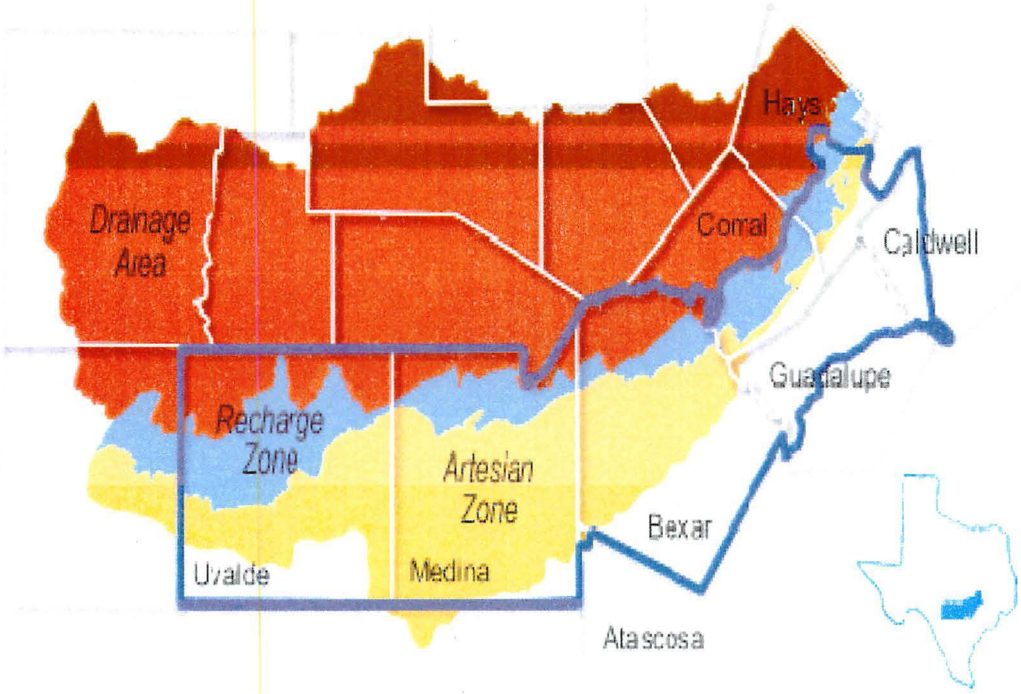
# Southwest Texas Rain Enhancement Association
# 2008 Edwards Aquifer Authority Final Report


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


## 2008 Project Staff

Ed Walker, Project Manager, Pilot-in-Charge (PIC)
Matthew Pope, Pilot
Stephanie Beall, Project Meteorologist
Debbie Farmer, Clerical



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## The Year in Review

2008 marked the seventh year of operations for the Edwards Aquifer Authority (EAA) by the Southwest Texas Rain Enhancement Association (SWTREA). The project this year was business as usual, with seeding taking place in Uvalde County from May until September. As the weather tends to do, the pattern this year was almost a complete flip flop for the EAA area. Most locations near the coastal areas were at or above normal, but locations further inland, including Uvalde County, were very dry. The dry conditions were not confined to just Uvalde County. Most of South Texas and the counties within the Aquifer saw a very dry year in 2008.

Seeding in the Authority target area of Uvalde County saw a total of five flights for the 2008 operational year, two of which were reconnaissance flights. A total of seven flights were conducted in 2007. The 2006 to 2008 was a period that shows how anomalous precipitation patterns can be. Starting with 2006, the area was coming out of a two-year drought. The pattern was active but not extremely active. 2007 brought ample rains to the area, which led to very tropical type clouds that were deemed not seedable, and flooding in some locations led to suspension of the project for a month. 2008 was a dry year for most locations as well. Showers and thunderstorms that did occur were tropical in nature and were deemed not seedable using glaciogenic flares.

The comparisons of these three years can show just how variable precipitation can be. Flights this year were limited due to the lack of suitable candidates for seeding. Clouds that were seeded were few and far between. September which is usually a very active month offered only three seeding flights for the entire SWTREA target area and no flights for Uvalde County.

As was the case last year, in addition to normal weather modification activities in the Edwards Aquifer Authority (EAA) target area, 2008 was the second year of a three year randomized seeding experiment. The randomized seeding experiment was also conducted by the EAA's other weather modification contractor, the South Texas Weather Modification Association (STWMA). The objective of randomized seeding operations for the Edwards Aquifer Authority was to select clouds that met the criteria for suitable seeding candidates. This was seeding at random, and from that point, measurements and observations were taken to determine if seeding had an effect on the cloud. The experiment was double blind so that ground operations staff would not know which clouds were seeded and which were not seeded due to bias that could occur. In other words, the staff was unaware of the seeding decision.

Since 2008, like 2007, was an unusual year in terms of how much rainfall, only a very small sample size was acquired. Data was collected from only one flight between the two projects and will be analyzed per the randomized criteria. Only one randomized seeding flight took place in Uvalde County during the 2008 season. The reason for such a small case size during the season was due to most of the convection in the EAA target area not meeting the randomized criteria. In particular, one criterion that must be met is that the convection is isolated and there is not other convection within a certain distance. Most

convective cells that did occur in Uvalde County were not isolated and thus a randomization could not be conducted on it.

Randomized procedures involved a black box that inside contained envelopes with a card inside. The card denoted either "SEED" or "NO SEED". A box was placed in the office for each project, STWMA and SWTREA. Each of the aircraft that participated in the experiment had a box placed in the aircraft.

Once the pilot had declared a "case" based on the criteria listed above, both the meteorologist and the pilot opened the first envelope in the box. The meteorologist then told the pilot the word on the card, who then determined whether to seed or not to seed based on the table below:

| **Radar** | **Aircraft** | **Action** |
|---|---|---|
| Seed | No Seed | No Seed |
| Seed | Seed | Seed |
| No seed | Seed | No Seed |
| No seed | No Seed | Seed |

The pilot, under no circumstances, told the meteorologist whether the decision was to seed or not seed, and the pilot and meteorologist did not communicate on issues related to the apparent effect of seeding or any noticeable effect. Any other normal conversation regarding safety of the pilot, aircraft, or any type of air traffic communication was talked about as normal.

