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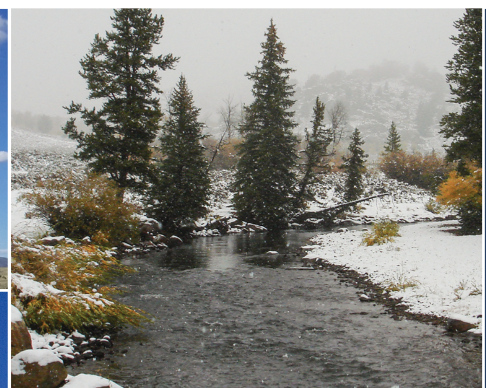
ANNUAL
REPORT

WYOMING • WIND RIVER RANGE
WEATHER MODIFICATION PROGRAM



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Wind
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Range

WEATHER MODIFICATION
INCORPORATED

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WYOMING WATER DEVELOPMENT
COMMISSION

6920 Yellowtail Road
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Cloud Seeding Operations in the Wind River Mountains of Wyoming 2014-2015 Season

ANNUAL REPORT

prepared by

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for the

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October 2015

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EXECUTIVE SUMMARY

Funding for cloud seeding operations in the Wind River Range for the winter of 2014-2015 was provided in part by the Wyoming state Legislature's "Omnibus Water Bill – Construction" approved by the 2014 Wyoming State Legislature. Per the legislation, the appropriate funds could only be expended once formal cost sharing agreements were in place with other Colorado River Basin water users. Wyoming's cost share was capped at 25% to reflect the benefits expected to be accrued to the State. Funding partners in support of continued weather modification activities in the Wind River Mountains during the winter of 2014-2015 include the Southern Nevada Water Authority, the Central Arizona Project (CAP), the Colorado River Board of California - Six Agency Committee, the Utah Department of Natural Resources, and the Arizona Department of Water Resources.

The same ten ground-based ice nucleus generators (ground generators) that were employed during the preceding Wyoming Weather Modification Pilot Program (WWMPP) were deployed for the 2014-2015 season. The Big Sandy Opening generator is shown in Figure 1. 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. As would be expected based on the ground generator locations, the majority of seeding was conducted when winds were from the west or southwest. A number of seeding events also occurred when winds were easterly, supporting the activation of the single ground generator near Lander. During the season, operations were conducted twenty-four hours a day, seven days a week. There were a total of 21 seeding events during the season, which varied widely from month-to-month.

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 (silver iodide, AgI particles) upslope into cold but yet-unfrozen clouds at speeds sufficient to ensure that transport would occur. The seeding rate is about 25 grams of silver iodide per generator, per hour. The results discussed in the report show a variance in the number of generators used from event-to-event. This variance is due to situations when the wind direction was such that only some of the generators needed to be activated. The two other requisite conditions were that water clouds had to have been present, and the temperature of the clouds aloft had to be cold enough (-6°C or colder) that the seeding agent would actually nucleate ice, thus starting precipitation development. This is discussed in greater detail in the body of the full report.

Figure 1. The ice nucleus generator sited at Big Sandy Opening on the southwest flank of the Wind River Range (WMI photograph). For the locations of all the generators, see Figure 4.

The requisite temperature and wind criteria necessary to initiate seeding operations were primarily satisfied through the release of weather balloons. A total of 20 weather balloons were released during the 5.5 month project. The presence of a water cloud was established by a real-time data feed from a radiometer sited near Boulder, WY. In addition to the observed measurements, forecasters utilized a high-resolution numerical weather model operated by the National Center for Atmospheric Research (NCAR) Research Applications Laboratory (RAL) to help determine whether or not atmospheric conditions were suitable for seeding. The radiometer and the numerical weather model runs, funded through an agreement between the US Bureau of Reclamation and NCAR, were made available to WMI forecasters on a daily basis.

Overall, the 2014-2015 winter offered fewer storms and fewer opportunities for seeding than would normally be expected. This was primarily due to a prevailing long-wave weather pattern that kept storm tracks largely north of the range, and also resulted in warmer-than-normal atmospheric temperatures, which made some storms too warm to seed effectively.

Additional and more detailed information is provided in the pages that follow, and the attached appendices. This is further supplemented by appendices. For increased ease of reading, a glossary of terms and acronyms is also provided.

ACKNOWLEDGMENTS

Weather Modification, Inc., is pleased to acknowledge the following persons and entities who made the 2014-2015 operations possible.

The Wyoming Water Development Office (WWDO) coordinated the entire effort and contributed 25% of the costs. The WWDO also acquired additional funding from the Colorado River Board of California – Six Agency Committee, the Central Arizona Project, the Southern Nevada Water Authority, the Utah Department of Natural Resources, and the Arizona Department of Water Resources.

The Research Applications Laboratory of the National Center for Atmospheric Research assisted operations by allowing real-time on-line access to their radiometer data and numerical weather model output, which aided forecasting and seeding decision-making.

Ms. Kathy Raper of the Sublette County Conservation District arranged for local students to visit the WMI facilities in Pinedale to learn about the program and observe weather balloon launches. WMI greatly appreciates the opportunity to continue providing educational training and community outreach.

WMI also acknowledges all the WMI staff who contributed to the success of the program, specifically meteorologists Dan Gilbert and Jason Goehring, technicians Michael Paul, Jeremy Silvey, and Ryan Richter, and all the administrative support provided by Erin Fischer, along with the other Fargo-based WMI support staff.

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 that makes it to the ground. This has prompted scientists and engineers to explore the possibility of augmenting water supplies by means of 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). 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 Wyoming Water Development Commission (WWDC) obtained legislative support and the funding for a 2014-2015 operational cloud seeding program in the Wind River Range. The funding provided by the 2014 Wyoming Legislature required that the State of Wyoming, through the WWDO, provide 25% of the operational cost. Additional funding would have to come from other sources, and is discussed in further detail in Section 1.4.

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. If the CCN are large or have properties that attract water (such as salt), the resulting droplets will be of increased size. All this happens on a very small scale, as illustrated in Figure 2. About one million (10^6) typical cloud droplets are required to produce a single, 1 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 in size, 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 versus rain, and it is this process that plays a significant role in winter clouds in Wyoming. For ice to form 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” (SLW); 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.

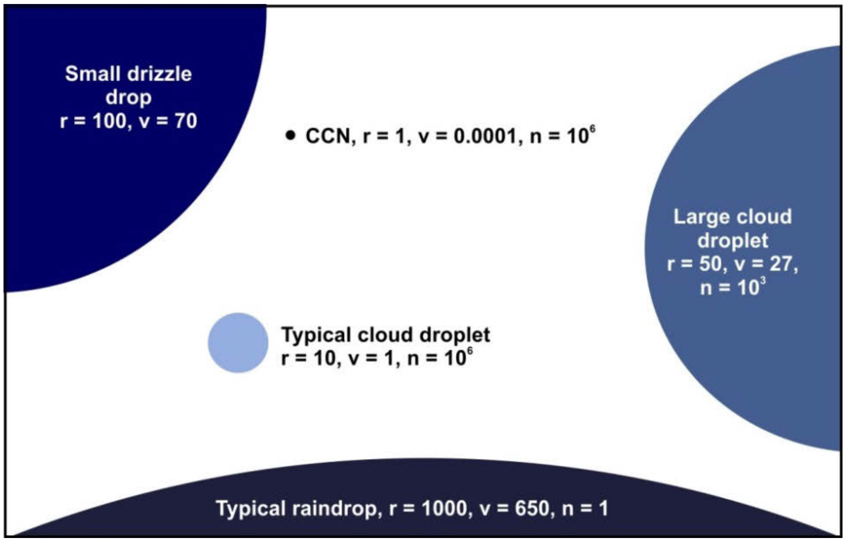

Figure 2. Relative characteristics of particles involved in cloud processes. For each, the radius (r, microns), fall velocity (v, cm per second), and number concentration (n, per liter) are given (after Wallace and Hobbs 1977). The raindrop shown (radius = 1000) is a 2 mm diameter raindrop.

Nature's solution to the lack of substrates available to encourage the freezing process in clouds comes in in the form of tiny particles called *ice nuclei.* Ice nuclei provide microscopic "templates" for supercooled liquid water to follow, and become the hard crystalline 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.

Once ice forms in a cloud, the crystals grow quickly. Initially, growth occurs through water vapor deposition directly on the nascent ice crystal, 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 -5°C, but do not immediately form ice crystals, they can be treated with silver iodide-based ice nuclei which immediately initiates 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 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.

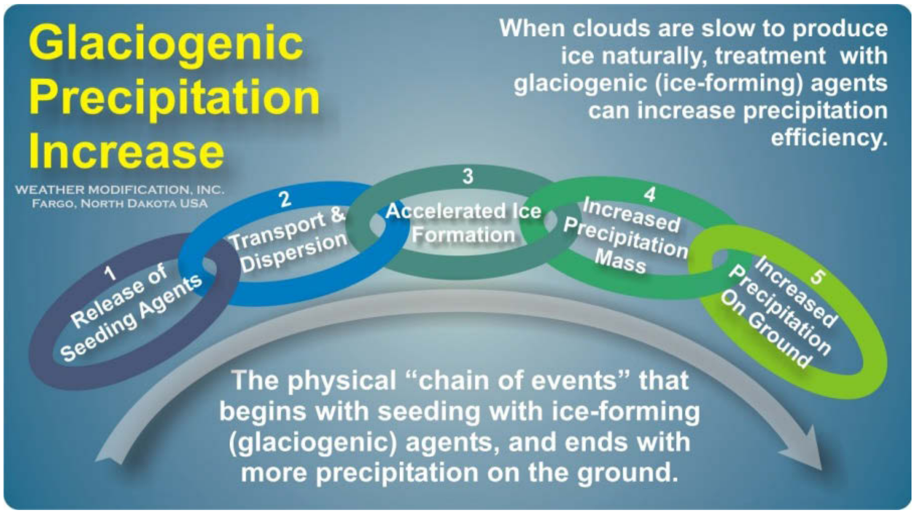

Figure 3. The physical chain-of-events that begins with release of ice-forming seeding agents, and culminates with increased precipitation.

Given the chain-of-events illustrated in Figure 3, 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. Natural ice nuclei, such as crystalline soil particles, do not act to form ice crystals until the cloud is much colder (at least as cold as +5°F). 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. As a result, precipitation formation within the cloud starts 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 Transition to 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 /-8°C). A colder temperature threshold was used in the research to ensure that more of the seeding agent would "activate" in the cloud and produce a strong seeding signature.

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). Widening the temperature window for seeding increases the number of seeding opportunities. Most operational (vs. research) seeding programs use this warmer temperature criterion.

1.4 2014-2015 Funding

In addition to the 25% of funding costs provided by the State of Wyoming, funding for the 2014-2015 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.

The Central Arizona Project. The Central Arizona Project (CAP) delivers Colorado River water via a 335-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 CAP 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.

The Arizona Department of Water Resources, and the ***Utah Department of Natural Resources***. These two state agencies also contributed to operations in the Wind River Range for the 2014-2015 season to help further the goals of a larger Colorado River Basin flow augmentation strategy, and improve system conditions.

2. STAFF AND FACILITIES

2.1 Personnel

The primary project personnel were the project forecasters who monitored the weather and made the decisions regarding which ice nucleus generators should be used, and when each should be turned on and off, and the project technicians who supplied, maintained, and operated the generators.

Meteorologists. Two meteorologists staffed the 2014-2015 operations season. Mr. Daniel Gilbert was located on site in Pinedale, WY throughout the project. In addition to coordinating data collection for the project, he also operated the weather balloons (the upper air sounding system). The second meteorologist was Mr. Jason Goehring, who worked off-site from his home, using weather resources available via the Internet. During the course of the WWMPP research, it had become apparent that quality forecasting and weather monitoring was possible through the Internet. This discovery resulted in considerable cost savings for the 2014-2015 Wind River Range operation, because travel, lodging, and living expenses are incurred only for those on site. Both Gilbert and Goehring are Weather Modification Association Certified Operators. Between the two of them, Gilbert and Goehring completed all the daily forecasting, weather monitoring, and implementation of seeding operations.

Technicians. Four technicians participated in the 2014-2015 operations. On-site technical work was conducted primarily by Mr. Michael Paul and Mr. Jeremy Silvey, who were occasionally assisted by Mr. Rich Keely. Mr. Ryan Richter was available to provide counsel and direction from the WMI home office in Fargo. Safety guidelines require that two technicians travel into the field together, especially in the event of equipment failure (i.e., a snowmobile breakdown), but also because two persons are sometimes required to complete tasks such as adding seeding solution to a generator.

2.2 Siting of Seeding Equipment

Seeding equipment was placed at ten sites for the 2014-2015 project, as shown in Figure 4. These sites were unchanged from those utilized in the WWMPP.

The generator placement was such that individual generators could be activated according to wind direction, and as storms passed and conditions changed. As shown in Figure 4, 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.

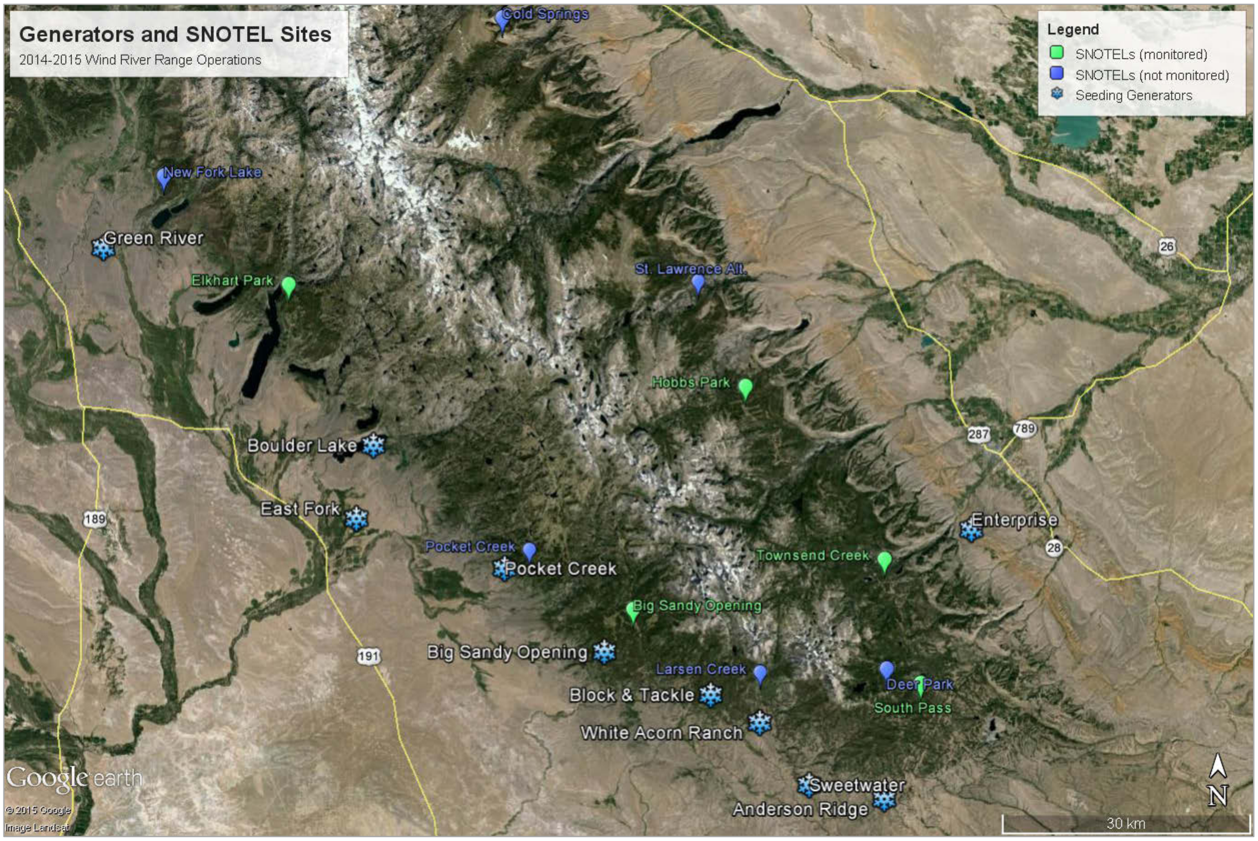

Figure 4. The locations of the ground-based ice nucleus generators are indicated by the snow crystal symbols. The green "balloons" indicate the locations of Natural Resources and Conservation Service (NRCS) snow telemetry (SNOTEL) sites used in monitoring snowpack during the 2014-2015 season. The blue balloons show the locations of additional SNOTELs that were not used because of proximity to sites that were used, or a short period of record (they were relatively new sites).

2.3 Ice Nucleus Generators

The ice nucleus generators were designed and fabricated by WMI. The primary components are shown in Figure 5.

