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The Texas Weather Modification COURIER

TAGD Discussed Weather Modification at Quarterly Meeting

By Greta S. Ramsdell
General Manager, Sutton County UWCD

The Texas Alliance of Groundwater Districts (TAGD) held its quarterly meeting in San Angelo on April 29th and 30th.

Front row, from left to right: Archie Ruiz-Columbié, Tommy Shearrer, Stephanie Beall, Robert Rhodes, Todd Flanagan and Chad Gerard. Back row: C.E. Williams, Ed Walker, Mike Mahoney, and Craig Funke.

Forty-eight water districts were represented from across the state.

The meeting kicked off at the Emergency Operations Building at Mathis Field with a presentation on new oil and gas technologies to protect water. Joe B. Cooper, general manager of the Middle-Trinity Groundwater Conservation District, reviewed the testimony he had given to the House of Representatives Energy Resources Committee in Austin. Deanya Williams, administrative manager of the Mesa Underground Water Conservation District reviewed

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Inside this issue:

PGCD's Permit Renewed for Four Years

By Jennifer Wright

Panhandle Groundwater Conservation District (PGCD) applied for a new permit for the Precipitation Enhancement Program with the Texas Department of Licensing and Regulation (TDLR) during December of 2007. After publishing a notice of intention in the *Amarillo Globe News* for three consecutive weeks, enough letters were received by TDLR to require a public meeting. TDLR held the public meeting on February 13, 2008, in Amarillo at the Texas Agrilife Research and Extension Center. About 50 farmers and ranchers, the majority of which were from outside of the Panhandle Groundwater District, attended this meeting to voice their concern about the program.

Since many of the speakers at the meeting expressed misgivings of the program, but could not provide solid evidence that the program is causing harm, on March 6, 2008, the weather modification advisory committee for TDLR made

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Texas Project Updates
A Review of 2007

West Texas Weather Modification

By Robert Rhodes

West Texas Weather Modification experienced a wet year in 2007. It can be shown throughout the Texas Association; when areas receive above normal natural precipitation, the number of seedable clouds and the number of seeding missions decrease. This was the case for west Texas in 2007. Seeding operations started on March 26th and ended on October 3rd with 46 operational days. 95 clouds were seeded with 1263 flares during 82 flights. 14 reconnaissance flights were flown while making an attempt to find seedable clouds on marginal days. Pilots flew 188 flight hours. Information on the 2007 season retrieved from the final report available on the webpage at www.wtwma.com.

2007 was a very wet year with a value (32.05in) at San Angelo over normal by 11.50 inches. Record rainfall across the region was associated with an abnormal pattern of the jet stream, several upper-level closed lows over Texas, and tropical systems affecting eastern Mexico and the transport of that moisture into Texas. July was the most active this season with 14 operational days. The wet pattern ceased quickly in September and failed to provide many days for thunderstorms.

The statistical reports conducted by Arquímedes Ruiz-Columbié shows a majority of seeding operations results were excellent or very good with an average seasonal increases to precipitation at 11%. Timing to small and large seeded clouds, (77% - 97%) was excellent. Small clouds showed increases for precipitation mass at 103%, cloud mass increases of 50%, lifetime increases at 27%, increases to cloud area at 33%, cloud volume increases of 52%, and volume above 6Km of 108%. Increases in precipitation mass by county were shown between 2.8 and 21.3%. Crockett, Sutton, and Schleicher counties were below 10% but were a consequence of environmental circumstances that did not provide numerous seedable conditions during the season. Total increases in precipitation for the target area were calculated at 1,186,200 acre-feet.

WTWMA (2002-2007					
	Seeded Clouds	Operational Days	Used Flares	Increase Million ac-f	Annual Rainfall
2002	285	47	3024	0.78	14.41
2003	265	50	3184	0.76	19.76
2004	109	46	1140	1.35	30.48
2005	133	39	1524	1.26	20.40
2006	157	53	1810	1.70	17.65
2007	95	46	1166	1.19	32.05

Table 1: Comparison of seasonal operations of 2002-2007.

The table below shows a comparison for seasonal operations conducted during 2002-2007. The average number of clouds seedable is about 125; seasons '02-'03 give a high number of seeded clouds due to the radar technology being used at that time. Doppler radar technology used after 2003 is more accurate in providing distinguished cells. The number of operational days for 2007 is comparable to 2004, although the number of seedable clouds is slightly more; it is noticeably less than 2004-2006. It is apparent from the number of flares and the calculated increases, that seeding operations have become more efficient over the years as well.

