**Southwest Texas Rain Enhancement Association**
**2004 Edwards Aquifer Authority Final Report**

**Prepared By:**
**Stephanie Beall**

**Contributions by:**
**David Cousins**

**2004 Project Staff**
Ed Walker
Project Manger, PIC
David Cousins
Project Meteorologist (March 1- July 19)
Stephanie Beall
Project Meteorologist (July 19 - November 15)
Debbie Farmer
Secretary
Cole Van Cleve
Pilot

# The Year in Review

2004 marked the third year of operations for the Edwards Aquifer Authority (EAA) by Southwest Texas Rain Enhancement Association (SWTREA). For most of the season, two planes were stationed in Uvalde County with the third plane used in seeding operations stationed at Carrizo Springs. In some instances, the Cessna 340 was used in seeding operations in Uvalde County, but the planes stationed in Uvalde County did the majority of seeding. One of our pilots, Cole Van Cleve was stationed in Uvalde while our pilot in command (PIC), Ed Walker was stationed in Carrizo Springs.

2004 marked the beginning of a cooperative effort between SWTREA and South Texas Weather Modification Association (STWMA). SWTREA moved its seeding operations into the same Pleasanton office as STWMA. Both meteorologists can work together during seeding operations and share common dialogue of meteorological importance.

Seeding in the Authority target area of Uvalde County saw a total of 15 flights for the 2004 operational year compared to 20 flights in 2003. The lower number of flights in 2004 compared with previous years may be due to the fact that operations were suspended over a short period of time from the 28$^{th}$ of June to the 5$^{th}$ of July due to excessive rainfall over the area. The project meteorologist made this decision at the time due to flash flood watches and warnings over Uvalde County for this time period. 2004 was a very wet year of Uvalde County that can be seen in estimated precipitation maps shown in the operational summary portion of this report.

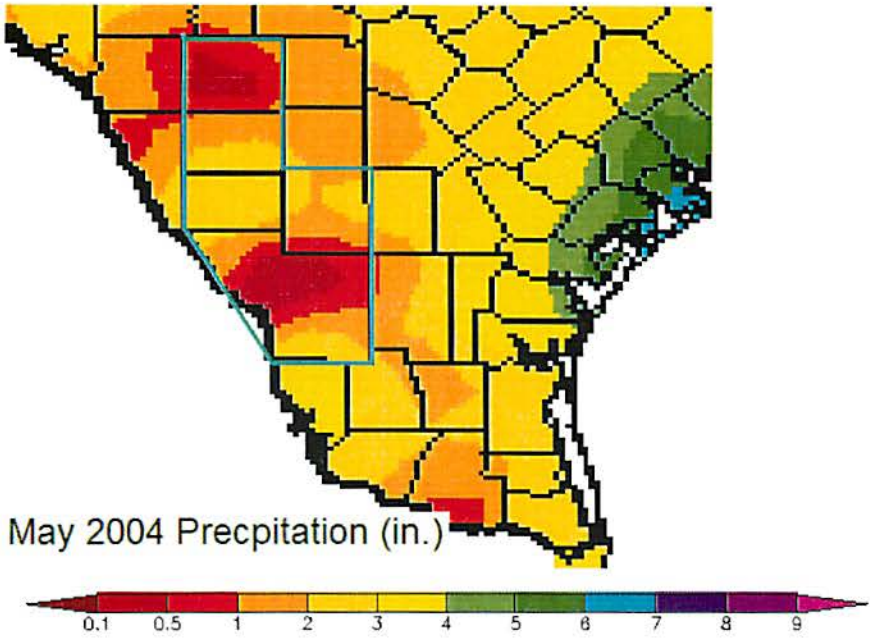
At the conclusion of the 2004 operational season for the Authority EAA target area, October 31$^{st}$, a radar evaluation was completed for the program. The findings are presented and discussed towards the end of this report.

