inches in the southern half.</p> <p>In the Sierra Madre range, cirrus clouds during the morning and early afternoon gave way to mid and low-level cloud cover during the evening and overnight hours. There were some snow showers during the overnight hours with accumulations up to 2.5 inches in the range.</p> <p>Max/Min temperatures Pinedale: 32/-2 Rock Springs: 38/12 Lander: 43/8 Dixon: 44/18 Observed ODC: +1</p>	<p>Seeding event WRR0184 began at 1756 MST on 12/01/2022.</p> <p>WRR0184 Summary: Generators: WR01, WR02, WR03, WR09, WR12. Time: 1756 (12/01) to 0100 (12/02) MST 0056 (12/02) to 0800 (12/02) UTC Duration: 7:04, 34:06 Total Time Seeding Material: 14.35 gallons (850.75 grams)</p>
02 December 2022, Friday	
<p>In the Wind River range, skies were partly cloudy due to orographic clouds. Orographic snow showers were observed over the mountains throughout the daytime with a NW wind flow and then clearing in the evening.</p> <p>In the Sierra Madre range, orographic snow showers were observed in the morning. Skies were overcast before clearing began in the evening.</p> <p>Max/Min temperatures Pinedale: 30/-9</p>	<p>No ground-based seeding was conducted.</p>



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<p>Rock Springs: 34/7 Lander: 38/8 Dixon: 40/-1 Observed ODC: 0</p>	
03 December 2022, Saturday	
<p>In the Wind River range, skies were mostly clear besides a few high cirrus clouds. Clouds moved in overnight and skies became overcast. In the Sierra Madre range, low-level clouds were observed, creating overcast skies throughout the day. Some snow showers occurred overnight with unfavorable wind flow.</p> <p>Max/Min temperatures Pinedale: 25/-11 Rock Springs: 20/-1 Lander: 27/5 Dixon: 30/-5 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
04 December 2022, Sunday	
<p>Thick clouds with light snowfall were over the WR range during the daytime, but the wind was not right for seeding operations. Favorable seeding conditions developed in the evening and continued until a little after midnight. The clouds slowly weakened overnight with shallow clouds Monday morning. Snowfall map showed 6 to 12 inch accumulation. The SM had thick clouds and continuous snowfall developing in the late afternoon and persisted the rest of the period. The wind was not favorable for seeding operations. Snowfall map showed 0.5 to 2 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 28/-4 Rock Springs: 26/4 Lander: 25/4 South Pass: 36/18 Dixon: 40/28 Observed ODC: +1</p>	<p>Seeding event WRR0185 began at 1932 MST on 12/04/2022.</p> <p>WRR0185 Summary: Generators: WR01, WR02, WR09, WR12. Time: 1932 (12/04) to 0132 (12/05) MST 0232 (12/05) to 0832 (12/05) UTC Duration: 6:00, 21:52 Total Time Seeding Material: 10.20 gallons (546.75 grams)</p>
05 December 2022, Monday	
<p>A shallow and broken low cloud was sitting over the northwest part of the WR during the daytime, but it was not quite sufficient enough for seeding operations. The cloud coverage diminished in the early evening, but then more small clouds formed over the range during the night. Snowfall map showed 0.5 to 1.5 inch accumulation on the range.</p>	<p>No ground-based seeding was conducted.</p>



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<p>The SM had continuous cloud coverage during the daytime and evening hours with light snowfall but little to no SLW. The cloud weakened during the night and only thin, shallow clouds were left by morning. Snowfall map showed 2 to 4 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 32/-6 Rock Springs: 32/17 Lander: 41/13 South Pass: 28/16 Dixon: 38/26 Observed ODC: 0</p>	
<p>06 December 2022, Tuesday</p>	
<p>Shallow and broken low clouds were over the WR during the daytime, with flurries that amounted to under half an inch. SLW was very limited and the wind was NW. The clouds diminished in the evening.</p> <p>The SM had only scattered low clouds during the daytime and then clear skies the rest of the period.</p> <p>Max/Min temperatures Pinedale: 27/-8 Rock Springs: 30/14 Lander: 37/11 South Pass: 25/12 Dixon: 31/8 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>07 December 2022, Wednesday</p>	
<p>A small low was moving from CA into CO throughout the day. The SM had increasing cloud coverage during the afternoon with continuous snowfall beginning in the evening, lasting through the night and into Thursday morning. SLW was spotty and the wind was not right for seeding operations. Snowfall map showed 2 to 6 inch accumulation.</p> <p>The WR had clear skies during the daytime. Just the edge of the low affected the WR, producing a few scattered snow showers during the night. Less than a half inch of accumulation fell in a few locations. The clouds cleared Thursday morning.</p> <p>Max/Min temperatures Pinedale: 25/-9 Rock Springs: 28/8 Lander: 35/10 South Pass: 28/14 Dixon: 27/1</p>	<p>No ground-based seeding was conducted.</p>



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Observed ODC: 0	
08 December 2022, Thursday	
<p>The WR had clear skies until high clouds moved in after midnight. Low clouds and light snowfall were developing over the range Friday morning.</p> <p>The SM had thick clouds and light snowfall left over from yesterday's low until mid afternoon. SLW was very limited and the wind was not right for seeding operations. The clouds quickly cleared by sunset. High and mid level clouds moved in before sunrise. Snowfall map showed 1 to 2 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 25/-8 Rock Springs: 25/9 Lander: 38/11 South Pass: 27/14 Dixon: 29/9 Observed ODC: 0</p>	No ground-based seeding was conducted.
09 December 2022, Friday	
<p>Snowfall increased over the WR range during the morning with favorable seeding conditions developing in the late morning and continuing through the afternoon. A cold front moved through around sunset, shifting the wind to NW and the snowfall diminished. The sky cleared in the evening with high and mid level clouds coming in before sunrise. Snowfall map showed 2 to 4 inches.</p> <p>Clouds formed over the SM in the early afternoon but bases remained above the peaks for most of the afternoon. Flurries existed in the late afternoon and most of the evening but amounted to less than half an inch. The wind was not right for seeding operations. The sky was clear overnight.</p> <p>Max/Min temperatures Pinedale: 23/-9 Rock Springs: 29/7 Lander: 36/6 South Pass: 23/12 Dixon: 32/5 Observed ODC: +2</p>	<p>Seeding event WRR0186 began at 0956 MST on 12/09/2022.</p> <p>WRR0186 Summary: Generators: WR01, WR02, WR03, WR09, WR12. Time: 0956 (12/09) to 1722 (12/09) MST 1656 (12/09) to 0022 (12/09) UTC Duration: 7:26, 34:03 Total Time Seeding Material: 12.95 gallons (851.25 grams)</p>
10 December 2022, Saturday	
In the Wind River range, skies were mostly cloudy to overcast at times. Orographic snow showers occurred, accumulating 1-2 inches in the mountains. The traj were not right for seeding operations.	No ground-based seeding was conducted.



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<p>In the Sierra Madre range, skies were mostly clear in the morning besides some high-level cirrus clouds. Mostly cloudy skies were observed in the afternoon, becoming overcast by the night.</p> <p>Max/Min temperatures Pinedale: 30/-9 Rock Springs: 29/7 Lander: 26/10 Dixon: 37/2 Observed ODC: 0</p>	
<p>11 December 2022, Sunday</p>	
<p>In the Wind River range, skies were mostly cloudy to overcast. Orographic snow showers occurred in the afternoon and evening, but the wind was not favorable for seeding. In the Sierra Madre range, skies were mostly cloudy to overcast. Snow showers occurred in the night with southerly wind.</p> <p>Max/Min temperatures Pinedale: 34/10 Rock Springs: 39/28 Lander: 44/13 South Pass: 30/21 Dixon: 43/12 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>12 December 2022, Monday</p>	
<p>In the Wind River range, skies were overcast. Snow showers occurred through most of the day, while the wind flow was not right for seeding operations. 3-6 inches of snow accumulation observed, with up to 8 inches in higher peaks. In the Sierra Madre range, skies were partly cloudy and became overcast in the evening. Snow showers occurred in the evening and overnight. 1-4 inches of snow accumulation observed, with up to 6 inches in higher peaks.</p> <p>Max/Min temperatures Pinedale: 32/19 Rock Springs: 33/17 Lander: 31/17 South Pass: 27/12 Dixon: 42/24 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>13 December 2022, Tuesday</p>	
<p>In the Wind River range, skies were overcast but cleared out in the night. Snow showers occurred through the morning and afternoon, stopping by the evening. 1-3 inches of snow accumulation was observed.</p>	<p>No ground-based seeding was conducted.</p>



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<p>In the Sierra Madre range, skies were overcast. Snow showers occurred throughout the day. 1-3 inches of snow accumulation observed, with up to 5 inches in higher peaks.</p> <p>Max/Min temperatures Pinedale: 21/-4 Rock Springs: 18/11 Lander: 20/14 South Pass: 16/3 Dixon: 23/13 Observed ODC: 0</p>	
14 December 2022, Wednesday	
<p>In the Wind River range, skies were mostly clear besides some orographic clouds in the afternoon. Some orographic snow showers occurred in the afternoon. Up to 2 inches of snow accumulation observed.</p> <p>In the Sierra Madre range, skies were overcast with snow showers occurring through most of the day. Up to 2 inches of snow accumulation observed.</p> <p>Max/Min temperatures Pinedale: 23/9 Rock Springs: 22/13 Lander: 25/9 South Pass: 18/-2 Dixon: 24/2 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
15 December 2022, Thursday	
<p>In the Wind River range, skies were mostly clear besides periods of orographic clouds and snow showers throughout the day. Up to an inch of snow accumulation observed, with up to 3 inches over the southwestern slopes.</p> <p>In the Sierra Madre range, skies were overcast with very light snow showers occurring in the morning and early afternoon. Up to an inch of snow accumulation observed.</p> <p>Max/Min temperatures Pinedale: 18/5 Rock Springs: 16/-2 Lander: 20/5 South Pass: 10/-13 Dixon: 17/-8 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
16 December 2022, Friday	
<p>The WR was clear except for a few mid level clouds at times and shallow low clouds over the far NW end during the night for a short period.</p> <p>The SM had small low clouds during the daytime but did not fully cover the range. Those clouds diminished around sunset with more low clouds developing during the night and faded away Saturday morning. SLW was very limited and the wind</p>	<p>No ground-based seeding was conducted.</p>



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<p>was not right for seeding. Snowfall map showed less than 0.5 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 19/-8 Rock Springs: 13/-3 Lander: 20/-3 South Pass: 18/3 Dixon: 10/-15 Observed ODC: -1</p>	
<p>17 December 2022, Saturday</p>	
<p>In the Wind River range, skies were mostly clear besides some cirrus clouds that moved through throughout the daytime. Skies cleared by the evening continuing through the overnight hours.</p> <p>In the Sierra Madre range, skies were mostly clear with some cirrus clouds moving throughout the day and isolated mid-level clouds during the afternoon. The skies stayed clear through the night. The range saw less than an inch of accumulation.</p> <p>Max/Min temperatures Pinedale: 18/-9 Rock Springs: 17/5 Lander: 7/-11 South Pass: 10/-13 Dixon: 10/-2 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>18 December 2022, Sunday</p>	
<p>The daytime hours saw a band of upper-level cirriform cloud pass over the area, but with little moisture at lower-levels. Toward sunset thin lenticular clouds formed near/at the peaks, but their spatial extent was far too small to warrant seeding. These persisted into the night, while another band of upper-level cloud passed overhead.</p> <p>Max/Min temperatures Pinedale: 19/-14 Rock Springs: 18/3 Lander: 10/-4 Dixon: 19/-11 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>19 December 2022, Monday</p>	
<p>Moisture began reaching the area in the late afternoon, with thin SLW clouds at the peaks near the Green River headwaters. Overnight, this SLW cloud became more widespread across the range, with the radiometer at East Fork showing periods of light SLW presence. Low-level winds in the Green River basin were generally light out of the NNW and unfavorable for ground generator use.</p> <p>Max/Min temperatures</p>	<p>No ground-based seeding was conducted.</p>



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Pinedale: 19/-2 Rock Springs: 27/18 Lander: 28/9 South Pass: 16/7 Dixon: 25/-1 Observed ODC: 0	
20 December 2022, Tuesday	
<p>The WR range was capped by thin orographic cloud along the peaks during the day, but low-level winds in the Green River valley did not cooperate for use of generators. After sunset, the extent of orographic SLW-bearing cloud expanded. Low-level winds remained uncooperative until around midnight, when southwesterly flow mixed to the surface allowing favorable trajectories across the range. These favorable conditions continued into Wednesday morning.</p> <p>The SM had overcast conditions during the daytime. Light snowfall began in the evening and continued through the night. The wind was not favorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 23/3 Rock Springs: 28/21 Lander: 21/12 South Pass: 21/14 Dixon: 31/24 Observed ODC: +2</p>	<p>Seeding event WRR0187 began at 2356 MST on 12/20/2022.</p> <p>WRR0187 Summary: Generators: WR09, WR10, WR14, WR16. Time: 2356 (12/20) to 1220 (12/21) MST 0656 (12/21) to 1920 (12/21) UTC</p> <p>WR01, WR02, WR03, WR 12, WR13 0148 (12/21) to 1307 (12/21) MST 0848 (12/21) to 2007 (12/21) UTC</p> <p>Duration: 12:24, 100:40 Total Time Seeding Material: 44.63 gallons (2516.75 grams)</p>
21 December 2022, Wednesday	
<p>Favorable seeding conditions continued in the WR until the early afternoon, but areas of light snowfall persisted until just after sunset. The clouds then gradually cleared during the evening and night. A good portion of the range received 6 to 10 inches.</p> <p>The SM had light snowfall continue until the late evening hours. There was a short period with favorable seeding conditions beginning after sunset. The clouds slowly diminished during the night with a few, thin low clouds clearing Thursday morning. Accumulation was 1 to 2 inches. A strong cold front moved through the state during the day, bringing a quick and vast drop in surface temperatures.</p> <p>Max/Min temperatures Pinedale: 28/-2 Rock Springs: N/A Lander: 36/-18 South Pass: 23/-15 Dixon: 31/-2 Observed ODC: +2</p>	<p>Seeding event WRR0187 continued until 1307 MST on 12/21/2022.</p> <p>Seeding event SMR0002 began at 1702 MST on 12/21/2022.</p> <p>SMR0002 Summary: Generators: SM10. Time: 1702 (12/20) to 1916 (12/21) MST 0002 (12/22) to 0216 (12/22) UTC Duration: 2:14 Total Time Seeding Material: 0.78 gallons (55.75 grams)</p>
22 December 2022, Thursday	
<p>Clear skies during the daytime until upper level clouds moved in from the SW just before sunset. High and mid level cloud coverage increased during the night, with thick mid level</p>	<p>No ground-based seeding was conducted.</p>



