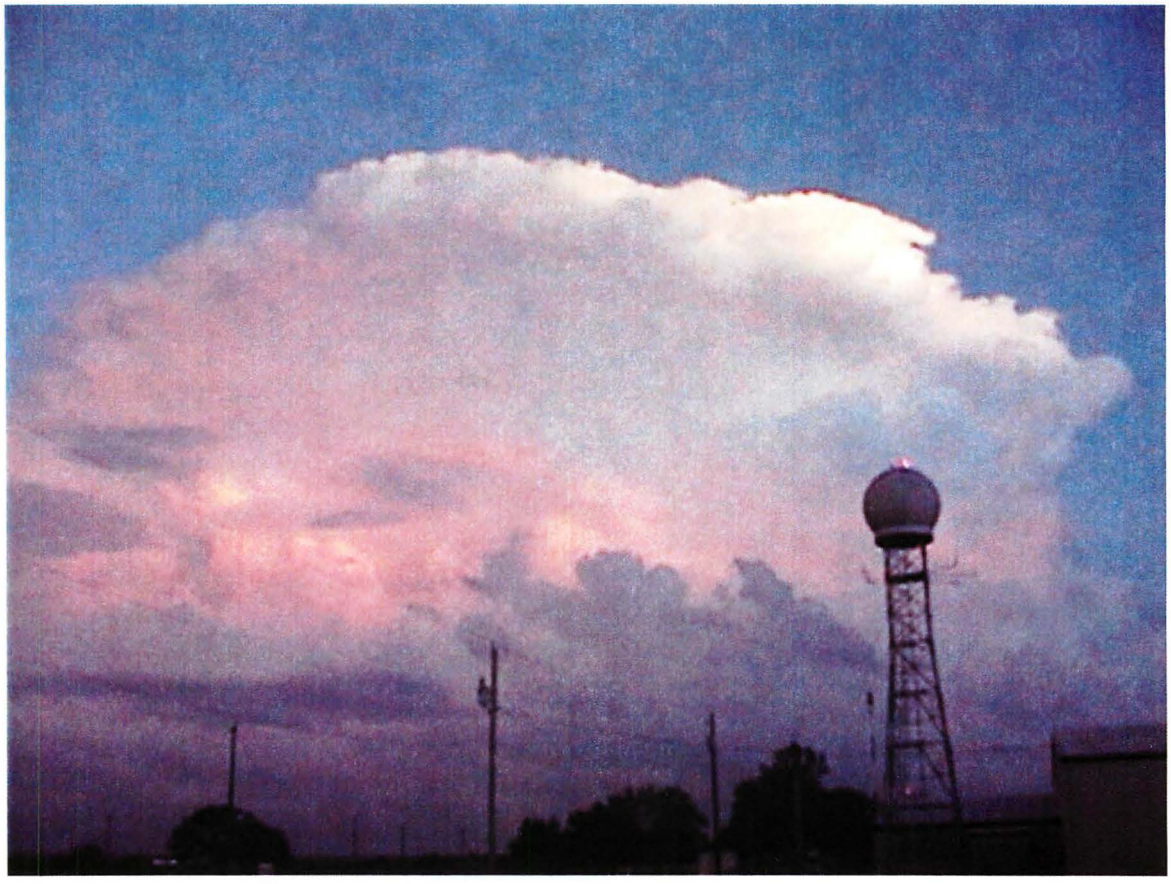
SOUTH TEXAS WEATHER MODIFICATION ASSOCIATION

EDWARDS AQUIFER AUTHORITY TARGET AREA



2005 REPORT

2005 FINAL REPORT

for the

SOUTH TEXAS WEATHER MODIFICATION ASSOCIATION

EDWARDS AQUIFER AUTHORITY TARGET AREA

by

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THE YEAR IN REVIEW

2005 marked the fourth year of operations for the Edwards Aquifer Authority (EAA) by the STWMA. Once again, N57AA was stationed at Stinson Field (SSF) in south San Antonio. Two of our pilots, Ron Merks and Mickey Chadwell, were stationed there. They worked along with Jim Transue and Tim Pickens, stationed at Pleasanton, and Larry Dement, stationed at Kenedy. N57AA did not fly as much this season due to flare rack problems, but Jim Transue and N8847P were able to fly numerous seeding missions in the EAA target area, henceforth referred to as the target area.

2005 turned out to be a good year for seeding in the target area, with 25 days of seeding. This compares with 20 days of seeding in 2004, 22 days in 2003, and 8 days in 2002. May saw a few days with seedable clouds, but was quieter than usual. June was incredibly disappointing, with no seeding missions taking place due to high pressure sitting over the area, effectively capping the convective potential. July exhibited a dramatic swing from June, with seeding taking place on 11 days within the target area. The busier weather pattern continued into August, with seeding missions taking place on seven days. Things began to wind down as fall approached, with only three days of seeding in September, and two in October. Despite the increase in convective activity over last year, rainfall amounts were significantly less in 2005, with some areas reporting rainfall deficits by the end of the year in excess of ten inches; this was mainly over Bexar County. Areas a bit further west over Medina and Bandera counties saw rainfall amounts closer to normal, but still on the dry side. A brief discussion on the meteorological perspective of the weather in summer 2005, along with seeding events will be presented later in the report.

Once the season concluded, Archie Ruiz, who works for Active Influence performing radar evaluations for the Texas weather modification projects, completed the radar evaluation of the program. Once again, the analysis shows that seeding may have produced favorable increases in rainfall, with apparent lifetime extensions in the seeded clouds along with other positive results. These numbers are presented and discussed towards the end of the report.