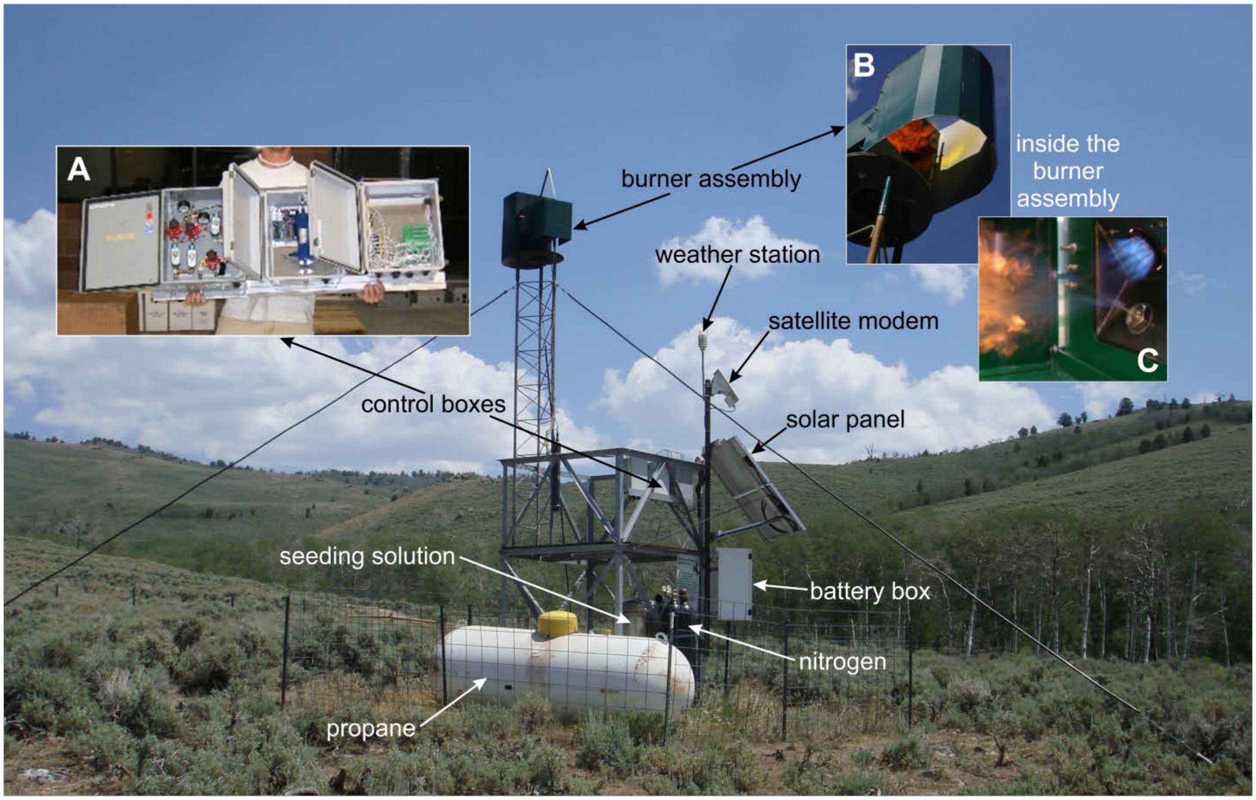

Figure 5. The primary components of the WMI remotely controlled ground-based ice nucleus generator are illustrated. Inset A, shows the contents of the control boxes. From left to right, these are: relays (electronic valves) to turn flows on and off, seeding solution flow rate regulation and measurement, 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 Wind River Range generators are fully independent, controlled via satellite, and powered by batteries charged by solar power. This provides the ability to site generators at higher elevations, significantly improving delivery of seeding agent to the clouds. Being remotely-controlled means that the generators can be activated and deactivated as weather conditions warrant. This results in less seeding agent being dispersed unnecessarily, as can occur with manually operated generators. All of the generator lines and fittings are made of corrosion-resistant stainless steel, necessary when high-performance seeding solutions, which contain oxidizers, are used. The generators are robust; designed to function in extreme temperatures, winds and precipitation.

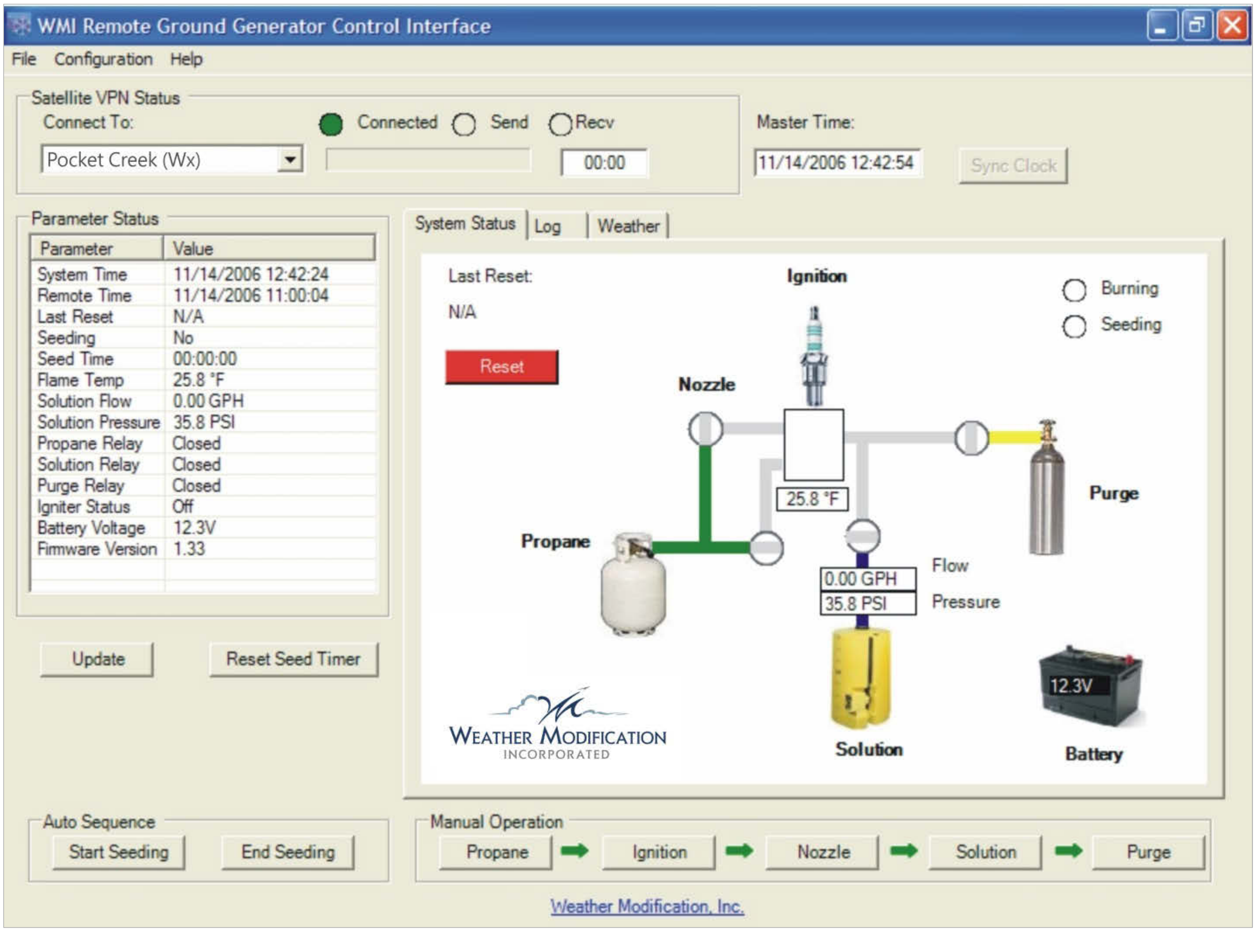

Figure 6. The control interface for the WMI remotely-controlled ground-based ice nucleus generator is shown, after connection is established via satellite, but before the generator is turned on. All flow valves are off, seeding solution flow is zero, but system status is fully reported.

The computer interface used to control the generators is shown in Figure 6. 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.

Clicking the Start Seeding button (lower left on the interface, Figures 6 and 7) 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 actually 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 5, 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, as shown in Figure 7.

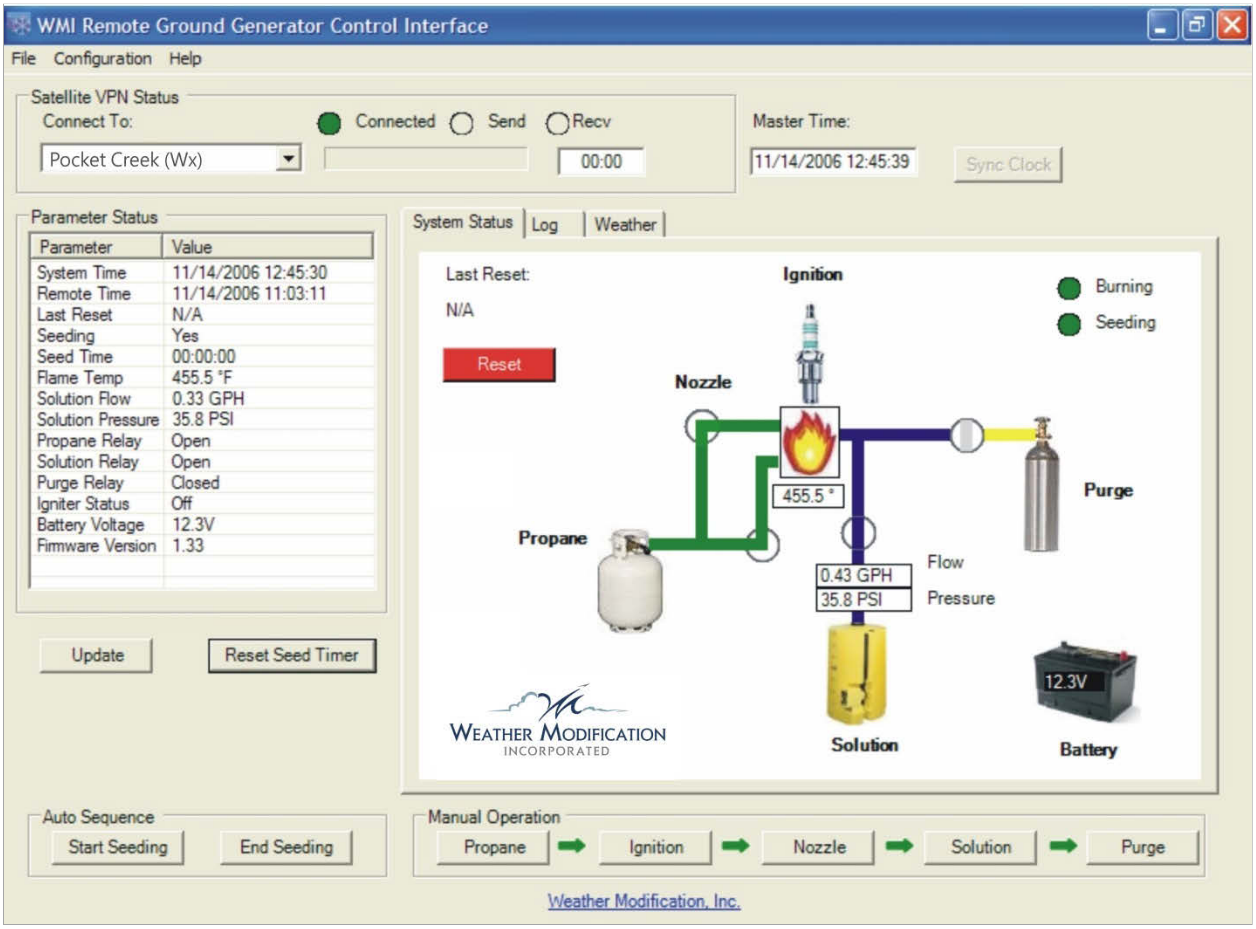

Figure 7. The WMI remote-controlled ice nucleus generator interface is shown, as it appears during seeding operations. Valves are open, the flame is known to be burning, and the seeding solution flow rate is also known. Seeding is certain.

2.4 Seeding Solution

The high performance seeding solution itself was tested at the Colorado State University Cloud Simulation and Aerosol Laboratory by DeMott (1997). The results of those tests determined that colder cloud temperatures produce a bigger yield of active ice nuclei per gram of AgI burned. As shown in Figure 8, the yield increases markedly from -6°C (+21.2°F) to -8°C (+17.6F), and even more at -10°C (+14°F). In the course of the WWMPP, a -8°C temperature at the 700 hPa altitude (about 10,000 ft, approximate mountain top) was used as the threshold for seeding. At that temperature about 2 x 10^{13} ice nuclei are active for each gram of AgI burned. In English, this is 20,000,000,000,000, or 20,000 trillion nuclei. At -6°C, only 3 x 10^{11} nuclei are active, just 300,000,000,000, only 300 trillion. Although the results indicate that cloud seeding efficiency decreases with warmer temperatures, the temperature criteria used in an operational program is typically warmer than those used in research based applications. Research studies provide the foundation for the design of operational programs. Operational programs in the western United States commonly commence seeding operations at -5 or -6°C. In the 2014-2015 Wind River operations, -6°C at 700 hPa was the threshold temperature used.

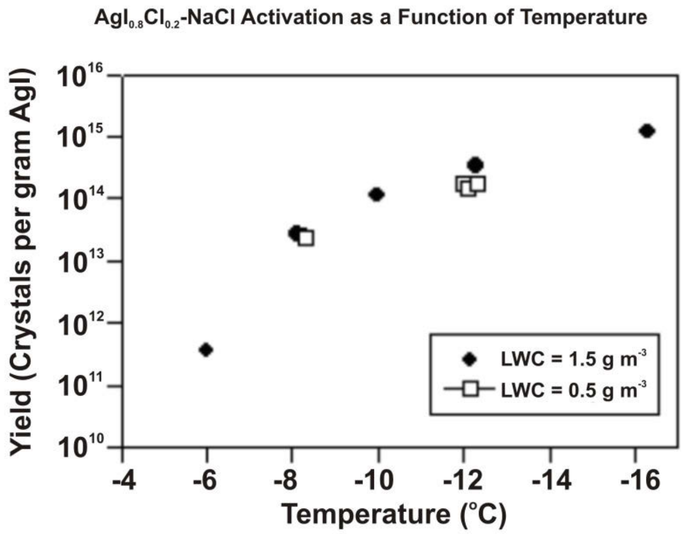

Figure 8. Yield as measured by the number of active ice nuclei per gram of silver iodide (AgI) burned, is shown as a function of temperature (DeMott 1997). These nuclei are comprised of silver iodide, silver chloride, and salt (NaCl).

It was previously mentioned that this seeding solution is "high-performance". This means that unlike simpler solutions that produce a pure AgI nucleus, this "high performance" solution also contains salt, which enables it to function by the condensation-freezing mechanism. The non-salty, simple AgI nucleus functions by the contact-freezing mechanism. The difference between the two are as follows:

Contact-freezing. For this freezing process to occur, the ice nucleus must come into contact with a supercooled cloud droplet (≥ -5°C). The speed at which this type of nucleation occurs depends upon the density of the water droplets in the cloud. Clouds with a low 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 slow nucleation of the cloud. In clouds with a high 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.

Condensation-freezing. Nuclei of this type have the advantage of containing salt, which attracts water vapor to the nuclei to form water droplets, eliminating the requirement for a collision process. As soon as the droplets containing these nuclei cool to at least -5°C, freezing results. 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 frequent maintenance.

2.5 Atmospheric Soundings (Weather Balloons/Rawinsondes)

Weather balloons were released from the WMI shop, in Pinedale, WY to help determine whether or not weather conditions were suitable for seeding. Each balloon carried a miniaturized weather probe that measured temperature, humidity, and pressure. In addition, the GPS position of the balloon was also recorded. The atmospheric sounding data were recorded and compared to the operating criteria to verify that observed weather conditions were sufficient to initiate cloud seeding procedures.

Each sounding required approximately one hour to travel from the surface to the 100 hPa level (an altitude of about 53,000 feet). Upon completion, the sounding data were immediately shared via e-mail with NCAR, the National Weather Service Offices in Riverton and Cheyenne, and the State of Wyoming's Water Resources Data System (WRDS). All of the soundings were archived, and are available for any post-analysis efforts that might be undertaken.