At the September 30th conclusion of the 2008 operational season for the EAA target area, a radar evaluation was completed for the program. The findings are presented and discussed towards the end of this report. The flight logs for the 2008 seeding season are listed below.

# 2008 Flight Log for SWTREA EAA Target Area

## Seeding Flights

| Flight Number | Date | Aircraft | Total Time (hours) | Material used | Total Seeding Material used AgI (g) |
|---|---|---|---|---|---|
| 1 | 6/21/2008 | 847P | 0.5 | 8(40g) BIP Flares | 320 |
| 2 | 6/29/2008 | 847P | 0.55 | 16(40g) BIP Flares | 960 |
| 3 | 8/5/2008 | 622X | 0.9 | 11(40g) BIP Flares | 440 |

## Reconnaissance Flights

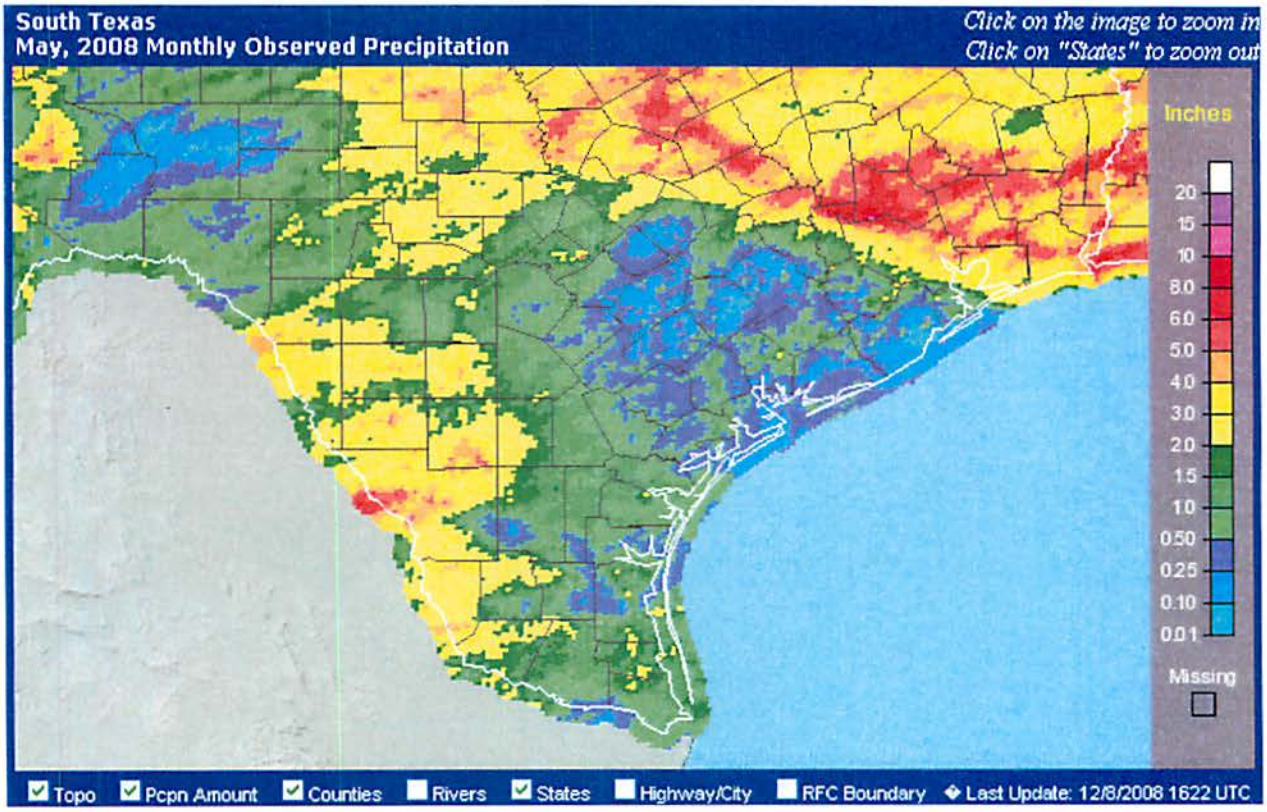
| Flight Number | Date | Aircraft | Total Time (hours) | Reason |
|---|---|---|---|---|
| 1 | 6/20/2008 | 498P | 0.75 | Storms were very short-lived |
| 2 | 8/16/2008 | 622X | 0.95 | No inflow with storms |

## Operational Summary

### May 2008

The month of May continued to be a very dry month for the area but a bit wetter than the previous month. An active weather pattern occurred during the middle of the month where a persistent trough was north/northwest of the area. This allowed disturbances to move across South Texas, but rain chances were not widespread. High pressure took control by the end of the month and persisted, making for hot and sunny days from the 20th of the month on. Even though the weather pattern was active during the middle part of the month, showers and thunderstorms stayed to the south of the EAA target area and thus no seeding operations were conducted during the month of May.