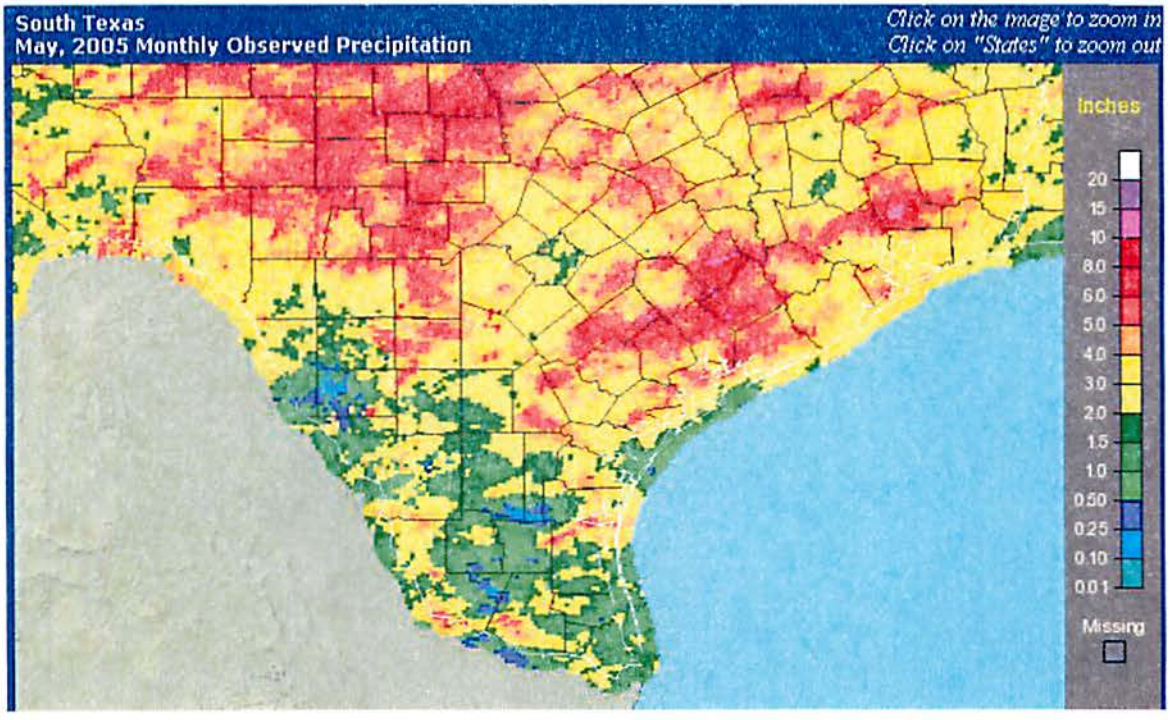
2005 FLIGHT LOG FOR EDWARDS AQUIFER AUTHORITY TARGET AREA

Date	Plane	Flight No.	Take Off Time	Landing Time	Total Time (hrs)	No. Flares Used	Amount of AgI (g)	Flare Locations
15-May	7AA	1	20:00	23:00	3.0	9	360	Bandera - 1; Medina - 8
26-May	7AA	2	18:15	21:45	3.5	3	120	Bandera - 1; Medina - 2
6-Jul	7AA	3	22:15	0:35	2.3	8	320	Bandera - 8
7-Jul	7AA	4	23:00	1:15	2.3	6	240	Bandera - 6
9-Jul	7AA	5	20:40	21:55	1.3	3	120	Medina - 3
14-Jul	47P	6	18:45	21:00	2.3	14	720	Bandera - 6; Medina - 7; Uvalde - 1
14-Jul	60P	7	18:55	20:25	1.5	2	160	Bandera - 2
15-Jul	47P	8	18:35	22:00	3.4	24	1680	Bandera - 1; Bexar - 6; Medina - 17
16-Jul	47P	9	21:50	23:45	1.9	3	120	Medina - 3
17-Jul	7AA	10	20:05	22:05	2.0	2	80	Bexar - 2
18-Jul	47P	11	22:15	0:05	1.8	16	640	Bandera - 3; Bexar - 12; Medina - 1
21-Jul	47P	12	19:10	22:05	2.9	18	720	Bexar - 10; Medina - 8
24-Jul	60P	13	21:40	23:15	1.6	12	480	Bexar - 12
29-Jul	47P	14	22:05	23:45	1.7	5	200	Bexar – 4; Medina - 1
2-Aug	47P	15	19:40	21:20	1.7	7	280	Bandera - 5; Medina - 2
5-Aug	47P	16	16:55	20:35	3.7	20	800	Bexar - 11; Medina - 9
6-Aug	47P	17	18:10	20:40	2.5	14	560	Bandera - 8; Medina - 4; Uvalde - 2
13-Aug	09P	18	23:00	0:25	1.4	3	120	Medina - 3
15-Aug	47P	19	18:20	20:00	1.7	9	360	Bandera - 9
15-Aug	09P	20	20:45	23:45	3.0	6	240	Uvalde - 6
19-Aug	60P	21	20:25	22:45	2.3	2	160	Bexar - 2
19-Aug	47P	22	21:50	23:45	1.9	8	320	Medina - 8
29-Aug	47P	23	17:35	20:00	2.4	25	1000	Bandera - 2; Medina - 23
3-Sep	47P	24	19:35	21:50	2.3	3	120	Bexar - 3
10-Sep	70P	25	20:10	20:30	0.3	1	40	Bexar - 1
10-Sep	09P	26	20:30	23:45	3.3	11	440	Bexar - 5; Medina - 6
12-Sep	47P	27	21:25	23:00	1.6	2	80	Medina - 2
3-Oct	47P	28	20:00	21:05	1.1	5	200	Medina - 5
31-Oct	47P	29	19:00	21:45	2.8	20	800	Bandera - 8; Medina - 12
Totals:		**29 flights**			**63.5**	**261**	**11480**	**Bandera - 60; Bexar - 68; Medina - 124; Uvalde - 9**