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<p>clouds over the WR Friday morning. Very cold temperatures, with the 4 stations all below zero.</p> <p>Max/Min temperatures Pinedale: 0/-27 Rock Springs: N/A Lander: -13/-23 South Pass: 0/-24 Dixon: -1/-22 Observed ODC: -2</p>	
23 December 2022, Friday	
<p>Low clouds formed over both project regions during the morning and strengthened throughout the afternoon. SLW existed but the wind was unfavorable for seeding operations. Snowfall was limited and amounted to less than 1 inch accumulation in both locations. The clouds thinned over the WR during the night.</p> <p>Max/Min temperatures Pinedale: 16/-15 Rock Springs: N/A Lander: -9/-28 South Pass: 30/1 Dixon: 21/-19 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
24 December 2022, Saturday	
<p>There were broken, shallow low clouds over the WR during the morning with little to no snowfall. Scattered snow showers occurred during the night, but the wind was unfavorable for seeding operations.</p> <p>Thin clouds covered the SM during the daytime and evening with no snowfall. Areas of snowfall existed during the night and into Sunday morning. The wind was not favorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 34/10 Rock Springs: N/A Lander: 10/-11 South Pass: 34/27 Dixon: 33/21 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
25 December 2022, Sunday	
<p>In the Wind River range, skies were partly to mostly cloudy during the day. Some orographic snow showers occurred with broken coverage. Up to an inch of snow accumulation observed.</p> <p>In the Sierra Madre range, skies were mostly cloudy throughout the day. Winds were gusty in the late morning/early afternoon.</p>	<p>No ground-based seeding was conducted.</p>



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<p>Max/Min temperatures Pinedale: 36/12 Rock Springs: N/A Lander: 47/5 South Pass: 37/25 Dixon: 37/16 Observed ODC: -1</p>	
26 December 2022, Monday	
<p>In the Wind River range, skies were mostly cloudy throughout the day with some clearing in the late afternoon/evening. Some snow showers occurred. Up to an inch of snow accumulation observed, with up to 2 inches in higher peaks. In the Sierra Madre range, skies were mostly cloudy throughout the day with some snow showers. Half an inch of snow accumulation was observed, with up to an inch and a quarter in higher peaks.</p> <p>Max/Min temperatures Pinedale: 32/10 Rock Springs: N/A Lander: 29/18 South Pass: 32/19 Dixon: 40/19 Observed ODC: 0</p>	No ground-based seeding was conducted.
27 December 2022, Tuesday	
<p>Thick clouds with continuous snowfall (heavy at times) and radiometer detected LW developed in the morning and persisted throughout the afternoon and evening. The temperature was too warm for seeding operations. A cold front brought colder air a little before midnight and favorable seeding conditions existed for a few hours before the wind became parallel to the range. The clouds weakened by sunrise. Snowfall map showed the top of the range received 8 to 14 inches.</p> <p>The SM had continuous snowfall begin in the afternoon and lasted throughout the period but was weakening Wednesday morning. The temperature and wind were not favorable for seeding operations. The range had 5 to 8 inches of accumulation.</p> <p>Max/Min temperatures Pinedale: 34/12 Rock Springs: 38/32 Lander: 51/17 South Pass: 36/28 Dixon: 42/18 Observed ODC: +1</p>	<p>Seeding event WRR0188 began at 2211 MST on 12/27/2022.</p> <p>WRR0188 Summary: Generators: WR09, WR10, WR12, WR14, WR16. Time: 2356 (12/20) to 1220 (12/21) MST 0656 (12/21) to 1920 (12/21) UTC Duration: 4:48, 23:24 Total Time Seeding Material: 10.06 gallons (585 grams)</p>
28 December 2022, Wednesday	
<p>Shallow and thin low clouds were over the WR during the daytime, but no LW was detected by the radiometer. The clouds thickened over the southern slopes during the evening</p>	No ground-based seeding was conducted.



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<p>and persisted into Thursday morning, but the wind was not favorable for seeding operations.</p> <p>The SM had widespread cloud coverage from morning through evening, but snowfall was limited and the wind was not right for seeding. Only broken, shallow low clouds existed overnight.</p> <p>Max/Min temperatures Pinedale: 28/9 Rock Springs: 36/17 Lander: 41/16 South Pass: 28/16 Dixon: 37/13 Observed ODC: 0</p>	
<p><i>29 December 2022, Thursday</i></p>	
<p>Shallow and thin low clouds were over the southern slopes of the WR during the daytime, but slowly faded throughout the afternoon. High and mid level clouds moved in during the evening and night with low clouds returning by Friday morning, but snowfall didn't begin until mid morning.</p> <p>The SM had broken cloud coverage throughout the daytime with scattered snow showers. Those clouds thinned during the evening with widespread clouds moving in overnight. The wind was not favorable for seeding at any point. Snowfall map showed less than half inch accumulation.</p> <p>Max/Min temperatures Pinedale: 21/-6 Rock Springs: 25/14 Lander: 33/14 South Pass: 18/10 Dixon: 25/5 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p><i>30 December 2022, Friday</i></p>	
<p>Waves of thicker clouds passed over the WR during the daytime with light snowfall. No LW was detected by the radiometer until the late afternoon when the wind was becoming unfavorable for seeding. Thin and inconsistent cloud coverage existed during the evening and night with periods of snowfall but no SLW. The clouds began thickening Saturday morning. Snowfall map showed 2 to 5 inches of accumulation on the top of the range.</p> <p>The SM had more consistent thick mid level cloud coverage throughout the period with snowfall beginning in the later afternoon and continuing through most of the night, tapering off by sunrise. The wind was not right for seeding operations.</p> <p>Max/Min temperatures Pinedale: 21/-6 Rock Springs: 30/14 Lander: 32/8 South Pass: 28/12 Dixon: 31/7 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>



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31 December 2022, Saturday	
<p>Orographic clouds blanketed the WR range at the start of the forecast period, though coverage and consistency waned into the afternoon hours. Low level winds and observed liquid water were sufficient for a seeding event. The seeding ended as surface winds pivoted north. A second wave of enhanced cloud cover and SLW overspread the WR range overnight, but winds were not favorable for seeding.</p> <p>In the SM range, periods of orographic cloud cover with SLW and snow showers were observed, but warm low-level temps and dominant southerly flow were not conducive for seeding.</p> <p>Max/Min temperatures Pinedale: 30/16 Rock Springs: 36/27 Lander: 45/15 South Pass: 25/21 Dixon: 36/30 Observed ODC: +1</p>	<p>Seeding event WRR0189 began at 0822 MST on 12/31/2022.</p> <p>WRR0189 Summary: Generators: WR09, WR10, WR12, WR13, WR14, WR16. Time: 0822 (12/31) to 1538 (12/31) MST 1522 (12/31) to 2238 (12/31) UTC Duration: 7:16, 43:16 Total Time Seeding Material: 19.32 gallons (1081.75 grams)</p>
01 January 2023, Sunday	
<p>Low clouds and snow showers were observed midday through the overnight hours in both the WR and SM ranges and their adjacent valleys. Low-level north-northeast flow was observed in the WR range, though not quite easterly enough for proper plume transport from Enterprise, and signs of SLW from the radiometer and satellite were short-lived.</p> <p>In the SM range, light and variable wind was generally not upslope from the position of the SM GGENS.</p> <p>SWE increases of a tenth to a quarter inch were seen on the west side of the WR range, but up to an inch east of the divide. In the SM range, widespread 1" SWE increases were observed, with Sandstone picking up 1.5" SWE.</p> <p>Max/Min temperatures Pinedale: 28/18 Rock Springs: 28/21 Lander: 28/24 South Pass: 23/18 Dixon: 42/30 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
02 January 2023, Monday	
<p>Periods of light snow showers continued across the WR and SM ranges, with light snow still falling in both regions Tuesday morning. SWE accumulations were not nearly as significant as they were on Sunday, but the WR observed a trace to a half inch, highest in the southeast, and the SM received a more consistent quarter inch. Periods of valley fog and stratus containing SLW were observed much of the period, but tepid</p>	<p>No ground-based seeding was conducted.</p>



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<p>surface winds were not sufficient to lift any GGEN seeding material to requisite heights at the cloud base.</p> <p>Max/Min temperatures Pinedale: 27/12 Rock Springs: 23/20 Lander: 26/23 South Pass: 20/14 Dixon: 35/20 Observed ODC: 0</p>	
03 January 2023, Tuesday	
<p>Widespread low clouds covered most of the SW half of WY during the daytime and evening. The clouds broke up during the night, but shallow clouds remained over the SM region into Wednesday morning with small, thin clouds on the southern slopes of the WR. Despite the cloud coverage, snowfall was very light with the WR receiving less than 0.5 inch accumulation and the SM around 1 inch. The wind was not favorable for seeding in the WR but would have been right in the SM during the night had GGEN issues not prevented seeding operations.</p> <p>Max/Min temperatures Pinedale: 21/5 Rock Springs: 24/17 Lander: 24/15 South Pass: 23/14 Dixon: 25/11 Observed ODC: +1</p>	<p>No ground-based seeding was conducted.</p>
04 January 2023, Wednesday	
<p>The WR had only small, thin low clouds over the southern slopes, diminishing by late afternoon. Only a dusting of snowfall occurred. There were high and mid level clouds during the evening and night then low clouds started forming early Thursday morning.</p> <p>Shallow low clouds lingered over the SM throughout the daytime with very light snowfall that amounted to less than 1 inch accumulation. The wind was not favorable for seeding operations. The clouds diminished in the evening with multiple cloud layers returning Thursday morning.</p> <p>Max/Min temperatures Pinedale: 19/-11 Rock Springs: 25/15 Lander: 24/0 South Pass: 27/12 Dixon: 26/8 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
05 January 2023, Thursday	
<p>In the Wind River range, skies were overcast throughout the day with snow showers. 1-3 inches of snow accumulation</p>	<p>Seeding event WRR0190 began at 0934 MST on 01/05/2023.</p>



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<p>observed, with up to 5 inches in higher peaks. Favorable seeding conditions had developed in the morning and lasted to the middle of the afternoon, at which point the traj were no longer favorable for plume transport.</p> <p>In the Sierra Madre range, skies were mostly cloudy throughout the day with some snow showers. Half an inch to an inch of snow accumulation was observed, with up to an inch and three quarters in higher peaks.</p> <p>Max/Min temperatures Pinedale: 27/14 Rock Springs: 33/14 Lander: 26/1 South Pass: 28/9 Dixon: 33/24 Observed ODC: +1</p>	<p>WRR0190 Summary: Generators: WR01, WR09, WR12. Time: 0934 (01/05) to 1518 (01/05) MST 1634 (01/05) to 2218 (01/05) UTC Duration: 5:41, 9:06 Total Time Seeding Material: 4.08 gallons (227.25 grams)</p>
<p>06 January 2023, Friday</p>	
<p>In the Wind River range, skies were partly cloudy to cloudy throughout the day with little to no snowfall and NW wind flow.</p> <p>In the Sierra Madre range, skies were cloudy with light snowfall throughout most of the day. Half an inch to 2 inches of snow accumulation was observed. The wind was not right for seeding operations.</p> <p>Max/Min temperatures Pinedale: 27/19 Rock Springs: 38/14 Lander: 23/3 South Pass: 27/10 Dixon: 39/21 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>07 January 2023, Saturday</p>	
<p>In the Wind River range, skies were mostly clear with some cirrus clouds observed. Clouds moved over the range overnight.</p> <p>In the Sierra Madre range, skies were partly to mostly cloudy throughout the day. Clouds increased overnight.</p> <p>Max/Min temperatures Pinedale: 28/2 Rock Springs: 34/14 Lander: 18/1 South Pass: 23/10 Dixon: 34/13 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>08 January 2023, Sunday</p>	
<p>There were areas of mid level clouds around both regions during the daytime. The WR had light snowfall begin during the early evening diminishing by the middle of the night.</p>	<p>No ground-based seeding was conducted.</p>



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<p>Snowfall map showed 0.5 to 3 inch accumulation. The wind was not favorable for seeding operations. The SM had only a few snow showers around midnight amounting to less than half an inch accumulation.</p> <p>Max/Min temperatures Pinedale: 21/-2 Rock Springs: 21/8 Lander: 24/2 South Pass: 28/19 Dixon: 33/10 Observed ODC: 0</p>	
09 January 2023, Monday	
<p>Low clouds started forming over the WR in the late morning. By the time sufficient SLW formed, the wind was about to become unfavorable for plume transport so no seeding occurred. Snowfall continued the rest of the day into Tuesday with periods of LW but the wind remained unfavorable. Snowfall map showed 2 to 6 inches accumulation. The SM had low clouds gradually developing throughout the afternoon. Thick clouds persisted over the range throughout the evening and night, but snowfall was limited and less than half an inch fell. The wind was not right for seeding.</p> <p>Max/Min temperatures Pinedale: 21/-2 Rock Springs: 28/5 Lander: 29/5 South Pass: 32/18 Dixon: 39/8 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
10 January 2023, Tuesday	
<p>The WR had favorable seeding conditions develop in the morning and continued to the middle of the afternoon, when the wind became unfavorable for plume transport. Snowfall was light and inconsistent during the afternoon and most of the evening. Heavier, widespread snowfall moved in by late evening and continued through the night, while the wind remained unfavorable. Snowfall map showed a good portion of the range received 6 to 10 inches. The SM had broken light snowfall during the daytime and then continuous snowfall the rest of the period. The wind was southerly and not right for ground seeding. Snowfall map also showed 6 to 10 inches.</p> <p>Max/Min temperatures Pinedale: 30/19 Rock Springs: 35/25 Lander: 33/12 South Pass: 32/21 Dixon: 40/33 Observed ODC: +1</p>	<p>Seeding event WRR0191 began at 0942 MST on 01/10/2023.</p> <p>WRR0191 Summary: Generators: WR01, WR02, WR03, WR12. Time: 0942 (01/10) to 1433 (01/10) MST 1642 (01/10) to 2133 (01/10) UTC Duration: 4:51, 16:44 Total Time Seeding Material: 7.57 gallons (418.75 grams)</p>



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11 January 2023, Wednesday	
<p>The WR region had widespread cloud coverage in the morning but moved away in the early afternoon. Shallow low clouds lingered through the afternoon and evening, clearing overnight. The wind was NW and not favorable for seeding. Snowfall map showed 4 to 6 inches on most of the range with an area over 12.</p> <p>The SM had continuous cloud coverage through the daytime and evening then diminishing clouds overnight. Snowfall was very light and only amounted to 1 to 3 inches. The wind was borderline but not quite favorable for seeding.</p> <p>Max/Min temperatures Pinedale: 30/10 Rock Springs: 32/20 Lander: 34/19 South Pass: 28/21 Dixon: 42/24 Observed ODC: 0</p>	No ground-based seeding was conducted.
12 January 2023, Thursday	
<p>The WR had scattered, shallow, low clouds for most of the afternoon, with just a dusting of snowfall. No significant coverage occurred. Thin high clouds covered the region during the nighttime hours.</p> <p>The SM were clear until a shallow cloud bank developed in the early afternoon persisting into the early evening hours. These clouds didn't fully cover the range and the wind was unfavorable for seeding. There was up to 1 inch accumulation. After those clouds diminished, thin high clouds moved into the region.</p> <p>Max/Min temperatures Pinedale: 23/-8 Rock Springs: 28/14 Lander: 28/7 South Pass: 32/19 Dixon: 29/4 Observed ODC: -1</p>	No ground-based seeding was conducted.
13 January 2023, Friday	
<p>Thin upper level clouds covered the area for most of the day. A chinook cloud formed on the NE side of the WR in the afternoon, going away after sunset. A wave of snowfall moved through during the night, dropping 1 to 4 inches on the WR and 0.5 to 2 inches on the SM. The temperature was too warm for seeding operations during that time. Only scattered low clouds were left by Saturday morning.</p> <p>Max/Min temperatures Pinedale: 21/0 Rock Springs: 25/11 Lander: 22/7 South Pass: 41/19 Dixon: 28/9</p>	No ground-based seeding was conducted.