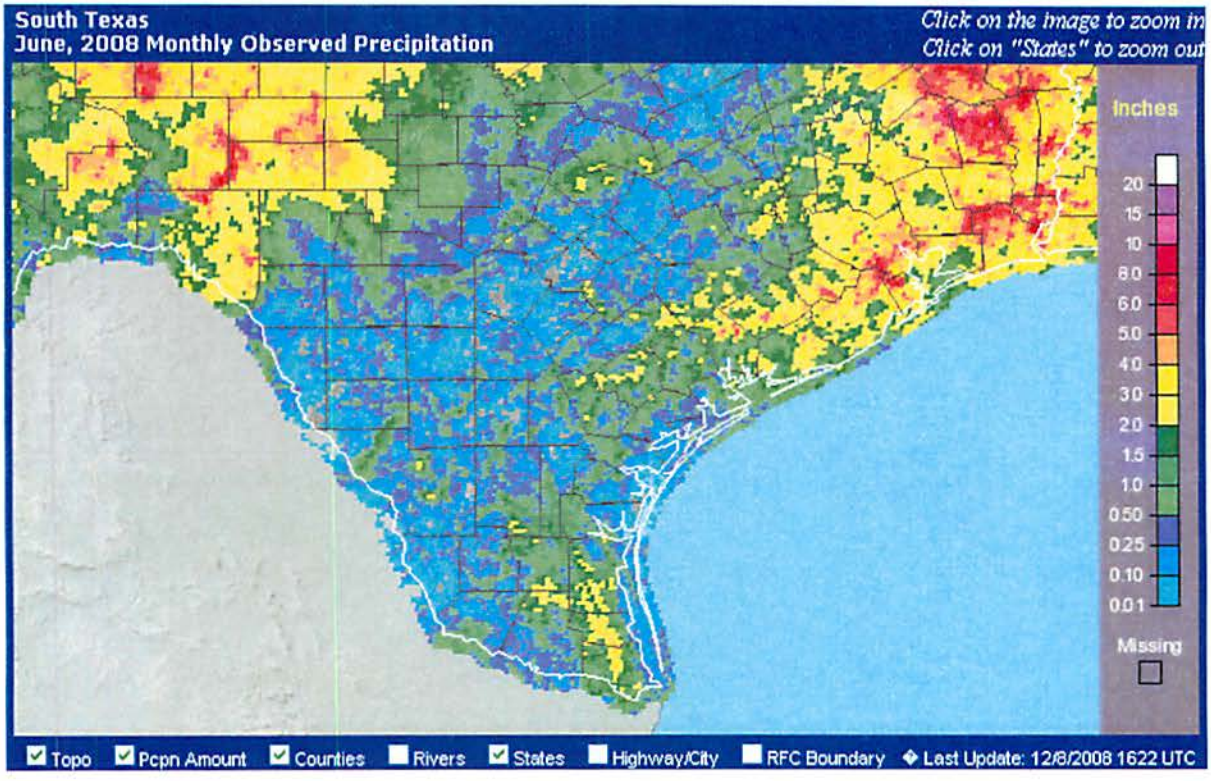
After looking at the graphic below for the month of May, one can tell that precipitation was about average for the month. May is typically one of the wettest months for South Texas and this graphic illustrates that well. Further south into the Rio Grande Valley, precipitation was well above average for the month.



**June 2008**

June was a very dry month not only for the EAA target area but for most of south Texas. The continual upper level ridge of high pressure that usually orients itself over the area late in the summer prohibited any type of convection, let alone clouds, to occur over the area. The first two weeks of the month were extremely dry and hot for south Texas. A change in the pattern finally occurred during the latter part of the month with a stationary boundary providing chances for convection around the 21st of the month. This allowed for an active pattern to continue over the area. Another seeding flight took place near the end of the month as an upper level low that was west of the area provided for ample shower and thunderstorm chances into the new month. A total of two flights took place in Uvalde County for the month of June. A total of 24 flares and 960g of AgI were used.

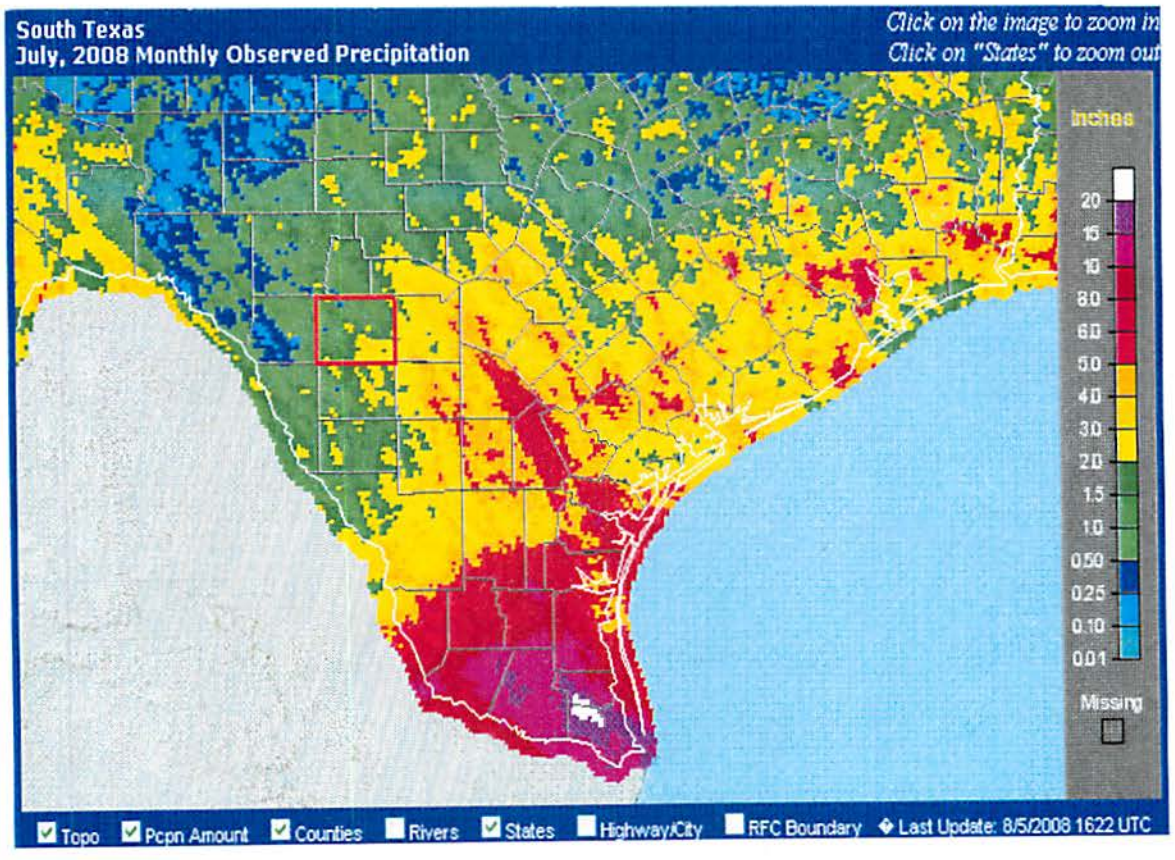
The graphic below shows a very dry month for not only Uvalde County but for most of South Texas. Most locations in Uvalde County only received between 0.01 inches and 1.5 inches. Locations to the east and northwest were much wetter compared to South Texas.