MAY 2005

May turned out to be a wetter than normal month for parts of the target area, mainly spots in Bandera and Medina counties, with totals exceeding 6 inches in several spots. A lot of the rain fell during overnight Mesoscale Convective System (MCS) events, although there were daytime events that occurred as well. Some of these events were seedable, particularly May 15, 26 and 28. On May 15, the leading edge of an MCS pushed into the target area from the northwest. Several locations along the leading edge of rain were seeded, with apparent benefits being noted in areal coverage and intensity. While this was considered a very good day as far as seeding goes, the best day of the month was the 26th, when the remains of an MCS moved across the target area, with new activity developing along the leading edge. This activity was seeded, even with flares fired just outside the target area border. In the latter case, the seeding helped a storm which sat over Stinson Field in south San Antonio. This particular cell dropped over 2 inches of rain. The third round of seeding in the EAA target area was performed by one of the SWTREA planes in Medina County, but the reporting of this event will be deferred to them and not included in STWMA numbers.

Overall for the month, two days saw seeding operations take place. Twelve 40g flares were burned within the target area (Bandera - 2; Medina - 10), totaling 480g of AgI.



MAY 15

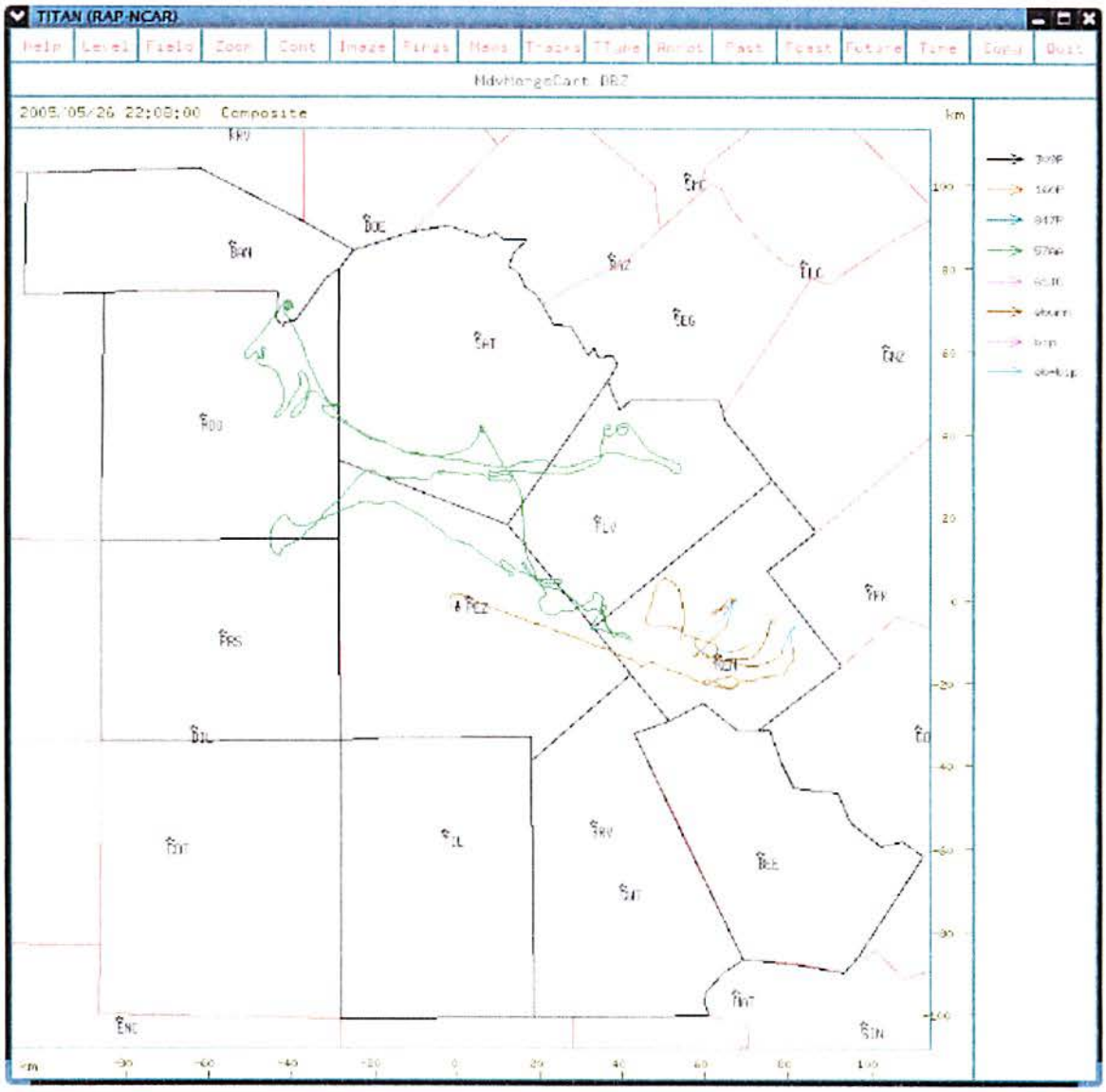
A typical northwest flow event was ongoing in the morning, with an MCS over west-central Texas sliding southeastward. This feature approached the northern border of the target area early in the afternoon. A few showers developed out ahead of the main area of convection. A plane was dispatched at 2000 UTC to seed activity south of Medina County, which eventually grew northward into Medina County. Seeding was done in Medina and Bandera counties over the course of the afternoon as the complex pushed eastward. Increases in intensity and particularly areal coverage were noted. Overall, it was a very good day as far as apparent effects from seeding.