West Texas Weather Modification is looking forward to 2008. With moderate La Niña conditions moving into spring and potentially summer, it is expected to be a dry year. West Texas has been dry since September except for an exceptionally wet week during the middle of March. Daily rainfall records for the 17th and 18th were set. Rainfall at Mathis field between the 17th and 23rd of 3.89in and rain on a few other days yielded a sum of 4.64 inches resulting in the 2nd highest monthly rainfall since records began. As of May 8, only two operations occurred; one in March and two in April. The majority of the early season has been dominated by a dry westerly zonal flow from northern Mexico and the Desert Southwest eastward across the state of Texas. However, on March 17th, a deep trough dug into northern Mexico placing west Texas in the most dynamic part of the trough with a strong jet over the region as well. Although March was a wet month, we expect that since the March event was one large system, the season will ultimately be dry. Referring back to the table showing comparison by year, the pattern should supply more than average days with seedable

Southwest Texas Rain Enhancement Association

By Stephanie Beall

Another season is in the books for the Southwest Texas Rain Enhancement Association (SWTREA). 2007 was the ninth year of operations and the seventh full year of 24-hour 7-day per week cloud seeding and hail suppression. This year was drastically different from 2006. 2006 was a very dry, hot year for the area and drought conditions were prevalent across most of Southern Texas. However, things quickly turned around in 2007 as a very consistently wet pat-

tern occurred over most of South Texas. The first couple months of 2007 allowed for the drought of 2006 to become a distant memory. As the spring months unfolded, too much rain became the problem across most of the South and Southwest Texas area. The saying "feast or famine" can accurately describe the contrast between 2006 and 2007. The wettest months by far were March and July. Due to very heavy rain and river flooding across the area, seeding operations were suspended off and on during the late spring into summer months. July, which is usually the most active month for cloud seeding, had few flights due to the suspension criteria being enforced. Another thing that kept cloud seeding flights at a minimum was the prevalent occurrence of warm cloud bases. When warm cloud bases are present, seeding is not effective due to the cloud already being an efficient rain producer. The seeding material is ineffective since there is not much ice present in the cloud.

For the first time in two years, a severe weather season actually occurred in South Texas. April in particular was a busy month with hail suppression activities due to a couple weeks of a very favorable setup across South Texas synoptically for severe weather. Operations at times were suspended in the spring due to the threat of tornadic storms over the region.

Below is a table for a town in of the five counties in the SWTREA target area. The table contains precipitation totals for 2006, 2007, and the climatological normal for each location. The comparison for 2006 and 2007 was done to emphasis how completely different these two years were.

Dimmit County
Carrizo Springs (2006): 12.14 inches
Carrizo Springs (2007): 31.21 inches
Carrizo Springs (normal): 21 inches
LaSalle County
Cotulla (2006): 16 inches
Cotulla (2007): 38.19 inches
Cotulla (normal): 21 inches
Uvalde County
Uvalde (2006): 14.3 inches
Uvalde (2007): 18.35 inches
Uvalde (normal): 23 inches
Webb County
Laredo (2006) 15 inches
Laredo(2007): 29.77 inches
Laredo(normal): 19 inches
Zavala County
Crystal City (2006) 12 inches
Crystal City (2007): 29.77 inches
Crystal City (normal): 19 inches

From the tables above, rainfall was far above average for the target area for 2007. At points during the year, flood conditions were common across parts of the target area. This was the case in most locations in South Texas during 2007, with places further to the east of the SWTREA target area receiving over 40 inches of rain through November. By September, the pattern started to turn and drier conditions returned to South Texas. This may be attributed in part by the development of a La Nina episode in the South Pacific.

Panhandle Groundwater Conservation District Precipitation

By Jennifer Wright

Panhandle Groundwater Conservation District's 2007 Precipitation Enhancement Program's first mission occurred on March 28th and the last mission occurred on September 26th. Typically, the season runs from April 15th until September 30th; however, if suitable opportunities are present before the 15th the season will commence.

