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WYOMING • WIND RIVER RANGE
WEATHER MODIFICATION PROGRAM



W i n d
R i v e r



M o u n t a i n
R a n g e



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WYOMING WATER DEVELOPMENT
C O M M I S S I O N

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**Cloud Seeding Operations in the
Wind River Range of Wyoming
2017-2018 Season**

EXECUTIVE SUMMARY

prepared by

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BACKGROUND AND OVERVIEW

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.

Funding for cloud seeding operations in the Wind River Range for the winter of 2017-2018 was provided in part by the 2017 Wyoming State Legislature's *Omnibus Water Bill – Construction*. The Wyoming State Legislature has mandated that the funding rate for the State will not exceed 25% of total project costs, leaving 75% of the project costs to be split among other Colorado River Basin water users, or interested parties. Funding partners in support of continued weather modification activities in the Wind River Mountains during the winter of 2017-2018 include the Southern Nevada Water Authority, the Central Arizona Project (CAP), and the Colorado River Board of California - Six Agency Committee.

The weather pattern produced near-normal storm frequency, with five seeding events occurring in December 2017, three in January 2018, five in February 2018, and five more in March 2018, for a project total of eighteen storms. Seasonal snowpack varied over the target areas, but at season end ranged from a minimum of about 80% of normal median values at the Townsend Creek and South Pass SNOTEL sites to over 125% at the Hobbs Park site. No suspensions occurred during the 2017-2018 season.

Scientific Basis

Clouds in the lower troposphere form when, in cooling air, water vapor condenses upon cloud condensation nuclei (CCN), forming cloud droplets. After the formation of the cloud droplets, precipitation development in Wyoming winter storms occurs through the formation of ice. However, ice does not form spontaneously at temperatures colder than 32°F (0°C). In the absence of ice nuclei, water can become “supercooled” (supercooled liquid water, SLW), meaning the water in the cloud remains in liquid form at temperatures well below 32°F (0°C). 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 freezing, but these substrates are largely absent in the free atmosphere.

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

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 initiate ice crystal formation, thus starting the ice-phase precipitation process. Ground-based seeding is commonly used in orographic applications, especially when the prevailing wind flow is roughly perpendicular to the mountain range, so that seeding agent is lofted immediately upward into the targeted clouds. This orographic seeding technique was the prime strategy used to seed winter clouds throughout the WWMPP, and continued to be the main approach utilized in the Wind River Range during the operational seeding seasons in the winters since.

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 $+23^{\circ}\text{F}$ (-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.

FIELD RESOURCES

Figure 1 provides the ten ground-based generator sites used for the 2017-2018 project. 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 1, 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.

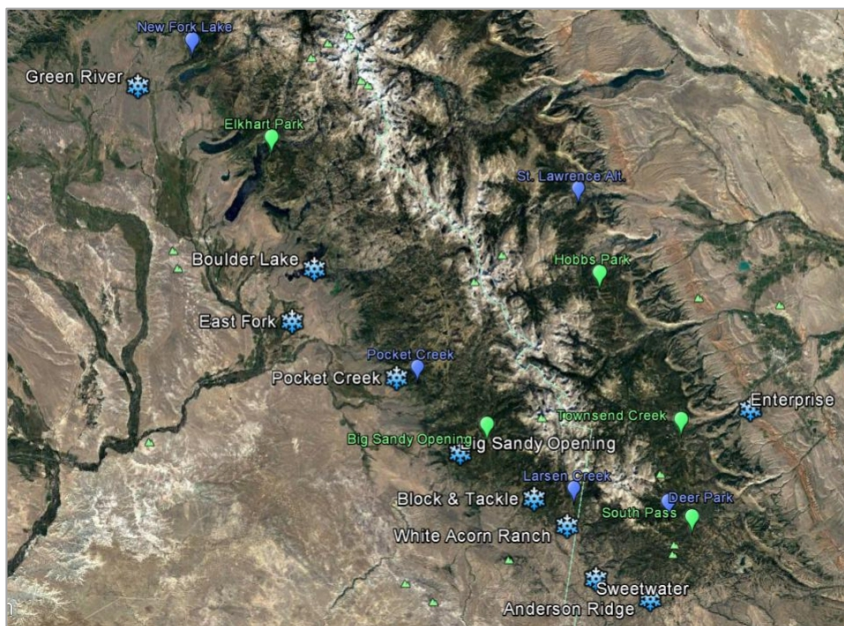


Figure 1. The locations of the ground-based ice nucleus generators are indicated by the snow crystal symbols. The green “balloons” indicate the locations of Natural Resources and Conservation Service (NRCS) snow telemetry (SNOTEL) sites used in monitoring snowpack during the 2017-2018 season. The blue balloons show the locations of additional SNOTELs that were not used because of proximity to sites that were used, or a shorter period of record (they were relatively new sites).