# 2004 Flight Log for SWTREA EAA Target Area

| | Flight # | Date | Aircraft | Total Time (hours) | Materials Used | Total Seeding Material AgI (g) |
|---|---|---|---|---|---|---|
| | 1 | 6/4/2004 | 622Q | 0.63 | 5 BIP Flares (80g) | 400 |
| | 2 | 6/7/2004 | 370P | 2.82 | 12 BIP Flares (40g) | 480 |
| | 3 | 6/17/2004 | 622Q | 0.9 | 8 BIP Flares (40g) | 320 |
| | 4 | 6/23/2004 | 622Q | 0.62 | 5 BIP Flares (40g) | 200 |
| | 5 | 6/24/2004 | 622Q | 0.78 | 8 BIP Flares (80g) | 640 |
| | 6 | 6/27/2004 | 622Q | 0.33 | 2 BIP Flares (40g) | 80 |
| | 7 | 7/30/2004 | 622Q | 0.08 | 2 BIP Flare (40g) | 80 |
| | 8 | 8/6/2004 | 622Q | 1.33 | 9 BIP Flares (40g) | 360 |
| | 9 | 8/9/2004 | 498P | 2.92 | 5 BIP Flares (80g) | 400 |
| | 10 | 8/11/2004 | 498P | 1 | 3 BIP Flares (40g)<br>3 BIP Flares (80g) | 360 |
| | 11 | 8/18/2004 | 498P | 1 | 3 BIP Flares (40g) | 120 |
| | 12 | 8/22/2004 | 622Q | 1.85 | 12 BIP Flares (40g) | 480 |
| | 13 | 8/28/2004 | 622Q | 1.35 | 18 BIP Flares (40g) | 720 |
| | 14 | 9/23/2003 | 622Q | 1.35 | 13 BIP Flares (40g) | 520 |
| | 15 | 9/24/2003 | 370P | 0.7 | 5 BIP Flares (40g) | 200 |
| **Totals** | **15** | | | **18.63** | **92 (40g) BIP Flares**<br>**21 (80g) BIP Flares** | **5,360** |

**May:** Some showers and thunderstorms moved through in the early morning hours but ceilings were very low on the 1st. High pressure dominated the rest of that week and for the most part the pattern remained the same for the rest of the month. A strong upper level ridge was in place of the region with a consistent pattern of high pressure at the surface. There were no flights flown in Uvalde County in the month of May due to the prevailing weather pattern, which was a combination of a strong upper level ridge and associated high pressure at the surface.

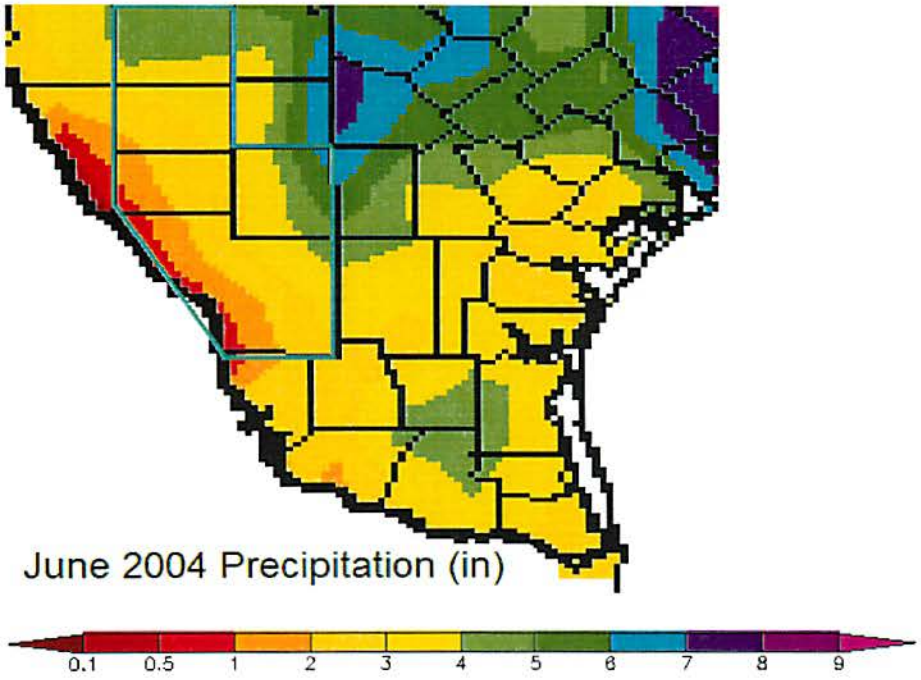
**High Plains Regional Climate Center**
**May 2004 Estimated Precipitation**




**June:** June was a very active and wet month over the target area. June got off to a quick start with high pressure moving out of the area 4th. The first mission took place in the early morning hours over Uvalde County due to a small area of showers and thunderstorms that was present. On the 7th, an afternoon seeding flight took place in Uvalde County where showers and thunderstorms were forming along the base of an upper level trough. A sea breeze in conjunction with high instability contributed to the initiation of some showers and thunderstorms in Uvalde County on the 17th. An evening mission took place in the southwest corner of Uvalde County. Dry air resided over the area until the 23rd when moisture returned to the area and a seeding flight was launched due to thunderstorm activity in the area. A short seeding flight took place in the afternoon hours. On the 24th the same type of showers and thunderstorms kicked off in the evening hours in Uvalde County. A seeding flight took place in the early evening hours. A flash flood warning was later issued for Uvalde County at 5:20 P.M. At this point the seeding mission for Uvalde was discontinued. Showers and