Nine 40g flares were burned (Bandera - 1; Medina - 8), totaling 360g of AgI.

MAY 26

A complex of showers and thunderstorms approached the area from the northwest in the morning and early afternoon hours. As the leading edge of the complex pushed into Bandera County, new shower and thunderstorm activity developed. As this activity began to develop, 7AA was launched from Stinson Field at 1815 UTC (1:15pm) to investigate the developing cells near Medina Lake. Several flares were fired into these clouds, with merging of the cells appearing to take place about a half hour later. Then, activity developed on the south side of San Antonio, about over Stinson Field. The plane managed to seed this storm from just over the county line, in Atascosa Co. This storm moved very slowly (< 5 mph) and dropped over two inches of rain over the south side of San Antonio. Soon after seeding, a Flood advisory, followed by a Flash Flood Warning, were issued for Bexar County, so seeding ceased.

Three 40g flares (Bandera - 1; Medina - 2) were burned in the target area, totaling 120g of AgI. It is important to note that there were two other flares fired in Atascosa County which affected the storm in southern Bexar County.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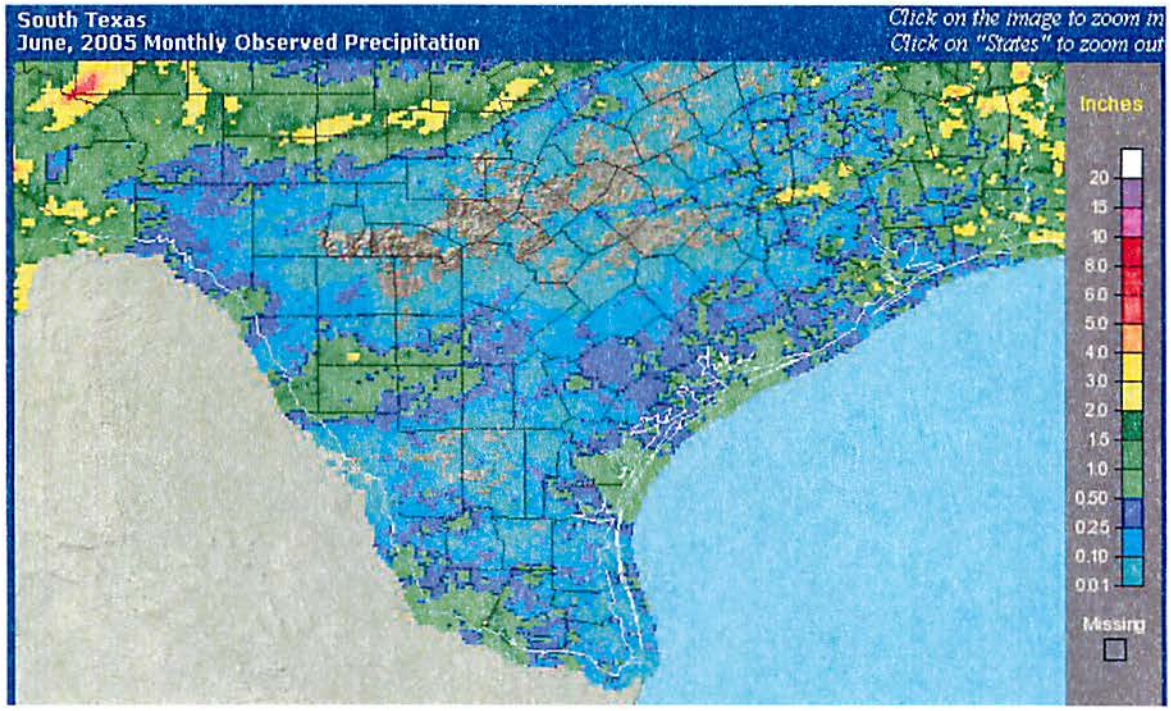
JUNE 2005