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.

Ice Nucleus Generators

The ice nucleus generators were designed and fabricated by WMI. 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. Remotely-controlled 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.

Seeding Solution

The high performance seeding solution itself was tested at the Colorado State University Cloud Simulation and Aerosol Laboratory by DeMott (1997). Those tests determined that colder cloud temperatures produce a bigger yield of active ice nuclei per gram of AgI burned. The yield increases markedly from -6°C (+21.2°F) to -8°C (+17.6°F), and even more at -10°C (+14°F). At a cloud temperature of -6°C, 3×10^{11} nuclei are active, 300,000,000,000, or 300 billion. 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. As in previous seasons, the 2017-2018 Wind River operations used a temperature criterion of -6°C at 700 hPa (about 10,000 feet above sea level).

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. Nuclei of this type attract water vapor and immediately form water droplets, eliminating the requirement for collisions between ice nuclei and cloud droplets. 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 droplets 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.

Soundings

When necessary, weather balloons were released from the WMI shop in Pinedale to determine whether 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 obtained. 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.

Weather Stations

Two generator sites were equipped with Vaisala WXT-510 weather stations, Enterprise and White Acorn Ranch. 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.

Shop and Field Site Servicing

Throughout the season WMI maintained a shop in Pinedale, WY 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 MW41 rawinsonde system used for the calibration and tracking of the weather balloons was also at the shop, as well as all of the upper air consumables: helium, balloons, and rawinsondes. Internet service was available, allowing immediate sharing of upper air data with other interested parties (NWS, WRDS).

FORECASTING AND OPERATIONAL DECISION-MAKING

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.

The WWDO radiometer was deployed at a residence near Boulder, WY. Since the presence of liquid water in the clouds over the target area is essential for successful seeding, this measurement was most helpful. The radiometer location for this winter season was the same as was used during the Wyoming Weather Modification Pilot Project.

Numerical Modeling

WMI added project-specific numerical modeling support to the Wind River seeding project for the entire 2017-2018 season.

WRF Modeling. For the 2017-2018 season, WMI added runs of the Weather Research and Forecasting (WRF) model specifically tailored to the Wind River seeding program, running a 2.5 km resolution grid initialized with the High Resolution Rapid Refresh (HRRR) model and using the North American Model (NAM) for boundary conditions at 3-hour intervals. A large number of graphical outputs were developed specifically to aid the cloud seeding decision-making. An example is shown in Figure 2. Additional examples are provided in the full report.

HYSPLIT Modeling. During the 2017-2018 season, WMI ran the Hybrid Single-Point Lagrangian Integrated Trajectory (HYSPLIT) plume dispersion model to establish a better idea of seeding agent plume behavior. On days, with all WRF runs, the plume trajectory model was initialized with WRF data and used to help make better-informed seeding decisions. These HYSPLIT plots were output in one-hour increments, with each plot showing forecast locations of plume centerline (the most dense portions of the plumes) for four hours.

Stability throughout the Wind River domain was made part of the suite of products created during the WMI WRF model runs. The meteorologists also considered Froude Number to determine if the plume(s) would go over the range or be blocked by it, and consulted the HYSPLIT plots, which reinforced the other indications. Thus, if cloud and temperature conditions were favorable, seeding would occur only if the seeding agent was likely to reach its intended destinations!