thunderstorm continued over Uvalde County on the 25th and 26th but a flash flood warning remained in effect. On the 27th with flash flood warnings lifted, a seeding flight took place in Uvalde County in the afternoon hours due to shower and thunderstorm activity. Flash flood and river flood warnings were once again issued on the 28th until Tuesday evening, the 29th. Strong showers and thunderstorms continued across Uvalde County with very heavy rainfall. Flash flood and river warning still in effect. The project meteorologist decided to suspend cloud seeding operations in Uvalde County through Monday July 5th due to excessive rainfall in Uvalde County. There were total of six flights for the month of June.

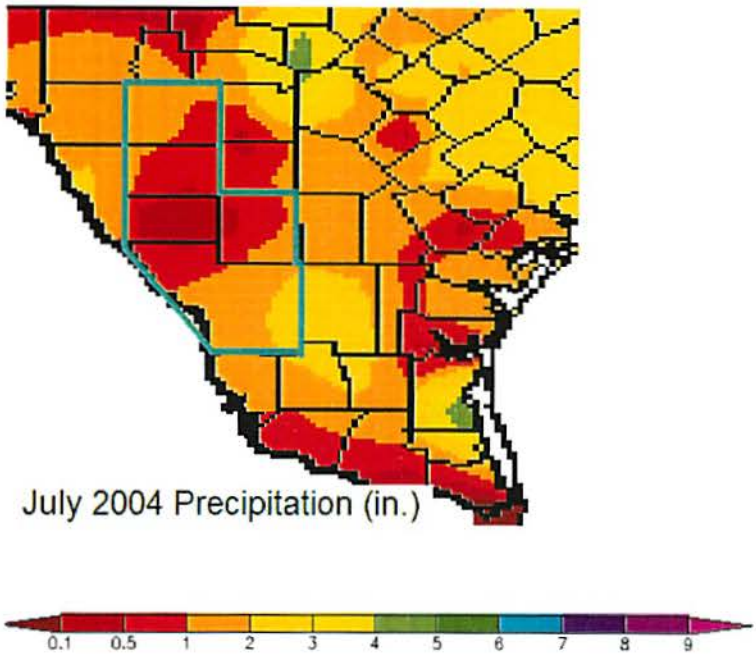
**High Plains Regional Climate Center**
**June 2004 Estimated Precipitation**




**July:** The first day of the month still under restrictions of no seeding. High pressure then moved into the area on the 2nd and continued until the 10th of the month. An upper level low and a tropical wave moved through South Texas on the 10th but no seedable clouds were in Uvalde County. After a few days, high pressure once again replaced the upper level low. An area of extended high pressure was dominant until the 19th. Only two missions took place, one was a reconnaissance mission and the other was a seeding mission. The reconnaissance mission that was flown on the 19th over Uvalde County was mainly associated with an old outflow boundary. This early afternoon mission yielded some activity but soon weakened due to lack of a forcing mechanism. This cluster of showers and thunderstorms only last about an hour or so. The mission on the 30th was very short but a few flares were fired into

seedable clouds. An area of rain and embedded thunderstorms developed across Uvalde and another county around 1:00 PM. After a few scans of the radar, the area of interest transformed into more of a stratiform rain event. Two flares were fired in Uvalde County for this mission. A total of two missions took place in this month.

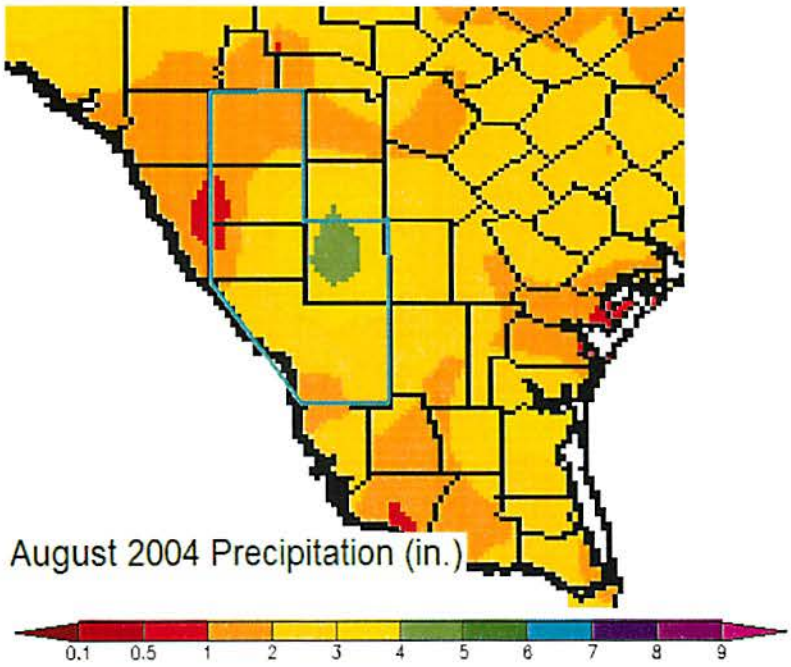
**High Plains Regional Climate Center**
**July 2004 Estimated Precipitation**