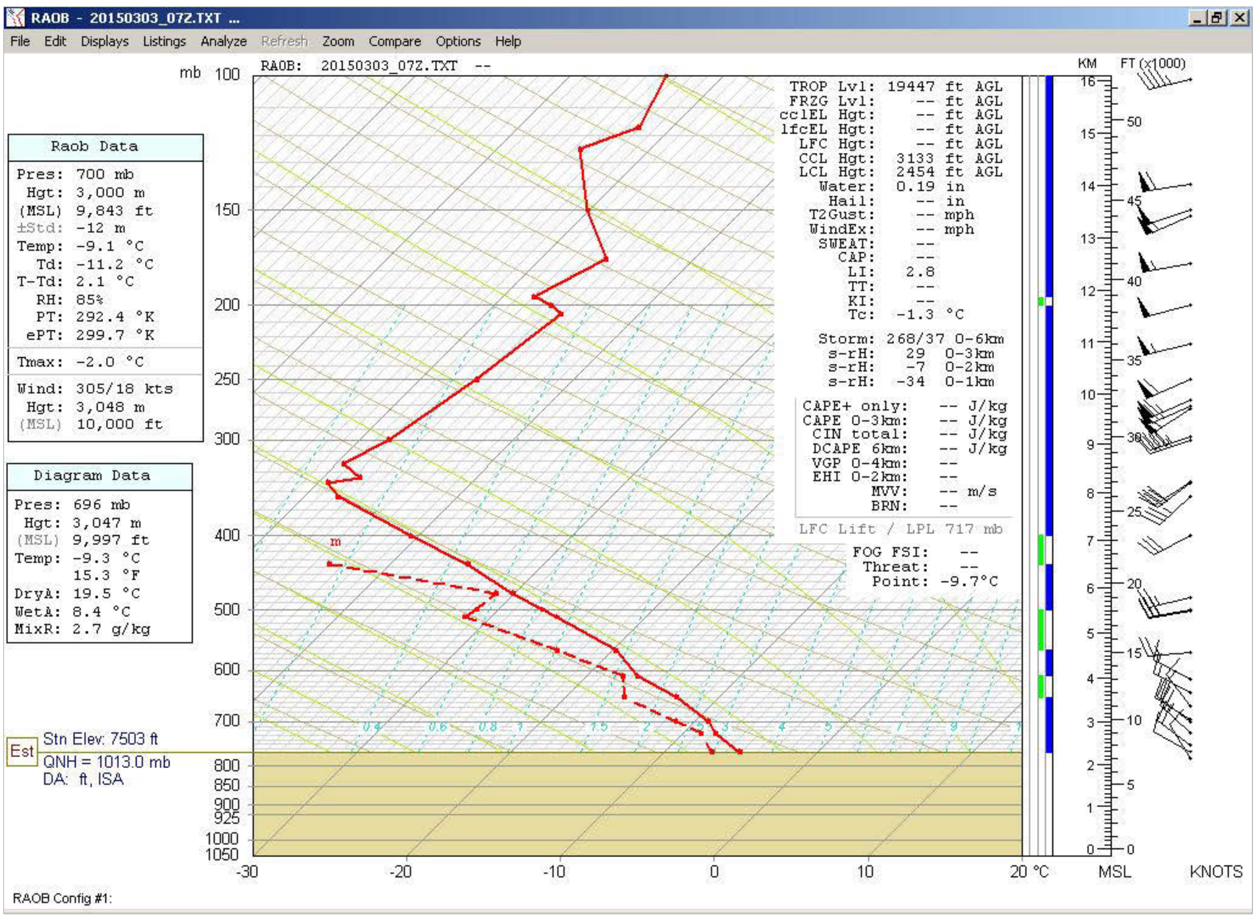

Figure 9. A plot of the upper-air sounding obtained from the weather balloon released from Pinedale, WY at midnight on March 3, 2015. The temperature at 700 hPa level (approximately 10,000 feet) was -9.1°C (+15.6°F), and the wind speed was from 305° (northwest) at 18 knots (21 miles per hour), both well within the acceptable range for seeding.

2.6 Weather Stations

Five of the ten generator sites were equipped with Vaisala WXT-510 weather stations. These compact, tower-mounted instruments measured temperature, humidity, pressure, and wind speed and direction. Data storage of each station was limited to 8 hours; therefore technicians downloaded the data at regular intervals during seeding events, using the connection afforded by the generator satellite modem. These data were shared with NCAR/RAL, to aid in their modeling studies.

In the previous WWMPP seasons, only two of the generators in the Wind River Mountains were equipped with the WXT-510 weather stations, but with the completion of the project, four others that had been in use in the Medicine Bow and Sierra Madre Ranges became available. One of those was not fully functional, but the other three were added to sites in the Wind River Range.

2.7 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 and the preparation and release of weather balloons.

The shop housed WMI's 4x4 truck, snowmobiles/trailers, spare generator parts, trouble-shooting equipment, and replacement nitrogen tanks. The Vaisala Digicora rawinsonde system used for the calibration and tracking of the weather balloons was also at the shop, as well as all the upper air consumables: helium, balloons, and rawinsondes. Internet service was available, allowing immediate sharing of upper air data with other interested parties (NCAR, NWS, WRDS).

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, European Community satellite imagery, Northern Illinois University, and Unisys. While many of the web-based weather products (i.e., National Weather Service (NWS) products) were publicly available, some data sources were project-specific.

Radiometer. A radiometer was deployed by NCAR at a private residence near Boulder, WY (Figure 10). Funding for this instrument was external to operations, but NCAR graciously shared the real-time liquid water data obtained by this instrument with the project forecasters. Since the presence of liquid water in the clouds over the target area is essential for successful seeding, this measurement was most helpful.

Numerical Model – RT-FDDA. During the 2014-2015 season NCAR/RAL also ran a sophisticated, high-resolution numerical model, a version of the Weather Research and Forecasting (WRF) model that produced real-time (RT) output. The model also ingested additional weather data during runs, a capability known as four-dimensional (x, y, z, and t) data assimilation (FDDA), and therefore is referred to as the "RT-FDDA". Output from this model was shared with the forecasting team and proved to be very useful. An example of RT-FDDA output is shown in Figure 11.

Atmospheric Soundings. The atmospheric soundings (weather balloons/rawinsondes) were discussed in Section 2.5. Data from the soundings were immediately shared with the NWS, NCAR, and WRDS. NCAR also utilized the atmospheric sounding data in the RT-FDDA model to help work towards improving the model's accuracy.

Figure 10. The radiometer sited near Boulder, WY. The instrument does not transmit, but passively measures the atmospheric liquid water and water vapor. (NCAR photograph by Daniel Breed.)

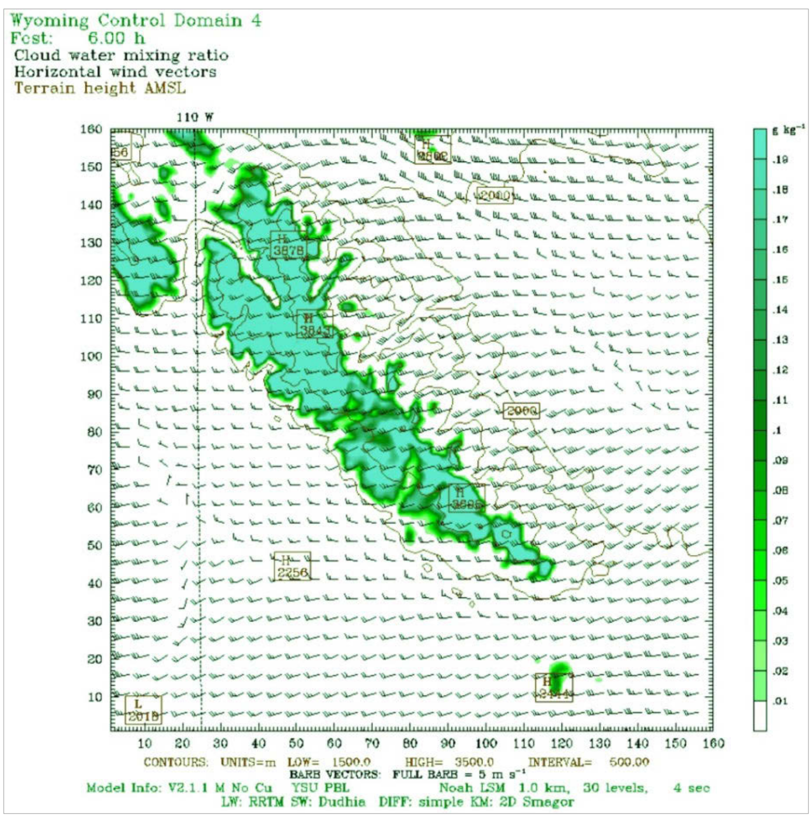

Figure 11. Shown here is one of many various plots output by the NCAR RT-FDDA numerical model. In this case, cloud water mixing ratio over the Wind River Mountains is shown for the time six hours hence. Thus, one would expect a good likelihood of liquid water cloud over the range later in the day.

3.2 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 early update was followed by a much more detailed forecast and weather briefing, typically disseminated to the WWDC 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 Daily Wyoming Wintertime Scale (DWWS), shown in Table 1, numerically categorized the probability of seeding operations occurring.

TABLE 1. The Daily Wyoming Wintertime Scale

DWWS	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 mountains.
-1	*No*	Limited coverage or short-lived orographic clouds, not enough temporal or spatial extent to warrant seeding activities.
0	*Possible*	Some orographic clouds or stratiform cloud deck(s) over mountain tops. SLW likely insufficient for seeding operations or winds clearly unfavorable.
+1	*Yes*	Orographic clouds and/or stratiform cloud deck(s) enshrouding mountain tops, winds favorable and SLW likely sufficient for seeding operations.
+2	*Yes*	Persistent orographic clouds and/or stratiform cloud deck(s) enshrouding mountain tops, SLW probable, winds favorable. Lengthy operations possible.

The seeding criteria were straightforward. First, 700 hPa temperature, meaning temperature near the cloud elevation at about 10,000 feet, had to be equal to, or less than -6°C (+21.2°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 taken into account, as it helped inform which generators would be activated.

The first criterion, temperature, was confirmed by a weather balloon sounding released from Pinedale, WY (Section 2.5, Figure 9). In lieu of the sounding, the RT-FDDA model output was used, supplemented by prognostic, synoptic scale, upper air weather charts.

The presence of SLW was confirmed by the real-time data from the radiometer (Figure 10) located near Boulder, WY. These data was also supplemented by RT-FDDA model output.

The wind speed and direction were confirmed by the atmospheric sounding, coupled with the forecast winds from the RT-FDDA model (Figure 11).

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 would be activated, when, and for how long. The length of time a generator was activated depended upon how long weather conditions were expected to remain 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.

4. OPERATIONS

Seeding operations were conducted on twenty-one occasions, as enumerated in Table 2. The busiest month was December, when favorable conditions developed seven times.

Table 3 summarizes operations by month and provides season totals. November had two seeding opportunities, one at project start-up, and another at the end of the month. As noted, December had the most opportunities, but three of the seven were in easterly flow, with the Enterprise generator operated solo.

January had just two events, but both were quality opportunities, the first being 13 hours in duration, and the second over 11 hours. After the second event on 16 January, no additional seeding opportunities materialized until almost a month later on 15 February.

Furthermore, beginning with 15 February there were five upslope opportunities in a row that could use only the Enterprise generator. These five events resulted in a total of 36.8 generator hours. Compare this to March, which had just three events, but all three in southwesterly flow that allowed use of nine generators (all except Enterprise), and thus resulted in 226.8 generator hours, the most of any month. April was more like February, both events again being in upslope flow, utilizing the Enterprise generator.

TABLE 2. Wyoming Weather Modification Wind River Mountains, 2014-2015 Seeding Summary					
Date	*Number of Generators Utilized*	*Length of Seeding in hours*	*AgI Released This Date (kg)*	*AgI Monthly Total (kg)*	*AgI Season Total (kg)*
15-Nov-14	7	5.6	0.964		0.96
30-Nov-14	7	5.0	0.878	1.8416	1.84
1-Dec-14	7	14.4	2.375		4.22
14-Dec-14	1*	17.8	0.217		4.43
19-Dec-14	5	8.0	0.896		5.33
20-Dec-14	7	17.8	2.279		7.61
25-Dec-14	9	11.7	2.538		10.15
25-Dec-14	1*	14.2	0.216		10.36
29-Dec-14	1*	0.9	0.002	8.5237	10.37
5-Jan-15	4	13.0	1.289		11.65
16-Jan-15	7	11.1	1.841	3.1296	13.49
15-Feb-15	1*	2.6	0.062		13.56
16-Feb-15	1*	6.2	0.153		13.71
21-Feb-15	1*	15.0	0.320		14.03
25-Feb-15	1*	9.3	0.186		14.22
26-Feb-15	1*	3.7	0.065	0.7867	14.28
3-Mar-15	9	4.5	1.060		15.34
3-Mar-15	9	10.4	2.334		17.68
24-Mar-15	9	10.3	2.320	5.7147	20.00
2-Apr-15	1*	16.1	0.451		20.45
15-Apr-15	1*	28.1	0.803	1.2539	21.25
Totals	-	225.7	-	-	-
*seeding event with easterly flow, utilizing only the Enterprise generator					

Note that from 16 January until 3 March, weather conditions suitable for seeding from westerly flow did not occur. It is not uncommon for winters to have a mix of stormy and calm periods, but it's considered atypical to have a period of seven weeks pass by, in which only a few brief episodes of easterly flow could be seeded.

TABLE 3. Summary of Seeding Events During the 2014-2015 Winter Season					
Month	*Events ( ) easterly flow*	*Event Averages*		*Seeding Agent (kg)*	
		Number of Generators	*Generator Hours**	*Average Released per Event*	*Total Released*
November	2	7.0	35.9	0.921	1.842
December	7 (3)	4.4	54.0	1.218	8.524
January	2	5.5	62.9	1.565	3.130
February	5 (5)	1.0	7.3	0.157	0.787
March	3	9.0	73.3	1.905	5.715
April	2 (2)	1.0	22.1	0.046	1.254
Totals/Averages	*21 (10)*	*4.3*	*257.8 / 42.9*	*1.012*	*21.25*
**generator hours = sum of the hours each generator was run for each event, e.g, 4 generators each operated for 3.5 hours = 14 generator hours.*					

Table 4 shows the activity of each of the ten generators on a case-by-case basis. Each seeding event has two rows, the top indicates whether or not each generator was requested (REQ), and the bottom whether or not the generator ran (RAN). Ideally, every time a generator was requested it would run for the entire duration of the event.

However, the complexity of the generators and the extreme weather pretty much preclude perfection, for we see in Table 4 three red “NO”s, and five yellow “PARTIAL”s. Only once did more than one generator fail in the same event; that occurred on 19 December 2015. Three generators ran perfectly all season: Sweetwater, Anderson Ridge, and East Fork. Sweetwater and Anderson Ridge are located at the southern end of the range and were not used often. Of the other seven, six failed only once. The seventh, Pocket Creek, failed completely once in December, and ran for only part of an event during March. Note that none of the generators suffered from recurrent problems, and when a problem arose, maintenance technicians quickly addresses the issue.

The good news from all this is that the generator performance for the season was very good, resulting in 93.8% functionality. This is testimony to the diligence and skill of the technicians.

TABLE 4. 2014-2015 Ice Nucleus Generator Activity

Wind River Range			WR01 Big Sandy	WR02 Block & Tackle	WR03 White Acorn	WR04 Sweetwater	WR05 Anderson	WR07 Enterprise	WR09 Boulder Lake	WR10 East Fork	WR12 Pocket Creek	WR13 Green River	#Ggens Called	#Ggens Active
20141115	WRR0001	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES		7
20141130	WRR0002	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES		7
20141201	WRR0003	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES		7
20141214	WRR0004	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20141219	WRR0005	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	NO	YES	YES	NO	NO	NO	YES	YES	NO	YES		5
20141220	WRR0006	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES		7
20141225	WRR0007	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	9	
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES		9
20141225	WRR0008	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20141229	WRR0009	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		0
20150105	WRR0010	REQ	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	4	
		RAN	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES		4
20150116	WRR0011	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7	
		RAN	YES	PARTIAL	YES	NO	NO	NO	YES	YES	YES	YES		6.5
20150215	WRR0012	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150216	WrR0013	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150221	WRR0014	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150225	WRR0015	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150226	WRR0016	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150303	WRR0017	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	9	
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	PARTIAL	YES		8.75
20150303	WRR0018	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	9	
		RAN	YES	YES	PARTIAL	YES	YES	NO	YES	YES	YES	PARTIAL		8
20150324	WRR0019	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	9	
		RAN	YES	YES	YES	YES	YES	NO	PARTIAL	YES	YES	YES		8
20150402	WRR0020	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
20150415	WRR0021	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	1	
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO		1
												TOTALS	92	86.25
													RUN =	93.8%
													FAIL =	6.2%

5. OUTREACH

Whenever possible WMI likes to be receptive to requests to educate those showing an interest in our field efforts. During the 2014-2015 season such interest was made known through the Sublette County Conservation District (SCCD), which arranged for local students to visit the shop and learn about upper air soundings, and even to participate in the release of a weather balloon (Figure 12).