**July 2008**

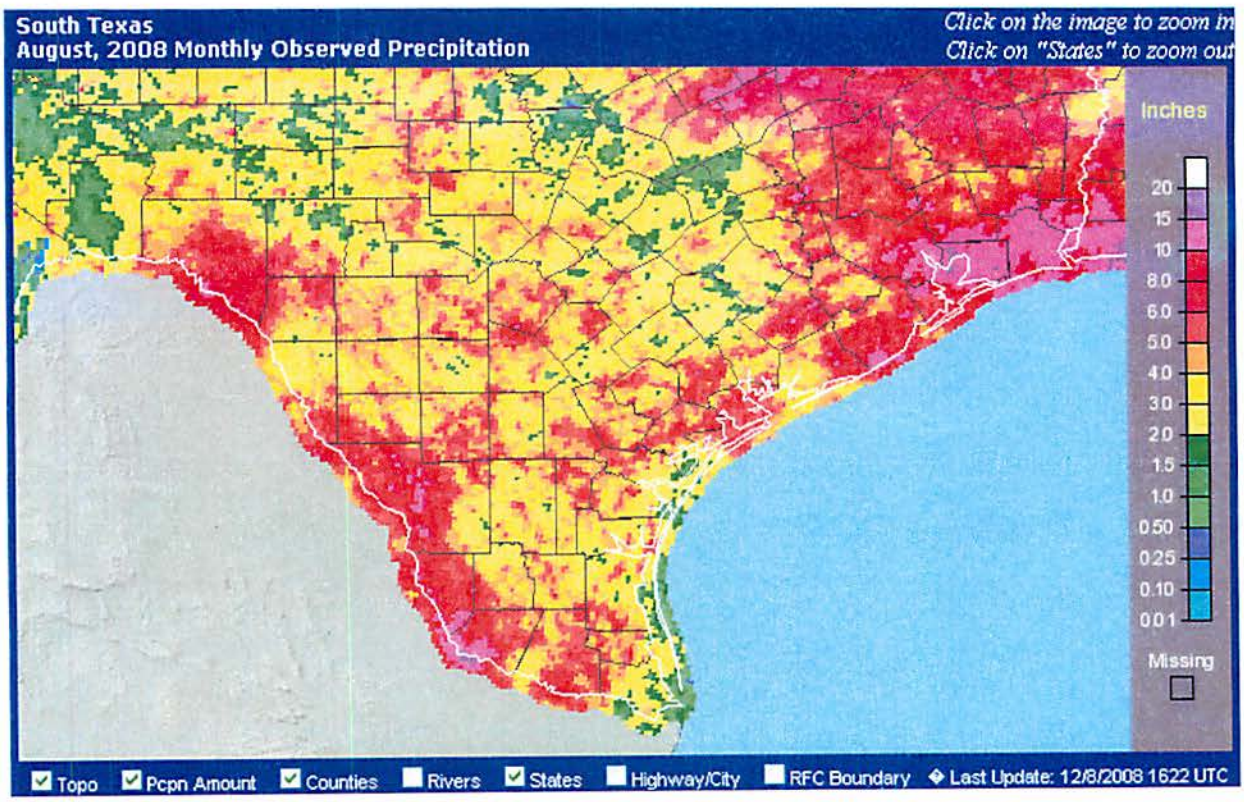
After a rather dry month in June, July proved to be even drier across the area. A persistent ridge of high pressure managed to settle in over the central part of the U.S and really didn't move much for most of the month. However, some locations in Uvalde County did manage to receive above average rainfall for the month due to the effect of Hurricane Dolly. A large rainfall difference was noted over the area from southeast to northwest, solely due to the presence of Dolly during the last couple weeks of July. The southeastern parts of the county managed to be a couple of inches above normal, the central parts of the county were at about normal, and the north/northwestern portions of the county were below normal. Due to the ongoing dry month, no missions were flown during the month of July in Uvalde County.

The graphic below represents rainfall for the month of July. Uvalde County is outlined in red. July brought more precipitation to the area than the previous month. The locations of highest precipitation in this graphic are along the coastal areas, mainly due to the influence of Hurricane Dolly impacting the region.