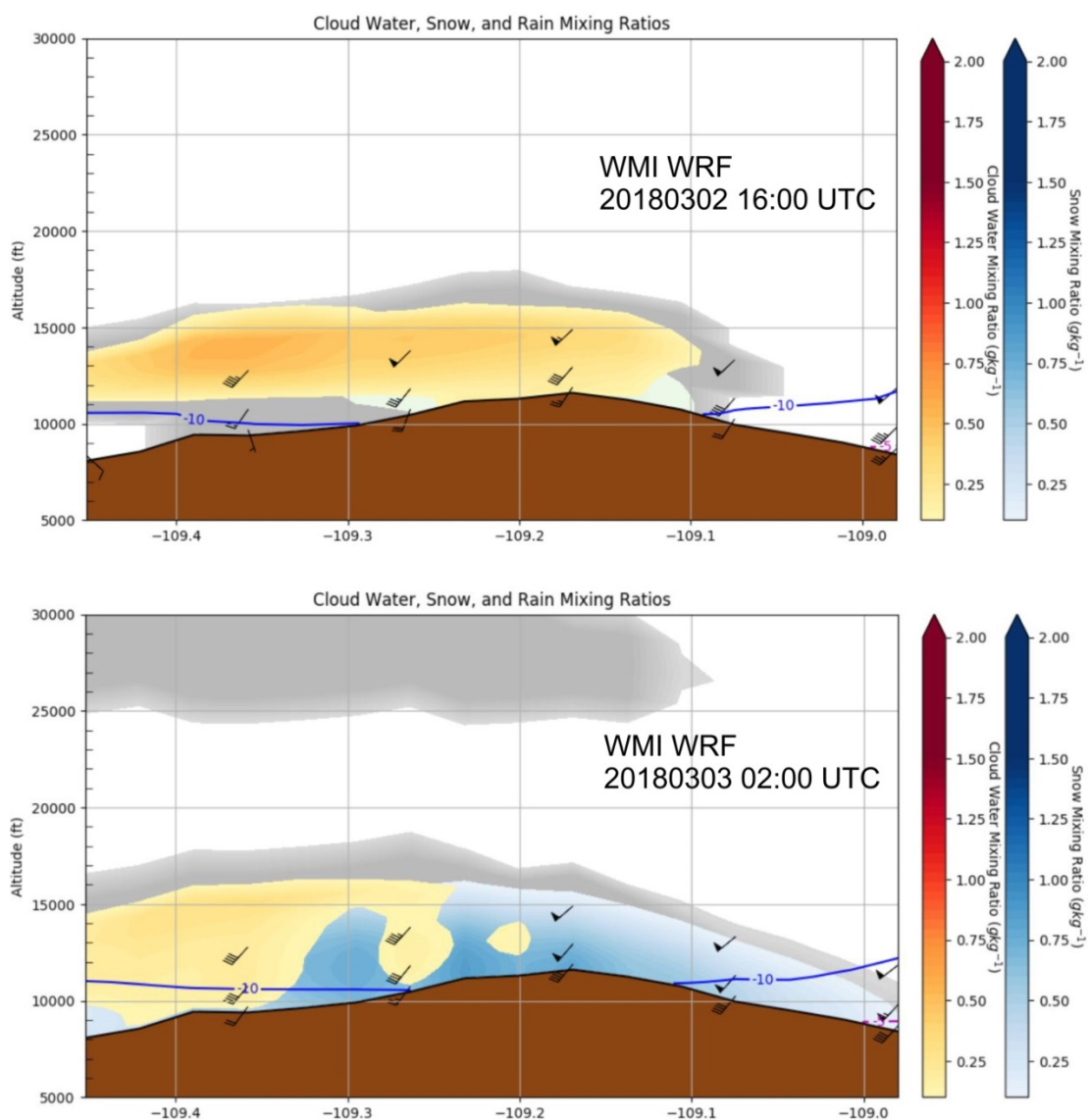


Figure 2. Vertical cross sections through the Pocket Creek generator site, approximately perpendicular to the axis of the Wind River Mountains. The top panel represents 16:00 UTC on March 2nd, or 9 AM MST, the bottom is ten hours later at 02:00 UTC March 3rd, or 7 PM MST on March 2nd.

Timetables and Routines

If seeding was not underway at dawn, the following daily routine ensued. WMI furnished a daily “first glance” update that provided an outlook into the probability of seeding operations taking place that day. This very simple form, sent to all project personnel, provided an early look at the weather expected each day. Four time periods were specified, from issuance until noon, from noon until sunset, from sunset until midnight, and from midnight until dawn the next day. The probability of seeding operations occurring in each of these time periods was rated by the forecaster as *no chance*, *unlikely*, *possible*, or *probable*. Technicians used this outlook to help inform equipment operation and maintenance decisions. In instances when seeding operations were already active in the morning, the “first glance” outlook would still be issued, reflecting the status of current operations.

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

The temperature seeding criterion was determined by consulting the most recent prognostic numerical modeling runs. When such consultation yielded uncertain results, that is, temperatures at 700 hPa not clearly -6°C or colder, a weather balloon sounding was released from the Pinedale shop. The presence of SLW was confirmed by the real-time data from the radiometer located near Boulder, WY. The wind speed and direction were obtained from the numerical models, except when atmospheric soundings were done. 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.

SEEDING OPERATIONS

Funding was available for approximately 4 months of operations. The new operational timeline was expected to run from 1 December 2017 to 31 March 2018. However, due to contractual delays, the start of the seeding season was setback from the 1st to the 9th of December. Thus, the 2017-2018 project was active for 113 days.