This year we seeded eight less days and 20 fewer clouds than in 2006; however, our additional rainfall amount across the district increased from 2.75 inches in 2006 to 2.80 inches in 2007[1]. The increase can be attributed to seeding larger clouds during 2007 that had a longer lifetime, and larger area and volume. Due to longer lifetimes of the clouds, many seeding days had two to three seeding missions. With a total of 59 missions, 2007 had only one less seeding mission than 2006.

During 2007, we flew one seeding mission in March, six seeding missions in April, eight seeding and five reconnaissance missions in May, 10 seeding missions in June, 10 seeding missions in July, 10 seeding and four reconnaissance missions in August, and five seeding and one reconnaissance missions in September. The District made the most of our opportunities when conditions were in our favor.

The total number of flares used in 2007 was 482 less than in 2006. A total of 1004 flares including 40 gram and 80 gram burn-in-place (BIP) and 20 gram ejectable flares were fired during the 2007 season. Of the 612 total BIP flares, 554 were fired within the District which included Carson, Donley, Gray, Roberts, Wheeler, and parts of Potter, Armstrong, Hemphill and Hutchinson counties and the other 58 flares were released in the buffer zone which included Hansford, Ochiltree, Lipscomb, Moore, Hartley, Oldham, Deaf Smith, Swisher, Briscoe, Hall, Childress and Collingsworth counties in Texas and Ellis, Roger Mills and Beckham counties in Oklahoma. Of the 392 total ejectable flares, 356 were fired within the District and

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36 were released in the buffer zone.

Not only did we slightly increase the amount rainfall across the District during 2007, but we also lowered the cost per acre/inch from $0.017 in 2006 to $0.011 in 2007. Overall the 2007 season was slightly less active than 2006, but just as successful.

1 Ruiz-Columbié, Arquimedes. Panhandle (White Deer) Annual Evaluation Report 2007. p 5.

Variables	2006	2007	Yearly Average Difference
Days Flown	46	38	8
Missions	60	59	1
# of flares used	1486	1004	482
Clouds Seeded	82	62	20
Ac/Ft of Additional Water	926,400	941,600	15,200
Ac/In. of Additional Water	11,116,800	11,299,200	182,400
Additional Water (in inches) Received per District Acre	2.75	2.80	0.05

Above is a table that compares the PGCD's PEP comparison from the 2006 and 2007 seeding seasons.

South Texas Weather Modification Association

By Todd Flanagan

South Texas Weather Modification Association (STWMA) continued to conduct cloud seeding operations over south-central Texas in 2007, marking year number eleven. The past year was rather wet, with several intense rainfall episodes occurring in southern and central Texas primarily in the May through August period. On several occasions event totals topped 10 inches. Because of the persistent heavy rains and subsequent flooding, seeding operations were conducted on fewer days than in years past. 2007 was comparable to 2002, the last time destructive flooding occurred within the target area. Cloud seeding operations occurred on 23 days during the year. This compares with 57 days of seeding in 2006, 54 days of seeding in 2005, 50 days of seeding in 2004, 42 days in 2003, and 18 days in 2002. A measly 66 hours of flight time were logged for the year.

One of, if not the best day for cloud seeding this past year was on May 10 when an upper low over north-central Texas helped ignite showers and thunderstorms across the target area. Aggressive seeding of developing showers and thunderstorms took place, with several cells merging into a line that traversed the central and southern target area and continued all the way to Corpus Christi by late that evening. Another day of seeding took place on the 24th. Between June and mid-August, over 20 inches of rain fell over a good portion of south-central Texas. Suspensions took their toll on seeding, with over six weeks of down time. It was a bittersweet result: Although we did not seed as many clouds as years past, the drought had come to a temporary end. A reconnaissance flight took place on July 14th but convection would die before the plane arrived. This was the only flight for July, with no seeding taking place during the month. This happened once before, in July 2002. Seeding operations resumed in mid-August after a couple weeks of much-needed dry weather, with eight more days of seeding. This turned out to be the busiest month in terms of seeding operations. September was a near normal month in terms of rainfall and seeding activity, with six more days of operations. October 8th turned out to be the final day of cloud seeding for 2007.