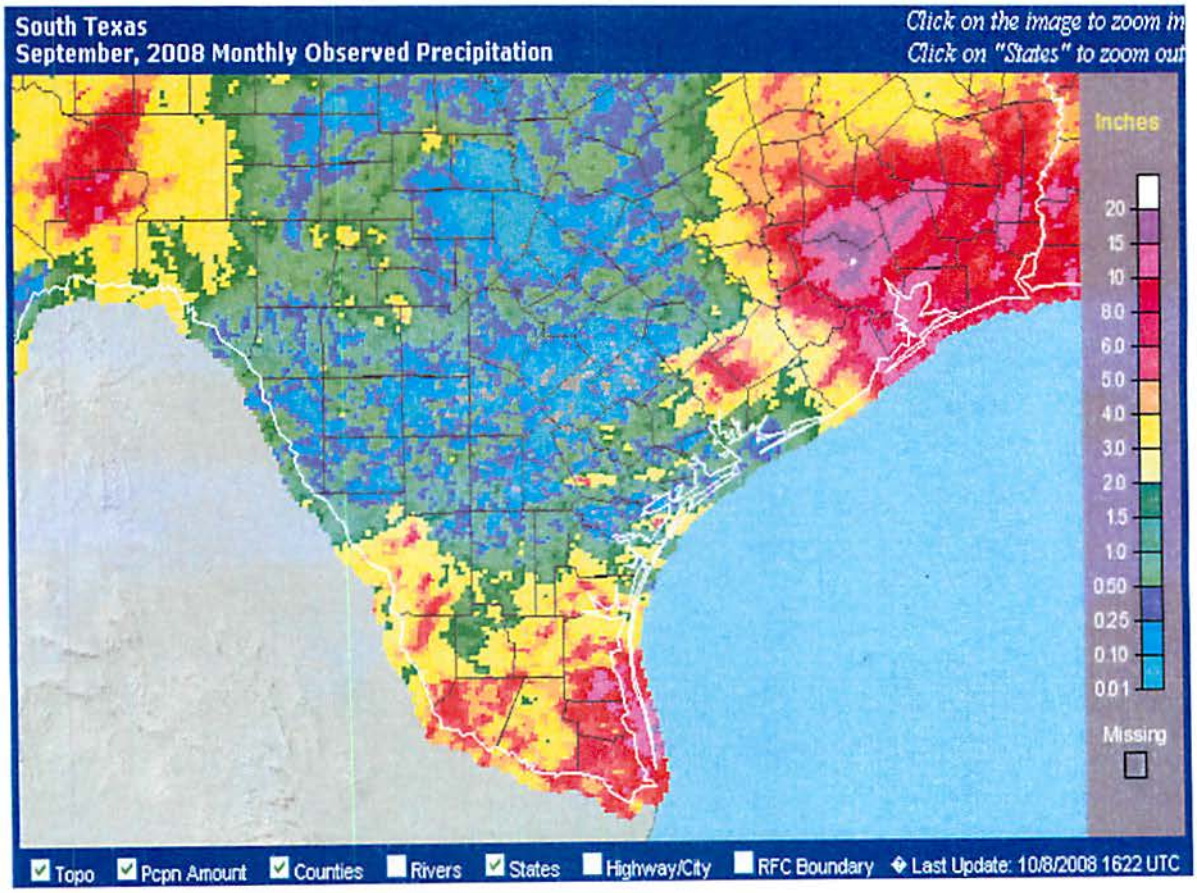
**August 2008**

The first part of August was a dry one, comparable to the latter part of July. It seemed as though a ridge of high pressure remained the norm across the area until about the middle of the month. For the last two weeks of the month, the area was under the influence of mid to upper level lows that seemed to remain over northern Mexico. Many locations to the south of Uvalde County received large rainfall totals for the month and these rains brought them up to near normal for the month. As well, near the end of the month, locations around Del Rio, TX received almost 10 inches of rain in one day. However, Uvalde County did not totally miss out. Most parts of the county received anywhere from 4-6 inches for the month, which in most locations is above normal for the month. In terms of weather modification, the month was pretty slow even though rain fell for almost the last two weeks of the month. The persistent tropical nature of the clouds in Uvalde County yielded them unseedable due to the natural lack of ice in the cloud. As well, the embedded nature of the convection on a few occasions inhibited seeding in the county. For the month of August, one seeding flight and one reconnaissance mission took place. A total of 10(40g) BIP Flares and 400g of AgI were used. The graphic below shows the observed precipitation for the month of August for the South Texas region.



**September 2008**

After a wet end to the month in August, September proved to be a much drier one across Uvalde County and into most of south Texas. Looking at the graphic below, one can see that a large hole in heavy precipitation extending from central Texas into south Texas. The wet spots were over the Big Bend area and near Houston. The large precipitation maxima near Houston were due to Hurricane Ike. Other than that, most locations around the EAA and the SWTREA target areas were pretty dry. Uvalde County received only about 1-2 inches of rain for the month, which is typically one of the wetter months for south Texas. A lack of convection for most of the month yielded no flights for Uvalde County. The lack of convection was due to persistent ridge of high pressure over central Texas.



## 2007/2008 EAA COMPARISON

| YEAR | 2007 | | | 2008 | | |
|---|---|---|---|---|---|---|
| MONTH | # of flights | Total Seeding Material | # of seeding days | # of flights | Total Seeding Material | # of seeding days |
| MAY | 2 | 1,120g AgI | 2 | 0 | 0g AgI | 0 |
| JUNE | 1 | 280g AgI | 1 | 2 | 960g AgI | 2 |
| JULY | 0 | 0g AgI | 0 | 0 | 0g AgI | 0 |
| AUGUST | 4 | 1,640g AgI | 4 | 1 | 440g AgI | 1 |
| SEPTEMBER | 0 | 0g AgI | 0 | 0 | 0g AgI | 0 |
| TOTAL | 7 | 3,040g AgI | 7 | 3 | 1400g AgI | 3 |

The preceding table gives a historical glance of a comparison of the Authority seeding activities for 2007 and 2008. This is useful to see what kind of activity has been ongoing throughout the last two years of the Authority project.

2008 was definitely not a very active year in terms of weather modification. As stated previously in this report, a very dry pattern persisted across the area for the year. A more tropical pattern was in place over the season. This pattern brought a couple of hurricanes to the coastal areas of Texas and left areas inland, including Uvalde County, very dry.

## Meteorological Perspective of Seeding in 2008

This section is a summary of perceived efforts of cloud seeding as determined by radar trends. From the project meteorologist perspective, the 2008 seeding season saw below normal flight activity due to tropical convection that is not deemed as seedable with glaciogenic material. A few events did not offer very good seeding conditions due to large complexes of rain having undefined bases.

May offered no missions, but precipitation was about normal for the month. This is about average for this time of year, but cloud bases and warm based convection allowed for fewer opportunities that would have otherwise been seeded.