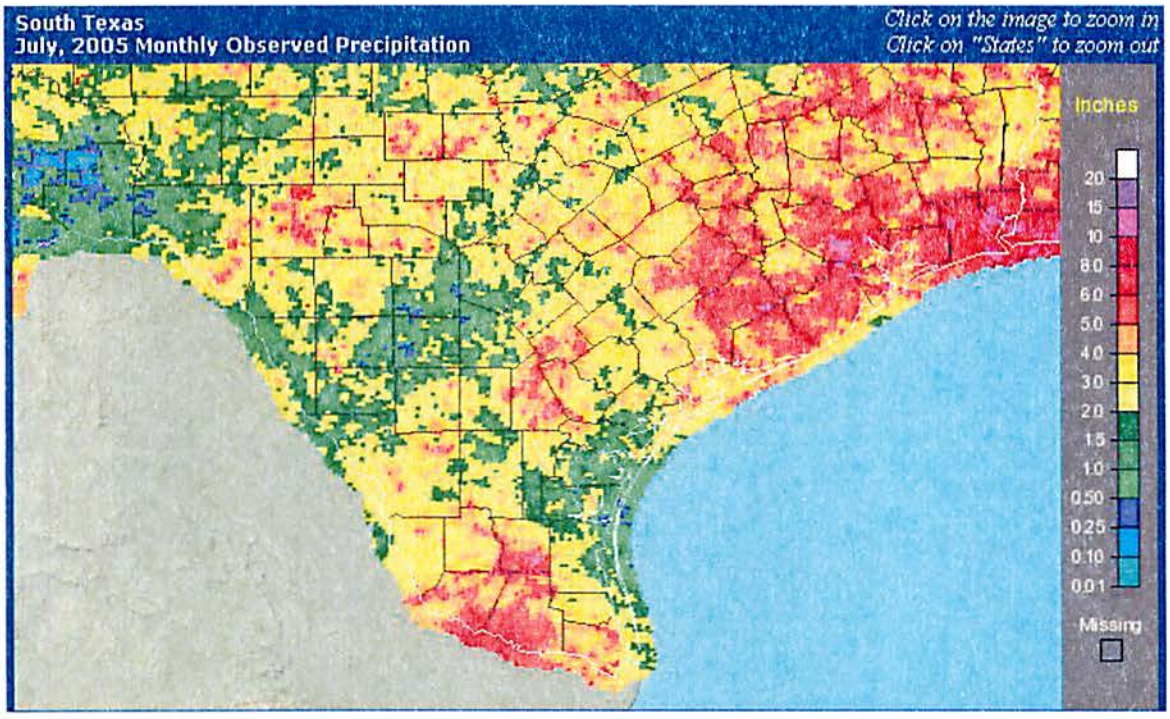
June turned out to be a very disappointing month as far as weather modification activities go. There were a few nocturnal events early in the month which dropped meager amounts of rain. High pressure began to build in after the first week of June, and more or less remained over the area for the remainder of the month. This promoted a very dry spell for south Texas, with very little convection taking place, the majority of which was near the coast. As such, there were no recorded seeding missions in the EAA target area.



JULY 2005

After the unusually dry spell in June due to stagnant high pressure over the area, July was almost at the opposite end of the spectrum. The area of high pressure weakened and shifted far enough west to allow for a northwest flow type of pattern, with thunderstorm complexes developing in west Texas and moving towards the target area. After a few days, the pattern changed again and a moist easterly flow began to infiltrate south Texas. Weak disturbances rotating around the large high pushed west/southwest across the area, generating convection on an almost daily basis. Then, just after mid-month, Hurricane Emily approached northeast Mexico/deep south Texas, with the outer rainbands moving just south of the target area. After that, easterly flow and various disturbances helped generate convection through the end of the month.

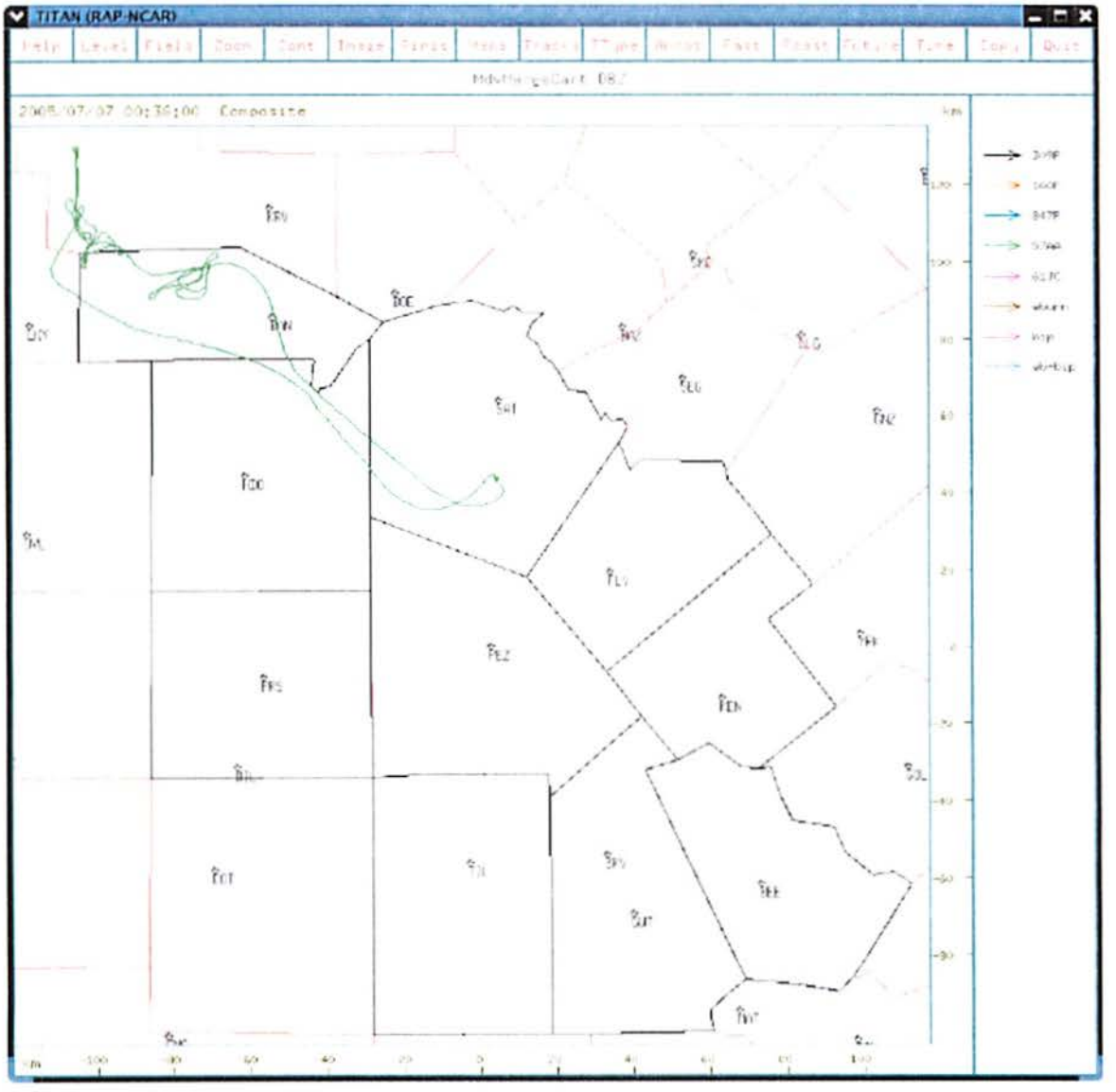
For the month, there were 11 days on which seeding took place within the EAA target area. Twelve flights were logged during the month. A total of 113 flares were used for seeding (Bandera - 26; Bexar - 46; Medina - 40; Uvalde - 1), which amounts to 5480g of AgI. It was a welcome change from the doldrums of June.