Additional outreach was achieved through the presentation of project activities at Wyoming weather modification Technical Advisory Team (TAT) meetings. The technical advisory team, initially organized by the WWDO for the WWMPP, is comprised of representatives of interested State and Federal agencies. Wyoming agencies include the State Engineer's Office, the Department of Environmental Quality, the Department of Transportation, the University Office of Water Programs, and the Game and Fish Department. Federal agency representation includes several different forests (Bridger-Teton, Shoshone, and Medicine Bow), the U.S. Geological Service, the NWS Riverton and Cheyenne offices, the Bureau of Land Management, and the NRCS. The TAT met twice in 2015, the first time, in Cheyenne on 29 January, and again on 21 July in Pinedale. WMI presented the 2014-2015 Wind River operational seeding efforts to the TAT at both of these meetings.

Figure 12. Pinedale high school students and staff learn how to release weather balloons at the WMI shop during a 2014-2015 public outreach event. Sounding data were provided for further examination in class. The instrumentation is contained in the little white package being held in the right hand, while the balloon is held in the left. (SCCD photograph by Kathy Raper)

6. SUMMARY

The 2014-2015 cloud seeding effort in the Wind River Range began on 15 November 2014, and concluded on 30 April 2015, a duration of 5.5 months. Twenty-one seeding events were conducted. Eleven events involved four or more generators, seeding in westerly or southwesterly flow. The other ten were solo events using the Enterprise generator, in easterly upslope flow. A total of 21.25 Kg of silver iodide was released.

The ice nucleus generators operated reliably, seeding as intended almost 94% of the time. Generator failures occurred infrequently, in fact, only one generator, Pocket Creek, experienced two operational issues during the course of the season.

The winter as a whole was lacking in seeding opportunities. This was not limited to Wyoming, as programs in neighboring Idaho and Utah reported similar lack of opportunities. In the Wind River Range flow from the northwest is parallel to the range axis rather than across it, so seeding wasn’t possible under those conditions, which occurred frequently. Temperatures warm in the spring, so in April meeting the temperature criterion can be problematic. The last seeding opportunity occurred on 15 April 2015.

7. LIST OF TERMS AND ACRONYMS

Where applicable, definitions are those provided by the *Glossary of Meteorology*, published by the American Meteorological Society (2000), and are used by permission.

accretion	see ***riming***.
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 ***silver iodide***.
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
BTAC	Bridger-Teton Avalanche Center
CAP	Central Arizona Project
CCN	cloud condensation nucleus
CSU	Colorado State University
DWWS	Daily Wyoming Wintertime Scale, a number from -3 to +2 indicating the likelihood of seeding operations.
GPS	Global Positioning System
glaciogenic seeding	cloud seeding with ice-forming aerosols
ground generator	see ***ice nucleus generator***.
hPa	hectopascals, equivalent to one millibar, 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.
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 ***supercooled liquid water***.
IN	see ***ice nucleus.***
mb	millibar, same as hectopascals (***hPa***)
MOU	Memorandum of Understanding
MSL	above mean sea level
NaCl	the chemical notation for sodium chloride, common table salt
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
NWS	National Weather Service, U.S. Department of Commerce
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.
prognostic	A model used to predict future weather conditions. For example, model output showing the expected conditions over a specific area at a specified future time. The *RT-FDDA* model was run in a predictive mode.
radiometer	a passive (non-transmitting) instrument that measures liquid water and water vaper in the atmosphere.
RAL	Research Applications Laboratory, NCAR, P.O. Box 3000, Boulder, CO 80307
rawinsonde	commonly called a ***weather balloon***, 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 ***supercooled*** cloud droplets that freeze wholly or partially upon contact.
RIW	the airport and meteorological station identifier for Riverton, Wyoming.
RT-FDDA	Real-time Four Dimensional Data Assimilation, a version of the WRF model run by NCAR
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 ***supercooled liquid water.***
SNOTEL	sites instrumented, operated, and maintained by the ***NRCS***, to measure precipitation, ***SWE*** and other related parameters in the mountains.
SCCD	Sublette County Conservation District, Pinedale, WY
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)
TAT	The Wyoming Weather Modification Pilot Project ***Technical Advisory Team***, comprised of representatives of federal, state, and local agencies interested in or affected by the project.
upslope	a term describing flow from a direction other than the climatological norm that produces orographic cloudiness and precipitation. In this report, the term refers to easterly flow against the Wind River Mountains, contrary to the westerly flow that generates the majority of the range's precipitation.

USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
UTC	universal time coordinates, formerly known as Greenwich Mean Time, and Zulu time.
UW	The University of Wyoming
WMI	Weather Modification, Inc., 3802 20th Street North, Fargo, ND 58102
WR	Wind River Mountain Range
WRDS	Water Resources Data System, University of Wyoming, Dept. 3943, 1000 E. University Ave., Laramie, WY 82071
WRF	the Weather Research and Forecasting numerical model
WRR	Wind River Range, Wyoming
WSEO	Wyoming State Engineer's Office, responsible for the issuance of Wyoming cloud seeding permits
WWDC	Wyoming Water Development Commission, the state body directing the WWDO
WWDO	Wyoming Water Development Office, 6920 Yellowtail Road, Cheyenne, WY 82002
WWMPP	Wyoming Weather Modification Pilot Project

8. REFERENCES

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Appendix A. Daily Operations Summaries

Wyoming Weather Modification Wind River Mountains
2014-2015 Season – WMI Daily Project Summaries

15 November 2014, Saturday	
As the project season began at 0000 MST (15th), seedable conditions existed. Moderate super cooled liquid water was observed along with widespread orographic and upper level snow and westerly winds. Just before dawn, winds shifted to NW becoming unfavorable for orographic cloud and seeding. Skies were rapidly clearing around dawn in the morning. Thin orographic clouds were present throughout most of the afternoon. Coverage was insufficient for operations. Around sunset, low stratus and fog developed in the lowlands which banked up against the range through the late night hours. The mountains were mainly clear overnight. Max/Min temperatures PNA: 23/-6 RKS: 30/1 LND: 11/-6 Observed DWWS: +1	Seeding event WRR0001 was called at 2350 MST on 11/14/2014 for seeding to begin shortly after 0000 MST on 11/15/2014. <u>Case WRR0001</u> Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13 Time: 00:00 to 05:10 MST 07:00 to 12:10 UTC Duration: 5:10, 36:52 Total Time Seeding: 927.7g silver (15.84 gallons)
16 November 2014, Sunday	
Skies were mostly clear throughout the period with the exception of a few thin high based orographic clouds above the peaks during the day. There was nothing remotely close to seedable. Winds were gusty, and blowing snow obscured visibility throughout the day. Max/Min temperatures PNA: 21/-13 RKS: 21/-1 LND: 24/-12 Observed DWWS: -1	No ground-based seeding was conducted.
17 November 2014, Monday	
The sky was clear for most of the day, with the exception being thin, upper level clouds, which moved in from the NW a little before sunrise.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 27/12 RKS: 30/10 LND: 32/6 Observed DWWS: -2	
18 November 2014, Tuesday	
Scattered to broken high and mid level clouds flowed over the area all day. Max/Min temperatures PNA: 32/5 RKS: 37/14 LND: 31/6 Observed DWWS: -2	No ground-based seeding was conducted.
19 November 2014, Wednesday	
There were a few high clouds around in the morning then more high and mid level clouds during the eveni and overnight. Max/Min temperatures PNA: 34/9 RKS: 43/22 LND: 34/16 Observed DWWS: -2	No ground-based seeding was conducted.
20 November 2014, Thursday	
Thick orographic clouds and upper level clouds were present during the day. Light snow occurred, but the warm temperatures, nil SLW, and weak wind flow were not right for seeding. Cloud cover cleared out around 10Z, and only some thin orographic clouds and scattered low and midlevel clouds were present in the early morning hours. Max/Min temperatures PNA: 37/9 RKS: 39/27 LND: 34/16 Observed DWWS: 0	No ground-based seeding was conducted.
21 November 2014, Friday	
Orographic arch clouds were present in the morning, and then skies were mostly clear during the afternoon. Thick cloud layers overspread the range overnight, while marginal orographic clouds	No ground-based seeding was conducted.

enshrouded the mountains. SLW and temperatures were not right for seeding. Max/Min temperatures PNA: 37/9 RKS: 44/22 LND: --/-- Observed DWWS: 0	
22 November 2014, Saturday	
Thick overcast layers blanketed the range all day. Cloud layers started to clear out in the late evening for a few hours, but then more cloud layers overspread the range overnight. Heavy snow occurred all day with thick orographic clouds present through around 00z. It was too warm to seed all day. The temps reached seeding criteria in the evening, but then the winds became unfavorable. Max/Min temperatures PNA: 36/10 RKS: 41/28 LND: --/-- Observed DWWS: 0	No ground-based seeding was conducted.
23 November 2014, Sunday	
There were some thin, low clouds on the SW slopes of the range during the afternoon and early evening hours. There were widespread mid and low level clouds passing through during the evening and overnight. Periods of light snowfall occurred, but the wind flow northwesterly and not favorable for seeding. The clouds were diminishing or moving away by sunrise. Max/Min temperatures PNA: 27/10 RKS: 3121 LND: --/-- Observed DWWS: 0	No ground-based seeding was conducted.
24 November 2014, Monday	
Thin, low clouds were over the far NW part of the range for most of the range, while the rest of the range was clear. High clouds moved in during the evening and then widespread mid and low clouds	No ground-based seeding was conducted.

producing snowfall came in after midnight. The wind flow remained too northwesterly and not right for seeding operations. Max/Min temperatures PNA: 27/7 RKS: 21/20 LND: 37/20 Observed DWWS: 0	
25 November 2014, Tuesday	
Thick, mid and low clouds continued over the range through the morning and afternoon. There were fewer mid level clouds during the evening and overnight, but the low clouds persisted. The wind flow was NW and the temperature was too warm for seeding operations. Max/Min temperatures PNA: 32/12 RKS: 37/21 LND: 46/20 Observed DWWS: 0	No ground-based seeding was conducted.
26 November 2014, Wednesday	
Thick low orographic clouds covered most of the range early in the day, but they thinned out during the afternoon. Waves of low, mid, and upper level clouds moved through during the evening and overnight hours. By morning, orographic and low stratus clouds enshrouded the mountains. The wind was northwesterly, and temperatures were too warm for operations. Max/Min temperatures PNA: 37/19 RKS: 46/34 LND: 48/25 Observed DWWS: 0	No ground-based seeding was conducted.
27 November 2014, Thursday	
Low stratus and arch clouds were present during the morning and early afternoon. Clouds diminished later in the day although some thin high bases orographic clouds lingered all day. Arch clouds redeveloped overnight, and low mid and upper level cloud layers overspread the range in	No ground-based seeding was conducted.

the early morning. Max/Min temperatures PNA: 43/14 RKS: 50/33 LND: 58/27 Observed DWWS: 0	
28 November 2014, Friday	
Orographic clouds were present throughout the period along with broken to overcast low mid and high level cloud layers. The orographic clouds thickened overnight, and some light snow occurred. Temperatures were much too warm for seeding throughout the period. Max/Min temperatures PNA: 46/14 RKS: 55/36 LND: 64/40 Observed DWWS: 0	No ground-based seeding was conducted.
29 November 2014, Saturday	
Thick low clouds developed over the range during the morning hours; the clouds lasted until clearing Sunday morning. The radiometer detected LW for most of the day. The temperature cooled into the seeding range after midnight. Max/Min temperatures PNA: 41/27 RKS: 50/30 LND: 55/46 Observed DWWS: +1	Seeding event WRR0002 was called at 0105 MST on 11/30/2014 and began at 0121 MST. Case WRR0002 Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13 Time: 01:21 to 06:20 (11/30) MST 08:21 to 13:20 UTC Duration: 4:59, 34:51 Total Time Seeding: 871.25g silver (14.43 gallons)
30 November 2014, Sunday	
High clouds moved into the area during the morning hours and continued through the evening hours before moving away. Low clouds developed over the range during the night with radiometer detected LW, but these conditions were only short lived. Max/Min temperatures PNA: 27/7 RKS: 40/19 LND: 45/12	No ground-based seeding was conducted.

Observed DWWS: 0	
01 December 2014, Monday	
Thick orographic clouds blanketed the range throughout the period. Orographic snowfall was nearly continuous through the entire period. Temperatures were just barely within seeding criteria during the day, and then became too warm around midnight. Max/Min temperatures PNA: 32/14 RKS: 37/15 LND: 45/9 Observed DWWS: +2	Seeding event WRR0003 was called at 0920 MST on 12/01/2014 and began at 0951 MST. <u>Case WRR0003</u> Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13 Time: 09:51 to 0:10 MST 16:51 (12/01) to 07:10 (12/02) UTC Duration:14:19, 100:06 Total Time Seeding: 2,502.5g silver (39.04 gallons)
02 December 2014, Tuesday	
Thick orographic clouds were in place during the morning and early afternoon, and then the wind became northwesterly and orographic clouds thinned out during the rest of the period. Broken to scattered low level clouds passed overhead throughout the day. Overcast thick layers moved in after sunset and remained over the region throughout the night. It was too warm for seeding during the morning, and then there were no seedable orographic clouds during the afternoon through overnight hours. Max/Min temperatures PNA: 37/19 RKS: 43/28 LND: 53/28 Observed DWWS: 0	No ground-based seeding was conducted.
03 December 2014, Wednesday	
Marginal orographic clouds were present in the morning along with low overcast clouds. The orographic clouds were thinner during the afternoon through overnight hours. Low and midlevel overcast remained in place throughout the period. Waves of light snow passed through all day and night. It was too warm for seeding. Max/Min temperatures PNA: 34/19 RKS: 36/26	No ground-based seeding was conducted.

LND: 43/20 Observed DWWS: 0	
04 December 2014, Thursday	
Thin orographic clouds and overcast stratus were present in the morning. The low clouds became scattered during the afternoon while a few high based orographic clouds lingered. Overnight, low overcast redeveloped along the western slopes while orographic arch clouds extended east of the peaks. Max/Min temperatures PNA: 34/19 RKS: 43/24 LND: 39/25 Observed DWWS: 0	No ground-based seeding was conducted.
05 December 2014, Friday	
Low clouds were around the range from the morning through the evening, but with weak wind flow the clouds did not cover the range. Neither precipitation nor SLW occurred. High clouds covered the area beginning in the late evening and through the night. Max/Min temperatures PNA: 41/23 RKS: 45/31 LND: 54/27 Observed DWWS: -1	No ground-based seeding was conducted.
06 December 2014, Saturday	
Low clouds developed over the range during the morning hours, lasted through the afternoon and evening then diminished a few hours before sunrise. The radiometer detected LW through most of the period but snowfall was minimal. The wind and temperature were not favorable for seeding operations. Max/Min temperatures PNA: 37/18 RKS: 46/26 LND: 45/26 Observed DWWS: 0	No ground-based seeding was conducted.

07 December 2014, Sunday	
There were some small, low clouds over the range during the morning hours, but no significant coverage occurred. Some mid level clouds developed during the later afternoon and then high clouds covered the region beginning during the evening. Max/Min temperatures PNA: 39/19 RKS: 46/29 LND: 52/25 Observed DWWS: -1	No ground-based seeding was conducted.
08 December 2014, Monday	
The range was mostly clear in the morning and early afternoon. Mid to high level clouds overspread the area for a few hours during the late afternoon, and skies were overcast at sunset. The clouds then moved east of the range and skies were clear during the late evening and overnight hours. There were no orographic clouds over the mountains. Max/Min temperatures PNA: 37/14 RKS: 46/24 LND: 47/24 Observed DWWS: -2	No ground-based seeding was conducted.
09 December 2014, Tuesday	
The range was clear during the day. Waves of broken to overcast high clouds passed overhead during the late evening and overnight hours. There were no low or orographic clouds. Max/Min temperatures PNA: 37/12 RKS: 46/20 LND: 56/22 Observed DWWS: -2	No ground-based seeding was conducted.
10 December 2014, Wednesday	
The range was clear during the day. Broken to overcast high and midlevel clouds overspread the range in the evening and remained over the area through morning. There were no orographic clouds	No ground-based seeding was conducted.

or precipitation. Max/Min temperatures PNA: 43/18 RKS: 45/21 LND: 52/27 Observed DWWS: -2	
11 December 2014, Thursday	
High clouds were around all day and mid level clouds existed during the evening and nighttime. Small, low clouds were over the range too, but coverage was very minimal. Max/Min temperatures PNA: 39/12 RKS: 44/20 LND: 45/22 Observed DWWS: -1	No ground-based seeding was conducted.
12 December 2014, Friday	
Mid level clouds were around the region throughout the day. Continuous low clouds with radiometer detected LW developed over the range overnight. These clouds persisted into Saturday morning. The wind flow was SSW but the temperature was much too warm for seeding operations. Max/Min temperatures PNA: 45/21 RKS: 49/35 LND: 49/29 Observed DWWS: 0	No ground-based seeding was conducted.
13 December 2014, Saturday	
Low clouds existed over the range in the morning with southerly flow, but the clouds had mostly diminished by noon. Widespread mid level clouds and some low clouds moved in during the afternoon. The wind shifted to northerly flow during the evening creating a thick cloud bank on the northern side of the range. The temperature was too warm for seeding until a little after midnight. Max/Min temperatures	Seeding event WRR0004 was called at 0055 MST on 12/14/2014 and began at 0108 MST. <u>Case WRR0004</u> Generators: WR07 Time: 01:08 to 21:20 MST 08:08 to 04:20 UTC Duration: 20:12, 17:48 Total Time Seeding: 445g silver (3.56 gallons)

PNA: 37/28 RKS: 44/29 LND: 54/33 Observed DWWS: +1	
14 December 2014, Sunday	
Moderate snow and thick overcast cloud layers blanketed the range throughout the period. Thick orographic clouds were present through the late evening, and then the wind became less favorable and the clouds became thinner overnight. Liquid water was minimal but present throughout the period. Low level winds were light, but they had an easterly component making seeding possible from the Enterprise generator until the evening. Max/Min temperatures PNA: 28/23 RKS: 29/22 LND: 36/26 Observed DWWS: +2	Seeding event WRR0004 continued until 2120 MST.
15 December 2014, Monday	
Thin low clouds were banked up along the western slopes during the day while the higher elevations had clear skies. Thicker cloud clover overspread the range after midnight including low stratus clouds. A few flurries were observed overnight as well. Winds were too light and variable for seeding operations. The cloud cover thinned out a bit at dawn. Max/Min temperatures PNA: 30/3 RKS: 27/8 LND: 31/12 Observed DWWS: 0	No ground-based seeding was conducted.
16 December 2014, Tuesday	
Low and midlevel cloud layers were present throughout the period, but weak winds were not favorable for orographic cloud development. The winds mostly flowed around the range all day and night, and plume trajectories were not favorable for seeding. Max/Min temperatures PNA: 27/7	No ground-based seeding was conducted.