At the request of the Edwards Aquifer Authority (EAA), the STWMA began a multi-year experiment within the EAA target area where randomized seeding would take place. With a bit of guidance from the National Center for Atmospheric Research (NCAR), a randomization protocol was developed that would guide both the pilot and the meteorologist in conducting a randomized seeding experiment. The flight to the area of developing convection would take place and the pilot would determine if the activity was seedable based on cloud appearance, inflow strength and location. Once a seedable candidate was found, the randomized decision procedure would take place. This involves both the meteorologist and pilot opening an envelope, inside of which would be a card with either "SEED" or "NO SEED" written on it. The meteorologist would convey his envelope content to the pilot, but the pilot would not tell the meteorologist what was in his envelope. If both envelopes matched, the pilot would seed the cloud. He would continue the mission as usual, burning flares as long as conditions warranted. If the envelopes did not match, the pilot would continue to fly in the favorable location, but only "pretending" to burn flares as long as conditions warranted. By doing the randomization in this manner, only the pilot truly knows if the cloud or clouds were seeded. The cards and notes for each day were to be placed into separate manila envelopes for future analy-

sis, the purveyor of which has yet to be determined. Radar data from each day was also to be saved, again for future analysis. There were a few exceptions to the randomization enactment. If the activity was on the edge of the target area about to exit, if a large weather system such as a squall line or mesoscale convective complex was in the area, or if warnings were issued, the randomized protocol was not put into effect.

As it turns out, 2007 was not the best year for starting this experiment. The weather was not very cooperative, with only five days allowing for the randomized protocol to be enacted. In addition, it was not until late June before the protocol was developed. It is the hope of the STWMA that the upcoming seasons will be more favorable for continuing the randomized experiment.

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the Alliance's website and presented possible modifications for the future.

The Texas Weather Modification Association (TWMA) provided an in-depth depiction of rain clouds, thunderstorms and the various methods of enhancing rainfall. Tommy Shearrer, president of TWMA, welcomed the Alliance members and gave a brief history of weather modification. Stephanie Beall of the Southwest Texas Rain Enhancement Association discussed the critical nature of the water situation in Texas and how weather modification augments current rainfall. Todd Flanagan of the South Texas Weather Modification Association explained the operational aspects of determining when cloud seeding will be effective and how weather situations are evaluated. Todd also presented information on the assessment of additional rainfall caused by weather modification, based on analysis by Archie Ruiz-Columbié of Active Influence & Scientific Management. A study on the influence of large amounts of dust on clouds and rainfall was discussed by Robert Rhodes, meteorologist for the West Texas Weather Modification Association (WTWMA). Questions were then answered by the presenters and Craig Funke, chief pilot of the STWMA and Project Manager of WTWMA. The attendees then toured the West Texas Weather Modification Association's facilities and inspected the airplanes owned by the Association. A reception was held in the weather modification hanger and was sponsored by Daniel B. Stephens and Associates and LBG-Guyton Associates.

The following day the TAGD meeting moved to Old Fort Concho and Representative Drew Darby welcomed the group. The business meeting followed and then Representative Harvey Hildebran spoke to the water district managers and board members regarding legislative issues. The meeting concluded at noon.

Weather Modification: California Style

A winter of snow pack augmentation

By Stephanie Beall

For weather modification meteorologists in Texas, the typical season runs anywhere from early March to late September depending on where in the state the meteorologist is located. However, during the winter time, when there is a lack of suitable clouds to seed, weather modification meteorologists typical spend their time doing research or catching up on final reports. For me, this winter was much, much different. In a continuing effort to allow Texas to excel in weather modification, I accepted a winter job with North American Weather Consultants conducting cloud seeding operations. This company is based out of Salt Lake City, Utah, and contracts with water districts, power companies, and river authorities to do cloud seeding all over the world. This year, North American won a contract for the King River cloud seeding Project based out of Fresno, California. This project was mainly funded by the Kings River Conservation district. The target area, shown below, is located at the base of the Southern Sierra-Nevada Mountains in the