JULY 6

An MCS that had moved into west and central Texas during the overnight and morning hours had dissipated, leaving behind an outflow boundary that was slowly pushing southward towards the northern target area. With daytime heating peaking, showers and thunderstorms began to develop late in the afternoon along the boundary, with cells moving southward into Bandera County. A flight was launched to treat the activity in Bandera County, with seeding also taking place in Kerr County, just to the north, where storms were initially developing and moving south. The best activity remained at and just north of the Kerr/Bandera County line, although western Bandera County did see some beneficial light rains from this activity.

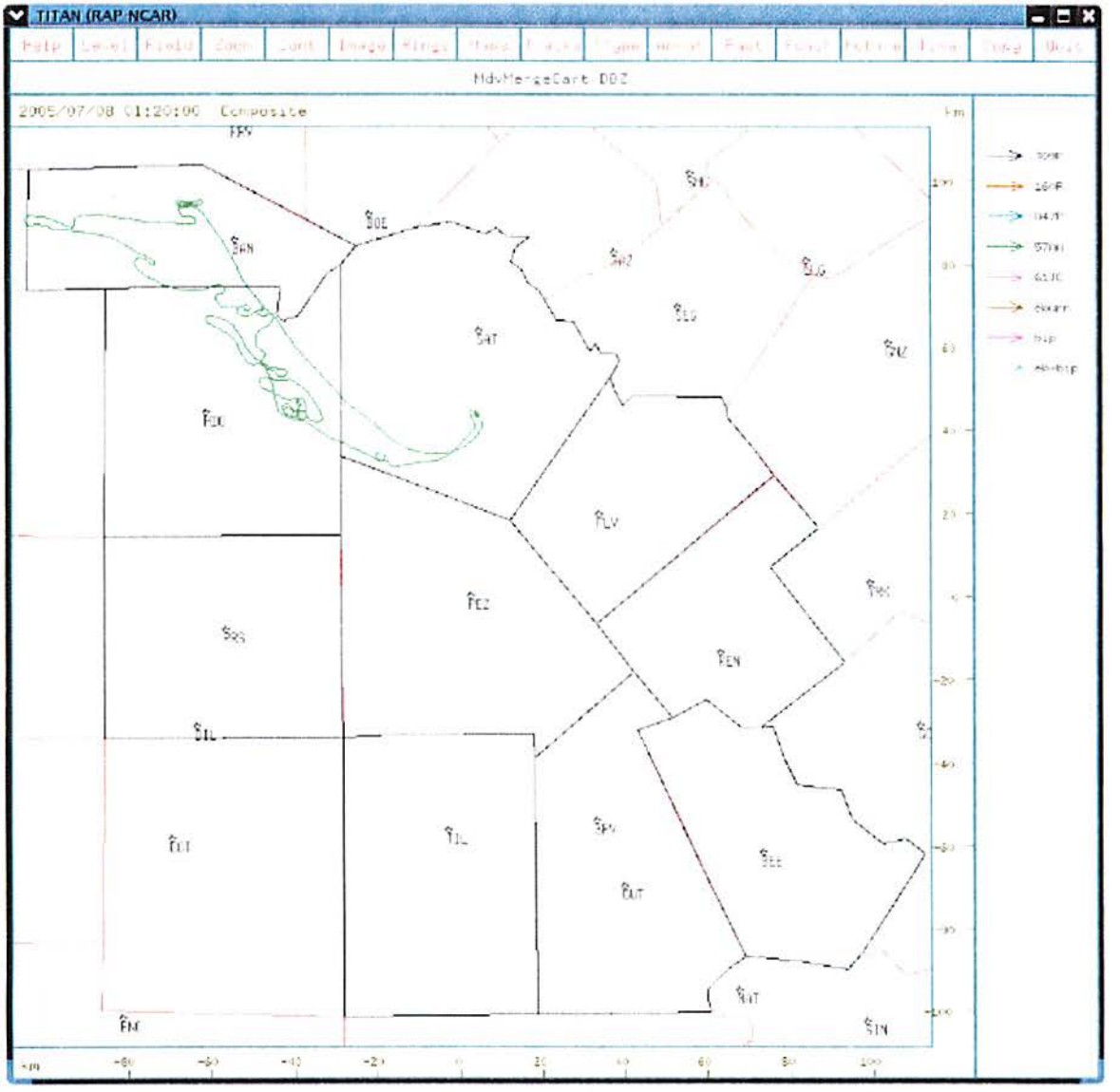
Eight flares were burned in Bandera County, totaling 320g of AgI.