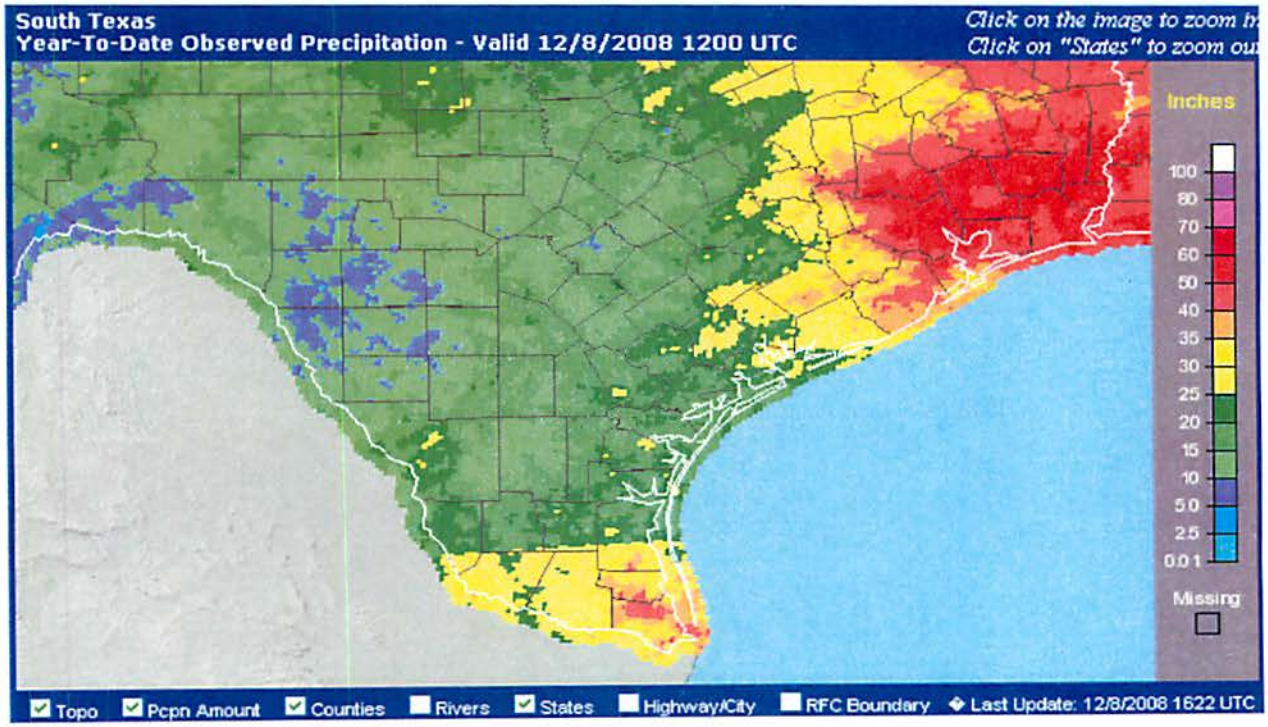
June offered two missions this month. Even though the area was very dry for the month, a couple of seeding flights occurred on convection that moved into the EAA target area. July offered no missions for Uvalde County. High pressure dominated the area for a large part of the month, keep the area mostly sunny and dry.

August offered one seeding flight and one reconnaissance flight over the area. The lack of flights this month was mostly due to the unseedable nature of the clouds that were over the area. This included warm clouds that were lacking natural ice that is needed for glaciogenic cloud seeding in Texas.

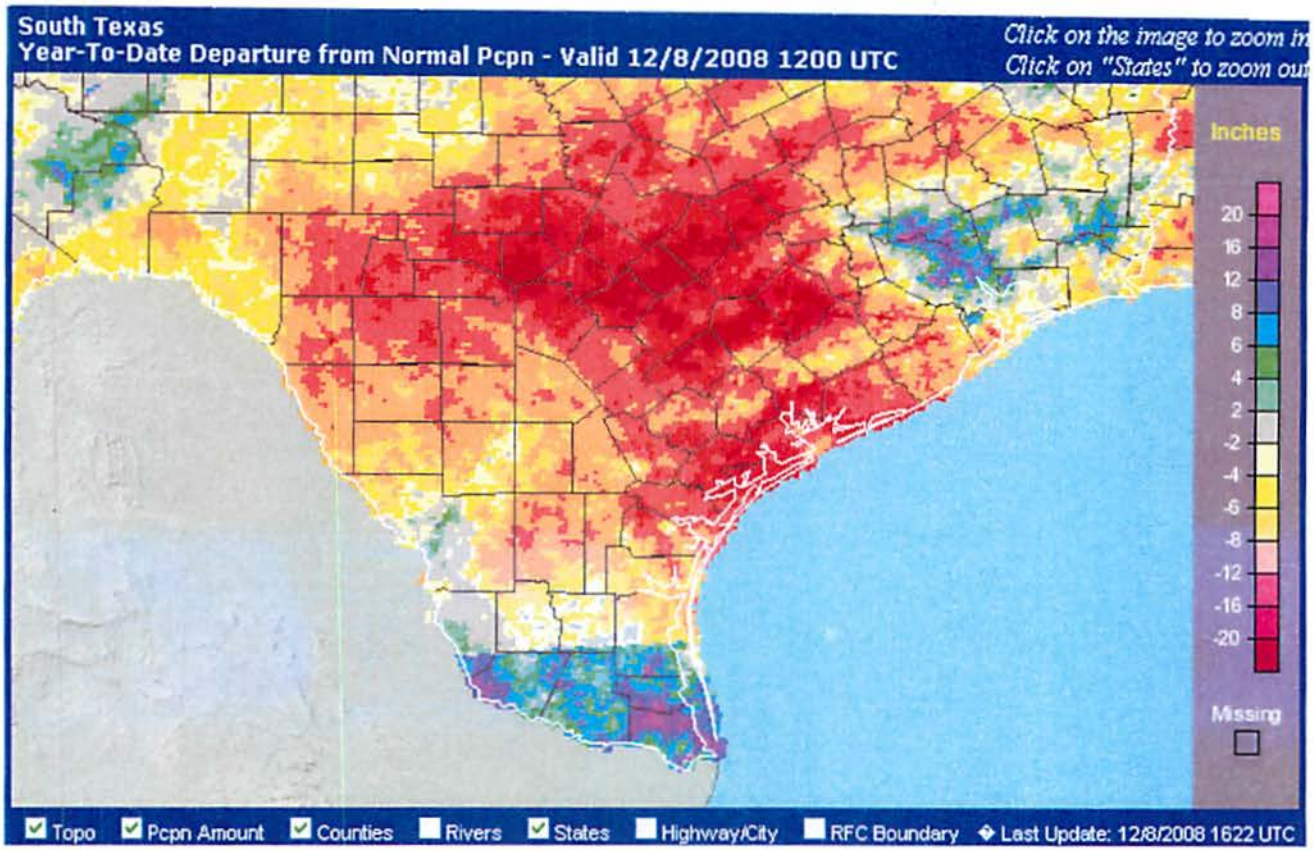
In September, no flights were flown across the EAA target area. Most of south Texas was dry with the exception of the coastal areas which exhibited a heavily tropical pattern in place. This included a hurricane over southeast Texas around mid-month.