**August:** August was a very active month for Uvalde County. On the 9th, an upper level trough slowly moved its way across south Texas this afternoon. This produced showers and thunderstorms over the target area and allowed for a seeding mission to be launch into Uvalde County. A total of 5 flares were burned for this mission that only lasted a little less than an hour. On the 11th, an outflow boundary associated with a Mesoscale Convective System (MCS), moved across north central Texas in the early morning hours started to approach the area. This coupled with daytime heating and destabilization of the atmosphere allowed showers and thunderstorms to fire around 1 p.m. The pilot was launched on the activity after some time of monitoring the developing activity. Also, a cold front was moving into the area that pushed through later in the evening and evolved into a squall line. The squall line did not affect Uvalde County. The mission in the afternoon used 10 flares. After about a week of no seedable activity in Uvalde County, a trough axis with an associated shortwave once again moved across south Texas on the 18th. Spotty shower activity soon turned into promising thunderstorms and seeding operations commenced. The mission took place in the early evening hours and lasted only about an hour. Three flares were fired during this mission. On the 21st, there had been ongoing convective activity south of Uvalde. Many

of the boundaries left over from this activity sparked showers and thunderstorms in the early afternoon and late afternoon hours. Another short wave associate with a mid to upper level trough slowly moved through south central Texas on the 22nd. A total of 12 flares were fired on the 22nd over Uvalde County. A cold front associated with a slow moving trough was the main reason for convection on the 28th of the month. This lifting mechanism caused most of convection. Also an outflow boundary slowly moved its way south from strong to severe thunderstorm activity to the north early in the day. This outflow boundary allowed additional development of convection resulting in a mission. A total of 18 flares were fired with this mission and was given a rating of very good. A very strong thunderstorm developed around the town of Uvalde around 1pm. The storm was expected to move to the north, but slow movement along with new development to the south allowed close to 3 inches of rain to fall in an hour. A total of six flares were fired during this mission. A total of 6 flights took place in the month of August.

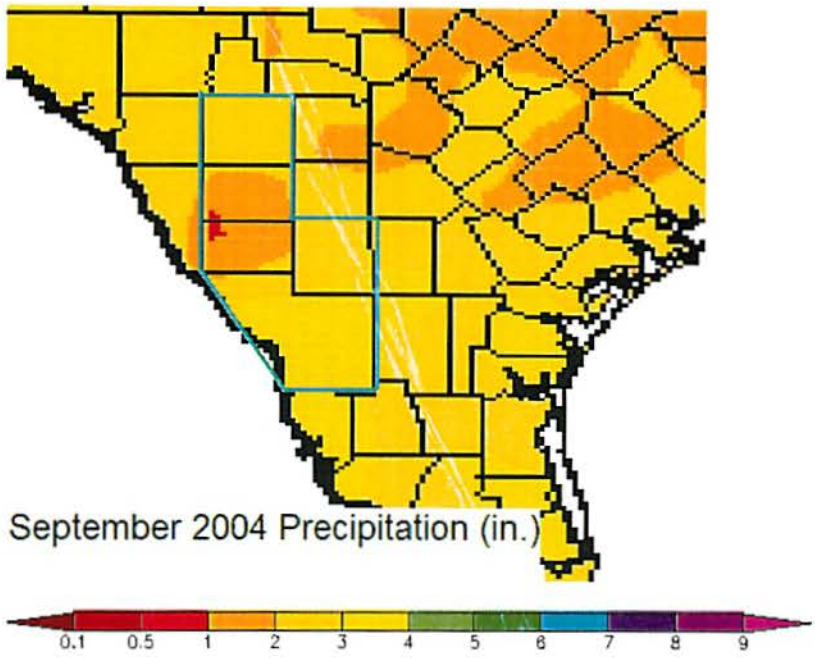
**High Plains Regional Climate Center**
**August 2004 Estimated Precipitation**