JULY 7

A weakening MCS was moving south across west-central Texas in the morning hours. It eventually dissipated, leaving a southward-moving outflow boundary. Intense heating of the atmosphere was taking place during the afternoon, with temperatures in excess of 100°F. As the outflow boundary approached the northwestern target area, a cluster of showers and thunderstorms developed between Fredericksburg, Kerrville and Junction. This activity pushed into Bandera County late in the afternoon, with a flight being launched to treat the incoming activity. Cloud bases were unusually high for south Texas, averaging around 8000 feet MSL. The activity appeared to respond favorably to seeding, with areal coverage expanding. Seeding was interrupted, however, by San Antonio International re-directing flights around the storms in the area where seeding was taking place.

Six flares were burned in Bandera County, totaling 240g of AgI.



JULY 9

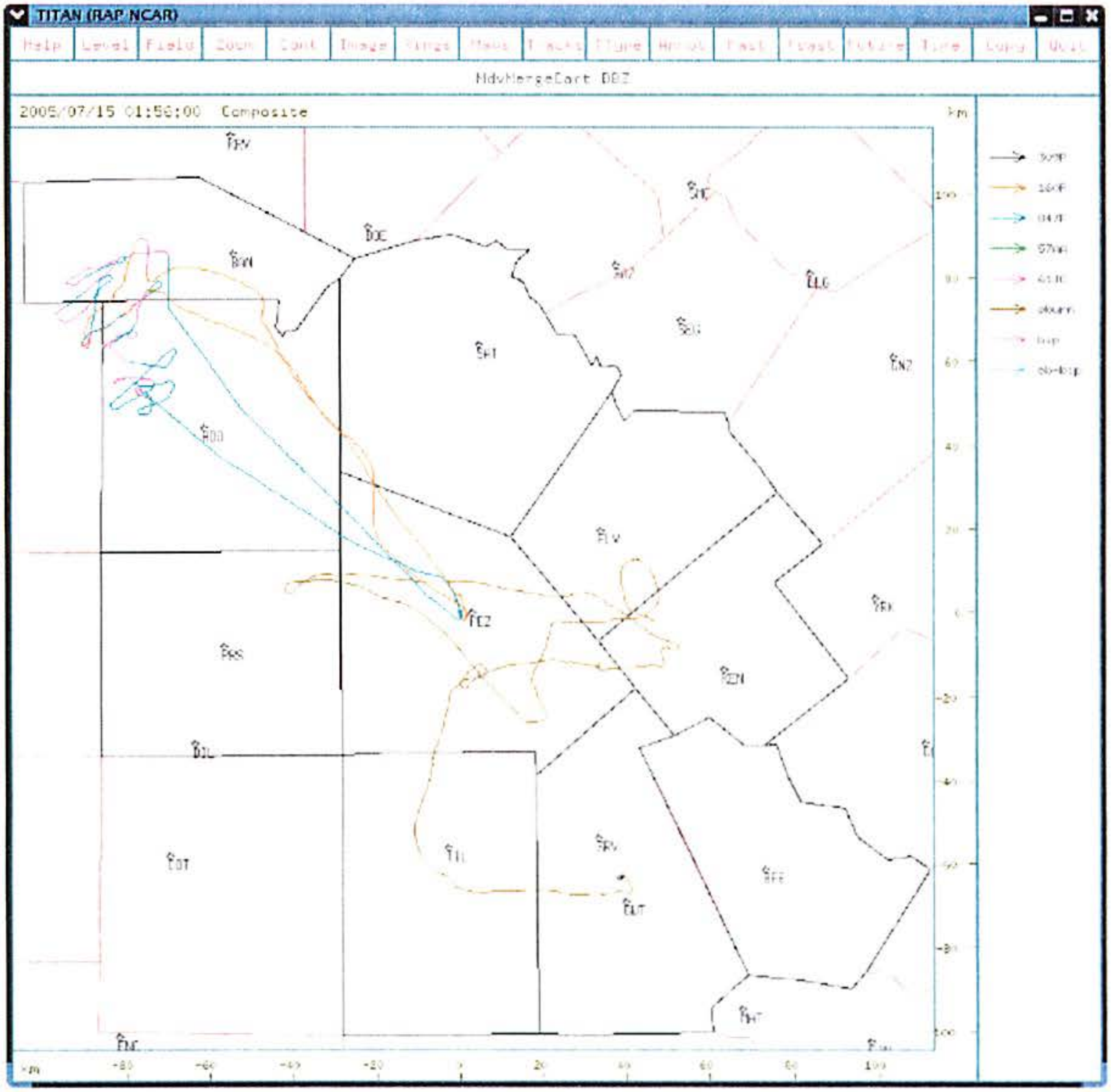
An upper low was spinning in the Gulf waters south of Houston/northeast of Corpus Christi. Small spiral bands of showers were rotating around the low, heading west towards the target area. With dry air being pulled south around the low, this activity did not make it into the target area. However, further west, vorticity maxima were moving south along the eastern periphery of the ridge over the west, one of which produced overnight convection along the Rio Grande. A second vort max was heading south, and began producing convection in the northwestern part of the target area, in Medina/Uvalde counties as well as far western Bandera County. This seeding event was a cooperation of both STWMA and SWTREA pilots, as the activity lie along the border between the two. STWMA had flare rack problems after the first few flares, and had to switch out planes for one of SWTREA's (70P). Overall, the seeding was a success as the activity congealed into one larger storm that moved south across both target areas.