Overall, a total of three flights took place in the EAA target area, summarizing the season as below average. Below is the total precipitation for the year-to-date across South Texas. The page thereafter shows the percentage of normal for South Texas. These graphics can clearly show that 2008 was a very dry year for most of South Texas and the Edwards Aquifer. In particular, most of Uvalde County was very dry compared to the other counties in south Texas.

**2008 Precipitation (Year-to-date 12/8/2008)**



**2008 Departure from Normal (Year-to-date 12/8/2008)**

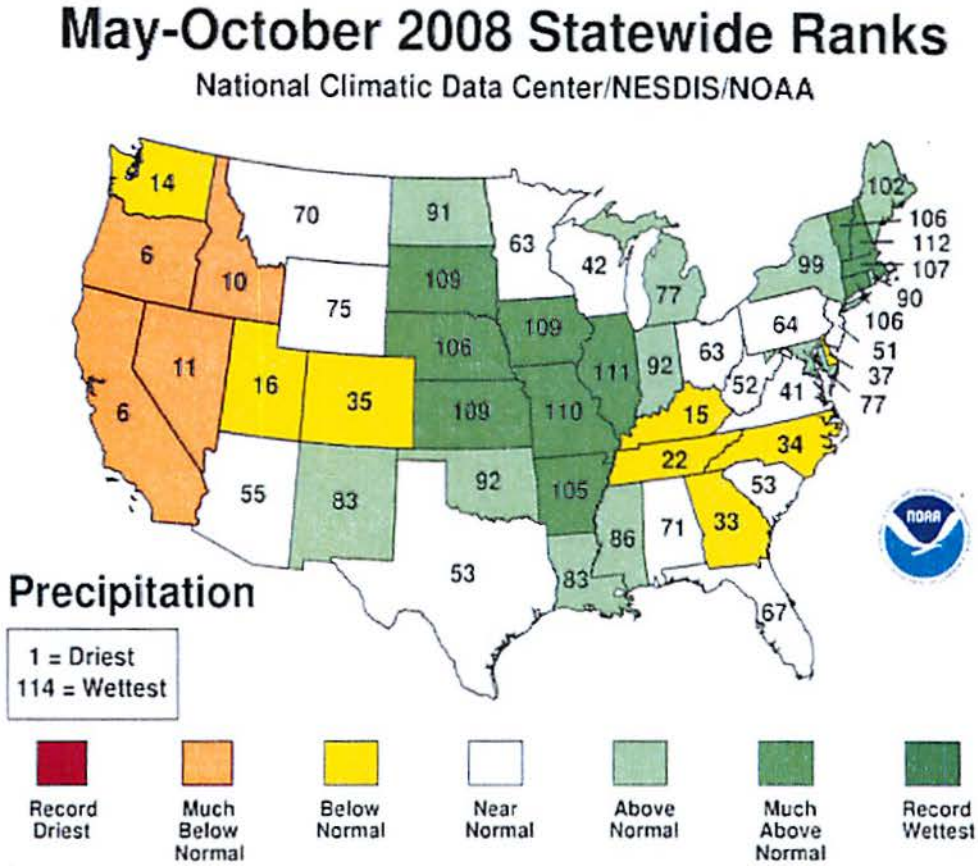



The next two figures take another look at precipitation amounts across the United States and how it compared to South Texas in 2007.