**September:** This month was relatively quiet weather wise. Most of the month was dominated by an upper level ridge and high pressure. The only weather that did warrant flight's was near the end of the month. Most of the weather that was happening on the 23rd was associated with Tropical storm Ivan. With Ivan still off the southeastern Texas coast, a tropical influence caused instability in the SWTREA target area. Also a cold front was north of the area and expected to collide with Ivan and cause a heavy rain event. This is fact did not happen but showers and thunderstorms did occur in Uvalde county. Notes indicated that echoes in Uvalde County did seem to intensify a short time after being seeded. A total of 14 flares were used in the early evening seeding mission. The flight was rated very good. An early afternoon mission on the 24th was flown in Uvalde County. After making landfall near Port Arthur, Ivan and its associated showers stayed well to the east of the target area. A weak

upper level short wave was the main convective initiator for the day. This allowed some showers and thunderstorms to occur with the aid of daytime heating. This early evening mission used a total of 5 flares. This seeding mission was rated excellent. Two flights were flown for the month of September.

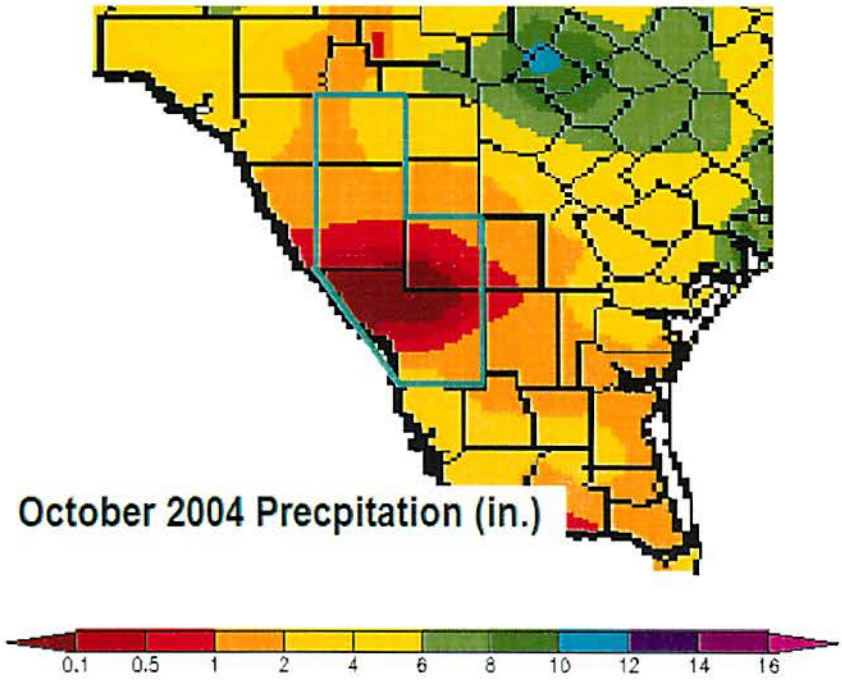
**High Plains Regional Climate Center**
**September 2004 Estimated Precipitation**




**October:** October was a very quiet month not only for Uvalde County but a very quiet one for the SWTREA target area. A total of 3 missions were flown in the month of October for the association, one of which being a reconnaissance mission. There was a combination of weather situations that took place over south central and southwest Texas over the month in the target area to discourage cloud seeding. The first part of the month did offer some chances for seeding but not in Uvalde County due to upper level troughs that were present in the area. Most of the seeding that was conducted for the month of October was done in the first two weeks. The activity that was flown upon was a combination of upper level shortwaves that traveled along the bases of the troughs that made it into south Texas. The last two weeks of the month had very unusual weather. Above average temperatures for the month was the main story. An upper level ridge was present over south Texas keeping most rain and convection activity well to the north of Uvalde County. On the 14th of the month a cold front did pass through the area. A reconnaissance mission was flown in the early morning hours of the 14th. Near the 31st of the month into the 1st of November a powerful cold front did make its way through Uvalde County, past the SWTREA target and stalled off

shore. Convection did occur in the early morning hours of the 1st however Uvalde County was under a flash flood warning and no flights occurred. Before this event, flash flood watches were posted for Uvalde County and other counties in the SWTREA target area. No seeding flights occurred in Uvalde County for the month of October.