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Observed ODC: 0	
14 January 2023, Saturday	
<p>In the Wind River range, broken overcast skies were seen in the morning and early afternoon with cloud cover continuing to increase through the evening into the overnight hours. Snow showers occurred around the range with the northern part receiving around 4 inches and the southern part of the range receiving around 2.5 inches. The temperature was too warm for seeding operations until the wind shifted to NW flow in the early evening.</p> <p>In the Sierra Madre range, skies were partly cloudy throughout the day with clouds increasing overnight. Snow showers occurred during the overnight hours with SM receiving around 2.5 inches of accumulation.</p> <p>Max/Min temperatures Pinedale: 25/5 Rock Springs: 30/13 Lander: 25/11 South Pass: 36/19 Dixon: 34/16 Observed ODC: 0</p>	No ground-based seeding was conducted.
15 January 2023, Sunday	
<p>There were widespread thick clouds with light snowfall covering most of WY during the daytime and evening. The wind direction was not right for seeding in the SM and was too weak for plume transport in the WR. The clouds cleared over the WR during the night, but shallow low clouds lingered over the SM into Monday morning. Snowfall map showed 0.5 to 4 inch accumulation in the WR and 3 to 6 in the SM.</p> <p>Max/Min temperatures Pinedale: 30/12 Rock Springs: 33/25 Lander: 28/9 South Pass: 28/21 Dixon: 38/30 Observed ODC: 0</p>	No ground-based seeding was conducted.
16 January 2023, Monday	
<p>The WR had thin mid level cloud coverage around during the daytime. Low clouds existed during the evening and nighttime with light snowfall, but the wind was not favorable for seeding operations. A half to 2 inches of accumulation fell on the range. The clouds had thinned by Tuesday morning.</p> <p>The SM had cloud coverage throughout most of the period, but snowfall was very limited, amounting to less than 1 inch. The wind was southerly and not right for seeding. The clouds were breaking up and thinning by Tuesday morning.</p>	No ground-based seeding was conducted.



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<p>Max/Min temperatures Pinedale: 18/-4 Rock Springs: 30/16 Lander: 26/17 South Pass: 28/19 Dixon: 34/13 Observed ODC: 0</p>	
<p>17 January 2023, Tuesday</p>	
<p>The WR had thickening cloud coverage in the early afternoon with light snowfall from mid afternoon to the middle of the night. With northerly flow, most of the snowfall was on the northern slopes, but the wind was not right for seeding with Enterprise. Most of the range received less than 1 inch, but the NE corner had up to 4 inches accumulation. The clouds had cleared away by Wednesday morning.</p> <p>The SM had light snowfall begin in the late afternoon and continued into Wednesday. SLW was very low and inconsistent, and the wind was NE, which is not favorable for seeding. Snowfall map showed 2 to 5 inches on the range.</p> <p>Max/Min temperatures Pinedale: 23/-2 Rock Springs: 26/13 Lander: 25/16 South Pass: 27/19 Dixon: 33/27 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>18 January 2023, Wednesday</p>	
<p>A CO low had developed Tuesday night and was moving eastward, slowly pulling away from the area. The WR region had already dried and saw clear skies for most of the day while thick clouds covered the SE quarter of WY, including the SM region, until the evening hours. The snowfall in the SM was light and ended by late afternoon, amounting to 1 to 2.5 inches. Seeding was attempted in the afternoon, but GGEN issues prevented seeding from occurring. The SM region cleared overnight while high clouds moved into the WR region from the west.</p> <p>Max/Min temperatures Pinedale: 23/-6 Rock Springs: 24/11 Lander: 26/7 South Pass: 23/12 Dixon: 28/4 Observed ODC: +1</p>	<p>No ground-based seeding was conducted.</p>
<p>19 January 2023, Thursday</p>	
<p>Broken mid level clouds spread over the area during the daytime. Low clouds started forming over the WR in the late afternoon, with light snowfall during the evening and night. The wind flow was not right for seeding. Snowfall map showed</p>	<p>No ground-based seeding was conducted.</p>



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<p>1 to 4 inches, with the highest amounts on the northern slopes. The clouds were diminishing by Friday morning. The SM had periods of low clouds during the night with flurries that amounted to less than half an inch. There were only thin clouds by Friday morning.</p> <p>Max/Min temperatures Pinedale: 19/-13 Rock Springs: 20/9 Lander: 14/-1 South Pass: 28/14 Dixon: 27/-1 Observed ODC: 0</p>	
<p>20 January 2023, Friday</p>	
<p>Thin low clouds were around the edges of the WR in the morning but diminished in the early afternoon and the sky was clear until high clouds moved in just before sunset. Scattered areas of low clouds and light snowfall developed over night. Snowfall amounted to less than 1 inch and the wind was not favorable for seeding. By Saturday morning, only shallow clouds were left on the lowlands around the range. The SM had thin, mid level cloud coverage during the daytime and evening. Some passing low clouds left a dusting of snowfall overnight, with only thin mid level clouds Saturday morning.</p> <p>Max/Min temperatures Pinedale: 12/-8 Rock Springs: 24/9 Lander: 18/7 South Pass: 25/14 Dixon: 19/3 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>21 January 2023, Saturday</p>	
<p>In the Wind River range, skies were mostly clear with a few cirrus clouds at times. Some high-level cirrus clouds were observed overnight, but skies were mostly clear. In the Sierra Madre range, skies were partly to mostly cloudy throughout the day. Some snow showers occurred in the evening and overnight. Less than half an inch of snow accumulation was observed.</p> <p>Max/Min temperatures Pinedale: 5/-13 Rock Springs: 16/9 Lander: 20/1 South Pass: 25/3 Dixon: 19/9 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>22 January 2023, Sunday</p>	



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<p>In the Wind River range, there were some cirrus clouds in the morning. Low-mid level clouds moved in during the afternoon. Skies became mostly clear at night on the western side of the range, while the eastern side of the range observed some snow showers overnight.</p> <p>In the Sierra Madre range, skies were partly cloudy in the morning with clouds increasing in the afternoon. Some snow showers occurred in the evening and overnight.</p> <p>Max/Min temperatures Pinedale: 9/-17 Rock Springs: 19/10 Lander: 21/-5 South Pass: 23/1 Dixon: 20/-2 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
23 January 2023, Monday	
<p>In the Wind River range, some areas experienced fog in the morning. Skies were mostly clear with some cirrus clouds occurring during the day. Clouds increased overnight.</p> <p>In the Sierra Madre range, some snow showers occurred before dawn. Skies were partly cloudy during the daytime. A few more snow showers occurred overnight. Up to a half inch of snow accumulation was observed.</p> <p>Max/Min temperatures Pinedale: 21/-17 Rock Springs: 21/13 Lander: 23/10 South Pass: 21/10 Dixon: 25/10 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
24 January 2023, Tuesday	
<p>The WR was clear until mid level clouds spread across in the later afternoon hours. Broken clouds covered the region during the evening and night with some light snowfall during the night, but the wind was northwesterly. The clouds cleared to the east Wednesday morning. Snowfall map showed a dusting of accumulation.</p> <p>The clouds over the SM thickened around noon, with favorable seeding conditions for a few hours until the clouds thinned by mid afternoon. Widespread, thin clouds covered the region during the evening and night, thickening Wednesday morning. Snowfall map showed less than half an inch accumulation.</p> <p>Max/Min temperatures Pinedale: 21/0 Rock Springs: 19/10 Lander: 20/6 South Pass: 21/10 Dixon: 21/6 Observed ODC: +1</p>	<p>Seeding event SMR0004 began at 1212 MST on 01/24/2023.</p> <p>SMR0004 Summary: Generators: SM10. Time: 1212 (01/24) to 1445 (01/24) MST 1912 (01/24) to 2145 (01/24) UTC Duration: 2:33 Total Time Seeding Material: 1.17 gallons (63.75 grams)</p>



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25 January 2023, Wednesday	
<p>The WR had broken to scattered mid and low cloud coverage throughout the day. There were a few areas of light snowfall with minimal accumulation. SLW was very limited and the wind was NW.</p> <p>In the SM, northwest flow organized enough moisture and winds to produce orographically-enhanced SLW along with light to moderate snow late Wednesday morning into the evening. Two to three tenths of an inch (0.2-0.3") of snow water was accumulated during this time. Snow stopped overnight and clouds thinned to mostly sunny skies by Thursday morning.</p> <p>Max/Min temperatures Pinedale: 21/3 Rock Springs: 19/5 Lander: 27/10 South Pass: 18/1 Dixon: 19/4 Observed ODC: +1</p>	<p>Seeding event SMR0005 began at 1013 MST on 01/25/2023.</p> <p>SMR0005 Summary: Generators: SM10, SM11. Time: 1013 (01/25) to 1534 (01/25) MST 1713 (01/25) to 2234 (01/25) UTC Duration: 5:21 Total Time Seeding Material: 2.94 gallons (133.75 grams)</p>
26 January 2023, Thursday	
<p>Clouds began increasing in the afternoon and evening for both the Wind River and Sierra Madre, with some light to moderate snow occurring in the evening and night. Around a quarter inch (0.20-0.40") of SWE was noted around both ranges from the late afternoon/overnight activity. Light northwest winds for the Wind River generators, and south winds for the Sierra Madre generators precluded seeding activities.</p> <p>Max/Min temperatures Pinedale: 27/-11 Rock Springs: 27/7 Lander: 36/12 South Pass: 19/1 Dixon: 24/-11 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
27 January 2023, Friday	
<p>In the Wind River range, skies were overcast with snow showers occurring through most of the day. Some clouds cleared in the evening before snow showers started up again. SLW was too light and inconsistent for seeding operations. 3-6 inches of snow accumulation were observed, with up to 10 inches in higher peaks.</p> <p>In the Sierra Madre range, skies were overcast with snow showers throughout the day. 6-10 inches of snow accumulation were observed, with 10-15 inches observed in higher peaks. Seeding operations were suspended in the SM.</p> <p>Max/Min temperatures Pinedale: 27/10 Rock Springs: 30/24</p>	<p>No ground-based seeding was conducted.</p>



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Lander: 32/17 South Pass: 21/14 Dixon: 27/23 Observed ODC: 0	
28 January 2023, Saturday	
<p>In the Wind River range, skies were overcast with periods of snowfall occurring through most of the day. The wind was not favorable for seeding operations and SLW was very limited. 2-5 inches of snow accumulation were observed, with up to 6-8 inches observed in higher peaks.</p> <p>In the Sierra Madre range, skies were overcast with very light snow showers. The wind was not right for seeding operations. 1-2 inches of snow accumulation were observed, with up to 4 inches observed in higher peaks.</p> <p>Max/Min temperatures Pinedale: 23/0 Rock Springs: 27/3 Lander: 23/0 South Pass: 18/-4 Dixon: 29/16 Observed ODC: 0</p>	No ground-based seeding was conducted.
29 January 2023, Sunday	
<p>Cold temperatures in the morning and even colder air moving in during the night. The clouds over the WR had thinned by mid day with thin cloud coverage during the afternoon and the clouds moved away in the evening. The sky was clear until high clouds moved in from the west early Monday morning. Snowfall map showed less than 1 inch accumulation.</p> <p>The SM had nearly continuous snowfall for most of the day. SLW was limited and the wind was not favorable for seeding operations. The clouds had begun to diminish Monday morning. Snowfall map showed 4 to 6 inches on the range.</p> <p>Max/Min temperatures Pinedale: 10/-24 Rock Springs: 4/-14 Lander: -1/-20 South Pass: -6/-13 Dixon: 22/-1 Observed ODC: 0</p>	No ground-based seeding was conducted.
30 January 2023, Monday	
<p>A bitterly cold day! Thin high and mid level clouds over the WR in the morning moved away shortly after noon. The sky was clear until shallow low clouds formed over the NW part of the range early Tuesday morning.</p> <p>Shallow low clouds were over the SM in the morning and then diminished in the early afternoon. There were clouds just to the south of the range through the afternoon, but the SM were</p>	No ground-based seeding was conducted.