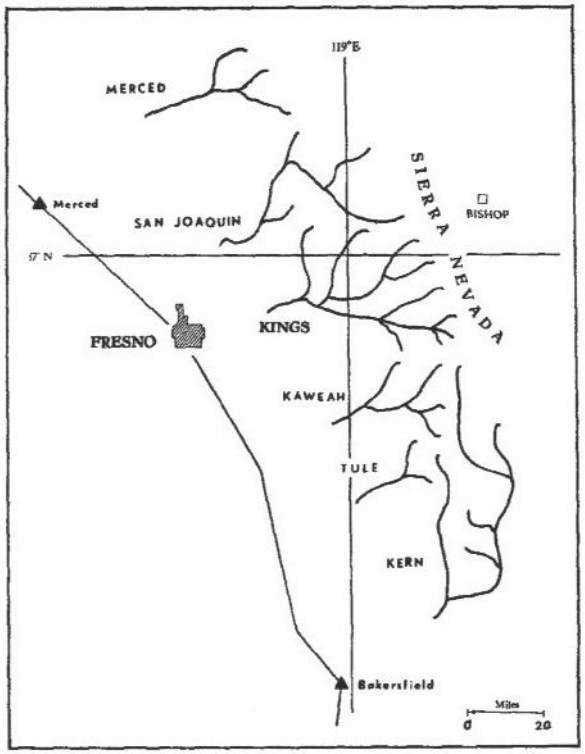

FIG. 1. Watersheds of the southern Sierra.

Snow Pack Continues on Page 6

Snow Pack Continued from Page 5

Kings River Watershed. The diagram shows the Kings Watershed along with the surround watersheds in Central California. The Kings River is one of the main rivers that comes out of the Sierras, running into the Central valley of California. At the base of the target area, is Pine Flat Dam. The primary objective of increasing snow pack during the winter months is to allow for additional snow pack to accumulate during the winter months and in the spring when snow pack starts to melt, the water from this fills Pine Flat Dam. The Kings River Project is one of the longest running weather modification projects in the world, with its first season in 1955.

Even though there are similarities when comparing snow pack augmentation to rain enhancement, they are very different things. The same type of material is used to seed the cloud but the mechanics of getting this material to the right part of the cloud is very different. In Texas, cloud seeding is done during unstable conditions where thunderstorms blossom. Snow fall is very different, in that it exists in a fairly stable weather situation. The updrafts that are critical in summer time thunderstorms do not exist when seeding a snow storm. As well, seeding is not only done by aircraft, it is also done by a network of cloud nuclei generators (CNG's) which are located in the higher terrain of the target area. As well, thunderstorms last on the matter of hours, where snowstorms can last on the order of days. The project staff was made of a project meteorologist, a pilot, Herb Speckman, who is also a pilot for the Panhandle Groundwater Conservation District's precipitation enhancement project, and a fill technician who made sure the CNG network was constantly in a state of readiness for incoming weather systems.

Above is a picture of the cloud nuclei generator.

As stated before, the projects in Texas require a steady updraft at the base of the thunderstorm in order for seeding to occur. With a snow storm, the flight tracks that were set up for the pilot to fly on and the ground generators required a west, south, or southwesterly wind component in order for either the aircraft or the seeding plume from a generator to incept the region of best available super-cooled liquid water. The pilot flies in heavy icing conditions in order to be in the area of best super-cooled liquid water. When systems come out of the north or northwest, seeding operations could not be conducted because the lift was occurring form a different direction. With a southwesterly wind moving perpendicular to the mountains, enhanced orographic lifting would occur, and this would be the best time for seeding. The better the lift, the better the chance the seeding material would have to make it to the appropriate temperature of -5°C. The seeded snow would then make it up into the highest terrain of the target area where it awaits it spring time melt.

The project operated from early January to early April time frame. The season was very active for January, with about 105% of normal snow pack over the Kings River Watershed area. This allowed for ample seeding opportunities during January into February. La Nina and an enhanced Madden-Julian Oscillation (MJO) allowed for above average snowfall during these months. This was much welcome from people around the area due to very dry conditions last year. However, the pattern made a flip-flop, much like it can here in Texas, into March and April. During these two months, only 0.02 inches precipitation fell over the watershed. This kept the normal at about 103% for the season, and a good amount of snow available for melting in the spring.

After a four month stint in Central California, the weather modification season once again started in Texas. After working in a different area of weather modification, I have learned how important it is for projects in Texas to work with other companies who do weather modification in order to continue the flow of knowledge and experience continuous in order to benefit not only the associated parties but water users as well.

References:

Henderson, Thomas. "A Ten Year Non-Randomized Cloud Seeding Program on the Kings River in California" Journal of Applied Meteorology (1966): 697-702.