**High Plains Regional Climate Center**
**October 2004 Estimated Precipitation**



# 2003/2004 Edwards Aquifer Authority Comparison

| YEAR | 2003 | | | 2004 | | |
|---|---|---|---|---|---|---|
| MONTH | # of flights | Total Seeding Material | # of seeding days | # of flights | Total Seeding Material | # of seeding days |
| MAY | 2 | 240g AgI | 1 | 0 | 0g AgI | 0 |
| JUNE | 5 | 2,560g AgI | 5 | 6 | 2,120g AgI | 6 |
| JULY | 3 | 2,290g AgI | 3 | 1 | 80g AgI | 1 |
| AUGUST | 3 | 1,520g AgI | 3 | 6 | 2,440g AgI | 6 |
| SEPTEMBER | 6 | 2,000g AgI | 5 | 2 | 720g AgI | 2 |
| OCTOBER | 1 | 40g AgI | 1 | 0 | 0g AgI | 0 |
| TOTAL | 20 | 8,650g AgI | 18 | 15 | 5,360g AgI | 15 |

The preceding table gives a historical glance at a comparison of the Authority seeding activities for 2003 and 2004. This is useful to see what kind of activity has been ongoing throughout the last two years of the Authority project.

## Meteorological Perspective of Seeding in 2004

This section will be a summary of perceived efforts of cloud seeding as determined by radar trends.

May did produce convective events but the weather pattern for the month this year was not very conducive to that of cloud seeding. The only flight that did occur was not a seeding mission due to low ceilings.

June offered a plethora of opportunities for cloud seeding and yielded a total of 6 missions which is a large amount for the month compared to the total of 15 missions that was flown for the entire operational season. Near the end of the month, from the 28$^{th}$ into the 5$^{th}$ of July, seeding operations were not conducted due to saturation of the ground and continuing shower activity that contributed to flood and flash flood conditions.

July offered no seeding in the beginning of the month due to flight restrictions. After the restrictions had been lifted, seeding operations continued around the 30$^{th}$ of the month. July only yielded one cloud seeding mission.

August was very different compared to that of July. The very dominate pattern which consisted of a strong upper level ridge and associated high pressure at the surface was not present this month. Most of the seeding missions were attributed to daytime heating and outflow boundaries. A total of six cloud seeding flights were conducted during the month of August. This was one of the two months that were the most active.

September was a very quite month. A total of two missions took place over the Authority target area that SWTREA was responsible for. The first mission of the month was conducted due to the presence of Tropical Storm Ivan over Uvalde County. The other mission that was conducted this month was due to a weak upper level shortwave.

October was the last month in which seeding operations were conducted for the EAA target area. A total of two missions were flown this month. The small amount of flight activity was due to a strong upper level ridge pattern that was in place for most of south Texas. A strong cold front did move into the area near the 31st and produced convection but a flash flood warning did not allow a cloud seeding mission to occur.

Overall, with a total of 15 flights for the EAA target area, the season is summarized as good. Most of the flights that did occur in the EAA target were rated as excellent or very good. The clouds seemed, for the most part, in the target area to respond well when seeding was conducted. For the months where activity was at a minimum, an upper level ridge and associated high pressure at the surface was the contributing factor to the lack of clouds and convection.

In short, the cloud seeding that took place over the Edwards Aquifer Authority target area yielded excellent results. An 87% increase in precipitation mass over the Authority area was determined.

## Edwards Aquifer Authority Radar Analysis for 2004

The following contains excerpts from Archie Ruiz's 2004 radar analysis for the Authority's target area that includes Bandera, Bexar, Medina, and Uvalde counties. Archie Ruiz is employed by Active Influence, which is a branch of the Texas Weather Modification Association. Not only does he conduct a radar analysis for SWTREA but also for the rest of the weather modification programs in the state of Texas. This analysis takes the data from the project for the entire season and determines the effectiveness of cloud seeding. This analysis is the same methodology used to evaluate the STWREA 2004 PEP program for the Authority included in the STWREA 2004 final report. This analysis includes the enhanced rainfall benefit for STWREA and SWTREA target area, including Bandera, Bexar, Medina and Uvalde counties. Mr. Ruiz evaluations suggest a combined benefit for the Authority's 2004 PEP program of 350,716 acre feet. A substantial increase over last year's combined benefit of 122,518 acre feet.

A total of **36 clouds** were seeded and identified by TITAN in **15 operational days**. (NOTE: two other days on which seeding took place were not evaluated due to improper files in the archive or bad data).