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<p>clear the rest of the period. The snowfall map showed a dusting of snowfall from the morning clouds.</p> <p>Max/Min temperatures Pinedale: -8/-35 Rock Springs: -1/-19 Lander: -9/-27 South Pass: 3/-11 Dixon: 1/-30 Observed ODC: -1</p>	
31 January 2023, Tuesday	
<p>Another cold morning around the area, with a general warming trend throughout the day. Shallow low clouds existed over the NW part of the WR in the morning with mid level clouds spreading over the area in the afternoon. Low clouds existed over the southern slopes during the evening with light snowfall that amounted to less than half an inch accumulation. The wind was not right for seeding. Most of the clouds diminished overnight.</p> <p>The SM were clear until after midnight. Shallow low clouds formed during the night, but no snowfall fell in the range.</p> <p>Max/Min temperatures Pinedale: 5/-36 Rock Springs: 16/-14 Lander: -2/-31 South Pass: 21/-6 Dixon: 2/-34 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
01 February 2023, Wednesday	
<p>Scattered low and mid level clouds spread over the WR during the daytime hours and persisted through the evening. Some flurries occurred but less than half an inch accumulated. The clouds cleared overnight.</p> <p>The SM had shallow low clouds linger over the range for most of the morning and afternoon. The snowfall map showed 1 to 2 inches of snowfall, but most of that was from the early morning. No SLW existed and the wind wasn't right for seeding. The clouds diminished in the evening.</p> <p>Max/Min temperatures Pinedale: 19/-11 Rock Springs: 25/7 Lander: 15/-11 South Pass: 28/14 Dixon: 16/-6 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
02 February 2023, Thursday	
<p>The sky was clear over the area until a few high clouds moved into the WR from the NW with some mid level clouds during the evening. It was clear again overnight and then mid level</p>	<p>No ground-based seeding was conducted.</p>



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<p>clouds formed over the WR early Friday morning. The SM area was clear the entire period.</p> <p>Max/Min temperatures Pinedale: 19/-11 Rock Springs: 31/13 Lander: 20/2 South Pass: 36/23 Dixon: 20/-8 Observed ODC: -2</p>	
<p>03 February 2023, Friday</p>	
<p>A chinook cloud existed on the NE side of the WR during the daytime but otherwise it was clear. Low clouds developed over the range during the evening with a few showers occurring for a short period around midnight. Less than an inch of snow accumulated, with around an inch of snow observed in higher peaks.</p> <p>In the Sierra Madre range, skies were partly cloudy with upper-level cirrus clouds present throughout the daytime and evening. Mid level clouds formed during the night but cleared by morning.</p> <p>Max/Min temperatures Pinedale: 23/-9 Rock Springs: 25/8 Lander: 20/5 South Pass: 28/16 Dixon: 26/-8 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>04 February 2023, Saturday</p>	
<p>In the Wind River range, skies were mostly clear throughout the day with a few mid-level and cirrus clouds present. Skies became overcast overnight. Orographic clouds and snow showers developed over the range by Sunday morning. Up to 0.25 inches of snow accumulated in the mountains.</p> <p>In the Sierra Madre range, skies were mostly clear with increasing clouds in the evening and overnight.</p> <p>Max/Min temperatures Pinedale: 23/-6 Rock Springs: 32/10 Lander: 37/12 South Pass: 27/14 Dixon: 34/11 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>05 February 2023, Sunday</p>	
<p>In the Wind River range, light snowfall existed most of the day, with favorable seeding conditions from the mid afternoon to the early evening. 1-3 inches of snow accumulated with almost 4 inches observed in higher peaks.</p>	<p>Seeding event WRR0192 began at 1417 MST on 02/05/2023.</p> <p>WRR0192 Summary: Generators: WR01, WR02, WR03.</p>



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<p>In the Sierra Madre range, cloud coverage increased during the daytime. Snow showers occurred during the evening and overnight. Conditions were favorable for seeding from the mid evening to the middle of the night. Up to 2 inches of snow accumulated with up to 2.5 inches observed in higher peaks.</p> <p>Max/Min temperatures Pinedale: 28/3 Rock Springs: 33/21 Lander: 31/14 South Pass: 30/12 Dixon: 41/14 Observed ODC: +2</p>	<p>Time: 1417 (02/05) to 1805 (02/05) MST 2117 (02/05) to 0105 (02/06) UTC Duration: 3:48, 11:24 Total Time Seeding Material: 6.08 gallons (285 grams)</p>
<p>06 February 2023, Monday</p>	
<p>The WR had small, broken low clouds over the range with snow showers for most of the daytime, diminishing a little before sunset. The snowfall amounted to less than 1 inch accumulation. The sky was clear until around sunrise when some high and mid level clouds moved through Tuesday morning.</p> <p>The SM region had widespread cloud coverage during the daytime, with light snowfall. The wind was not quite favorable for seeding and SLW was very limited. The clouds diminished throughout the evening hours, but shallow low clouds lingered over the range during the night. Snowfall map showed around 1 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 28/-4 Rock Springs: 29/17 Lander: 34/18 South Pass: 27/18 Dixon: 28/10 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>07 February 2023, Tuesday</p>	
<p>After mid level clouds moved out of the WR in the morning the sky was clear until the evening. High and mid level clouds moved in before midnight with low clouds forming over the range during the night. Snowfall didn't begin until around sunrise.</p> <p>The SM had shallow low clouds linger through the daytime. Snowfall map showed up to 1 inch accumulation but most of that occurred in the early morning and the wind was not favorable for seeding at any point during the day. The clouds diminished in the evening, and it was clear until a band of mid level clouds moved in Wednesday morning.</p> <p>Max/Min temperatures Pinedale: 32/12 Rock Springs: 29/17 Lander: 26/10 South Pass: 32/18 Dixon: 27/0</p>	<p>No ground-based seeding was conducted.</p>



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Observed ODC: 0	
08 February 2023, Wednesday	
<p>Favorable seeding conditions developed in the WR during the morning and lasted to the middle of the afternoon, at which point the wind changed to NW and the clouds broke up. Periods of low clouds and light snowfall existed during the evening and night, but the wind remained unfavorable for seeding. Snowfall map showed 1 to 3 inches accumulation. The SM had broken cloud coverage until the mid afternoon, when thick clouds formed over the range. Favorable seeding conditions existed for a few hours in the early evening hours until the wind became too northerly for proper plume transport. Light snowfall continued through the night, but the cloud was thinning Thursday morning. Snowfall map showed 2 to 4 inches.</p> <p>Max/Min temperatures Pinedale: 28/9 Rock Springs: 32/12 Lander: 36/16 South Pass: 28/14 Dixon: 26/-3 Observed ODC: +2</p>	<p>Seeding event WRR0193 began at 0838 MST on 02/08/2023.</p> <p>WRR0193 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 0838 (02/08) to 1425 (02/08) MST 1538 (02/08) to 2125 (02/08) UTC Duration: 5:47, 42:43 Total Time Seeding Material: 21.35 gallons (1069.5 grams)</p> <p>Seeding event SMR0006 began at 1704 MST on 02/08/2023.</p> <p>SMR0006 Summary: Generators: SM10, SM11. Time: 1704 (02/08) to 1945 (02/08) MST 0004 (02/09) to 0245 (02/09) UTC Duration: 2:31, 4:49 Total Time Seeding Material: 2.13 gallons (120.5 grams)</p>
09 February 2023, Thursday	
<p>The WR was clear throughout the day except for a few high clouds during the night. Shallow low clouds were over the SM in the morning, becoming broken after noon with deteriorating cloud coverage throughout the afternoon. The clouds were completely gone by early evening, and it was clear overnight. The snowfall from the morning amounted to less than half an inch accumulation.</p> <p>Max/Min temperatures Pinedale: 19/-9 Rock Springs: 21/5 Lander: 27/6 South Pass: 27/7 Dixon: 18/1 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
10 February 2023, Friday	
<p>The sky was clear over the project regions for most of the day except for high cloud coverage increasing a little before sunrise and throughout Saturday morning.</p> <p>Max/Min temperatures Pinedale: 21/-13 Rock Springs: 31/8 Lander: 17/0 South Pass: 36/23</p>	<p>No ground-based seeding was conducted.</p>



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Dixon: 25/1 Observed ODC: -3	
11 February 2023, Saturday	
<p>Skies had increasing cirrus cloud coverage throughout the daytime over the area. Thicker clouds were observed during the evening and early night but were thinning by Sunday morning.</p> <p>Max/Min temperatures Pinedale: 23/-8 Rock Springs: 22/6 Lander: 21/5 South Pass: 32/18 Dixon: 29/-6 Observed ODC: -2</p>	No ground-based seeding was conducted.
05 February 2023, Sunday	
<p>In the Wind River range, light snowfall existed most of the day, with favorable seeding conditions from the mid afternoon to the early evening. 1-3 inches of snow accumulated with almost 4 inches observed in higher peaks.</p> <p>In the Sierra Madre range, cloud coverage increased during the daytime. Snow showers occurred during the evening and overnight. Conditions were favorable for seeding from the mid evening to the middle of the night. Up to 2 inches of snow accumulated with up to 2.5 inches observed in higher peaks.</p> <p>Max/Min temperatures Pinedale: 28/3 Rock Springs: 33/21 Lander: 31/14 South Pass: 30/12 Dixon: 41/14 Observed ODC: +2</p>	<p>Seeding event WRR0192 began at 1417 MST on 02/05/2023.</p> <p>WRR0192 Summary: Generators: WR01, WR02, WR03. Time: 1417 (02/05) to 1805 (02/05) MST 2117 (02/05) to 0105 (02/06) UTC Duration: 3:48, 11:24 Total Time Seeding Material: 6.08 gallons (285 grams)</p> <p>Seeding event SMR0006 began at 2132 MST on 02/05/2023.</p> <p>SMR0006 Summary: Generators: SM10. Time: 1732 (02/05) to 0200 (02/06) MST 0432 (02/06) to 0900 (02/06) UTC Duration: 4:13 Total Time Seeding Material: 1.24 gallons (105.5 grams)</p>
06 February 2023, Monday	
<p>The WR had small, broken low clouds over the range with snow showers for most of the daytime, diminishing a little before sunset. The snowfall amounted to less than 1 inch accumulation. The sky was clear until around sunrise when some high and mid level clouds moved through Tuesday morning.</p> <p>The SM region had widespread cloud coverage during the daytime, with light snowfall. The wind was not quite favorable for seeding and SLW was very limited. The clouds diminished throughout the evening hours, but shallow low clouds lingered</p>	No ground-based seeding was conducted.



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<p>over the range during the night. Snowfall map showed around 1 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 28/-4 Rock Springs: 29/17 Lander: 34/18 South Pass: 27/18 Dixon: 28/10 Observed ODC: 0</p>	
07 February 2023, Tuesday	
<p>After mid level clouds moved out of the WR in the morning the sky was clear until the evening. High and mid level clouds moved in before midnight with low clouds forming over the range during the night. Snowfall didn't begin until around sunrise.</p> <p>The SM had shallow low clouds linger through the daytime. Snowfall map showed up to 1 inch accumulation but most of that occurred in the early morning and the wind was not favorable for seeding at any point during the day. The clouds diminished in the evening, and it was clear until a band of mid level clouds moved in Wednesday morning.</p> <p>Max/Min temperatures Pinedale: 32/12 Rock Springs: 29/17 Lander: 26/10 South Pass: 32/18 Dixon: 27/0 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
08 February 2023, Wednesday	
<p>Favorable seeding conditions developed in the WR during the morning and lasted to the middle of the afternoon, at which point the wind changed to NW and the clouds broke up. Periods of low clouds and light snowfall existed during the evening and night, but the wind remained unfavorable for seeding. Snowfall map showed 1 to 3 inches accumulation. The SM had broken cloud coverage until the mid afternoon, when thick clouds formed over the range. Favorable seeding conditions existed for a few hours in the early evening hours until the wind became too northerly for proper plume transport. Light snowfall continued through the night, but the cloud was thinning Thursday morning. Snowfall map showed 2 to 4 inches.</p> <p>Max/Min temperatures Pinedale: 28/9 Rock Springs: 32/12 Lander: 36/16 South Pass: 28/14 Dixon: 26/-3 Observed ODC: +2</p>	<p>Seeding event WRR0193 began at 0838 MST on 02/08/2023.</p> <p>WRR0193 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 0838 (02/08) to 1425 (02/08) MST 1538 (02/08) to 2125 (02/08) UTC Duration: 5:47, 42:43 Total Time Seeding Material: 21.35 gallons (1069.5 grams)</p> <p>Seeding event SMR0006 began at 1704 MST on 02/08/2023.</p> <p>SMR0007 Summary: Generators: SM10, SM11. Time: 1704 (02/08) to 1945 (02/08) MST 0004 (02/09) to 0245 (02/09) UTC Duration: 2:31, 4:49 Total Time Seeding Material: 2.13 gallons (120.5 grams)</p>



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09 February 2023, Thursday	
<p>The WR was clear throughout the day except for a few high clouds during the night. Shallow low clouds were over the SM in the morning, becoming broken after noon with deteriorating cloud coverage throughout the afternoon. The clouds were completely gone by early evening, and it was clear overnight. The snowfall from the morning amounted to less than half an inch accumulation.</p> <p>Max/Min temperatures Pinedale: 19/-9 Rock Springs: 21/5 Lander: 27/6 South Pass: 27/7 Dixon: 18/1 Observed ODC: -1</p>	No ground-based seeding was conducted.
10 February 2023, Friday	
<p>The sky was clear over the project regions for most of the day except for high cloud coverage increasing a little before sunrise and throughout Saturday morning.</p> <p>Max/Min temperatures Pinedale: 21/-13 Rock Springs: 31/8 Lander: 17/0 South Pass: 36/23 Dixon: 25/1 Observed ODC: -3</p>	No ground-based seeding was conducted.
11 February 2023, Saturday	
<p>Skies had increasing cirrus cloud coverage throughout the daytime over the area. Thicker clouds were observed during the evening and early night but were thinning by Sunday morning.</p> <p>Max/Min temperatures Pinedale: 23/-8 Rock Springs: 22/6 Lander: 21/5 South Pass: 32/18 Dixon: 29/-6 Observed ODC: -2</p>	No ground-based seeding was conducted.
12 February 2023, Sunday	
<p>In the Wind River range, skies were mostly clear besides some cirrus clouds observed in the evening. In the Sierra Madre range, skies were cloudy in the morning with some clearing in the afternoon and evening.</p> <p>Max/Min temperatures Pinedale: 19/-8 Rock Springs: 30/7</p>	No ground-based seeding was conducted.



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Lander: 25/7 South Pass: 43/18 Dixon: 30/3 Observed ODC: -2	
13 February 2023, Monday	
<p>The WR were clear until high and mid level clouds moved in a little after sunset. Low clouds developed during the night with a few areas of light snowfall that amounted to around half an inch accumulation.</p> <p>The SM had thick mid level clouds push into the region from the south during the late afternoon. Those clouds moved away by midnight, but thin low clouds developed during the night lasting into Tuesday morning. No snowfall occurred.</p> <p>Max/Min temperatures Pinedale: 23/-9 Rock Springs: 28/2 Lander: 22/2 South Pass: 34/18 Dixon: 27/-5 Observed ODC: 0</p>	No ground-based seeding was conducted.
14 February 2023, Tuesday	
<p>Low clouds developed over the WR during the afternoon with northerly wind flow. Continuous snowfall occurred from the mid afternoon until a little before sunrise. SLW was very limited and the traj was not quite favorable for seeding. Snowfall map showed a good portion of the northern slopes received 4 to 9 inches.</p> <p>Low clouds over the SM diminished in the morning, then it was clear until mid level clouds moved across in the late afternoon. Broken mid level clouds remained until widespread clouds pushed in from the south with light snowfall continuing into Wednesday morning. The wind was not right for seeding. Snowfall map showed 0.5 to 2 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 18/-8 Rock Springs: 21/9 Lander: 30/6 South Pass: 23/3 Dixon: 24/8 Observed ODC: 0</p>	No ground-based seeding was conducted.
15 February 2023, Wednesday	
<p>The WR had small low clouds and thin mid level cloud coverage until the mid afternoon. The sky was clear the rest of the period. Snowfall map showed a dusting from the morning cloud coverage.</p> <p>The SM had widespread cloud coverage until starting to move away during the evening. The clouds had thinned in the early afternoon and snowfall was very light the rest of the</p>	No ground-based seeding was conducted.