RKS: 31/9 LND: 20/7 Observed DWWS: 0	
17 December 2014, Wednesday	
There were broken, small low clouds over the SW slopes of the range for most of the day. No significant coverage occurred over the range and only areas of flurries existed. Max/Min temperatures PNA: 32/10 RKS: 27/4 LND: 18/-1 Observed DWWS: -1	No ground-based seeding was conducted.
18 December 2014, Thursday	
There were only a few mid level clouds around during the daylight hours over the range. Low clouds developed over the SW slopes in the late evening and lasted through the night, but with NW wind flow the clouds did not fully cover the range. Some LW was detected but precipitation was very minimal. LND had fog most of the day, which kept the temperature very cold. Max/Min temperatures PNA: 30/5 RKS: 33/13 LND: 13/-5 Observed DWWS: -1	No ground-based seeding was conducted.
19 December 2014, Friday	
There were low clouds over the SW slopes of the range during the morning and afternoon but not fully covering the range. After sunset, the wind flow switched from NW to westerly, forming wider cloud coverage over the range, with LW and light precipitation. During the night the wind slowly went back to NW flow. Max/Min temperatures PNA: 32/16 RKS: 34/18 LND: 17/-6 Observed DWWS: +1	Seeding event WRR0005 was called at 1900 MST on 12/19/2014 and began at 1913 MST. <u>Case WRR0005</u> Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13 Time: 19:13 (12/19) to 03:10 (12/20) MST 02:13 (12/20) to 10:10 (12/20) UTC Duration: 8:03, 39:36 Total Time Seeding:990g silver (14.73 gallons)

<table>
<tr><th colspan="2">20 December 2014, Saturday</th></tr>
<tr><td>Thick cloud cover and snow were present throughout the period. The low level winds were light, but they were just enough to create orographic clouds and cross-barrier flow. Seeding began at 3:38pm MST (20th) with seven of the western GGENS. At 9:24pm (20th), two of the southernmost GGENS were turned off due to a slight wind shift. Seeding continued through the night with the five northern GGENS and ended at 9:23am today (21st). Snow was continuous through the night. The radiometer indicated intermittent liquid water spikes.

Max/Min temperatures
PNA: 32/19
RKS: 34/25
LND: 31/7
Observed DWWS: +2</td><td>Seeding event WRR0006 was called at 1516 MST on 12/20/2014 and began at 1538 MST.

<u>Case WRR0006</u>
Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13
Time: 15:38 (12/20) to 09:23 (12/21) MST
22:38 (12/20) to 16:23 (12/21) UTC
Duration: 17:45, 100:26 Total Time
Seeding: 2510.75g silver (37.46 gallons)</td></tr>
<tr><th colspan="2">21 December 2014, Sunday</th></tr>
<tr><td>Thick overcast clouds and orographic clouds completely covered the range throughout the period, and snowfall was nearly constant throughout the period. The temperature was too warm for seeding during the morning and afternoon. The winds shifted to the northwest becoming parallel to the range for the afternoon and overnight hours. No seeding occurred.

Max/Min temperatures
PNA: 34/19
RKS: 39/29
LND: 39/14
Observed DWWS: 0</td><td>No ground-based seeding was conducted.</td></tr>
<tr><th colspan="2">22 December 2014, Monday</th></tr>
<tr><td>Thin low clouds were present in the morning. The clouds nearly cleared out during the early afternoon, and then more low cloud cover moved in late in the day. The cloud cover diminished overnight, and the range was totally clear by morning. Winds and temps were not right for seeding.

Max/Min temperatures
PNA: 28/10</td><td>No ground-based seeding was conducted.</td></tr>
</table>

RKS: 33/15 LND: 35/17 Observed DWWS: 0	
23 December 2014, Tuesday	
The region was clear during the daylight hours. Some high and mid level clouds moved through during the evening and then more widespread clouds overnight. Low clouds had formed over the SW slopes a little before sunrise but with the NW wind flow, the clouds did not fully cover the range. Max/Min temperatures PNA: 23/9 RKS: 27/10 LND: 29/12 Observed DWWS: -1	No ground-based seeding was conducted.
24 December 2014, Wednesday	
Shallow, low clouds were over the SW slopes during the morning and afternoon, but the clouds did not fully cover the range with NW wind flow. Just before sunset, a strong push of moisture came in with favorable SW wind and SLW. These conditions remained through the night, but the wind began shifting to northerly flow around sunrise. Max/Min temperatures PNA: 27/3 RKS: 36/18 LND: 36/11 Observed DWWS: +2	Seeding event WRR0007 was called at 1758 MST on 12/24/2014 and began at 1844 MST. <u>Case WRR0007</u> Generators: WR01, WR02, WR03, WR04, WR05, WR09, WR10, WR12, WR13 Time: 18:44 to 06:24 MST 01:44 to 13:24 UTC Duration: 11:40, 104:54 Total Time Seeding: 2,622.5g silver (41.72 gallons)
25 December 2014, Thursday	
Thick clouds covered the area from the morning through the evening, with widespread snowfall during that time. After midnight, the clouds began weakening and SLW amounts diminished. Thin clouds, with areas of light precipitation remained Friday morning. The surface temperature at the three project stations steadily fell during the day, with daily highs occurring well before sunrise. Max/Min temperatures PNA: 28/5 RKS: 29/13 LND: 27/18	Seeding event WRR0008 was called at 1107 MST on 12/25/2014 and began at 1115 MST. <u>Case WRR0008</u> Generators: WR07 Time: 11:15 to 01:26 MST 18:15 to 08:26 UTC Duration: 14:11 Total Time Seeding: 354.5g silver (3.55 gallons)

Observed DWWS: +2	
26 December 2014, Friday	
Light snow and flurries occurred in the early morning. Scattered low and midlevel clouds were in place until noon. The cloud cover diminished throughout the afternoon becoming mostly clear, and then clouds redeveloped around sunset. Low and midlevel overcast was in place during the evening and most of the night. There were no seedable clouds. Wind flow and liquid water content were poor. Max/Min temperatures PNA: 18/0 RKS: 17/10 LND: 20/12 Observed DWWS: 0	No ground-based seeding was conducted.
27 December 2014, Saturday	
During the day, the range had waves of high clouds and some thin high-based orographic clouds. Marginal orographic clouds developed in the late evening and persisted through the night. Thick overcast layers were present through the night as well. Snow fell from around midnight through morning. There was insufficient liquid water for seeding, and the plume trajectories were too northwesterly. No seeding occurred. Max/Min temperatures PNA: 14/-15 RKS: 17/2 LND: 17/1 Observed DWWS: 0	No ground-based seeding was conducted.
28 December 2014, Sunday	
Low, mid, and high level overcast was present throughout most of the period. Marginal orographic clouds were present in the morning, and then the flow gradually shifted to the north in the afternoon and these clouds diminished. East flow developed in the late evening, and orographic clouds redeveloped along the east slopes for the overnight hours. Snow was nearly continuous throughout the period.	Seeding event WRR0009 was called at 2145 MST on 12/28/2014 and began at 2149 MST. <u>Case WRR0009</u> Generators: WR07 Time: 21:49 to 22:40 MST 04:49 to 05:40 (12/29) UTC Duration: 0:51 Total Time Seeding: 21.25g silver (0.04 gallons)

Max/Min temperatures PNA: 14/-8 RKS: 24/7 LND: 22/0 Observed DWWS: +1	
29 December 2014, Monday	
Low clouds were around the area for most of the period, but the clouds did not fully cover the range and mostly limited to the eastern slopes. No SLW existed and the wind flow was very light. The clouds were diminishing and moving away by sunrise. Max/Min temperatures PNA: 10/-17 RKS: 11/-5 LND: 15/-4 Observed DWWS: -1	No ground-based seeding was conducted.
30 December 2014, Tuesday	
Clear and cold, dangerously cold lows. The project area was clear throughout the whole period. In fact almost all of WY was clear, except for a few high clouds in the far south and some in the NE. Max/Min temperatures PNA: -6/-33 RKS: -3/-14 LND: -2/-21 Observed DWWS: -3	No ground-based seeding was conducted.
31 December 2014, Wednesday	
There was an area of mid level clouds over the range in the late morning and early afternoon. Other than that, the area was clear. Another day with dangerously cold temperatures. Max/Min temperatures PNA: 1/-33 RKS: 00/-21 LND: -5/-27 Observed DWWS: -2	No ground-based seeding was conducted.
01 January 2015, Thursday	
Low clouds covered the eastern slopes throughout the day. Light snow occurred for a few hours in the mid to late afternoon, but there was insufficient	No ground-based seeding was conducted.

liquid water for seeding. The range became mostly clear just after sunset and remained clear through the night. Max/Min temperatures PNA: 14/-8 RKS: 24/7 LND: 22/0 Observed DWWS: 0	
02 January 2015, Friday	
The range was mostly clear during the day. In the late afternoon, a layer of thin low clouds covered the northern end of the range. Low and midlevel clouds overspread the range in the evening and persisted through the night. Light snow began around 11pm. Light intermittent snow continued through the night. The northwest wind direction was not right for seeding or orographic cloud development. Max/Min temperatures PNA: 14/-8 RKS: 27/8 LND: 18/-4 Observed DWWS: 0	No ground-based seeding was conducted.
03 January 2015, Saturday	
Light snow occurred in the morning and early afternoon, and then a few low clouds hung over the range through the late afternoon and evening. Overcast cloud layers overspread the range in the late evening which remained in place through morning. Some very thin orographic clouds were observed at dawn, but nothing seedable. There were no seedable clouds due to northwest wind flow. Max/Min temperatures PNA: 23/0 RKS: 27/17 LND: 18/-2 Observed DWWS: 0	No ground-based seeding was conducted.
04 January 2015, Sunday	
The wind flow remained NW and unfavorable for orographic development from the morning through	Seeding event WRR0010 was called at 2251 MST on 01/04/2015 and began at 2305 MST.

the mid evening hours. By late evening, the wind was more westerly, producing orographic lift over the range and seeding conditions. Thicker, colder clouds came in after midnight. Max/Min temperatures PNA: 25/-2 RKS: 32/18 LND: 8/-5 Observed DWWS: +1	 Case WRR0010 Generators: WR09, WR10, WR12, WR13 Time: 23:05 (01/04) to 12:05 (01/05) MST 06:05 (01/05) to 19:05 (01/05) UTC Duration: 13:00, 52:04 Total Time Seeding: 1301.75g silver (21.18 gallons)
05 January 2015, Monday	
Thick clouds with westerly wind were over the range during the morning, but by late morning the wind was shifting to NW and the clouds were thinning over the top of the range. Broken cloud coverage remained around the range for the rest of the day, but the wind and temperature were not favorable for seeding. Max/Min temperatures PNA: 34/19 RKS: 39/29 LND: 38/-3 Observed DWWS: +1	Seeding event WRR0010 continued until 1200 MST on 01/05/2015.
06 January 2015, Tuesday	
Low clouds were over the range during the morning and most of the afternoon, diminishing before sunset. The wind and temperature were not right for seeding. High and mid level clouds existed for the rest of the period, mostly leaving just before sunrise. Max/Min temperatures PNA: 34/9 RKS: 42/33 LND: 51/14 Observed DWWS: 0	No ground-based seeding was conducted.
07 January 2015, Wednesday	
The range was mostly clear throughout the day. Some scattered high and midlevel clouds moved in during the evening. Overnight, the midlevel clouds became more widespread and overcast, and a few isolated thin orographic clouds were present as well. There were no seedable clouds.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 32/7 RKS: 37/26 LND: 17/11 Observed DWWS: -1	
08 January 2015, Thursday	
Skies were clear through midafternoon. Around 21z, stratus clouds began forming along the eastern slopes. Stratus and fog surrounded the range in the evening and overnight hours while the peaks remained clear above the cloud layer. Max/Min temperatures PNA: 32/5 RKS: 46/19 LND: 29/8 Observed DWWS: 0	No ground-based seeding was conducted.
09 January 2015, Friday	
Low clouds were in place in the morning. The clouds partially cleared out in the afternoon, and then mid and upper level clouds moved in during the late afternoon and evening. Overcast cloud layers obscured the range overnight. Very extensive orographic arch clouds developed overnight with spread from the peaks of the WR range to the eastern WY state border. Max/Min temperatures PNA: 21/12 RKS: 27/14 LND: 20/11 Observed DWWS: 0	No ground-based seeding was conducted.
10 January 2015, Saturday	
There was plenty of cloud coverage around the region throughout the day, but with weak low level wind flow the thick clouds just hung around the edge of the range with only thin coverage over the top. Broken, thicker clouds came over the range during the night, but the wind and temperature were not favorable for seeding. Max/Min temperatures PNA: 28/3	No ground-based seeding was conducted.

RKS: 35/22 LND: 25/10 Observed DWWS: 0	
11 January 2015, Sunday	
The range was obscured by layers of low, mid, and upper level clouds throughout the period. Light snow continued off and on throughout the period. The low level winds were weak and not right for proper plume transport. Orographic lift was poor. No seeding occurred. Max/Min temperatures PNA: 32/18 RKS: 39/31 LND: 31/18 FWZ: 34/27 Observed DWWS: 0	No ground-based seeding was conducted.
12 January 2015, Monday	
Low clouds were around the range in the morning but not covering to range. Mid level clouds moved in during the late afternoon and lasted through the middle of the night. Some flurries occurred but the wind flow was too weak for orographic development and unfavorable for seeding. Max/Min temperatures PNA: 32/21 RKS: 38/29 LND: 28/23 FWZ: 28/27 Observed DWWS: 0	No ground-based seeding was conducted.
13 January 2015, Tuesday	
A few thin small orographic clouds were present in the morning and early afternoon. Low clouds lingered over the far southern end of the range throughout much of the day. All cloud cover cleared out by sunset. Skies remained clear overnight. No seeding occurred. Max/Min temperatures PNA: 28/-4 RKS: 34/21 LND: 24/20 FWZ: 28/21	No ground-based seeding was conducted.

Observed DWWS: 0	
14 January 2015, Wednesday	
A small wave of isolated upper level clouds moved through during the evening hours. The project region was otherwise clear throughout the forecast period. Max/Min temperatures PNA: 21/-8 RKS: 31/18 LND: 21/9 FWZ: 37/27 Observed DWWS: -3	No ground-based seeding was conducted.
15 January 2015, Thursday	
The range was mostly clear during the day. At sunset, a few low clouds were developing along the eastern slopes. Throughout the evening and overnight hours, marginal orographic clouds developed and overcast upper layers overspread the region. Arch clouds also spread eastward from the peaks. The orographic cloud thickness and coverage were not sufficient for seeding. No seeding occurred. Max/Min temperatures PNA: 23/-8 RKS: 41/17 LND: 17/4 FWZ: 43/23 Observed DWWS: 0	No ground-based seeding was conducted.
16 January 2015, Friday	
The range had only mid and upper level clouds around in the morning. A little after noon, thick low clouds with snowfall and radiometer detected LW spread over the range. Favorable seeding conditions persisted until after midnight, when the wind switched to NW flow. Once the wind switched, the clouds quickly diminished, leaving the range clear. Max/Min temperatures PNA: 32/5 RKS: 42/25 LND: 48/11	Seeding event WRR0011 was called at 1340 MST on 01/16/2015 and began at 1426 MST. <u>Case WRR0011</u> Generators: WR01, WR02, WR03, WR09, WR10, WR12, WR13 Time: 14:26 (01/16) to 01:32 (01/17) MST 21:26 (01/16) to 08:32 (01/17) UTC Duration: 11:06, 73:47 Total Time Seeding: 1844.5g silver (30.26 gallons)

<table>
<tr><td>FWZ: 36/19
Observed DWWS: +2</td><td></td></tr>
<tr><td colspan="2">17 January 2015, Saturday</td></tr>
<tr><td>Scattered to broken mid level clouds were around the region during the morning and afternoon. Low clouds began slowly forming over the range during the evening hours with light snowfall beginning during the night. Radiometer detected LW was present but the temperature was too warm for seeding operations.