**Table 1. Small Seeded Sample versus Control Sample (15 couples, averages)**

| Variable | Seeded Sample | Control Sample | Simple Ratio | Increases (%) |
|---|---|---|---|---|
| **Lifetime** | 105 min | 65 min | 1.62 | 62 **(47)** |
| **Area** | 53.6 $km^2$ | 37.0 $km^2$ | 1.45 | 45 **(26)** |
| **Volume** | 155.2 $km^3$ | 110.7 $km^3$ | 1.40 | 40 **(31)** |
| **Top Height** | 7.5 km | 7.6 km | 0.99 | -1 **(0)** |
| **Max dBZ** | 48.9 | 48.6 | 1.01 | 1 **(0)** |
| **Max dBZ height** | 4.2 km | 4.6 km | 0.91 | -9 **(-11)** |
| **Vol > 6km** | 26.9 $km^3$ | 23.6 $km^3$ | 1.14 | 14 **(15)** |
| **Precip Flux** | 363.9 $m^3/s$ | 270.5 $m^3/s$ | 1.35 | 35 **(15)** |
| **Precip Mass** | 1869.5 kton | 963.6 kton | 1.94 | 94 **(87)** |
| **Cloud Mass** | 118.1 kton | 86.5 kton | 1.37 | 37 **(14)** |
| **η** | 15.8 | 11.1 **(9.6)** | 1.42 | 42 **(65)** |

Bold values in parentheses are modeled values, whereas **η** is defined as the quotient of precipitation mass divided by cloud mass, and is interpreted as efficiency. A total of 34 flares were used in this sub-sample with a very good timing **(84%)** for an effective dose about **100 ice-nuclei per liter**. A very good increase of 87% in precipitation mass together with an increase of 14 % in cloud mass illustrates that the seeded clouds grew at the expense of the environmental moisture (they are open systems) and used only a fraction of this moisture for their own maintenance. The increases in lifetime (47%), area (26%) volume (31%), and volume above 6 km (15%) are notable. There were no increases in maximum reflectivity (0%), and in top height (0%). The seeded sub-sample seemed 65% more efficient than the control sub-sample. Results are evaluated as **excellent**.

An increase of 87% in precipitation mass for a control value of 963.6 kton in 15 cases means:

**= 15 x 0.87 x 963.6 kton = 12,575 kton = 10,198 ac-f**

The sub-sample of 13 **large seeded clouds** received a synergetic analysis. On average, the seeding operations on these large clouds affected 75% of their whole volume; with an excellent timing (90% of the material went to the clouds in their first half-lifetime). A total of 78 flares were used in this sub-sample for an effective dose about **100 ice-nuclei per liter**.

Also on average, large clouds were 35 minutes old when the operations took place; the operation lasted about 30 minutes, and the large seeded clouds lived 290 minutes.

Table 2 shows the corresponding results:

**Table 2. Large Seeded Sample versus Virtual Control Sample (13 couples, averages)**

| Variable | Seeded Sample | Control Sample | Simple Ratio | Increases (%) |
|---|---|---|---|---|
| **Lifetime** | 290 min | 210 min | 1.38 | 38 |
| **Area** | 668 $km^2$ | 547 $km^2$ | 1.22 | 22 |
| **Precip Mass** | 84,807 kton | 60,036 kton | 1.41 | 41 |

Timing for this sub-sample was excellent (90%) and the increases are appreciable.

An increase of 41% in precipitation mass for a control value of 60,036 kton in 13 cases may mean:

□ 2 **= 13 x 0.41 x 60,036 kton = 319,992 kton = 259,513 ac-ft**

The sub-sample of 7 type B seeded clouds received a synergetic analysis. On average, the seeding operations on these type B clouds affected 45% of their whole volume; with a good timing (55% of the material went to the clouds in their first half-lifetime). A total of 61 flares were used in this sub-sample for an effective dose about **70 ice-nuclei per liter**.

Also on average, type B clouds were 190 minutes old when the operations took place; the operation lasted about 25 minutes, and the type B seeded clouds lived 300 minutes.

**Table 3. Type B Seeded Sample versus Virtual Control Sample (40 couples, averages)**

| Variable | Seeded Sample | Control Sample | Simple Ratio | Increases (%) |
|---|---|---|---|---|
| **Lifetime** | 300 min | 265 min | 1.13 | 13 |
| **Area** | 774 $km^2$ | 668 $km^2$ | 1.16 | 16 |
| **Precip Mass** | 109,395 kton | 95,126 kton | 1.15 | 15 |

Timing for this sub-sample was good (55%).

An increase of 15% in precipitation mass for a control value of 95,126 kton in 7 cases may mean:

□ 3 **= 7 x 0.15 x 95,126 kton = 99,882 kton = 81,005 ac-ft**

**The total increase:** □ **=** □ 1 **+** □ 2 **+** □ 3 **= 350,716 ac-ft**

## APPENDIX

**Mesoscale Convective System (MCS)** is a large complex of showers and thunderstorms at least 100 km (~60 miles) across, and may be as large as 500 km (~310 miles) across.