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<p>afternoon. No SLW existed and the wind was not favorable for seeding. Snowfall map showed 0.5 to 2 inch accumulation. The sky was clear overnight.</p> <p>Max/Min temperatures Pinedale: 12/-20 Rock Springs: 13/1 Lander: 12/-3 South Pass: 10/0 Dixon: 15/5 Observed ODC: 0</p>	
16 February 2023, Thursday	
<p>Clear skies over the area throughout the day, except for a chinook arch cloud that developed on the NE side of the WR early Friday morning.</p> <p>Max/Min temperatures Pinedale: 9/-24 Rock Springs: 20/-4 Lander: 5/-9 South Pass: 32/10 Dixon: 14/-15 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
17 February 2023, Friday	
<p>Skies were mostly clear besides some cirrus clouds observed throughout the day.</p> <p>Max/Min temperatures Pinedale: 18/-18 Rock Springs: 28/4 Lander: 15/-4 South Pass: 18/5 Dixon: 23/-6 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
18 February 2023, Saturday	
<p>In the Wind River range, skies were mostly clear besides some cirrus clouds observed throughout the day. Low to mid-level clouds moved in overnight, with some snow showers, but the wind was not favorable for seeding operations. In the Sierra Madre range, skies were mostly clear besides some cirrus clouds observed throughout the day. Low clouds moved in overnight with light snowfall. The wind was not right for seeding until later Sunday morning.</p> <p>Max/Min temperatures Pinedale: 14/-17 Rock Springs: 29/3 Lander: 26/-4 South Pass: 21/1 Dixon: 33/-5 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
19 February 2023, Sunday	



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<p>The WR had increasing cloud coverage during the afternoon, with broken clouds continuing through the night. Areas of snow showers occurred but accumulation was less than 1 inch. The wind was not favorable for seeding operations. The SM had thick low clouds with light snowfall during the morning and favorable seeding conditions for a short time in the late morning. The clouds weakened in the afternoon but remained the rest of the period with minimal snowfall and unfavorable wind flow. Snowfall map showed 0.5 to 2 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 27/-4 Rock Springs: 28/19 Lander: 31/10 South Pass: 23/12 Dixon: 30/19 Observed ODC: +1</p>	<p>Seeding event SMR0007 began at 0950 MST on 02/19/2023.</p> <p>SMR0008 Summary: Generators: SM10. Time: 0950 (02/19) to 1130 (02/19) MST 1650 (02/19) to 1830 (02/19) UTC Duration: 1:40 Total Time Seeding Material: 0.42 gallons (41.75 grams)</p>
<p>20 February 2023, Monday</p>	
<p>The WR had mid level clouds around the region but the range itself was mostly clear during the daytime hours. Thick clouds developed during the evening with continuous snowfall on the range beginning around midnight. Favorable seeding conditions formed during the night and persisted into Tuesday morning. Snowfall map showed mostly 0.5 to 2 inch accumulation on the range by Tuesday morning. The SM had cloud coverage throughout the day. Light snowfall in the morning slowly decreased during the afternoon with only a few scattered showers in the evening and night. Snowfall map showed around 1 inch accumulation.</p> <p>Max/Min temperatures Pinedale: 34/21 Rock Springs: 34/26 Lander: 45/17 South Pass: 37/18 Dixon: 35/27 Observed ODC: +1</p>	<p>No ground-based seeding was conducted.</p> <p>WWDO directed seeding suspension began at 2000 MST for the WR.</p>
<p>21 February 2023, Tuesday</p>	
<p>Mostly cloudy skies Tuesday gave way to moderate snow late/evening and overnight, becoming more showery Wednesday morning. For the Wind River range, SNOTELs recorded between 0.2" and 0.8" of snow water out of a widespread analyzed 6-12 inches of new snow. Favorable seeding conditions continued until the early-afternoon hours, after which SLW rapidly diminished and winds became unfavorable. For the Sierra Madre, SNOTELs recorded between 0.9 and 1.5 inches of new snow water out of an analyzed 10-14 inches of snowfall.</p> <p>Max/Min temperatures</p>	<p>No ground-based seeding was conducted.</p> <p>WWDO directed seeding suspension began at 1200 MST for the SM and continued for the WR.</p>



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Pinedale: 34/21 Rock Springs: 36/14 Lander: 47/9 South Pass: 28/3 Dixon: 39/29 Observed ODC: +1	
22 February 2023, Wednesday	
<p>Cloudy with snow showers tapering off overnight to a few peaks of sun by Thursday morning. For the Wind River range, additional snow water amounts ranged from less than 0.1" on the northern end to 0.25-0.5" on the south end. While seeding activity was suspended, only a brief window of favorable trajectories along with minimal supercooled water would have limited seeding potential.</p> <p>For the Sierra Madre around 0.2-0.5" of snow water was accumulated. While more liquid water could be seen in the lower levels on satellite, unfavorable southwest winds would have prevented ground-based seeding if activity was not suspended.</p> <p>Max/Min temperatures Pinedale: 21/-9 Rock Springs: 12/-11 Lander: 9/-13 South Pass: 3/-2 Dixon: 37/-14 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p> <p>Seeding suspension ended in the WR at 2300 MST Feb 22 and at 0800 MST Feb 23 in the SM.</p>
23 February 2023, Thursday	
<p>Partly cloudy with orographic clouds over the range for the day with snow showers, on and off. SLW was limited as temperatures were cold enough for natural ice formation to occur. For the Wind River range, additional snow amounts range from 0.9"-1.3" with the largest amounts occurring in the northern part of the range.</p> <p>For the Sierra Madre around 1.8" of snow was accumulated. Unfavorable southwest winds prevented ground-based seeding activity.</p> <p>Max/Min temperatures Pinedale: 3/-24 Rock Springs: 8/-14 Lander: -5/-26 South Pass: 10/-20 Dixon: 28/-1 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
24 February 2023, Friday	
<p>In the Wind River range, orographic snow showers and clouds were observed throughout the day. SLW was too limited for seeding operations. Clearing over the lowlands around the range occurred overnight with areas of fog. Half an inch to 2 inches of snowfall were observed.</p>	<p>No ground-based seeding was conducted.</p>



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<p>In the Sierra Madre range, widespread snowfall occurred in the morning with orographic snow showers over the range in the afternoon. The wind was not favorable for seeding. Around an inch to 1.5 inches of snowfall were observed.</p> <p>Max/Min temperatures Pinedale: 9/-18 Rock Springs: 15/-6 Lander: -2/-19 South Pass: 14/1 Dixon: 27/10 Observed ODC: 0</p>	
<p>25 February 2023, Saturday</p>	
<p>In the Wind River range, high cirrus clouds occurred in the morning with orographic clouds over the range throughout the day. Orographic snow showers ended around midday. Clouds thickened again during the night with snowfall beginning a few hours before sunrise. Around 1-3 inches of snowfall were observed.</p> <p>In the Sierra Madre range, orographic clouds with snow showers lingered over the range into the late afternoon. Only high and mid level clouds existed during the night, increasing in coverage by Sunday morning. Around 2-4.5 inches of snowfall were observed.</p> <p>Max/Min temperatures Pinedale: 19/-15 Rock Springs: 25/1 Lander: 33/-2 South Pass: 27/7 Dixon: 38/12 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>26 February 2023, Sunday</p>	
<p>In the Wind River range, orographic snow showers occurred over the range during the morning and afternoon, becoming continuous snowfall in the evening and through the night. Favorable seeding conditions developed shortly after sunset and continued into Monday. Around 2-6 inches of snowfall were observed.</p> <p>In the Sierra Madre range, high cirrus clouds and orographic clouds were observed over the range throughout the day. Snow showers occurred overnight. Less than an inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 27/3 Rock Springs: 31/7 Lander: 39/10 South Pass: 28/16 Dixon: 37/8 Observed ODC: +1</p>	<p>Seeding event WRR0194 began at 1845 MST on 02/26/2023.</p> <p>WRR0194 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 1845 (02/26) to 0553 (02/28) MST 0145 (02/27) to 1253 (02/28) UTC Duration: 35:08, 137:26 Total Time Seeding Material: 66.32 gallons (3435.75 grams)</p>



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27 February 2023, Monday	
<p>Persistent orographic clouds over both project regions throughout the entire day. Snowfall with SLW was nearly continuous as well. The WR had some GGEN sites with favorable traj all day until just before sunrise Tuesday morning. The wind was not favorable for seeding in the SM. Snowfall map showed the WR range received over 4 inches accumulation with 8 to 13 on the SE part, while the SM generally had 1 to 2 inches.</p> <p>Max/Min temperatures Pinedale: 23/5 Rock Springs: 36/17 Lander: 32/21 Dixon: 31/26 Observed ODC: +2</p>	<p>Seeding event WRR0194 continued all day, ending at 0553 MST on 2/28/2023.</p>
28 February 2023, Tuesday	
<p>Continued thick cloud coverage over the project areas during the daytime, thinning in the evening hours. Favorable seeding conditions redeveloped in the WR during the morning and persisted until around sunset.</p> <p>The SM had favorable seeding conditions begin around the same time as the WR, but SLW was expected to have dropped off by mid afternoon and seeding ended. Small low clouds over the mountains and widespread thin mid level clouds existed overnight. Snowfall map showed 2 to 4 inches accumulation on the WR and while the SM received 5 to 8 inches.</p> <p>Max/Min temperatures Pinedale: 21/-8 Rock Springs: 25/9 Lander: 33/15 Dixon: 29/1 Observed ODC: +2</p>	<p>Seeding event WRR0195 began at 0928 MST on 02/28/2023.</p> <p>WRR0195 Summary: Generators: WR09, WR10, WR12, WR13, WR14, WR16. Time: 0925 (02/28) to 1736 (02/28) MST 1625 (02/28) to 0036 (03/01) UTC Duration: 8:01, 45:12 Total Time Seeding Material: 22 gallons (1133 grams)</p> <p>Seeding event SMR0009 began at 0936 MST on 02/28/2023.</p> <p>SMR0009 Summary: Generators: SM10. Time: 0936 (02/28) to 1423 (02/28) MST 1636 (02/28) to 2123 (02/28) UTC Duration: 4:47 Total Time Seeding Material: 1.34 gallons (119.5 grams)</p>
01 March 2023, Wednesday	
<p>Thin mid level clouds and small low clouds were over the WR in the morning, but both diminished in the early afternoon. There were a few areas of mid level clouds in late afternoon and evening, and then some short-lived low clouds during the night. Snowfall map showed 1 to 2 inches on the NE part of the range while the rest received less than half an inch. The SM region had thin cloud coverage in the morning which thickened during the afternoon. Low clouds and light snowfall began over the range in late afternoon and continued through the evening hours. The snowfall mostly ended by midnight, but shallow low clouds persisted into Thursday morning. The</p>	<p>No ground-based seeding was conducted.</p>



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<p>wind flow was not right for seeding. Snowfall map showed 2 to 4 inches.</p> <p>Max/Min temperatures Pinedale: 23/-2 Rock Springs: 26/6 Lander: 28/5 Dixon: 32/1 Observed ODC: 0</p>	
02 March 2023, Thursday	
<p>High and mid level cloud coverage increased during the afternoon in the WR region. Low clouds developed after sunset and persisted through the night, but snowfall was very limited and amounted to less and half an inch. The wind flow was not right for seeding operations.</p> <p>Shallow low clouds over the SM in the morning, faded away in the early afternoon. Widespread mid level clouds arrived a little before sunset and moved through during the evening hours. Low clouds with light snowfall developed during the night, but the wind was not right for seeding. Snowfall map showed 1 to 2 inches.</p> <p>Max/Min temperatures Pinedale: 25/-6 Rock Springs: 24/8 Lander: 29/2 Dixon: 22/10 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
03 March 2023, Friday	
<p>Persistent orographic clouds over both project regions throughout the entire day. The wind was not favorable for seeding in the SM. Clouds cleared out over WR during the evening hours. Snowfall map showed the WR range received around 2 inches accumulation with 5 inches in the NE part, while the SM generally had around 7 inches in the southern half of the range.</p> <p>Max/Min temperatures Pinedale: 25/-6 Rock Springs: 26/13 Lander: 26/8 South Pass: 19/3 Dixon: 34/16 Observed ODC: +1</p>	<p>Seeding event WRR0196 began at 1047 MST on 03/03/2023.</p> <p>WRR0196 Summary: Generators: WR03, WR09, WR10, WR13, WR14, WR16. Time: 1047 (03/03) to 1518 (03/03) MST 1747 (03/03) to 2218 (03/03) UTC Duration: 4:31, 26:19 Total Time Seeding Material: 13.41 gallons (658 grams)</p>
04 March 2023, Saturday	
<p>Persistent orographic clouds over both project regions throughout the entire day. The wind was not favorable for seeding in the SM. Waves of SLW moved over the WR throughout the night and into Sunday morning with natural ice formation dominating for most of the night. Snowfall map showed the WR range received around 8-6" accumulation</p>	<p>No ground-based seeding was conducted.</p>