Seeding was conducted on eighteen occasions, as enumerated in Table 1. December, February, and March each had five seeding events. January was the least active month with only three events. Table 2 summarizes operations by month and provides season totals.

Easterly flow seeding events occurred twice during the 2017-2018 operational season. In total, 32.2 kg of seeding agent were released. Generators were operated for a total of 192:34 hours during the season, accruing a total of 1,232 generator hours. [Generator hours are calculated by summing the number of hours each generator was operated. For example, six generators operated for five hours yields thirty generator hours.]

The sixteen seeding events that utilized more than one generator were all quality opportunities that used four to nine generators, and were of four or more hours in duration. Six events were twelve hours or longer, and three exceeded twenty hours.

Date	Number of Generators Utilized	Length of Seeding (hours)	Total Seeding (hours)	AgI Released This Date (kg)	AgI Monthly Total (kg)	AgI Season Total (kg)
20-Dec-17	7	4:25	30:46	0.845	8.468	0.845
21-Dec-17	1	3:36	3:36	0.077		0.922
23-Dec-17	7	24:00	167:23	4.539		5.460
25-Dec-17	7	11:14	77:33	2.299		7.760
27-Dec-17	4	6:24	25:35	0.708		8.468
12-Jan-18	7	11:03	77:17	1.955	4.002	10.423
25-Jan-18	9	5:46	45:57	1.199		11.622
26-Jan-18	5	6:35	32:52	0.848		12.470
8-Feb-18	6	5:44	33:33	0.881	10.414	13.351
15-Feb-18	6	12:00	71:49	1.908		15.259
17-Feb-18	7	5:01	34:39	0.921		16.179
18-Feb-18	9	21:44	179:53	4.766		20.945
26-Feb-18	9	12:56	77:37	1.939		22.884
2-Mar-18	9	30:20	173:01	4.197	9.305	27.080
4-Mar-18	9	12:14	70:42	1.756		28.837
9-Mar-18	7	4:12	29:24	0.779		29.616
17-Mar-18	9	10:37	95:14	2.446		32.063
26-Mar-18	1	4:43	4:43	0.127		32.189

Month	Events () denotes easterly flow	Event Averages		Seeding Agent (kg)	
		Number of Generators	Generator Hours*	Average Released per Event	Total Released
December	5 (1)	5.2	60.98	1.69	8.468
January	3	7.0	52.03	1.33	4.002
February	5	7.4	79.50	2.08	10.414
March	5 (1)	7.0	74.61	1.86	9.305
Totals/Averages	18 (2)	6.6	68.42	1.79	32.189

*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 1. Ice nucleus generator operations are shown for each of the eighteen seeding events during the 2017-2018 season.

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	
20171220	WRR0063	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20171221	WRR0064	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	1		
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO		1	
20171223	WRR0065	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20171225	WRR0066	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20171227	WRR0067	REQ	YES	NO	NO	NO	NO	NO	YES	NO	YES	4		
		RAN	YES	NO	NO	NO	NO	NO	YES	NO	YES		4	
20180112	WRR0068	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20180125	WRR0069	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	9		
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES		8	
20180126	WRR0070	REQ	YES	NO	NO	NO	NO	NO	YES	YES	YES	5		
		RAN	YES	NO	NO	NO	NO	NO	YES	YES	YES		5	
20180208	WRR0071	REQ	YES	YES	NO	NO	NO	NO	YES	YES	YES	6		
		RAN	YES	YES	NO	NO	NO	NO	YES	YES	YES		6	
20180215	WRR0072	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	NO	YES		6	
20180217	WRR0073	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20180218	WRR0074	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	9		
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES		9	
20180226	WRR0075	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	9		
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES		9	
20180302	WRR0076	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	9		
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES		9	
20180304	WRR0077	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20180309	WRR0078	REQ	YES	YES	YES	NO	NO	NO	YES	YES	YES	7		
		RAN	YES	YES	YES	NO	NO	NO	YES	YES	YES		7	
20180317	WRR0079	REQ	YES	YES	YES	YES	YES	NO	YES	YES	YES	9		
		RAN	YES	YES	YES	YES	YES	NO	YES	YES	YES		9	
20180326	WRR0080	REQ	NO	NO	NO	NO	NO	YES	NO	NO	NO	1		
		RAN	NO	NO	NO	NO	NO	YES	NO	NO	NO		1	
ZULU DATES ONLY												TOTALS	118	116
PARTIAL => 25% of Expected Runtime													RUN =	98.3%
													FAIL =	1.7%

Table 3 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. If a generator was requested to operate, a “Yes”, “No”, or “Partial” comment would be denoted in the appropriate (RAN) row. Generator performance for the season was excellent, at 98.3% functionality.