**Shortwave**, or shortwave trough, refers to a small-scale area of lower pressure, sometimes accompanied by showers and thunderstorms.

**Cell** refers to an updraft-downdraft couplet in a cloud. Clouds with several updraft-downdraft couplets are called **multicell** clouds. A storm with a single updraft-downdraft couplet (often rotating) that lasts for several hours is called a **supercell.**

**Pre-frontal trough** refers to an elongated area of low pressure found ahead of an advancing cold front. In south Texas, the passage of a pre-frontal trough usually signals the end of precipitation, as winds tend to turn more to the west or northwest, cutting off moisture supply.

**Precipitable Water** is the total amount of water vapor in a column of air above a given location. This value is expressed in inches. High precipitable water values (>1.5 inches) are indicative of the potential for heavy rain. Tropical airmasses usually have a precipitable water value in excess of two inches.

**Convective temperature** is the temperature required at or near the ground in order for convection (surface-based) to occur.

**TUTT**, or Tropical Upper Tropospheric Trough, refers to a upper level cold core area of low pressure found in the tropical and sub-tropical regions of the Earth. These disturbances are sometimes associated with shower and thunderstorm activity, and are associated with tropical waves.

**Theta-e**, or equivalent potential temperature, is the temperature a parcel or bubble of air would reach if it was lifted until all of the moisture condensed out, then brought back down to 1000 mb (at/near surface). A forecaster looks at theta-e to see how moisture is distributed over a region. High theta-e values are associated with moist airmasses, which storms may develop in and feed on.

**Jet streak** refers to the maximum wind speed within a river of faster-moving air (jet stream). Forecasters may look for jet streak locations at 850mb, 700mb, 500mb, and 250 mb in order to assess the possibility of strong/severe thunderstorms.

**Cap** refers to a warm layer of air aloft which acts as a lid, suppressing convection. The strength of the cap varies with time and location.

**Convective Inhibition** is the amount of energy required to overcome the cap, or the amount of energy required by a parcel of air to initiate deep convection (i.e., thunderstorms).

**Lifetime** refers to the length of time a cloud was detected on radar, with a reflectivity maximum of at least 32 dBZ.

**Area** refers to the two-dimensional space (length x width) covered by a cloud.

**Precip Flux** refers to the radar-derived volume of water falling through the bottom of the cloud per second.

**Precip Mass** refers to the total mass of water and ice for all droplets/crystals larger than 100 μm ($10^{-4}$ m) in a cloud.

**Small seeded clouds** are those clouds with a radar-derived Precip Mass less than 10,000 kilotons.

**Large seeded clouds** are those clouds with a radar-derived Precip Mass greater than 10,000 kilotons.

**Type B clouds** are those clouds, small or large, that were not seeded until they were at least one hour old, as determined by their presence on radar.

**Control clouds** are those clouds within 100 km of the radar that were NOT seeded. Control clouds are used to determine the effectiveness of seeding, as it represents "what would have happened" if seeding had not taken place.

**Effective dosage** refers to the amount of seeding material that was placed in the cloud. It is expressed as a concentration of ice nuclei per liter of air.

Radar analysis numbers came from Archie Ruiz's final report of the 2004 season for the EAA (5 pp).

# Acknowledgements

2004 was another successful season for the cloud seeding in the Edwards Aquifer Authority target area. The assessment was done and showed positive effects. This project could not be possible without the hard work and dedication of many people. In this section those appropriate parties will be thanked.

First of all, Todd Flanagan, who trained me for the time that I needed to be supervised. He taught me the ropes of cloud seeding operations, introduced me to the people I would be working with, and overall increase my knowledge base about meteorology and weather modification. With his expertise in the area, I feel like I am adequately prepared now to continue my job as a weather modification meteorologist. Also thanks to the pilots of the SWTREA project and the project manager and secretary, Cole Van Cleve, Ed Walker and Debbie Farmer. The contributions also by the former SWTREA project meteorologist, Dave Cousins can also not go unthanked. Also to the SWTMA pilots Ron Merks and Mickey Chadwell which have enabled our project to continue to operate in the absence of one of our pilots near the end of the season. There are others I would also like to thank that are involved with the STWMA including, Tommy Shearrer, Tim Pickens, as well as many others. These people have made the transition of working here and adapting to new surroundings very easy.

I am very sure that I have left out some people that have helped in the project and without them it would not be what it is. So to those of you, who know who you are, thanks so much for making my first experience with weather modification a very productive and good one! I look forward to working with everyone mentioned and no mentioned and learning even more.

Rainfall maps for the South Texas area for 2004 were taken from the following website:

http://www.hprcc.unl.edu/products/current.html