A Summary of the 2007 Texas Weather Modification Evaluation Report

By Arquimedes Ruiz-Columbié

Cloud seeding operations 2007 began over Texas in March. A total of 228 clouds were seeded and identified in 110 target area operational days. Table 1 below summarizes the general figures:

Table 1 Generalities

First operational day: March 28th, 2007 (WTWMA -San Angelo and SWTREA- Carrizo Spring)
Last operational day: October 8th, 2007 (STWMA –Pleasanton and SWTREA- Carrizo Spring)
Net Number of operational days: 110
Most active months May to August: ~ 70 % of the operation days,
Less active months: March: ~ 3 % of the operation days
October: ~ 2 % of the operation days
Number of seeded clouds: 228
(75 small seeded clouds, 75 large seeded clouds, 78 type B seeded clouds, and 9 npf))
Missed Opportunities: 4 (~ 2 % of the seedable conditions)
The following table 2 shows the calculated increases in precipitation mass (Δ) using radar data through the TITAN software.

Table 2 Estimated Increases

	#	Flares	Timing (%)	Dose (ice-nuclei per liter)	Δ (%)	Δ (million ac-f)	Δ (in) per cloud
Small Clouds	75	368	86	115	107	~0.065	0.52
Large Clouds	75	1096	94	95	46	~1.85	0.95
Type B Clouds	78	1372	71	95	15	~1.34	0.29
Total	228	2836				~3.26	
Average			84	102	55		0.58

Table 3 Results per Project

	# Seeded Clouds	# Operational Days	# Missed Opportunities	Timing (%)	Dose (ice-n per liter)	Δ (%)
Panhandle	62	35	1	84	100	51
WTWMA	95	46	2	80	85	47
STWMA	41	16	0	74	110	68
SWTREA	30	17	1	79	135	64

Final Comments

Results are evaluated as excellent despite the relative scarcity of seedable conditions (see last comment in this page). The main problem detected was the loss of radar data (5 operational days did not get proper files);

The micro-regionalization analysis showed increases per county; the average increase in precipitation, referred to an average seasonal value, is slightly above **9 %**;

Radar estimations of precipitation should be considered as measurements of trend. Nevertheless, seeding operations appeared to improve the dynamics of seeded clouds.

Season 2007 was very atypical over the target areas in Texas due to an anomalous location of the sub-tropical jet stream during the early spring which in turn produced strong Pineapple Connection of Pacific Ocean moisture, whereas, in June, the long presence of an Upper Level Low over North Texas added even more atypical conditions. Tropical Storm Erin (August), in dissipation, also was an important factor. These patterns explain why the seedable conditions were relatively scarce in comparison with season 2006 (details in “2007 Midseason Cloud

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a recommendation that the PGCD's permit be renewed. On March 13, 2008, TDLR issued the new permit that will extend through 2012. The new permit was issued for only the area within the PGCD; therefore, it eliminated all of the buffer zone, which had been included during the previous permit.

2008 Early Spring Precipitation in West Texas

By Robert Rhodes and Arquimedes Ruiz-Columbié

During the months of March and April 2008, the precipitation in West Texas has had a tricky spatial behavior which does not allow for an easy recount and the corresponding forecast. A hypothetical transect across the region might illustrate the previous statement. For instance in March (see table 1), Amarillo National Weather Service (NWS) station reported 0.30 inches in three precipitation days whereas the normal value is 1.13 inches. Lubbock NWS station reported only 0.10 inches in also three days when its normal value is 0.76 inches. By contrast, San Angelo NWS station reported 4.64 inches in seven precipitation days, which represented 469 % of the corresponding normal value (0.99 inches), whereas Del Río NWS station reported 0.57 inches in five days for a 59 % of the normal value (0.96 inches). It seems like West Central Texas was the only sub-region favored by precipitation during that month. Off the transect, Abilene NWS station reported 4.06 inches in nine days (normal value 1.41 inches) to corroborate it. Also, San Antonio NWS station reported a good value of 1.82 inches in seven days (~ 98 % of the normal value, 1.89 inches).