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<p>around the range, while the SM received around half an inch of accumulation.</p> <p>Max/Min temperatures Pinedale: 19/-15 Rock Springs: 29/9 Lander: 20/2 South Pass: 21/1 Dixon: 32/7 Observed ODC: 0</p>	
05 March 2023, Sunday	
<p>Persistent orographic clouds over both project regions throughout the entire day. The wind was not favorable for seeding in the SM. Favorable seeding conditions existed in the WR from mid morning until around noon. Natural ice formation dominated over the small pockets of SLW that moved over both ranges the rest of the day. The snowfall map showed the WR range received around 2" around the range with the northern part of the range receiving 4.5" accumulation, while SM received around 3" of accumulation.</p> <p>Max/Min temperatures Pinedale: 25/1 Rock Springs: 26/15 Lander: 24/6 South Pass: 17/5 Dixon: 34/20 Observed ODC: +1</p>	<p>Seeding event WRR0197 began at 0945 MST on 03/05/2023.</p> <p>WRR0197 Summary: Generators: WR03, WR09, WR13, WR14. Time: Duration: Seeding Material:</p>
06 March 2023, Monday	
<p>Scattered showers existed over the ranges during the daytime, with snowfall developing in the SM again during the night. Natural ice formation dominated over the small pockets of SLW that moved over both ranges. The wind was not favorable for seeding in the SM. The snowfall map showed the WR range received around 2-3" around the range with the southern part of the range receiving 4" accumulation, while SM received around 3" of accumulation.</p> <p>Max/Min temperatures Pinedale: 21/-8 Rock Springs: 26/13 Lander: 22/4 South Pass: 14/3 Dixon: 31/12 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
07 March 2023, Tuesday	
<p>In the Wind River range, skies were mostly clear during the daytime. Some orographic clouds and snow showers formed over the mountain tops at night. Less than half an inch of snowfall was observed.</p>	<p>No ground-based seeding was conducted.</p>



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<p>In the Sierra Madre range, snow showers occurred in the morning and late afternoon. Otherwise, skies were mostly cloudy. Less than an inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 19/-15 Rock Springs: 24/11 Lander: 15/0 South Pass: 14/-2 Dixon: 26/2 Observed ODC: -1</p>	
<p>08 March 2023, Wednesday</p>	
<p>In the Wind River range, snow showers occurred throughout the daytime and then only flurries in the evening and night. SLW was limited and too spotty for seeding operations. 0.5 to 2 inches of snowfall was observed.</p> <p>In the Sierra Madre range, skies were partly cloudy. Some snow occurred overnight, but the wind was not right for seeding. Less than a quarter inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 19/-17 Rock Springs: 27/6 Lander: 14/0 South Pass: 25/1 Dixon: 25/1 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>09 March 2023, Thursday</p>	
<p>The WR had low clouds and snowfall develop in the late afternoon, diminishing in the early evening hours. Conditions were not consistent enough for a seeding event. Only mid level clouds existed until low clouds and snowfall redeveloped in the middle of the night, lasting into Friday. The wind was not favorable during this period. Snowfall map showed 1 to 4 inches accumulation.</p> <p>The SM had scattered clouds diminish in the early afternoon and the sky was clear until high clouds moved in during the evening. Mid and a few low clouds developed during the night increasing Friday morning. Only a dusting of snowfall occurred.</p> <p>Max/Min temperatures Pinedale: 18/-9 Rock Springs: 28/7 Lander: 21/6 South Pass: 21/3 Dixon: 33/6 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>10 March 2023, Friday</p>	
<p>The WR had continued thick cloud coverage and snowfall during the daytime. The temperature became too warm for</p>	<p>No ground-based seeding was conducted.</p>



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<p>seeding right as the wind became favorable for seeding in the morning. A cold front moved through shortly after sunset, bringing colder temps but less moisture and the cloud diminished. Snow showers existed during the night, but conditions were not right for seeding. Snowfall map showed a good portion of the range received 6 to 10 inches. The SM had thickening cloud coverage during the morning and early afternoon. Light snowfall existed from mid afternoon until the cold front moved through a little after midnight. The clouds diminished behind the front with only small, low clouds left by Saturday morning. Snowfall map showed only 0.5 to 2 inches accumulation, but it was enough to push the SWE into suspension range.</p> <p>Max/Min temperatures Pinedale: 34/3 Rock Springs: 41/20 Lander: 46/5 South Pass: 30/12 Dixon: 41/10 Observed ODC: 0</p>	<p>Snotel data in the SM showed the accumulated SWE was above the suspension level, therefore seeding operations are suspended for the SM.</p>
<p>11 March 2023, Saturday</p>	
<p>Low and mid-level cloud cover during the morning with some showers before skies cleared for the rest of the daytime. No SLW existed and cloud coverage was insufficient for seeding. A few low clouds existed again during the night. The northern part of the range received around 1-2" of snow while the southern part of the range received around 0.5". Small, shallow low clouds over the SM in the morning gave way to clear blue skies in the SM range the rest of the daytime, except for isolated mid and high-level clouds. Upper-level cloud cover increased overnight with some isolated snow showers over the range by Sunday morning. SLW was insufficient for seeding and the wind was not favorable for seeding. Around 2" of snow fell in the northern part of the range with the far southern part of the range accumulating around 4".</p> <p>Max/Min temperatures Pinedale: N/A Rock Springs: N/A Lander: N/A South Pass: 19/1 Dixon: N/A Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>12 March 2023, Sunday</p>	
<p>Thin low clouds were over the southern slopes of the range from late morning to late afternoon. The sky was clear until shallow low clouds moved in during the evening and lasted through the night. Snowfall was very limited with only half an inch of accumulation. The wind was not right for seeding.</p>	<p>No ground-based seeding was conducted.</p>



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<p>Broken clouds were over the SM throughout the day. SLW was very limited and the wind was not right for seeding. No accumulating snowfall occurred.</p> <p>Max/Min temperatures Pinedale: 23/-11 Rock Springs: 28/12 Lander: 26/10 South Pass: 21/1 Dixon: 33/7 Observed ODC: 0</p>	
13 March 2023, Monday	
<p>In the Wind River range, snowfall with favorable seeding conditions occurred for a few hours in the afternoon. Snow showers occurred the rest of the day, but the wind was not right for more seeding operations. 0.5 to 2.5 inches of snowfall was observed.</p> <p>In the Sierra Madre range, skies were partly cloudy. Clouds increased in the evening with a few snow showers during the night, but cleared Tuesday morning.</p> <p>Max/Min temperatures Pinedale: 30/14 Rock Springs: 38/19 Lander: 28/10 South Pass: 27/19 Dixon: 38/16 Observed ODC: +1</p>	<p>Seeding event WRR0198 began at 1259 MDT on 03/13/2023.</p> <p>WRR0198 Summary: Generators: WR09, WR10, WR14, WR16. Time: 1259 (03/13) to 1605 (03/13) MDT 1859 (03/13) to 2205 (03/13) UTC Duration: 2:05, 3:00 Total Time Seeding Material: 1.5 gallons (75 grams)</p>
14 March 2023, Tuesday	
<p>In the Wind River range, continuous snowfall throughout the day. By the time the wind became favorable for plume transport, the temperature was warming and remained too warm for seeding the rest of the day. 4 to 10 inches of snowfall were observed on the range.</p> <p>In the Sierra Madre range, skies were mostly clear through the afternoon besides some upper-level cirrus clouds. Clouds increased in the evening and continuous snowfall began. 0.5 to 2 inches of snowfall were observed. The temperature and wind were not favorable for seeding operations.</p> <p>Max/Min temperatures Pinedale: 34/10 Rock Springs: 43/28 Lander: 45/16 South Pass: 34/21 Dixon: 43/28 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
15 March 2023, Wednesday	
<p>Continued thick clouds and snowfall over both project regions in the morning and early afternoon. The temperature cooled enough by mid day to allow for favorable seeding conditions in</p>	<p>Seeding event WRR0199 began at 1129 MDT on 03/15/2023.</p>



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<p>the WR until the clouds diminished in the middle of the afternoon. The WR had another wave of light snowfall on the northern slopes during the night, but was not enough for seeding operations and only small clouds were left by morning. The SM had continuous snowfall through the evening then scattered showers during the night. Most of both ranges received 2 to 6 inches.</p> <p>Max/Min temperatures Pinedale: 36/18 Rock Springs: 39/23 Lander: 49/25 Dixon: 42/29 Observed ODC: +1</p>	<p>WRR0199 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR16. Time: 1129 (03/15) to 1638 (03/15) MDT 1729 (03/15) to 2238 (03/15) UTC Duration: 5:09, 34:49 Total Time Seeding Material: 15.17 gallons (870.5 grams)</p>
<p>16 March 2023, Thursday</p>	
<p>The WR had a few small low clouds over the SE part of the range during the daytime. There were shallow low clouds over parts of the range for a short time during the night, but coverage was limited and no SLW existed. The snowfall map showed a few parts received a half inch except for the far SE had over 1 inch.</p> <p>The SM had scattered, small low clouds throughout the daytime, lasting into the early evening hours. An area of low clouds moved over the range a little before sunrise but cleared quickly. Up to 1 inch of snow accumulated.</p> <p>Max/Min temperatures Pinedale: 23/1 Rock Springs: 28/16 Lander: 31/17 South Pass: 18/1 Dixon: 26/10 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
<p>17 March 2023, Friday</p>	
<p>In the Wind River range, skies were mostly clear besides a few small clouds over the mountains.</p> <p>In the Sierra Madre range, skies were mostly clear besides some upper-level clouds over the range.</p> <p>Max/Min temperatures Pinedale: 19/-8 Rock Springs: 30/12 Lander: 32/16 South Pass: 19/-6 Dixon: 24/2 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>18 March 2023, Saturday</p>	
<p>In the Wind River range, skies were completely clear with some cirrus clouds during the late afternoon/evening. Skies continued to be clear overnight and into the morning.</p>	<p>No ground-based seeding was conducted.</p>



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<p>In the Sierra Madre range, skies were mostly clear besides some altostratus over the range. A small wave of flurries occurred during the overnight hours, amounting to 0.4" of accumulation.</p> <p>Max/Min temperatures Pinedale: 21/-13 Rock Springs: 33/10 Lander: 29/10 South Pass: 21/1 Dixon: 30/1 Observed ODC: -1</p>	
19 March 2023, Sunday	
<p>In the Wind River range, skies were completely clear until the afternoon as high-level cloud cover started to move in. Cloud cover continued to increase during the overnight hours with overcast skies and developing snowfall. Less than 0.2" fell. In the Sierra Madre range, skies were mostly clear besides some altostratus. Clouds started to increase during the afternoon and continued to increase through the overnight hours leaving overcast skies with some light snowfall by the time the sun rose. Less than 0.3" fell in the range.</p> <p>Max/Min temperatures Pinedale: 25/-11 Rock Springs: 39/12 Lander: 31/8 South Pass: 24/8 Dixon: 36/6 Observed ODC: -1</p>	No ground-based seeding was conducted.
20 March 2023, Monday	
<p>Low clouds with light snowfall and favorable seeding conditions existed over the WR from the morning through most of the afternoon. Widespread mid level clouds covered the region during the evening hours. Another wave of low clouds and favorable seeding conditions developed during the night until diminishing Tuesday morning. Snowfall map showed 1 to 3 inch accumulation. The SM had thick cloud coverage in the morning become broken to scattered during the afternoon. Mid level clouds also existed during the evening and early nighttime hours with consistent snowfall. SLW was limited and the wind was not right for seeding. Shallow low clouds with bases above the peaks moved in a little before sunrise. Snowfall map showed 4 to 6 inches of accumulation.</p> <p>Max/Min temperatures Pinedale: 28/5 Rock Springs: 38/24 Lander: 38/19 South Pass: 27/16 Dixon: 37/22 Observed ODC: +2</p>	<p>Seeding event WRR0200 began at 0854 MDT on 03/20/2023.</p> <p>WRR0200 Summary: Generators: WR01, WR02, WR03, WR09, WR12. Time: 0854 (03/20) to 1729 (03/20) MDT 1454 (03/20) to 2329 (03/20) UTC Duration: 8:35, 27:12 Total Time Seeding Material: 11.46 gallons (679.75 grams)</p> <p>Seeding event WRR0201 began at 0525 MDT on 03/21/2023.</p> <p>WRR0201 Summary: Generators: WR01, WR02, WR03, WR09, WR12. Time: 0525 (03/21) to 0933 (03/21) MDT 1125 (03/21) to 1533 (03/21) UTC Duration: 4:08, 13:37 Total Time Seeding Material: 6.51 gallons (360.5 grams)</p>



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21 March 2023, Tuesday	
<p>Low clouds over the WR in the morning were diminishing by late morning and the range was clear for a few hours in the afternoon before mid and high level clouds moved in from the south. Low clouds with light snowfall redeveloped during the night but the wind was not right for seeding. Snowfall map showed less than 1 inch.</p> <p>The SM had broken to scattered cloud coverage during most of the daytime but minimal snowfall occurred. Thick clouds with snowfall moved into the region in the late afternoon and continued for the rest of the day into Wednesday. 1 to 2 inches fell on the range.</p> <p>Max/Min temperatures Pinedale: 27/0 Rock Springs: 36/21 Lander: 39/24 South Pass: 23/12 Dixon: 33/12 Observed ODC: 0</p>	No ground-based seeding was conducted.
22 March 2023, Wednesday	
<p>Shallow low clouds were over the WR in the morning, then increased in the early afternoon with consistent snowfall. Favorable seeding conditions existed for a few hours during the afternoon before the wind became swirly and SLW became spotty. Light snowfall with unfavorable wind flow continued through the evening then the clouds thinned overnight. Snowfall map showed 2 to 5 inches.</p> <p>The SM had thick cloud coverage and snowfall during the daytime and evening, with the snowfall tapering off during the night. However, low clouds with bases above the peaks lingered into Thursday. The wind was not right for seeding. 3 to 6 inches fell on the range.</p> <p>Max/Min temperatures Pinedale: 30/9 Rock Springs: 33/24 Lander: 29/23 South Pass: 25/18 Dixon: 39/28 Observed ODC: +1</p>	<p>Seeding event WRR0202 began at 1443 MDT on 03/22/2023.</p> <p>WRR0202 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR16. Time: 1443 (03/22) to 1725 (03/22) MDT 2043 (03/22) to 2325 (03/22) UTC Duration: 2:42, 22:24 Total Time Seeding Material: 9.88 gallons (560 grams)</p>
23 March 2023, Thursday	
<p>Shallow low clouds were over the WR range for most of the day. Light snow showers during the afternoon and evening. Little to no SLW was detected by the radiometer. The low clouds diminished during the night, but mid level clouds moved into the region. Most of the range received less than 2 inches but the NW part had over 5.</p>	No ground-based seeding was conducted.