Max/Min temperatures
PNA: 28/14
RKS: 37/24
LND: 40/15
FWZ: 30/18
Observed DWWS: 0</td><td>No ground-based seeding was conducted.</td></tr>
<tr><td colspan="2">18 January 2015, Sunday</td></tr>
<tr><td>Thick low clouds with light snowfall and radiometer detected LW covered the NW ¾ of the range during the morning and most of the afternoon. By late afternoon the whole range was covered and remained to the middle of the night. The temperature was too warm for seeding until the middle of the night, but by then the clouds were diminishing as the wind flow was shifting to NW.

Max/Min temperatures
PNA: 34/12
RKS: 48/28
LND: 53/22
FWZ: 36/21
Observed DWWS: 0</td><td>No ground-based seeding was conducted.</td></tr>
<tr><td colspan="2">19 January 2015, Monday</td></tr>
<tr><td>Waves of midlevel clouds passed overhead throughout the day and into the late night hours. A few thin high based orographic clouds were present in the evening and late night along with some scattered stratus clouds. In the early morning, the cloud cover diminished. Skies were clear by dawn.

Max/Min temperatures
PNA: 32/3
RKS: 41/23</td><td>No ground-based seeding was conducted.</td></tr>
</table>

LND: 45/21 FWZ: 32/19 Observed DWWS: 0	
20 January 2015, Tuesday	
The range was mostly clear during the day. Low clouds surrounded the range during the overnight hours, but the peaks remained clear. Light snow was occurring on the east side of the range in the late night to early morning hours, but winds were not right for seeding and cloud coverage was not sufficient. No seeding occurred. Max/Min temperatures PNA: 25/-6 RKS: 31/16 LND: 34/14 FWZ: 37/12 Observed DWWS: 0	No ground-based seeding was conducted.
21 January 2015, Wednesday	
Low clouds surrounded the range during the afternoon, and some light snow occurred over the eastern slopes. Winds were not right for seeding. Cloud cover cleared out in the late afternoon and evening hours making the range mostly clear overnight. A few thin high clouds passed overhead in the early morning. No seeding occurred. Max/Min temperatures PNA: 18/-15 RKS: 25/9 LND: 27/9 FWZ: 19/9 Observed DWWS: 0	No ground-based seeding was conducted.
22 January 2015, Thursday	
Skies were clear over the region during the morning and afternoon. Mid and upper level cloud coverage increased during the evening and overnight. Low clouds formed a little before sunrise, but were not continuous in coverage over the project area due to weak wind flow. Max/Min temperatures PNA: 19/-17 RKS: 35/10	No ground-based seeding was conducted.

LND: 22/0 FWZ: 37/14 Observed DWWS: -1	
23 January 2015, Friday	
Thin, mid and low level clouds were over the range during the morning hours. Most of the clouds cleared out in the early afternoon, leaving only a few low clouds over the range for the rest of the afternoon. The evening brought fairly clear skies and then widespread mid and upper level clouds moved in overnight. Max/Min temperatures PNA: 32/-2 RKS: 35/22 LND: 35/10 FWZ: 32/25 Observed DWWS: -1	No ground-based seeding was conducted.
24 January 2015, Saturday	
Widespread high and mid level clouds covered the area from the morning through the early evening hours. A few low clouds existed during the afternoon and evening. The wind was NW and the temperature was warmer than the seeding threshold. More high and mid level clouds moved in overnight. Max/Min temperatures PNA: 36/0 RKS: 38/21 LND: 47/12 FWZ: 41/27 Observed DWWS: -1	No ground-based seeding was conducted.
25 January 2015, Sunday	
Waves of mid and upper level clouds passed over throughout the afternoon and evening. There were a few hours with clear skies in the late afternoon and then another wave moved in around sunset. All clouds exited the region around 10Z, and the range was totally clear for the rest of the night. Max/Min temperatures PNA: 39/28 RKS: 47/30	No ground-based seeding was conducted.

LND: 48/28 FWZ: 45/28 Observed DWWS: -2	
26 January 2015, Monday	
The range was mostly clear throughout the day with the exception of a couple thin high lenticular clouds above the peaks. The range was mainly clear during the night, but a small wave of midlevel clouds passed through between 04Z-07Z. Orographic clouds began forming after dawn as moisture started to flow into the region. Max/Min temperatures PNA: 41/12 RKS: 53/28 LND: 44/26 FWZ: 55/41 Observed DWWS: -2	No ground-based seeding was conducted.
27 January 2015, Tuesday	
Thin orographic clouds were present early in the period while midlevel clouds were moving into the region. The orographic and low, mid and upper level cloud layers thickened through the afternoon. Snow occurred in the late afternoon through late night hours. The clouds began to thin out in the early morning hours, and only flurries remained at dawn. Max/Min temperatures PNA: 41/9 RKS: 50/24 LND: 44/22 FWZ: 46/30 Observed DWWS: 0	No ground-based seeding was conducted.
28 January 2015, Wednesday	
Low clouds were around the range during the morning, thinned in the early afternoon but redeveloped in the later afternoon hours. These clouds then remained through the middle of the night before clearing over the top of the range by sunrise. The wind flow and temperature were not favorable for seeding operations all day. Max/Min temperatures	No ground-based seeding was conducted.

PNA: 37/19 RKS: 43/31 LND: 46/31 FWZ: 37/28 Observed DWWS: 0	
29 January 2015, Thursday	
Low stratus clouds/fog were around the range during the morning hours but did not reach up the slopes of the range. These clouds were mostly gone by noon. High clouds began moving in from the SW around sunset, becoming more widespread in the evening and then some mid level clouds appeared overnight. Max/Min temperatures PNA: 32/12 RKS: 38/28 LND: 41/27 FWZ: 32/25 Observed DWWS: -1	No ground-based seeding was conducted.
30 January 2015, Friday	
Widespread, thin high clouds covered the region throughout the daylight hours, becoming thicker just before sunset. Mid level clouds passed through during the evening, along with some brief periods of small, low clouds. The cloud coverage became more broken to scattered overnight. Max/Min temperatures PNA: 30/12 RKS: 37/28 LND: 38/24 FWZ: 34/28 Observed DWWS: -1	No ground-based seeding was conducted.
31 January 2015, Saturday	
Skies were mostly clear until sunset. Thin low level clouds moved in from the northwest during the evening. These clouds continued to pass over the northeastern side of the range throughout most of the night while the peaks and western slopes remained clear. There were no orographic clouds or low stratus decks enshrouding the mountain tops throughout the period. Skies cleared again by dawn. No seeding occurred.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 34/10 RKS: 41/20 LND: 41/22 FWZ: 37/18 Observed DWWS: -2	
01 February 2015, Sunday	
Skies were mostly clear in the morning. Upper level cloud layers overspread the region during the afternoon, and remained over the region through the night. Thick orographic clouds with snow developed in the late afternoon and remained through the night. Arch clouds spread east from the peaks overnight as well. The low level winds were from the WNW and just slightly too northerly for proper plume transport. Therefore, no seeding occurred. Max/Min temperatures PNA: 30/5 RKS: 35/19 LND: 31/19 FWZ: 28/10 Observed DWWS: 0	No ground-based seeding was conducted.
02 February 2015, Monday	
During the morning and afternoon, orographic clouds were thin and did not fully cover the range. Upper level cloud layers moved in just before sunset. In the evening hours, thicker orographic clouds developed. It was too warm for seeding. Orographic clouds thinned out again during the late night hours while waves of upper level cloud layers passed overhead. No seeding occurred. Max/Min temperatures PNA: 36/14 RKS: 44/30 LND: 46/19 FWZ: 34/25 Observed DWWS: 0	No ground-based seeding was conducted.
03 February 2015, Tuesday	
Low clouds were covering the NW part of the range during the morning and early afternoon while the	No ground-based seeding was conducted.

rest of the range was clear over the top. Thick clouds spread over the whole range by mid afternoon and lasted through the evening. The wind flow had been unfavorable for seeding during the afternoon then was better after sunset, but the temperature had warmed by then. Overnight, the wind became unfavorable again and only broken, low clouds existed around the range. No seeding occurred. Max/Min temperatures PNA: 37/16 RKS: 46/34 LND: 48/27 FWZ: 36/28 Observed DWWS: 0	
04 February 2015, Wednesday	
Low and mid level clouds with light snowfall were over the range during the morning and afternoon but the wind flow was not quite favorable for proper seeding plume transport. By the time the wind became more favorable, the temperature was warming. The clouds lasted until the mid evening before diminishing. A few, small low clouds persisted until Thursday morning. No seeding occurred. Max/Min temperatures PNA: 34/19 RKS: 42/31 LND: 33/13 FWZ: 32/19 Observed DWWS: 0	No ground-based seeding was conducted.
05 February 2015, Thursday	
Small low clouds existed during the morning and early afternoon but no significant coverage occurred. Scattered to broken high and mid level clouds flowed over the area throughout the day. No seeding occurred. Max/Min temperatures PNA: 34/10 RKS: 53/31 LND: 33/13 FWZ: 39/27 Observed DWWS: -1	No ground-based seeding was conducted.

06 February 2015, Friday	
The range was mostly clear in the morning. High and midlevel clouds passed through during the afternoon through the rest of the period. Thick orographic clouds developed overnight with snow and periods of good liquid water. The 700mb temperature was too warm for seeding operations. Max/Min temperatures PNA: 41/10 RKS: 57/33 LND: 52/29 FWZ: 43/32 Observed DWWS: 0	No ground-based seeding was conducted.
07 February 2015, Saturday	
Thick orographic clouds blanketed the range in the morning, and then clouds diminished somewhat during the afternoon and evening. Thicker orographic clouds returned for the overnight hours along with waves of upper level clouds. All cloud cover was starting to clear out at dawn. The 700mb temperatures remained too warm for seeding throughout the period. Max/Min temperatures PNA: 45/18 RKS: 55/34 LND: 58/36 FWZ: 45/32 Observed DWWS: 0	No ground-based seeding was conducted.
08 February 2015, Sunday	
Thin orographic clouds covered the northern half of the range early in the period, and then clouds cleared out for the afternoon and early evening. Waves of upper level clouds passed through from 3Z through the rest of the night with a few thin orographic clouds redeveloping. There were no clouds remotely close to seedable. No seeding occurred. Max/Min temperatures PNA: 43/25 RKS: 50/32 LND: 55/33	No ground-based seeding was conducted.

FWZ: 43/30 Observed DWWS: -1	
09 February 2015, Monday	
Cloud coverage over the range increased during the morning. Thick clouds with lots of radiometer detected LW were over the range from the late morning through the afternoon. The clouds thinned slightly by sunset, but remained through the evening before slowly diminishing overnight on the SE part of the range. The temperature remained too warm for seeding until after midnight, at which time the wind was becoming less favorable for plume transport, so no seeding occurred. Max/Min temperatures PNA: 36/18 RKS: 53/26 LND: 59/27 FWZ: 41/30 Observed DWWS: 0	No ground-based seeding was conducted.
10 February 2015, Tuesday	
Low clouds were over the SW slopes during the morning hours and then only scattered cloud coverage during the afternoon. The wind flow was not favorable for seeding. There was a brief period during the evening with thick clouds over the SE part of the range but it was not quite right for seeding. The range was then mostly clear overnight. Max/Min temperatures PNA: 36/18 RKS: 43/28 LND: 53/29 FWZ: 36/25 Observed DWWS: 0	No ground-based seeding was conducted.
11 February 2015, Wednesday	
The sky was clear around the region in the morning and early afternoon with some high clouds coming in in the later afternoon hours. Stratus clouds developed after sunset and covered the SE part of the range for a few hours. Widespread high and mid level clouds had come in by midnight, remained through the night and then were leaving	No ground-based seeding was conducted.

the area by sunrise. Max/Min temperatures PNA: 34/9 RKS: 45/24 LND: 49/26 FWZ: 36/23 Observed DWWS: -1	
12 February 2015, Thursday	
High and midlevel clouds passed over the region throughout the period. There were no low or orographic clouds. No seeding occurred. Max/Min temperatures PNA: 41/16 RKS: 50/31 LND: 62/31 FWZ: 46/30 Observed DWWS: -2	No ground-based seeding was conducted.
13 February 2015, Friday	
The range was totally clear during the day. Thin high clouds moved in during the evening. Midlevel clouds increased through the night coming nearly overcast by morning. Arch clouds formed downwind of the peaks for a few hours, and a few very thin orographic clouds formed above the peaks for a few hours in the early morning. No seeding occurred. Max/Min temperatures PNA: 45/23 RKS: 55/29 LND: 61/30 FWZ: 46/34 Observed DWWS: -1	No ground-based seeding was conducted.
14 February 2015, Saturday	
During the day, high and midlevel clouds passed overhead while only some thin small orographic clouds were present over the range at times. The high and midlevel clouds gradually diminished through the night. Marginal orographic clouds developed in the early morning along the northeast slopes with light NNE 700mb winds. No seeding occurred.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 45/21 RKS: 55/29 LND: 62/31 FWZ: 52/36 Observed DWWS: 0	
15 February 2015, Sunday	
Thick clouds developed over the SE part of the range during the morning, with northerly wind flow allowing for a short seeding event. The wind flow had become unfavorable for seeding before noon and remained NW the rest of the day. Broken low clouds were over the range the rest of the day while thicker clouds were around the range. Max/Min temperatures PNA: 36/14 RKS: 39/21 LND: 40/27 FWZ: 34/18 Observed DWWS: +1	Seeding event WRR0012 was called at 0842 MST on 02/15/2015 and began at 0852 MST. <u>Case WRR0012</u> Generators: WR07 Time: 08:52 to 11:29 MST 15:52 to 18:29 UTC Duration: 2:37 Total Time Seeding: 65.5g silver (1.02 gallons)
16 February 2015, Monday	
Thick clouds were banked up against the NE slopes during the morning and early afternoon hours allowing for seeding event. During the early afternoon, the wind flow was becoming unfavorable for proper plume transport. Broken to scattered low clouds with some areas of light snowfall existed over the range the rest of the afternoon and most of the evening. The range was mostly clear overnight. Max/Min temperatures PNA: 30/9 RKS: 30/15 LND: 28/13 FWZ: 19/12 Observed DWWS: +1	Seeding event WRR0013 was called at 0710 MST on 02/16/2015 and began at 0719 MST. <u>Case WRR0013</u> Generators: WR07 Time: 07:26 to 13:35 MST 14:26 to 20:35 UTC Duration: 6:09 Total Time Seeding: 153.75g silver (2.52 gallons)
17 February 2015, Tuesday	
Skies were clear except for some very isolated upper level clouds during the evening and overnight hours.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 30/5 RKS: 38/10 LND: 31/7 FWZ: 27/9 Observed DWWS: -3	
18 February 2015, Wednesday	
Skies were totally clear all day through sunset. In the evening, scattered high and midlevel clouds moves in and passed over the range throughout the night. A few arch clouds developed downwind overnight, well east of the southern peaks. Max/Min temperatures PNA: 39/14 RKS: 55/29 LND: 41/10 FWZ: 37/21 Observed DWWS: -2	No ground-based seeding was conducted.
19 February 2015, Thursday	
Skies were clear during the day. Cloud cover gradually increased through the night with marginal orographic clouds developing at times. Wind direction and temperature were not right for seeding. Max/Min temperatures PNA: 43/14 RKS: 54/30 LND: 55/24 FWZ: 41/28 Observed DWWS: 0	No ground-based seeding was conducted.
20 February 2015, Friday	
Waves of upper level cloud layers passed over throughout the period. Orographic clouds were present throughout the period, but they were mostly thin and did not cover the entire range due to the unfavorable northerly wind direction. No seeding occurred. Max/Min temperatures PNA: 34/19 RKS: 44/23 LND: 42/27	No ground-based seeding was conducted.