Comparisons with Previous Seasons

Comparisons of the three seasons of operational cloud seeding are provided in Tables 4 and 5. In Table 4, the lengths of seeding operations in each month are provided. Each season was different. In terms of actual number of hours with seeding operations, the 2015-2016 season tops the list. However, when one compares the hours of seeding conducted each season (Table 5), the 2016-2017 season was far above the others, 400 hours more than the 2015-2016 season.

TABLE 4. Hours of Seeding							
	<i>Nov</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>Season</i>
2014-2015	10:13	83:45	24:08	36:47	25:21	20:12	200:26
2015-2016	41:28	66:07	49:56	60:30	62:00	9:54	289:55
2016-2017	NA	120:22	63:12	58:53*	SUSP	NA	242:27
2017-2018	NA	49:37**	23:24	57:25	62:06	NA	192:54
Mean	25:50	79:57	40:18	58:09	49:49	15:03	231:26
*Project was suspended on February 11 th , 2017.							
**Project started on December 9 th , 2017, not December 1 st .							

The 2017-2018 season had the fewest hours during which seeding has been conducted during a season (Table 4), but more seeding hours, that is, more generators were operated during those opportunities (Table 5) than either of the first two seasons. Viewed another way, it can be said that full advantage was taken of those opportunities that presented themselves.

TABLE 5. Hours of Ice Nucleus Generator Operation							
	<i>Nov</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>Season</i>
2014-2015	71:43	377:52	125:51	36:47	219:54	20:12	852:19
2015-2016	86:21	375:03	328:57	180:56	191:31	9:54	1172:42
2016-2017	NA	815:05	396:22	406:57*	SUSP	NA	1618:24
2017-2018	NA	304:53**	156:06	397:31	373:04	NA	1231:34
Mean	79:02	468:13	251:49	246:21	255:33	15:03	1218:45
*Project was suspended on February 11 th , 2017.							
**Project started on December 9 th , 2017, not December 1 st .							

It is here noted that since the inception of operational seeding in the Wind River Mountains in the winter of 2014-2015 WMI has significantly improved the guidance available to its meteorological team, especially through numerical modeling products specifically-tailored to assist winter orographic cloud seeding. With these tools, we believe we are now more selective in our operational decision-making. We are also likely more responsive to shorter-term opportunities, and to changing conditions as storms pass.

OUTREACH

Whenever possible WMI likes to be receptive to requests to educate those showing an interest in our field efforts. As with previous seasons, WMI was approached by the Sublette County Conservation District (SCCD) during the 2017-2018 season to provide outreach regarding meteorological aspects of cloud seeding in the Wind River Range. WMI meteorologist, Dan Gilbert, and the SCCD arranged for local students to visit the WMI shop in Pinedale, WY and learn about the project and upper air soundings, and even to participate in the release of a weather balloon. WMI appreciates being asked to take part in this type of educational outreach, and has gladly conducted such events, which are done with the knowledge and support of the WWDO. It is important to WMI to be receptive to requests to educate those showing an interest in our weather modification efforts.

WMI also presented an update on the 2017-2018 Wind River operational seeding efforts at the Wyoming Weather Modification Technical Advisory Team (TAT) meeting held in Cheyenne, WY on February 6th, 2018. The TAT, initially organized by the WWDO to provide technical advice and support for the WWMPP, is largely 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 Natural Resources Conservation Service.

SUMMARY

The 2017-2018 cloud seeding effort in the Wind River Range began on December 9th, 2017, and officially concluded on 31 March 2018, a duration of nearly 4 months. The season started eight days later than intended due to a delay in finalizing the collaborative weather modification agreements. The conclusion date of 31 March 2018 was planned as a measure to address funding constraints and keep the Wind River Range cloud seeding program up and running during the heart of the 2017-2018 winter season.

There were no seeding suspensions during the season.

Eighteen seeding events were conducted between December 9th, 2017, and March 31st, 2018. All but two events involved the use of four or more generators, seeding in westerly or southwesterly flow. Twelve of the events utilized seven or more generators. A total of 32.19 kg of silver iodide was released in the course of 1,231 hours of generator operations.

The ice nucleus generators operated reliably, seeding as intended over 98% of the time. Only two generators experienced and performance issues, and each of those, only once.

In terms of hours of seeding generator operations, the winter was about average. In spite of a slow January, the season ranked second (out of four) in terms of total hours of generator operations.