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<p>The SM had thin clouds with bases generally above the peaks until thickening in the late afternoon. Snowfall occurred from the late afternoon through the evening and tapered off after midnight. The clouds thinned during the night but continued into Friday. 3 to 5 inches fell on the range.</p> <p>Max/Min temperatures Pinedale: 30/7 Rock Springs: 36/23 Lander: 41/13 South Pass: 25/12 Dixon: 35/16 Observed ODC: 0</p>	
24 March 2023, Friday	
<p>Low clouds with light snowfall developed over the WR in the early afternoon, but did not fully cover the range until the wind was starting to shift to NW. There was widespread cloud coverage and snowfall from late afternoon through the evening, but the wind was not right for seeding. The snowfall had pushed northward by midnight but circled back to the northern slopes by sunrise. Snowfall map showed 1 to 2 inches.</p> <p>The SM had thickening clouds in the late morning, but only broken coverage through most of the afternoon. Widespread thick cloud coverage from just before sunset through the night, but snowfall was generally light, and the wind was not right for seeding. 1 to 2 inches also fell on the SM.</p> <p>Max/Min temperatures Pinedale: 23/0 Rock Springs: 38/16 Lander: 38/21 South Pass: 23/9 Dixon: 35/16 Observed ODC: 0</p>	No ground-based seeding was conducted.
25 March 2023, Saturday	
<p>In the Wind River range, overcast skies all day as windy conditions and continued snow showers occurred. The wind was not right for seeding. Overcast skies continued through the night with clouds starting to clear out by morning. Pockets of around 7" fell around the range with a localized amount of 9" in the most northern part of the range. Around 5" was the average that fell around the range.</p> <p>In the Sierra Madre range, broken overcast skies throughout the day with some pockets of blue sky. Snow started falling during the late afternoon, but clouds cleared out by the evening hours and continued through the night with isolated clouds over the range. Around 3.8" of snow fell in the range.</p> <p>Max/Min temperatures Pinedale: 21/1 Rock Springs: 23/14</p>	No ground-based seeding was conducted.



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Lander: 26/19 South Pass: 14/1 Dixon: 27/7 Observed ODC: 0	
26 March 2023, Sunday	
<p>In the Wind River range, partially clear skies with high-level cloud cover and some orographic clouds over the range in the morning and afternoon. Scattered showers occurred during this time. Altostratus was present over the range for the entire day and clouds cleared out during the overnight hours. Skies stayed clear into the morning. In the northern part of the range around 2" of snow fell with trace amounts throughout the rest of the range.</p> <p>In the Sierra Madre range, mostly cloudy skies with upper-level cloudiness and some mid level clouds. This continued throughout the day until waves of upper-level clouds moved over the range during the evening. This cloudiness continued into the morning with broken overcast skies. A few showers existed. Around 1" of snow fell in the range.</p> <p>Max/Min temperatures Pinedale: 18/-11 Rock Springs: 23/8 Lander: 29/11 South Pass: 12/-2 Dixon: 31/6 Observed ODC: -1</p>	No ground-based seeding was conducted.
27 March 2023, Monday	
<p>In the Wind River range, mostly clear skies. Altostratus were present over the range for most of the day. Isolated snow showers around the range occurred throughout the day. Upper level cloud cover built during the early morning hours. An isolated 3" fell in the most northern part of the range with trace amounts throughout the rest of the area. In the Sierra Madre range, partially cloudy skies during the morning hours. Skies started to clear by the afternoon leaving completely sunny skies. Skies remained clear through the overnight hours and early morning. Upper-level cloudiness moved into the area Tuesday morning with mid-level clouds.</p> <p>Max/Min temperatures Pinedale: 14/-9 Rock Springs: 26/9 Lander: 28/10 South Pass: 15/5 Dixon: 26/6 Observed ODC: -1</p>	No ground-based seeding was conducted.
28 March 2023, Tuesday	
There were periods of mid level clouds around the project regions throughout the daytime and evening. Cloud coverage	No ground-based seeding was conducted.



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<p>increased during the night and scattered snow showers formed by sunrise over the mountains. 1 to 2 inches fell on the WR while the SM had less than 1 inch.</p> <p>Max/Min temperatures Pinedale: 25/-15 Rock Springs: 39/13 Lander: 31/6 South Pass: 21/1 Dixon: 35/6 Observed ODC: -1</p>	
29 March 2023, Wednesday	
<p>There were small low clouds over the WR in the morning with a few showers. The clouds thickened in the afternoon, with snowfall and radiometer detected SLW, but the temperature was too warm for seeding. Those clouds diminished by the mid evening. Snowfall with SLW formed again during the night, but the wind was not favorable for seeding. Snowfall map showed 1 to 4 inches on most of the range. The SM had broken cloud coverage for most of the daytime, with thicker clouds moving in a little before sunset, but snowfall was very limited. Those clouds lasted for just a few hours before diminishing. Broken, shallow low clouds developed again around sunrise.</p> <p>Max/Min temperatures Pinedale: 36/7 Rock Springs: 49/25 Lander: 34/19 South Pass: 34/12 Dixon: 46/28 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
30 March 2023, Thursday	
<p>Thin clouds over the WR thickened enough to allow for seeding operations for a few hours until thinning in the early afternoon. Thicker clouds returned by late afternoon, lasting over the range until the mid evening, but the wind was no longer favorable for seeding. The range had only thin cloud coverage the rest of the night. Snowfall map showed 0.5 to 2 inches. The SM had scattered clouds until thick clouds moved in by mid afternoon. Clouds with snowfall continued over the range the rest of the period. The wind was not right for seeding operations and SLW was limited. 2 to 5 inches of snowfall occurred.</p> <p>Max/Min temperatures Pinedale: 30/10 Rock Springs: 38/23 Lander: 37/18 South Pass: 28/18 Dixon: 47/27 Observed ODC: +1</p>	<p>Seeding event WRR0203 began at 0931 MDT on 03/30/2023.</p> <p>WRR0203 Summary: Generators: WR01, WR02, WR03, WR12. Time: 0931 (03/30) to 1324 (03/30) MDT 1531 (03/30) to 1924 (03/30) UTC Duration: 3:58, 15:37 Total Time Seeding Material: 8.35 gallons (390.25 grams)</p>



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31 March 2023, Friday	
<p>Small and shallow low clouds were over the WR during the morning and early afternoon. Thicker clouds with snowfall moved over by late afternoon and allowed for seeding operations until the wind became unfavorable in the early evening. Clouds with very light snowfall remained over the range through the night, but the wind was unfavorable for seeding. Snowfall amounted to 0.5 to 2.5 inches. The SM had continued snowfall during the daytime and weakening during the evening. Seeding could have occurred during the afternoon had the suspension not been in effect. The clouds thinned and broke up during the night. 1 to 3 inches of new snowfall.</p> <p>Max/Min temperatures Pinedale: 32/10 Rock Springs: 36/23 Lander: 41/22 South Pass: 27/12 Dixon: 36/19 Observed ODC: +2</p>	<p>Seeding event WRR0204 began at 1700 MDT on 03/31/2023.</p> <p>WRR0204 Summary: Generators: WR09, WR10, WR12, WR13, WR14, WR16. Time: 1700 (03/31) to 1729 (03/31) MDT 2300 (03/31) to 2329 (04/01) UTC Duration: 3:27, 20:34 Total Time Seeding Material: 9.66 gallons (514.25 grams)</p>
01 April 2023, Saturday	
<p>In the Wind River range, cloudy skies with persistent orographic cloud over the range. Snowfall around the range and the valley occurred throughout the day. Favorable seeding conditions existed from mid day until around midnight. Most of the range received around 10" of snow with the northern part of the range receiving 14.66" of accumulation. Cloudy skies persisted into the morning.</p> <p>In the Sierra Madre range, mostly clear skies throughout the early afternoon. Clouds moved in during the late afternoon but cleared out by evening. Skies continued to stay mostly clear through the night with cloud cover increasing during the early morning hours. Light snow showers around the range with 0.6" of snow accumulating.</p> <p>Max/Min temperatures Pinedale: 36/12 Rock Springs: 46/25 Lander: 47/24 South Pass: 28/17 Dixon: 42/23 Observed ODC: +2</p>	<p>Seeding event WRR0205 began at 1231 MDT on 04/01/2023.</p> <p>WRR0205 Summary: Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR14, WR16. Time: 1231 (04/01) to 0034 (04/02) MDT 1831 (04/01) to 0634 (04/02) UTC Duration: 12:03, 85:38 Total Time Seeding Material: 42.16 gallons (2141 grams)</p>
02 April 2023, Sunday	
<p>In the Wind River range, snowfall began by mid day and continued the rest of the day. SLW was limited in the early afternoon. Favorable seeding conditions existed for a few hours from mid afternoon to around sunset. The wind was not favorable the rest of the day.</p>	<p>Seeding event WRR0206 began at 1537 MDT on 04/02/2023.</p> <p>WRR0206 Summary:</p>



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<p>In the Sierra Madre range, skies were partly to mostly cloudy. Some snow showers occurred on the eastern side of the range. Up to 1 inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 30/21 Rock Springs: 36/26 Lander: 41/29 South Pass: 27/16 Dixon: 41/29 Observed ODC: +1</p>	<p>Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13, WR16. Time: 1537 (04/02) to 1852 (04/02) MDT 2137 (04/02) to 0052 (04/03) UTC Duration: 3:15, 15:17 Total Time Seeding Material: 6.71 gallons (382.25 grams)</p>
<p>03 April 2023, Monday</p>	
<p>A large system covered a good portion of the state throughout the day. The Wind River range had continuous snowfall, with very minimal SLW. 6-14 inches of snowfall was observed. The wind was not right for seeding operations.</p> <p>In the Sierra Madre range, snowfall was much less than the WR, with only 1-4 inches of snowfall observed. Most of that occurred in the late afternoon and evening.</p> <p>Max/Min temperatures Pinedale: 28/19 Rock Springs: 26/19 Lander: 30/24 South Pass: 21/16 Dixon: 38/20 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>04 April 2023, Tuesday</p>	
<p>Continued widespread cloud coverage and snowfall over a good portion of the state through the daytime hours, with the system moving away to the east overnight. In the Wind River range, continued snowfall occurred through the evening. The wind flow was NE during the afternoon, but SLW was not sufficient for seeding with Enterprise. The snowfall ended overnight. 10-14 inches fell on the NE slopes of the range with the rest of the range receiving 2 to 6 inches.</p> <p>In the Sierra Madre range, skies were partly cloudy in the morning and increased in the afternoon. Snow showers occurred in the afternoon and evening. The wind was not right for seeding. 1-3 inches of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 28/16 Rock Springs: 20/14 Lander: 26/16 South Pass: 21/16 Dixon: 16/9 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>05 April 2023, Wednesday</p>	
<p>In the Wind River range, skies were mostly clear with shallow orographic clouds over the range in the afternoon. Skies</p>	<p>No ground-based seeding was conducted.</p>



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<p>became overcast in the evening as snow showers began. Up to 3 inches of snowfall was observed.</p> <p>In the Sierra Madre range, skies were partly cloudy with broken orographic clouds over the mountains and a few snow showers through the evening. Less than an inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 23/-6 Rock Springs: 25/12 Lander: 24/7 South Pass: 16/1 Dixon: 29/7 Observed ODC: 0</p>	
06 April 2023, Thursday	
<p>Skies were clear throughout the day besides a few occasional clouds.</p> <p>Max/Min temperatures Pinedale: 27/-4 Rock Springs: 30/12 Lander: 33/11 South Pass: 19/1 Dixon: 32/4 Observed ODC: -3</p>	<p>No ground-based seeding was conducted.</p>
07 April 2023, Friday	
<p>In the Wind River range, skies were clear throughout the daytime besides a few upper-level cirrus clouds. Skies became overcast in the evening continuing through the night.</p> <p>In the Sierra Madre range, skies were clear throughout the day with some upper-level cirrus clouds entering in the evening.</p> <p>Max/Min temperatures Pinedale: 30/-2 Rock Springs: 35/12 Lander: 33/16 South Pass: 19/1 Dixon: 40/7 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>
08 April 2023, Saturday	
<p>In the Wind River range, the day started off with broken overcast skies and clouds started to clear out throughout the latter half of the day. Some orographic clouds developed in the late afternoon/evening but did not last long. Clouds continued to filter out throughout the overnight hours leaving clear blue skies by morning.</p> <p>In the Sierra Madre range, overcast skies throughout the daytime. Clouds started to clear out by the evening hours leaving some lenticular clouds over the range as the sun started to set. Clouds continued to move through the range during the overnight hours leaving partly cloudy skies by</p>	<p>No ground-based seeding was conducted.</p>



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<p>sunrise. Clouds continued to clear out during the morning leaving blue skies.</p> <p>Max/Min temperatures Pinedale: 42/28 Rock Springs: 42/21 Lander: 45/23 South Pass: 21/33 Dixon: 36/30 Observed ODC: -1</p>	
<p>09 April 2023, Sunday</p>	
<p>Clear skies around the area except for a few upper level clouds in the late afternoon and early evening, and then very thin ones again around sunrise Monday morning.</p> <p>Max/Min temperatures Pinedale: 43/14 Rock Springs: 50/27 Lander: 53/31 South Pass: 37/27 Dixon: 42/24 Observed ODC: -3</p>	<p>No ground-based seeding was conducted.</p>
<p>10 April 2023, Monday</p>	
<p>Warm and dry. The only clouds that were around the area were very thin high clouds during the afternoon.</p> <p>Max/Min temperatures Pinedale: 45/18 Rock Springs: 60/33 Lander: 55/31 South Pass: 48/32 Dixon: 46/27 Observed ODC: -3</p>	<p>No ground-based seeding was conducted.</p>
<p>11 April 2023, Tuesday</p>	
<p>In the Wind River range some upper-level clouds and hazy conditions were observed during the daytime. Mid level clouds increased in coverage during the night. In the Sierra Madre range, skies were clear throughout the day.</p> <p>Max/Min temperatures Pinedale: 43/18 Rock Springs: 65/30 Lander: 69/34 South Pass: 46/36 Dixon: 56/25 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>12 April 2023, Wednesday</p>	
<p>In the Wind River range, skies were overcast throughout the day with a very few showers. Only a dusting of snowfall was observed.</p>	<p>No ground-based seeding was conducted.</p>