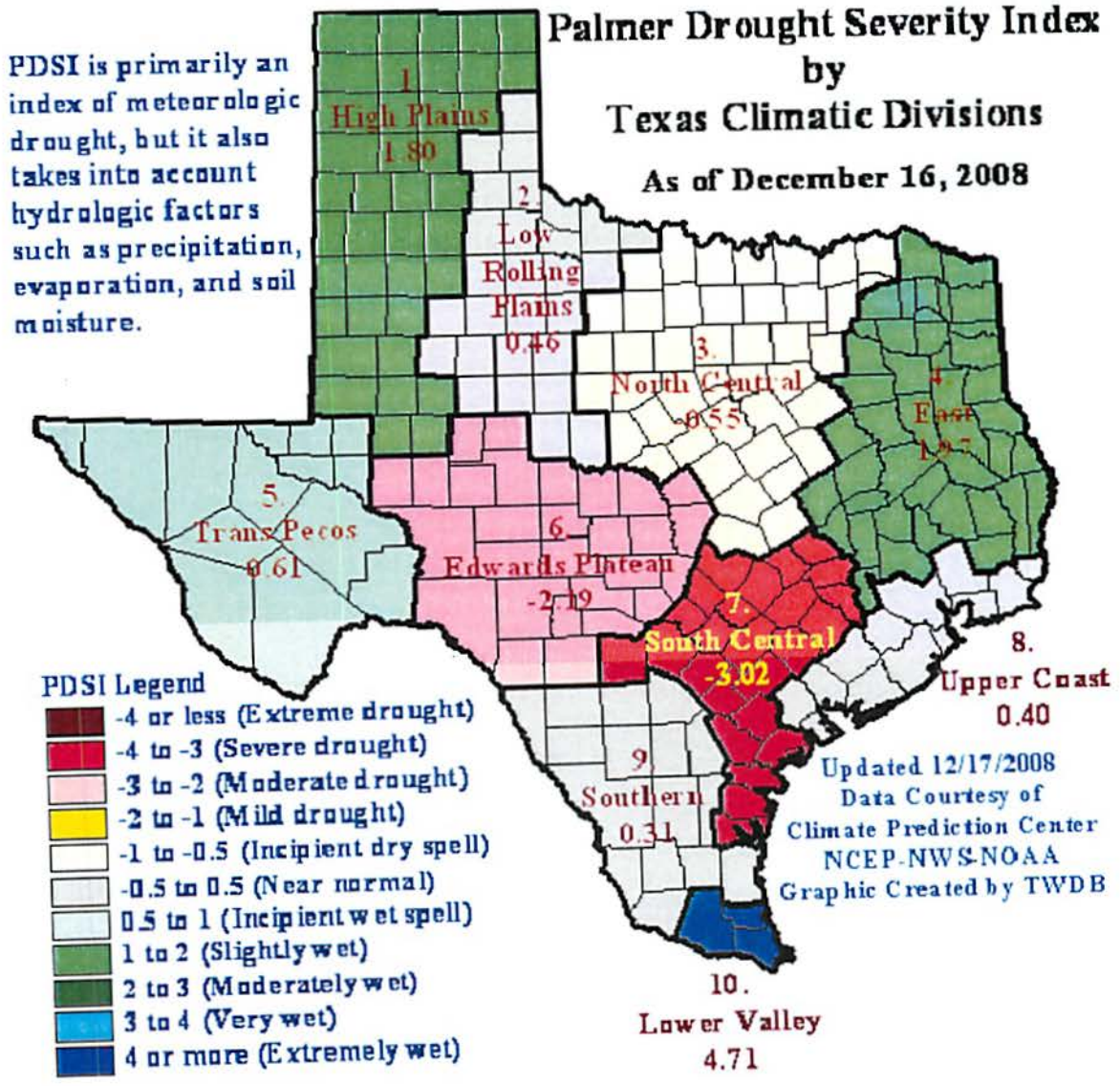
The following figure is a color coded picture of the United States. This graph represents precipitation from a period of May of 2008 to October 2008. This essentially depicts the average seeding season for the EAA, with the exception of October. Looking at the next graph, a number of things quickly jump out at the reader. First of all, a very wet regime is noted in the central and southern Plains. Locations to the east and the west of the central Plains were below average precipitation for this period of time. Out west, a continued dry pattern occurred during this time frame. This graphic shows a persistent ridge over the west and a persistent trough over the central and northern parts of the county. For Texas, it was an in-between year. Most locations in Texas were near normal for the year. This makes sense, with a few months during the season being very dry and a few months being very wet. For people who are unfamiliar with a trough and ridge, an explanation will follow of these common weather systems. A trough, or as it is commonly referred to, a trough of low pressure, usually induces rising air which allows cooler and warmer air to interact and create a temperature and pressure difference. These temperature and pressure differences usually create weather - most commonly in Texas, showers and thunderstorms. When a ridge or a ridge of high pressure is present, air is generally sinking, creating subsidence, or drying of the air. This eliminates most of the

moisture from the air including clouds. High pressure is usually associated with fair weather and warm temperatures during the summer, whereas low pressure is usually associated with cooler temperatures and more precipitation.

This figure illustrates a continuing presence of a ridge of high pressure over the western U.S and Southeastern U.S. This also shows a fairly constant presence of a trough of low pressure across the central and north-central parts of the U.S, leaving Texas somewhere in between.




The last picture that will further communicate the dryness of the summer is the Palmer Drought Severity Index (PDSI). This is used as a meteorological index of drought. This takes into account hydrological factors such as precipitation, evaporation, and soil moisture. This particular graphic shows the PDSI as of December 22, 2008. It shows that the Edwards Plateau was classified as in a moderate drought. The area further to the east was classified as in severe drought and the area further to the south as near normal. As well, most coastal regions in this graphic are either at normal or above normal, further showing how most of south Texas was influence heavily by a tropical pattern in place for the spring and summer months.


Palmer Drought Severity Index
by
Texas Climatic Divisions
As of December 16, 2008
PDSI is primarily an index of meteorologic drought, but it also takes into account hydrologic factors such as precipitation, evaporation, and soil moisture.
1. High Plains 1.80
2. Low Rolling Plains 0.46
3. North Central -0.55
4. East 1.97
5. Trans Pecos 0.61
6. Edwards Plateau -2.19
7. South Central -3.02
8. Upper Coast 0.40
9. Southern 0.31
10. Lower Valley 4.71
PDSI Legend
-4 or less (Extreme drought)
-4 to -3 (Severe drought)
-3 to -2 (Moderate drought)
-2 to -1 (Mild drought)
-1 to -0.5 (Incipient dry spell)
-0.5 to 0.5 (Near normal)
0.5 to 1 (Incipient wet spell)
1 to 2 (Slightly wet)
2 to 3 (Moderately wet)
3 to 4 (Very wet)
4 or more (Extremely wet)
Updated 12/17/2008
Data Courtesy of
Climate Prediction Center
NCEP-NWS-NOAA
Graphic Created by TWDB

## APPENDIX A

Arquímedes Ruiz-Columbié of Active Influence & Scientific Management annual analysis for the Edwards Aquifer Authority was not completed at the time of the printing of this report.

**Acknowledgements**

2008 was another successful season for cloud seeding in the Edwards Aquifer Authority target area. The assessment was completed 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 and foremost to the SWTREA project manager and chief pilot, Ed Walker, and Secretary, Debbie Farmer. As well, thanks go out to Matthew Pope who joined the project over the winter and has been indispensible to the success of the project. The continuing cooperation between SWTREA and the South Texas Weather Modification Assocation (STWMA) allows both projects to operate at the most productive level, with two highly skilled meteorologists operating the Edwards Aquifer Projects.