Table 1

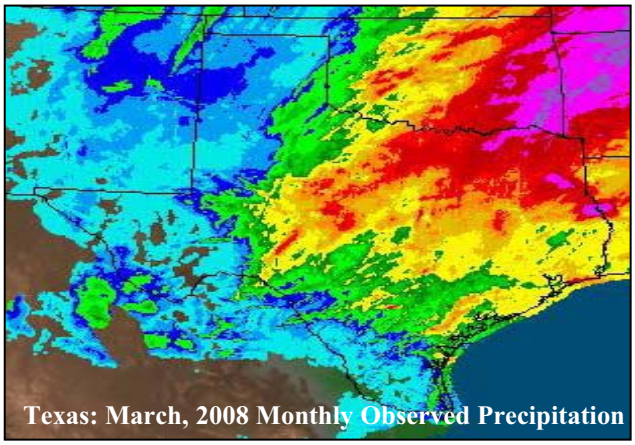
Precipitation (in)	Amarillo	Lubbock	San Angelo	Del Río
2008 March	0.3	0.1	4.64	0.57
Average March	1.13	0.76	0.99	0.96

For the region, March precipitation is usually an excellent predictor for the annual precipitation to come (see "Very Wet March 2007 in West Texas", Volume 1 issue 1 of the Texas Weather Modification COURIER, May 1st, 2007, page 4). However, the spatial pattern for March showed very dry conditions everywhere but over the West Central sub-region which was affected on March 17th and 18th by an effective fetch of moisture coming from the Pacific Ocean (pineapple connection). It was the exception and not the rule, as later a drier than normal April confirmed over the whole region (see table 2).

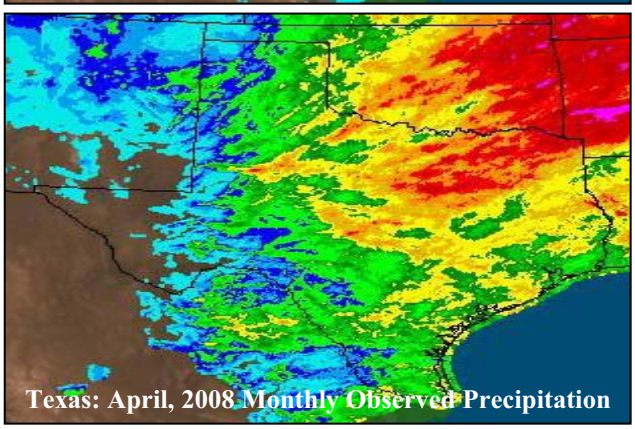
Table 2

Precipitation (in)	Amarillo	Lubbock	San Angelo	Del Río
2008 April	0.38	1.07	0.62	0.06
Average April	1.33	1.29	1.60	1.71

The main factor modulating the precipitation behavior this spring 2008 is the presence of La Niña conditions over the Tropical Pacific Ocean. In general, these conditions mean colder than normal sea surface temperatures with the subsequent reduction of evaporation which in turn inhibits the convection and the formation of thunderstorms. The sub-tropical jet is then not able to bring enough moisture across the continent and precipitation in West Texas results affected negatively. A brief look into the past La Niña years shows that 5 of 9 events yielded less than 13 inches of rain for Mathis Field in San Angelo and 4 of 9 cool events did not exceed 15.3 inches of rain. Since Mathis Field has a normal of 20.91 inches, these values exemplify that La Niña conditions typically leave Texas very dry. In south Texas, Pleasanton has a normal value of 27.60 inches. 5 of 9 events saw less than 20inches of rain and 2 of 9 events yielded less than 16 inches of rain. The remaining 4 La Niña events transpired with very wet periods and very dry periods throughout the year with totals reaching 44.70 inches. However, many of the high rain-



Texas: March, 2008 Monthly Observed Precipitation



Texas: April, 2008 Monthly Observed Precipitation

WMA Annual Meeting Westminster, Colorado April 21-25, 2008

By Todd Flanagan

The annual meeting of the Weather Modification Association was held in Westminster, Colorado, at the Westin Hotel. Unlike past meetings, this year the WMA held a joint meeting with the American Meteorological Society, who were hosting the 17th Conference on Planned & Inadvertent Weather Modification. Members from around the world gathered to give presentations dealing with topics ranging from research in cloud physics to updates on operational summer and winter programs to computer modeling of cloud seeding.