<table>
<tr><td>FWZ: 34/21
Observed DWWS: 0</td><td></td></tr>
<tr><td colspan="2">21 February 2015, Saturday</td></tr>
<tr><td>Thick clouds with favorable northerly wind flow developed a little after sunrise. Continuous snowfall with SLW and favorable wind flow continued until diminishing just before midnight, as the wind flow became less favorable for orographic forcing. Widespread stratus covered the region all night, diminishing after sunrise.

Max/Min temperatures
PNA: 30/12
RKS: 30/10
LND: 30/11
FWZ: 24/3
Observed DWWS: +2</td><td>Seeding event WRR0014 was called at 0810 MST on 02/21/2015 and began at 0819 MST.

<u>Case WRR0014</u>
Generators: WR07
Time: 08:19 to 23:21 (02/21) MST
15:19 (02/21) to 06:21 (02/22) UTC
Duration: 15:02 Total Time
Seeding: 375.75g silver (5.26 gallons)</td></tr>
<tr><td colspan="2">22 February 2015, Sunday</td></tr>
<tr><td>A widespread stratus cloud deck was around in the morning but quickly thinned. The range was clear the rest of the day, but areas of the thin, low clouds remained around the range into the evening.

Max/Min temperatures
PNA: 14/-15
RKS: 20/1
LND: 13/-3
FWZ: 5/-4
Observed DWWS: -1</td><td>No ground-based seeding was conducted.</td></tr>
<tr><td colspan="2">23 February 2015, Monday</td></tr>
<tr><td>The sky was clear over the range throughout the day. During the evening and overnight, there were some, small areas of mid level clouds around but not over the range.

Max/Min temperatures
PNA: 21/-24
RKS: 28/-2
LND: 20/-12
FWZ: 28/0
Observed DWWS: -3</td><td>No ground-based seeding was conducted.</td></tr>
<tr><td colspan="2">24 February 2015, Tuesday</td></tr>
<tr><td>Skies were totally clear during the day. Just before</td><td>No ground-based seeding was conducted.</td></tr>
</table>

<table>
<tr><td>sunset overcast cloud layers began moving in from the northwest. Low clouds remained throughout the night, while waves of high and midlevel clouds passed through. Only thin orographic clouds were present due to the unfavorable northwest winds. No seeding occurred.

Max/Min temperatures
PNA: 30/-9
RKS: 41/7
LND: 39/5
FWZ: 36/21
Observed DWWS: 0</td><td></td></tr>
<tr><td colspan="2">25 February 2015, Wednesday</td></tr>
<tr><td>Upper level clouds passed overhead throughout the day. Low level clouds enshrouded the range during the afternoon and evening with light east winds at 700mb. Winds became nearly calm in the late evening. Low clouds surrounded the range overnight, but there were no seedable clouds over the mountains.

Max/Min temperatures
PNA: 32/9
RKS: 39/15
LND: 37/20
FWZ: 32/12
Observed DWWS: +2</td><td>Seeding event WRR0015 was called at 1142 MST on 02/25/2015 and began at 1152 MST.

<u>Case WRR0015</u>
Generators: WR07
Time: 11:52 to 21:09 MST
18:52 (02/25) to 04:09 (02/26) UTC
Duration: 9:17 Total Time
Seeding: 232g silver (3.06 gallons)</td></tr>
<tr><td colspan="2">26 February 2015, Thursday</td></tr>
<tr><td>A low stratus deck surrounded the range in the morning while the mountains were clear. Low stratus then enshrouded the mountains during the afternoon hours along with some thin orographic clouds. Seeding occurred during the afternoon. The clouds over the mountains diminished in the evening hours. Thin low and midlevel clouds continued to pass over the range overnight.

Max/Min temperatures
PNA: 25/1
RKS: 23/5
LND: 19/2
FWZ: 12/0
Observed DWWS: +1</td><td>Seeding event WRR0016 was called at 1336 MST on 02/26/2015 and began at 1341 MST.

<u>Case WRR0016</u>
Generators: WR07
Time: 13:41 to 17:23 MST
20:41 (02/26) to 00:23 (02/27) UTC
Duration: 3:42 Total Time
Seeding: 92.5g silver (1.07 gallons)</td></tr>
<tr><td colspan="2"></td></tr>
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27 February 2015, Friday	
The range had only thin clouds in the morning and then cloud coverage increased in the afternoon. Areas of low clouds were then over the range from the mid afternoon through the night into Saturday morning. But the wind flow was not right for seeding and precipitation was not continuous. Max/Min temperatures PNA: 19/1 RKS: 31/2 LND: 17/-4 FWZ: 21/1 Observed DWWS: 0	No ground-based seeding was conducted.
28 February 2015, Saturday	
Shallow low clouds were around the range right away in the morning but the clouds diminished throughout the morning. Thicker clouds moved in just before sunset and lasted through the evening before diminishing overnight. There was very little precipitation and the wind flow was not favorable for seeding. Max/Min temperatures PNA: 27/7 RKS: 27/9 LND: 22/14 FWZ: 14/5 Observed DWWS: 0	No ground-based seeding was conducted.
01 March 2015, Sunday	
The range was clear during the daylight hours while some thin low clouds were around the lowlands in the morning. Broken high and mid level clouds moved in shortly after sunset and continued through the night. Max/Min temperatures PNA: 23/5 RKS: 30/6 LND: 25/12 FWZ: 21/1 Observed DWWS: -2	No ground-based seeding was conducted.
02 March 2015, Monday	
Very thick overcast clouds blanketed the range	Seeding event WRR0017 was called at 2000 MST

throughout the period. Seedable clouds and winds were present for the late evening, and then winds became unfavorable for part of the late night hours. Winds became favorable again in the early morning. Max/Min temperatures PNA: 30/1 RKS: 31/20 LND: 28/8 FWZ: 28/18 Observed DWWS: +2	on 03/02/2015 and began by 2041 MST. Case WRR0017 Generators: WR01, WR02, WR03, WR04, WR05, WR09, WR10, WR12, WR13 Time: 20:15 (03/02) to 01:00 (03/03) MST 03:15 (03/03) to 08:00 (03/03) UTC Duration: 5:45, 39:49 Total Time Seeding: 995.5g silver (17.43 gallons)
03 March 2015, Tuesday	
Thick overcast clouds blanketed the region through late afternoon. Seeding occurred during the morning and ended in the midafternoon. Clouds began to diminish in the mid to late afternoon hours. Thin orographic clouds and broken stratus remained in the evening, but skies eventually cleared overnight. Max/Min temperatures PNA: 25/-2 RKS: 28/-1 LND: 25/2 FWZ: 18/-6 Observed DWWS: +2	Seeding event WRR0018 was called at 0430 MST on 03/03/2015 and began at 0448 MST. Case WRR0018 Generators: WR01, WR02, WR03, WR04, WR05, WR09, WR10, WR12, WR13 Time: 04:48 to 15:13 MST 11:48 to 22:13 UTC Duration: 10:25, 89:06 Total Time Seeding: 2,227.5g silver (38.36 gallons)
04 March 2015, Wednesday	
Skies were totally clear during the day. Thin high clouds moved in overnight and continued to pass over the area through morning. There were no orographic clouds or low clouds over the range. Max/Min temperatures PNA: 21/-15 RKS: 22/-3 LND: 18/-7 FWZ: 19/-4 Observed DWWS: -2	No ground-based seeding was conducted.
05 March 2015, Thursday	
No low clouds existed all day. Areas of thin high clouds were around throughout the day. A few mid level clouds existed during the evening and overnight as well.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 34/5 RKS: 36/13 LND: 26/-5 FWZ: 34/14 Observed DWWS: -2	
06 March 2015, Friday	
There were thin, upper level clouds over the range in the morning and the clouds diminished before noon. The sky was then mostly clear all afternoon. An area of mid level clouds developed during the evening and persisted through the night. Max/Min temperatures PNA: 37/5 RKS: 44/22 LND: 47/12 FWZ: 39/28 Observed DWWS: -2	No ground-based seeding was conducted.
07 March 2015, Saturday	
An area of mid level clouds was near the range in the morning but were diminishing. More mid level clouds developed throughout the afternoon, becoming scattered by late afternoon. Cloud coverage slowly diminished throughout the evening and the range was clear by the middle of the night. Max/Min temperatures PNA: 41/12 RKS: 49/26 LND: 46/24 FWZ: 41/30 Observed DWWS: -2	No ground-based seeding was conducted.
08 March 2015, Sunday	
Skies were totally clear throughout the period. Max/Min temperatures PNA: 41/10 RKS: 50/27 LND: 45/23 FWZ: 37/28 Observed DWWS: -3	No ground-based seeding was conducted.

09 March 2015, Monday	
Scattered high and midlevel clouds passed over the range throughout the period. There were periods of clear skies as well. There were no low or orographic clouds. Max/Min temperatures PNA: 43/14 RKS: 53/26 LND: 49/26 FWZ: 45/30 Observed DWWS: -2	No ground-based seeding was conducted.
10 March 2015, Tuesday	
The range was totally clear until around 10Z in the morning when high and midlevel overcast layers overspread the region from the west. Skies were then overcast for the rest of the period. Max/Min temperatures PNA: 43/19 RKS: 54/27 LND: 54/29 FWZ: 43/32 Observed DWWS: -2	No ground-based seeding was conducted.
11 March 2015, Wednesday	
Thin, widespread clouds had moved into the area by the morning. The overcast clouds thickened throughout the day. Low, orographic clouds developed over the range after midnight, persisted for a few hours with favorable SW flow, and then were breaking up by sunrise as the wind shifted to NW. The temperature was too warm for seeding operations. Max/Min temperatures PNA: 43/19 RKS: 50/28 LND: 46/31 FWZ: 41/32 Observed DWWS: 0	No ground-based seeding was conducted.
12 March 2015, Thursday	
Broken, low clouds were over the range during the morning; the clouds became more continuous over the range shortly after noon, but the temperature	No ground-based seeding was conducted.

was too warm for seeding. By late afternoon, the clouds were diminishing with only a few small clouds around during the evening. The sky was then clear overnight over the range. Max/Min temperatures PNA: 45/28 RKS: 53/34 LND: 56/37 FWZ: 41/32 Observed DWWS: 0	
13 March 2015, Friday	
The range was clear in the morning. Fair weather cumulus clouds developed over the southern half of WY during the afternoon. There were a very few clouds over the range for a short period, with no significant coverage. The sky was clear after sunset until high clouds moved in from the west during the night. Max/Min temperatures PNA: 48/21 RKS: 55/26 LND: 58/33 FWZ: 45/30 Observed DWWS: -1	No ground-based seeding was conducted.
14 March 2015, Saturday	
High and midlevel overcast layers were over the region throughout the day. A few thin orographic clouds were observed overnight. The upper level cloud cover began to thin out around 12Z. Marginal orographic clouds remained in place through morning. It was much too warm for seeding. Max/Min temperatures PNA: 43/19 RKS: 55/28 LND: 50/21 FWZ: 46/32 Observed DWWS: -1	No ground-based seeding was conducted.
15 March 2015, Sunday	
High and midlevel clouds covered the range all day while marginal orographic clouds covered the peaks. In the evening and late night, there was a	No ground-based seeding was conducted.

break in the upper level clouds while orographic clouds remained. Thick overcast layers overspread the region again before dawn. High temperatures were unusually warm around the region. Max/Min temperatures PNA: 55/28 RKS: 68/34 LND: 66/39 FWZ: 52/36 Observed DWWS: -1	
16 March 2015, Monday	
Upper level cloud cover obscured the range throughout most of the period, although there were a few hours of partly sunny skies during the afternoon. A few thin orographic clouds developed, but nothing remotely seedable. Max/Min temperatures PNA: 57/28 RKS: 64/39 LND: 67/39 FWZ: 52/34 Observed DWWS: -1	No ground-based seeding was conducted.
17 March 2015, Tuesday	
There were broken cloud layers over the area in the morning, which became more scattered during the afternoon. Broken to scattered cloud layers continued through the evening and overnight, with some brief periods of thicker low clouds over the range during the night. Max/Min temperatures PNA: 50/30 RKS: 62/34 LND: 49/35 FWZ: 46/32 Observed DWWS: -1	No ground-based seeding was conducted.
18 March 2015, Wednesday	
Thin, high clouds were over the area during the morning through the mid afternoon hours. By late afternoon, small, scattered low clouds formed over the NE slopes of the range and the NW portion of the range too. All clouds had diminished by	No ground-based seeding was conducted.

midnight and it was clear overnight. Max/Min temperatures PNA: 45/30 RKS: 55/34 LND: 61/33 FWZ: 43/32 Observed DWWS: -1	
19 March 2015, Thursday	
The sky was clear over the range from the morning to the late evening hours. High clouds moved in from the NW before midnight and then some mid level clouds existed overnight. Max/Min temperatures PNA: 48/23 RKS: 54/26 LND: 56/28 FWZ: 45/28 Observed DWWS: -2	No ground-based seeding was conducted.
20 March 2015, Friday	
A few high and midlevel clouds were present in the morning, and then the range was clear during the afternoon and evening hours. Scattered high and midlevel clouds moved through in the late night and early morning. There were no orographic clouds, and no seeding occurred. Max/Min temperatures PNA: 52/21 RKS: 61/25 LND: 66/31 FWZ: 52/36 Observed DWWS: -2	No ground-based seeding was conducted.
21 March 2015, Saturday	
The range had a few thin high clouds in the morning. Upper level clouds increased throughout the day becoming overcast by sunset. During the late afternoon and early evening, low overcast and high based orographic clouds were observed. All clouds gradually diminished in the late evening through overnight becoming mostly clear by dawn. No seeding occurred.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 55/23 RKS: 63/28 LND: 67/34 FWZ: 52/37 Observed DWWS: -2	
22 March 2015, Sunday	
Skies were clear in the morning. Thick overcast overspread the region in the afternoon and evening. Low level clouds were observed over the range during the day. The upper level clouds thinned out becoming broken during the overnight hours. Thick overcast moved in again in the early morning, and some light snow occurred. It remained too warm for seeding. Max/Min temperatures PNA: 50/23 RKS: 54/32 LND: 61/32 FWZ: 45/32 Observed DWWS: 0	No ground-based seeding was conducted.
23 March 2015, Monday	
Thick clouds formed over the range during the morning and lasted to the mid afternoon. The temperature was too warm for seeding operations at this time. Waves of thick clouds passed through during the late afternoon and evening, but with NW wind flow the precipitation was inconsistent and short lived. Only thin, clouds existed overnight. No seeding occurred. Max/Min temperatures PNA: 43/28 RKS: 46/30 LND: 56/37 FWZ: 37/28 Observed DWWS: 0	No ground-based seeding was conducted.
24 March 2015, Tuesday	
Thick clouds with snowfall and favorable seeding conditions developed during the morning hours. These conditions lasted into the evening hours, when the wind began to shift to NW flow and the clouds thinned. Some thicker clouds passed	Seeding event WRR0019 was called at 1015 MDT on 03/23/2015 and began at 1036 MDT. Case WRR0019 Generators: WR01, WR02, WR03, WR04, WR05,

through overnight, but the wind was not right for seeding. Max/Min temperatures PNA: 37/23 RKS: 44/27 LND: 53/26 FWZ: 32/23 Observed DWWS: +2	WR09, WR10, WR12, WR13 Time: 10:36 (03/24) to 20:56 (03/24) MDT 16:36 (03/24) to 02:56 (03/25) UTC Duration: 10:20, 90:59 Total Time Seeding: 2,274.5g silver (38.14 gallons)
25 March 2015, Wednesday	
The range had only a few clouds during the morning. Thicker clouds with some small areas of light snowfall developed in the early afternoon. The wind flow was not quite favorable for orographic lift so the clouds did not fully cover the range and were diminished with a few hours. Only periods of high and mid level clouds existed during the evening and overnight. Max/Min temperatures PNA: 37/21 RKS: 45/24 LND: 50/29 FWZ: 36/21 Observed DWWS: -1	No ground-based seeding was conducted.
26 March 2015, Thursday	
Skies were mainly clear in the morning. Scattered midlevel clouds passed through during the afternoon. Some low cloud cover developed in the evening and overnight hours. There was nothing remotely seedable. No seeding occurred. Max/Min temperatures PNA: 50/23 RKS: 58/28 LND: 64/28 FWZ: 50/27 Observed DWWS: -1	No ground-based seeding was conducted.
27 March 2015, Friday	
The range was mostly clear through early afternoon. A cumulus field developed around the range during the late afternoon. Clear conditions returned in the evening and overnight hours. A few thin high based orographic clouds formed in the	No ground-based seeding was conducted.

early morning. There was nothing seedable. Max/Min temperatures PNA: 57/30 RKS: 66/37 LND: 74/36 FWZ: 57/37 Observed DWWS: -1	
28 March 2015, Saturday	
A few orographic clouds developed during the day, but they were short-lived did not fully cover the range. Waves of upper level cloud clouds passed through during the day as well. The range was mostly clear overnight. No seeding occurred. Max/Min temperatures PNA: 61/25 RKS: 70/36 LND: 73/40 FWZ: 55/36 Observed DWWS: -1	No ground-based seeding was conducted.
29 March 2015, Sunday	
The sky was mostly clear over the area all day. There were periods of high and mid level clouds but no significant coverage and the clouds just moved through. Max/Min temperatures PNA: 54/23 RKS: 60/29 LND: 65/33 FWZ: 50/30 Observed DWWS: -2	No ground-based seeding was conducted.
30 March 2015, Monday	
Another wonderful spring day. There were a few fair weather cumulus around the range for a short time in the afternoon. There were a few areas of high and mid level clouds overnight. Max/Min temperatures PNA: 57/23 RKS: 65/32 LND: 70/33 FWZ: 54/34	No ground-based seeding was conducted.