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<p>In the Sierra Madre range, skies were mostly cloudy with upper-level clouds throughout the day.</p> <p>Max/Min temperatures Pinedale: 46/28 Rock Springs: 64/45 Lander: 69/37 South Pass: 45/37 Dixon: 61/34 Observed ODC: -1</p>	
<p>13 April 2023, Thursday</p>	
<p>In the Wind River range, snowfall occurred through the afternoon. By the time the temperature cooled enough, the wind was starting to become unfavorable for plume transport. Partial clear occurred in the evening but more clouds moved in by Friday morning. Up to an inch of snowfall was observed over most of the range, with the northern end of the range receiving up to 3 inches of snowfall.</p> <p>In the Sierra Madre range, skies were partly cloudy through the afternoon, becoming overcast in the evening with snow showers on the eastern side of the range. Up to half an inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 36/19 Rock Springs: 52/26 Lander: 60/32 South Pass: 39/23 Dixon: 59/30 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>14 April 2023, Friday</p>	
<p>In the Wind River range, some orographic clouds occurred during the afternoon hours persisting into the early evening hours. No SLW was detected by the radiometer. Clouds started to clear out over the range through the overnight hours leaving clear skies which persisted into Saturday morning. Around 1-2" of snow fell around the range with some localized higher amounts.</p> <p>In the Sierra Madre range, overcast skies throughout the day. During the evening, snow showers moved in over the range continuing through the overnight hours and into the morning. By late morning, some clouds started to clear out leaving mostly cloudy skies. Around 4" fell in the range.</p> <p>Max/Min temperatures Pinedale: 32/12 Rock Springs: 35/24 Lander: 40/28 South Pass: 24/13 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>15 April 2023, Saturday</p>	



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<p>In the Wind River range, clear sunny skies for most of the day with some isolated cirrus and alto stratus over the range during the evening hours. Clear skies continued through the overnight hours and into the morning with clear sunny skies. In the Sierra Madre range, mostly cloudy skies in the morning with some clearing from the afternoon into the evening. By sunset, clouds completely cleared out except for some isolated cirrus. Clear skies continued throughout the night and into the morning.</p> <p>Max/Min temperatures Pinedale: 36/14 Rock Springs: 42/21 Lander: 44/22 South Pass: 26/10 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>16 April 2023, Sunday</p>	
<p>In the Wind River range, skies were mostly clear besides a few upper-level cirrus clouds. Cloud coverage increased in the evening. In the Sierra Madre range, skies were clear throughout the day.</p> <p>Max/Min temperatures Pinedale: 41/12 Rock Springs: 56/27 Lander: 61/29 South Pass: 37/19 Dixon: 54/22 Observed ODC: -2</p>	<p>No ground-based seeding was conducted.</p>
<p>17 April 2023, Monday</p>	
<p>In the Wind River range, skies were mostly clear besides a few upper-level cirrus clouds in the morning and early afternoon. Widespread clouds increased in the late afternoon, with light snowfall forming during the night. The temperature was too warm for seeding. In the Sierra Madre range, skies were mostly clear throughout the daytime besides some upper-level cirrus clouds. Clouds started to increase in the evening, becoming widespread overnight.</p> <p>Max/Min temperatures Pinedale: 43/21 Rock Springs: 60/39 Lander: 66/36 South Pass: 41/23 Dixon: 62/28 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p>18 April 2023, Tuesday</p>	
<p>In the Wind River range, snow showers occurred for most of the daytime, becoming continuous by late afternoon. The</p>	<p>Seeding event WRR0207 began at 1843 MDT on 04/18/2023.</p>



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<p>temperature was too warm before but had cooled by this time and favorable seeding conditions existed for a few hours before the clouds started to thin and diminish. Skies cleared overnight. 3-7 inches of snowfall was observed. In the Sierra Madre range, clouds increased throughout the day. Light snow showers began in the late afternoon and continued the rest of the day. Up to an inch of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 36/18 Rock Springs: 48/25 Lander: 50/33 South Pass: 41/18 Dixon: 61/32 Observed ODC: +1</p>	<p>WRR0207 Summary: Generators: WR09, WR13, WR14, WR16. Time: 1843 (04/18) to 2240 (04/18) MDT 0043 (04/19) to 0440 (04/19) UTC Duration: 3:57, 15:45 Total Time Seeding Material: 7.12 gallons (393.5 grams)</p>
<p><i>19 April 2023, Wednesday</i></p>	
<p>In the Wind River range, small orographic clouds were over the range in the morning and early afternoon. The clouds thickened by mid afternoon with snow showers, but the wind was not favorable for seeding operations. The clouds thinned in the evening. Up to 2 inches of snowfall was observed. In the Sierra Madre range, overcast skies were observed throughout most of the day. Snow showers occurred in the afternoon. Clouds cleared out in the evening. Up to 2 inches of snowfall was observed.</p> <p>Max/Min temperatures Pinedale: 30/7 Rock Springs: 35/21 Lander: 45/27 South Pass: 21/9 Dixon: 37/20 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
<p><i>20 April 2023, Thursday</i></p>	
<p>Scattered clouds and light showers developed in the WR region in the early afternoon lasting until around sunset. No continuous coverage occurred. Widespread clouds and light snowfall moved into the region during the night, but no SLW existed. Less than 1 inch snow accumulated on the range. The SM had thick clouds and snowfall for a few hours in the afternoon, but no SLW. Those clouds diminished by sunset, but a few showers occurred in the evening again. Widespread clouds moved in by sunrise. Snowfall map showed 0.5 to 2 inches accumulation.</p> <p>Max/Min temperatures Pinedale: 32/9 Rock Springs: 39/18 Lander: 49/27 South Pass: 25/12 Dixon: 37/16 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>



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21 April 2023, Friday	
<p>Widespread clouds and light snowfall around the WR region in the morning diminished to scattered showers over the range by early afternoon. Those showers slowly faded throughout the afternoon ending before sunset. No LW was detected by the radiometer. Continuous snowfall then developed on the NE slopes of the range in the evening and lasted until close to sunrise. The wind was not right for seeding with Enterprise. Snowfall map showed up to 6 inches on the NE part of the range with the rest receiving 0.5 to 2 inches.</p> <p>The SM had light continuous snowfall during the morning and afternoon, ending in the evening. Some SLW existed, but the traj were not favorable for seeding. Broken clouds covered the range through the night into Saturday morning. Snowfall map showed 2 to 4 inches on the range.</p> <p>Max/Min temperatures Pinedale: 34/18 Rock Springs: 43/23 Lander: 47/22 South Pass: 28/18 Dixon: 34/22 Observed ODC: 0</p>	<p>No ground-based seeding was conducted.</p>
22 April 2023, Saturday	
<p>The final day of the season saw scattered to broken clouds over both ranges with light showers. Coverage was never fully continuous. All snowfall had ended in the late afternoon and the clouds diminished by midnight.</p> <p>Max/Min temperatures Pinedale: 37/18 Rock Springs: 38/24 Lander: 43/25 South Pass: 28/16 Dixon: 40/23 Observed ODC: -1</p>	<p>No ground-based seeding was conducted.</p>



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Wind River & Sierra Madre Mountain Ranges



Appendix B. National Oceanic and Atmospheric Administration Final Operations Report

Silver iodide seeding agent amounts are stated in grams.

NOAA FORM 17-4A (4-81)		U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC		Form Approved OMB Control No. 0648-0025 Expires 05/31/2024								
INTERIM ACTIVITY REPORTS AND FINAL REPORT												
This report is required by Public Law 92-205; 85 Stat. 735; 145 U.S.C. 330b. Knowing and willful violation of any rule adopted under the authority of Section 2 of Public Law 92-205 shall subject the person violating such rule to a fine of not more than \$10,000, upon conviction thereof.												
☐ INTERIM REPORT ☒ FINAL REPORT												
Complete in accordance with instructions on reverse and forward one copy to: National Oceanic and Atmospheric Administration Office of Oceanic and Atmospheric Research 1315 East-West Highway, SSMC-3, Rm. 11216 Silver Spring, MD 20910												
REPORTING PERIOD												
FROM 11/8/2022 TO 04/22/2023												
MONTH	(a) NUMBER OF MODIFICATION DAYS	(b) NUMBER OF MODIFICATION DAYS PER MAJOR PURPOSE			(c) HOURS OF APPARATUS OPERATION BY TYPE		(d) TYPE AND AMOUNT OF AGENT USED					
		INCREASE PRECIPITATION	ALLEVIATE		OTHER	AIRBORNE	GROUND	SILVER IODIDE	CARBON DIOXIDE	UREA	SODIUM CHLORIDE	OTHER
			HAIL	FOG								
JANUARY	5	5				33.75	959					
FEBRUARY	7	7				252.33	7,353					
MARCH	9	9				168.8	4,750					
APRIL	3	3				116.67	3,406					
MAY												
JUNE												
JULY												
AUGUST												
SEPTEMBER												
OCTOBER												
NOVEMBER	4	4				126.35	3,661					
DECEMBER	6	6				259.48	6,893					
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS FOR FINAL REPORT	32	32				957.38	27,022					
DATE ON WHICH FINAL WEATHER MODIFICATION ACTIVITY OCCURRED (For Final Report only.) 04/19/2023												
CERTIFICATION: I certify that all statements in this report on this weather modification project are complete and correct to the best of my knowledge and are made in good faith.												
NAME OF REPORTING PERSON Jake Van Ornum												
AFFILIATION Weather Modification LLC												
SIGNATURE												
OFFICIAL TITLE Client Services Assistant												
STREET ADDRESS 3802 20th Street North												
CITY Fargo												
STATE ND												
ZIP CODE 58102												
DATE 10/19/2023												



WINTER GROUND OPERATIONS 2022-2023
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Wind River Mountain & Sierra Madre Ranges



Appendix C. Ice Nucleus Generator Operations Summary – 2022-2023

2022-2023 Generator Operations Summary - WIND RIVER & SIERRA MADRE MOUNTAINS

LAST UPDATED 20230428

GRAND TOTAL OPERATIONAL "SEED" HOURS= 957:23

Total Seeding Solution (Gallons)= 444.14

Monthly Totals	93:01	99:49	114:34	3:41	137:38	87:46	139:56	79:27	80:59	96:31	20:29	3:32	957:23	957:38		
November sub-total	9:04	18:18	13:05	3:41	14:53	14:54	8:22	9:04	16:01	15:14	2:44	1:01	126:21	126.35		
December sub-total	30:19	31:43	25:47	0:00	39:44	24:28	43:03	16:29	23:09	22:33	2:14	0:00	259:29	259.48		
January sub-total	6:44	3:35	3:34	0:00	1:32	0:00	10:26	0:00	0:00	5:21	2:33	0:00	33:45	33.75		
February sub-total	14:17	14:57	44:05	0:00	33:25	22:48	46:08	19:40	19:52	21:39	12:58	2:31	252:20	252.33		
March sub-total	21:23	23:08	19:56	0:00	28:51	14:32	16:39	15:59	15:51	12:29	0:00	0:00	168:48	168.80		
April sub-total	11:14	8:08	8:07	0:00	19:13	11:04	15:18	18:15	6:06	19:15	0:00	0:00	116:40	116.67		
UTC DATE	WR01 Big Sandy	WR02 Block & Tackle	WR03 White Acorn	WR07 Enterprise	WR09 Boulder Lake	WR10 East Fork	WR12 Pocket Creek	WR13 Green River	WR14 Willow Lake	WR16 Highland	SM10 Tullis West	SM11 High Savery	DAILY TOTAL	Operation #	Solution Used (gallons)	
11/9/2022	2:47	4:15	1:28		0:47	5:14	3:24		2:00	7:47			27:42	27.70	WRR 0181	12.12
11/13/2022				3:41									3:41	3.68	WRR 0182	1.79
11/15/2022											2:44	1:01	3:45	3.75	SMR 0001	2.17
11/28/2022	6:17	14:03	11:37		14:06	9:40	4:58	9:04	14:01	7:27			91:13	91.22	WRR 0183	44.09
12/2/2022	5:45	7:04	7:04		7:04		7:04						34:01	34.02	WRR 0184	14.35
12/5/2022	5:49	5:55			4:08		6:00						21:52	21.87	WRR 0185	10.20
12/9/2022	7:26	7:25	7:24		4:25		7:23						34:03	34.05	WRR 0186	13.96
12/22/2022	11:19	11:19	11:19		12:24	12:24	10:32	9:13	11:05	11:05			100:40	100.67	WRR 0187	44.63
12/22/2022											2:14		2:14	2.23	SMR 0002	0.78
12/27/2022					4:48	4:48	4:48		4:48	4:12			23:24	23.40	WRR 0188	10.06
12/31/2022					6:55	7:16	7:16	7:16	7:16	7:16			43:15	43.25	WRR 0189	19.32
1/4/2023													0:00	0.00	SMR 0003	0.00
1/5/2023	1:53				1:32		5:41						9:06	9.10	WRR 0190	4.08
1/10/2023	4:51	3:35	3:34				4:45						16:45	16.75	WRR 0191	7.57
1/24/2023											2:33		2:33	2.55	SMR 0004	1.17
1/25/2023										5:21			5:21	5.35	SMR 0005	2.94
2/5/2023	3:48	3:48	3:48										11:24	11.40	WRR 0192	6.08
2/6/2023											4:13		4:13	4.22	SMR 0006	1.24
2/8/2023	5:45	4:50	5:09		4:16	4:11	5:47	4:15	4:15	4:15			42:43	42.72	WRR 0193	21.32
2/9/2023											2:18	2:31	4:49	4.82	SMR 0007	2.13
2/19/2023											1:40		1:40	1.67	SMR 0008	0.42
2/27/2023	4:44	6:19	35:08		21:08	10:36	35:08	7:24	7:36	9:23			137:26	137.43	WRR 0194	66.32
2/28/2023					8:01	8:01	5:13	8:01	8:01	8:01			45:18	45.30	WRR 0195	22.00
2/28/2023											4:47		4:47	4.78	SMR 0009	1.34
3/3/2023			4:31		4:07	4:25		4:26	4:27	4:23			26:19	26.32	WRR 0196	13.41
3/5/2023			2:19					2:08					4:27	4.45	WRR 0197	2.13
3/13/2023					0:55					2:05			3:00	3.00	WRR 0198	1.50
3/15/2023	4:06	3:59	4:00		5:08	3:58	5:07	3:16	5:15				34:49	34.82	WRR 0199	15.17
3/20/2023	8:35	8:26			8:24		1:47						27:12	27.20	WRR 0200	11.46
3/21/2023	2:02	4:08	4:08		4:08								14:26	14.43	WRR 0201	6.51
3/22/2023	2:42	2:42	1:05		2:42	2:42	2:25	2:42	2:42	2:42			22:24	22.40	WRR 0202	9.88
3/30/2023	3:58	3:53	3:53				3:53						15:37	15.62	WRR 0203	8.35
3/31/2023					3:27	3:27	3:27	3:27	3:27	3:19			20:34	20.57	WRR 0204	9.66
4/1/2023	10:18	7:21	7:19		12:03	10:18	12:03	12:03	2:10	12:03			85:38	85.63	WRR 0205	42.16
4/2/2023	0:56	0:47	0:48		3:14	0:46	3:15	2:16		3:15			15:17	15.28	WRR 0206	6.71
4/19/2023					3:56			3:56	3:56	3:57			15:45	15.75	WRR 0207	7.12
END OF PROJECT																

END OF PROJECT