Monday's presentations dealt with possible approaches to hurricane mitigation with a few papers discussing this topic. A review of wintertime precipitation programs also took place. An icebreaker reception followed in the evening with a chance to mingle with other members of the WMA. Tuesday continued with more presentations on wintertime seeding programs during the morning, with summer seeding programs being discussed in the afternoon presentations. On Wednesday more summer seeding program presentations were given in the morning, while presentations on numerical modeling of planned and inadvertent weather modification took place during the afternoon. A cocktail hour and banquet took place in the evening with awards given out for contributions to the field of weather modification. The invited talk for the evening was given by a representative from the Department of Homeland Security.

Thursday was an off day for presentations, with a field trip to the National Center for Atmospheric Research's (NCAR) Mesa Lab and the NOAA Research Facility, both in Boulder. Much was learned about the massive computing facilities and research at NCAR, and a great presentation was given in 3D looking at various climate and weather models. At NOAA we were given presentations by a meteorologist from the local National Weather Service office and from the research division as well as an amazing display of weather and climate data on a giant suspended globe. All in all it was a very informative field trip. The WMA business meeting/dinner took place Thursday evening with several items of interest discussed. The executive board for 2008 was voted on, as was the location of next year's annual meeting, which will be Anaheim, CA. A brief presentation was given by Carlos Antonietti from Mendoza, Argentina, the location of this fall's semi-annual meeting.

During the conference, there were two evenings on which round table discussions were held. The first round table on Tuesday evening dealt with looking at viable approaches to hurricane modification with panelists including Dr. William Gray and Dr. William Cotton and chaired by Dr. Joe Golden. Discussion took place over what methods may or may not work, potential effects of modifying such a large and powerful force of nature and societal impacts on attempting such a feat. Another round table discussion took place on Thursday evening with the focus on the potential use of aerosols to mitigate adverse global warming impacts on precipitation and possible legal ramifications resulting from it.

WRF Modeling in Store for Texas Projects

By Robert Rhodes

Texas Weather Modification meteorologist attended a Weather Research Forecast (WRF) Model workshop late February with interest in bringing the technology into cloud seeding forecast, analysis, and evaluation of operations. The WRF model is a next-generation Mesoscale model developed by the National Center for Atmospheric Research and is capable of high resolution and smaller scale graphical forecasts.

Texas weather modification meteorologists are interested in the model for several reasons. The model can be initialized over the state of Texas, and nested domains can be used at higher resolutions for the individual projects. A nested domain refers to a large- low resolution box over Texas, and 3 smaller-high resolution boxes around the selected project areas. This will allow for more accurate forecasting of thunderstorm initialization, precipitation track forecast; temporally and spatially. This could also allow for a more timely launch and placement of seeding aircraft.

The model is capable of very fine resolution, input of local data, and correction of bias. With this in mind, monitoring model output over a period of time can allow meteorologist to alter parameters within the model, increasing the efficiency and develop another tool capable of advancing the evaluation conducted on seeding operations. For example, if a modeled cloud prior to seeding produces a quarter inch of rain over an area and the same cloud after seeding produces a half inch rain over the same area or over a larger swath; it can be reasoned that the effect of seeding is very efficient.

The difficulty associated with this proposal is cost and learning the system. We are discussing options with the company who provides data to the Texas Weather Modification Association (TWMA). The first option is that the Association buys the system components and sets it up at one of the four project offices.

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This will allow the meteorologists to have first hand experience with the system but also requires a significant amount of hands on independent learning. The second option is to have another source host the system components and feed model GRIB files to visualization software on other computers. This is similar to how TWMA receives the radar level 2 data feed. This decreases the burden on the Texas Association to repair or replace expensive system components.

The WRF model is at the forefront of model research and can be a valuable tool for operations, evaluations, and other projects to be determined.

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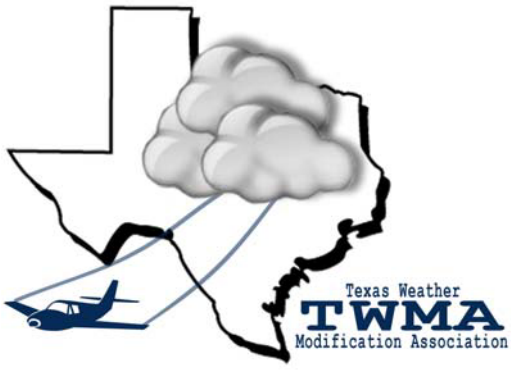

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