Observed DWWS: -1	
31 March 2015, Tuesday	
There were only a few high and mid level clouds around during the morning. Thick, convective and orographic clouds with precipitation developed during the afternoon and the clouds over the range lasted until the middle of the night. The clouds diminished as the wind was shifting to NW. The temperature had been too warm for seeding until around sunrise. Max/Min temperatures PNA: 64/21 RKS: 70/30 LND: 76/36 FWZ: 59/43 Observed DWWS: 0	No ground-based seeding was conducted.
01 April 2015, Wednesday	
High and midlevel clouds were present throughout the day along with widespread cumulus on the west side of the range. There were marginal orographic clouds and some flurries, but cloud cover was not sufficient for seeding. Overnight, the low level clouds diminished while upper level overcast layers overspread the region from the southwest. No seeding occurred. Max/Min temperatures PNA: 43/23 RKS: 48/29 LND: 55/26 FWZ: 45/27 Observed DWWS: 0	No ground-based seeding was conducted.
02 April 2015, Thursday	
Thick seedable clouds were present all day and all evening. Winds became parallel to the range overnight, and moisture dropped off. Clouds rapidly cleared out after 2am MDT, and skies became mostly clear by dawn. Max/Min temperatures PNA: 36/18 RKS: 36/22 LND: 40/24	Seeding event WRR0020 was called at 0858 MDT on 04/02/2015 and began at 0909 MDT. <u>Case WRR0020</u> Generators: WR07 Time: 09:09 (04/02) to 01:16 (04/03) MDT 15:09 (04/02) to 07:16 (04/03) UTC Duration: 16:07 Total Time Seeding:403.00g silver (7.41 gallons)

FWZ: 28/19 Observed DWWS: +2	
03 April 2015, Friday	
A few midlevel clouds were in place during the day with otherwise clear skies. Broken high and midlevel clouds moved in overnight, and some thin orographic clouds were also observed. A low stratus layer developed in the early morning. No seeding occurred. Max/Min temperatures PNA: 41/10 RKS: 44/17 LND: 49/15 FWZ: 32/14 Observed DWWS: -1	No ground-based seeding was conducted.
04 April 2015, Saturday	
A low stratus cloud desk developed over the range during the morning and lasted through the afternoon. No measurable precipitation fell and no seeding occurred. The evening was pretty much clear and then high and mid level clouds covered the area overnight. Max/Min temperatures PNA: 52/14 RKS: 59/23 LND: 60/23 FWZ: 43/19 Observed DWWS: 0	No ground-based seeding was conducted.
05 April 2015, Sunday	
A thin stratus cloud layer was over the range during the morning then thicker clouds developed in the afternoon but were diminishing by sunset. The temperature was too warm for seeding. Widespread high clouds were around from the late afternoon through the night along with some more stratus over the range during the night and into Monday morning. Max/Min temperatures PNA: 54/19 RKS: 62/31 LND: 66/30	No ground-based seeding was conducted.

FWZ: 50/32 Observed DWWS: 0	
06 April 2015, Monday	
There was a thin cloud layer over the range during the morning and then scattered convective clouds developed within the cloud deck during the afternoon. Some flurries occurred by no significant accumulation. The temperature was too warm for seeding until the evening, when the cloud and wind was no longer favorable. Only high and mid level clouds existed overnight. Max/Min temperatures PNA: 52/19 RKS: 61/31 LND: 64/33 FWZ: 45/32 Observed DWWS: 0	No ground-based seeding was conducted.
07 April 2015, Tuesday	
Overcast mid and upper level clouds were present in the morning along with marginal orographic clouds over parts of the range. Cloud coverage was mostly convective in the afternoon along with continued marginal orographic clouds over the range. More overcast layers moved in overnight. While there was some light snow, the orographic clouds never fully covered the mountains, and it remained to warm for operations. No seeding occurred. Max/Min temperatures PNA: 45/21 RKS: 55/30 LND: 50/31 FWZ: 41/28 Observed DWWS: 0	No ground-based seeding was conducted.
08 April 2015, Wednesday	
Thick overcast cloud layers blanketed the range throughout the day. Convection occurred on the east side of the range during the afternoon. Moderate snowfall occurred throughout the day, but it remained too warm for seeding. Clouds diminished in the late evening, and the range became mostly clear after 12Z. Low stratus then	No ground-based seeding was conducted.

developed in the early morning. Max/Min temperatures PNA: 41/27 RKS: 43/28 LND: 40/32 FWZ: 32/27 Observed DWWS: 0	
09 April 2015, Thursday	
Widespread convective clouds and showers were present throughout the afternoon and evening while thin orographic clouds were observed over the peaks. A few high and midlevel clouds lingered into the night, but cloud cover cleared out for the most part overnight. In the early predawn hours, orographic arch clouds began to form above the peaks, and spreading east of the range. Max/Min temperatures PNA: 43/23 RKS: 44/24 LND: 51/26 FWZ: 34/21 Observed DWWS: 0	No ground-based seeding was conducted.
10 April 2015, Friday	
There was a thin cloud layer over the range in the morning. There were scattered convective clouds around the range during the afternoon, but they were all shallow with no continuous coverage. Orographic arch clouds formed during the night. Max/Min temperatures PNA: 50/23 RKS: 54/27 LND: 59/30 FWZ: 43/30 Observed DWWS: -1	No ground-based seeding was conducted.
11 April 2015, Saturday	
Small, scattered low clouds were around the range during the morning with the clouds becoming more convective by noon. Widespread high and mid level clouds moved in during the afternoon with low clouds over the range for a short time in the afternoon. Another period of thick low clouds	No ground-based seeding was conducted.

covered the range from 05Z to 1030Z, then only small low clouds existed over the SW slopes into Sunday morning. The temperature was too warm for seeding until the clouds were diminishing. No seeding occurred. Max/Min temperatures PNA: 55/18 RKS: 61/28 LND: 65/35 FWZ: 46/32 Observed DWWS: 0	
12 April 2015, Sunday	
Scattered, small low clouds were around the range during the morning with only a few clouds lasting into the early afternoon hours. High and mid level clouds had moved into the area before sunset and the clouds lasted to the middle of the night before clearing. Max/Min temperatures PNA: 43/23 RKS: 52/32 LND: 57/35 FWZ: 41/28 Observed DWWS: -1	No ground-based seeding was conducted.
13 April 2015, Monday	
The range was mainly clear throughout the day. Around sunset, some arch clouds developed just downwind of the peaks. They lingered through the night. Some small patches of low clouds passed through in the early morning hours, mainly on the west side of the range. Max/Min temperatures PNA: 59/16 RKS: 63/30 LND: 67/30 FWZ: 52/30 Observed DWWS: -1	No ground-based seeding was conducted.
14 April 2015, Tuesday	
Convective clouds were present all day and all evening. Very gusty surface winds were observed during the day. Low and orographic clouds became	No ground-based seeding was conducted.

thick in the late afternoon through the rest of the period. Steady snow occurred through the night. Winds and temps were not favorable for seeding. Max/Min temperatures PNA: 63/21 RKS: 67/29 LND: 74/39 FWZ: 55/30 Observed DWWS: 0	
15 April 2015, Wednesday	
Thick orographic clouds and continuous snow were present throughout the entire period with the best conditions on the eastern side of the range. Wind direction favored the use of the Enterprise generator. Max/Min temperatures PNA: 37/27 RKS: 38/22 LND: 45/31 FWZ: 32/23 Observed DWWS: +2	Seeding event WRR0021 was called at 0755 MDT on 04/15/2015 and began at 0811 MDT. Case WRR0021 Generators: WR07 Time: 08:11 (04/15) to 12:16 (04/16) MDT 14:11 (04/15) to 18:16 (04/16) UTC Duration: 28:05, 28:05 Total Time Seeding:702g silver (13.20 gallons)
16 April 2015, Thursday	
Thick clouds with favorable seeding conditions continuing from Wednesday, lasted until right around noon, when the clouds quickly diminished. The afternoon had high and mid level clouds while a band of precipitation was SE of the range, spinning around a strong low in CO. That band moved over the range a little before sunset but only lasted a short period before diminishing. High and mid level clouds remained over the SE part of the range through the night. Max/Min temperatures PNA: 52/21 RKS: 35/26 LND: 41/31 FWZ: 30/23 Observed DWWS: +1	No ground-based seeding was conducted.
17 April 2015, Friday	
Strong low spinning over CO putting most of the WY in NE flow. Periods of high and mid level clouds	No ground-based seeding was conducted.

were over the range during the morning and afternoon hours, with arch clouds forming on the SW side in the late afternoon. A few low clouds existed from the mid evening to early nighttime, but no significant coverage occurred and the temperature was too warm for seeding operations. Max/Min temperatures PNA: 57/21 RKS: 39/30 LND: 56/33 FWZ: 41/28 Observed DWWS: -1	
18 April 2015, Saturday	
NE flow continued over most of WY through the evening as the strong low was over eastern CO. Only arch clouds existed during the morning over the range. Small, scattered convective clouds developed in the early afternoon and then a thick, orographic cloud covered the range from the mid afternoon through the evening. The temperature was too warm for seeding at this time. The clouds became thinner and broken after midnight, as the wind flow was less favorable for orographic forcing. Max/Min temperatures PNA: 21/13 RKS: 21/10 LND: 24/12 FWZ: 24/12 Observed DWWS: 0	No ground-based seeding was conducted.
19 April 2015, Sunday	
Widespread cumulus clouds were observed throughout the afternoon and evening. Thin low clouds covered the range throughout the period, but diminished near dawn. Light snow was nearly continuous throughout the evening and overnight hours. The wind flow was from the northwest and not right for seeding. It remained too warm for operations as well. Max/Min temperatures PNA: 50/28 RKS: 51/30 LND: 50/34 FWZ: 41/25	No ground-based seeding was conducted.

Observed DWWS: 0	
20 April 2015, Monday	
Widespread shallow cumulus was observed along the west side of the range during the afternoon and evening hours. Convective showers occurred over the southern end of the range during the afternoon. Skies were clear during the late evening, and then a few low clouds passed through overnight. There were no seedable clouds. Max/Min temperatures PNA: 55/23 RKS: 59/28 LND: 57/28 FWZ: 45/23 Observed DWWS: -1	No ground-based seeding was conducted.
21 April 2015, Tuesday	
Scattered convective clouds developed over west and southern WY beginning shortly after noon. The clouds diminished throughout the evening and the sky was clear overnight. The wind was not favorable for orographic development and the temperature was much warmer than the seeding threshold. Max/Min temperatures PNA: 59/21 RKS: 63/32 LND: 64/31 FWZ: 52/34 Observed DWWS: -1	No ground-based seeding was conducted.
22 April 2015, Wednesday	
Convective clouds began forming around the range in the late morning hours. Widespread cumulus clouds were scattered over most of WY for the afternoon and lasting into the early evening. No continuous covered existed over the WR range. High and mid level clouds were around in the evening and overnight with an area of low clouds moving towards the range Thursday morning. Max/Min temperatures PNA: 61/23 RKS: 66/34	No ground-based seeding was conducted.

LND: 69/35 FWZ: 54/39 Observed DWWS: -1	
23 April 2015, Thursday	
Thick low clouds formed over the range during the morning, but the clouds became more broken in coverage in the afternoon as there was more convective activity. Broken low and convective clouds covered the range, as well as most of the state, through the afternoon and to the mid evening hours. Shallow low clouds existed over the range for most of the night. The temperature was too warm for seeding. Max/Min temperatures PNA: 54/28 RKS: 60/37 LND: 67/43 FWZ: 50/36 Observed DWWS: 0	No ground-based seeding was conducted.
24 April 2015, Friday	
Convective showers began developing in the late after and continued with broken coverage throughout the afternoon and into the early evening. Some thunder and lightning was detected. Thin low clouds along with high and mid level clouds existed throughout the night. The temperature was too warm for seeding operations. Max/Min temperatures PNA: 50/21 RKS: 58/33 LND: 66/36 FWZ: 46/32 Observed DWWS: 0	No ground-based seeding was conducted.
25 April 2015, Saturday	
Overcast layers and thin orographic clouds were present in the morning, which cleared out for the afternoon allowing for widespread cumulus to develop during most of the day. During the evening and overnight hours, overcast cloud layers returned along with marginal orographic clouds and mixed precipitation. It remained too warm for seeding, and wind direction was unfavorable as well.	No ground-based seeding was conducted.

Max/Min temperatures PNA: 46/32 RKS: 53/35 LND: 60/40 FWZ: 43/32 Observed DWWS: 0	
26 April 2015, Sunday	
Thick status obscured the range throughout the period. Widespread nearly continuous precipitation occurred throughout the period. It was much too warm for seeding operations, and most of the precipitation fell as rain in the lower elevations. Max/Min temperatures PNA: 46/34 RKS: 49/36 LND: 44/33 FWZ: 36/30 Observed DWWS: 0	No ground-based seeding was conducted.
27 April 2015, Monday	
Thick stratus and showers were in place over the range for most of the afternoon with a few shallow cumulus clouds over the lowlands surrounding the mountains. Low level winds were too light to produce orographic clouds. Cloud cover diminished in the evening and overnight. Skies became mostly clear in the early morning hours. It remained much too warm for seeding. Max/Min temperatures PNA: 54/36 RKS: 51/34 LND: 49/34 FWZ: 37/30 Observed DWWS: 0	No ground-based seeding was conducted.
28 April 2015, Tuesday	
Sky was clear over the range all day. There were some high clouds over central WY but those did not reach the WR range. Max/Min temperatures PNA: 61/32 RKS: 63/32	No ground-based seeding was conducted.

LND: 67/33 FWZ: 57/32 Observed DWWS: -3	
29 April 2015, Wednesday	
The sky was clear in the morning. A band of high clouds moved through in the early afternoon, and then scattered cumulus developed over the area along with high based orographic clouds existed from the mid afternoon to the early evening. A few more mid level clouds passed through in the evening with clear skies over the range during the night. Max/Min temperatures PNA: 66/30 RKS: 72/40 LND: 76/41 FWZ: 61/43 Observed DWWS: -1	No ground-based seeding was conducted.
30 April 2015, Thursday	
A band of mid level clouds moved through the range in the morning. Scattered cumulus had developed by noon and lasted into the late afternoon. No continuous coverage existed during this time. After the clouds had moved away before sunset, the range was clear until a few high clouds came in overnight. Max/Min temperatures PNA: 61/32 RKS: 70/44 LND: 65/41 FWZ: 57/37 Observed DWWS: -1	No ground-based seeding was conducted.

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 ADMINISTRATION

Form Approved OMB No. 0648-0025
Expires 03/31/08

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.

NOAA FILE NUMBER
14-1642

[ ] INTERIM REPORT [X] 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 Room 11216
Silver Spring, MD 20910

REPORTING PERIOD
FROM 11/15/2014 TO 04/30/2015

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 HAIL	ALLEVIATE FOG	OTHER	AIRBORNE	GROUND	SILVER IODIDE	CARBON DIOXIDE	UREA	SODIUM CHLORIDE	OTHER
JANUARY	2	2					24	3,130				
FEBRUARY	5	5					37	787				
MARCH	3	3					25	5,714				
APRIL	2	2					32	1,254				
MAY												
JUNE												
JULY												
AUGUST												
SEPTEMBER												
OCTOBER												
NOVEMBER	2	2					11	1,842				
DECEMBER	7	7					85	8,524				
TOTAL	21	21	0	0	0	0	214	21,251	0	0	0	0
TOTALS FOR FINAL REPORT	21	21	0	0	0	0	214	21,251	0	0	0	0

DATE ON WHICH FINAL WEATHER MODIFICATION ACTIVITY OCCURRED *(For Final Report only.)*

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: Bruce A. Boe

AFFILIATION: Weather Modification, Inc.

SIGNATURE: Bruce A. Boe

STREET ADDRESS: 3802 20th Street North

OFFICIAL TITLE: Vice President - Meteorology

CITY: Fargo | STATE: ND | ZIP CODE: 58102 | DATE: 05/01/2015

Appendix C. Project Contact List (redacted)

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WWMWRM 2014-2015			
Last Revised 17 November 2014 - VER3			
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REDACTED - PUBLIC RELEASE ALLOWED			
Last Updated: 11/17/2014			