Three flares were burned in Medina County, totaling 120g of AgI.

JULY 14

A trough of low pressure was located north of the target area. Instability levels were relatively high today, with the risk of severe weather and flash flooding present. By early afternoon, showers and thunderstorms began to develop near the trough, with a slow motion to the southeast. A flight was dispatched to Bandera County in the early afternoon as the activity began to enter the northwestern target area. Results from the seeding appear very favorable, with areal expansion noted and a steady maintenance of the intensities. Other activity began to develop to the south of this initial area of convection, and this was also seeded. The activity pushed south across the entire target area, merging into a line south of San Antonio.

16 flares (10x40g; 6x80g) were burned (Bandera - 8; Medina - 7; Uvalde - 1), totaling 880g of AgI.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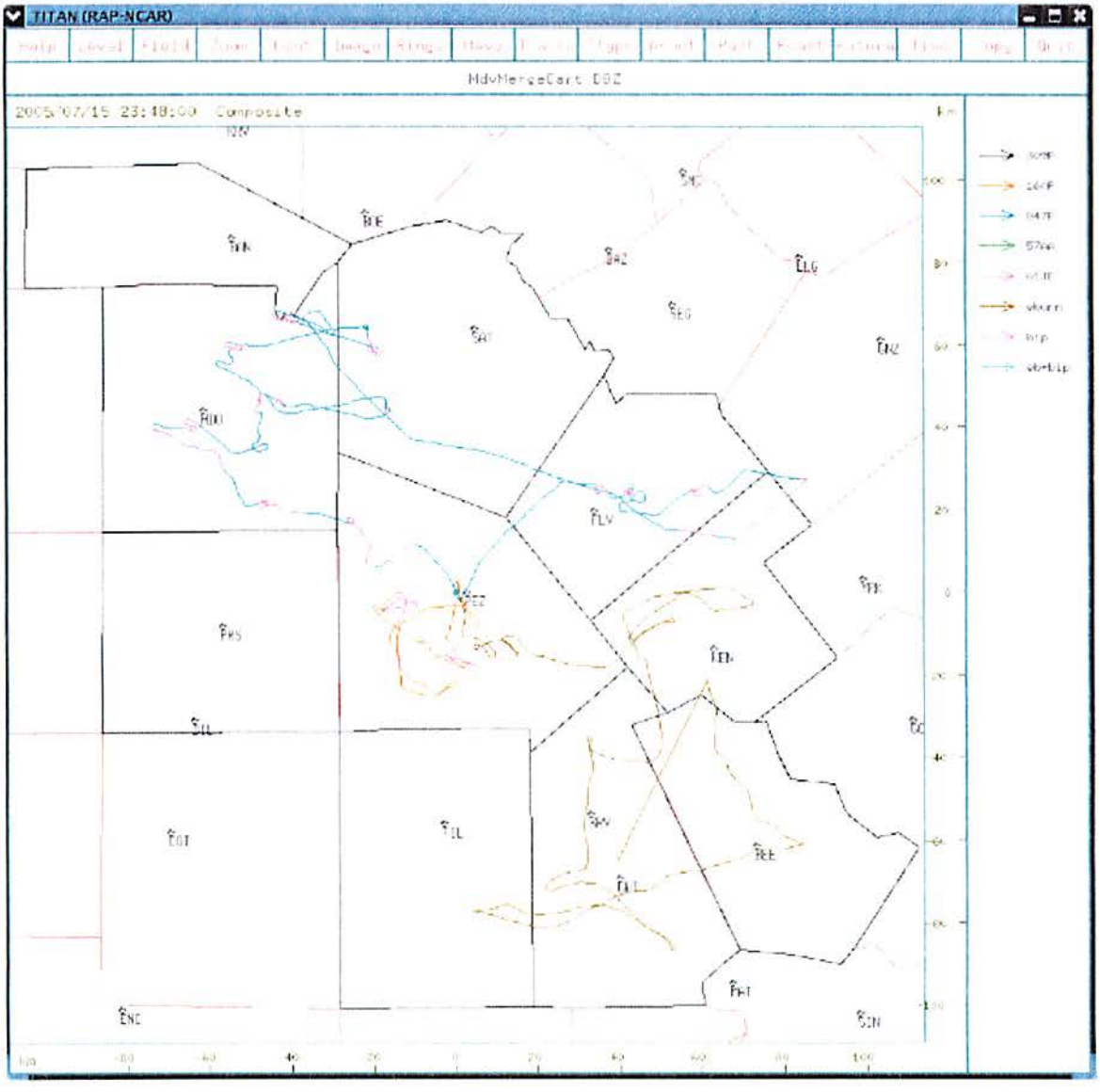
JULY 15

A very moist airmass was in place over the target area today, with only a weak atmospheric cap. Abundant cloud cover in the early morning began to burn off before noon. It didn't take much time before showers and thunderstorms began to develop across much of the target area. A flight was dispatched early in the afternoon to treat developing convection over the target area. Results from seeding appeared to be very favorable, particularly in terms of cell lifetime and areal coverage expansion. Visual comparison of radar data between the seeded activity and the untreated activity makes this clearer.

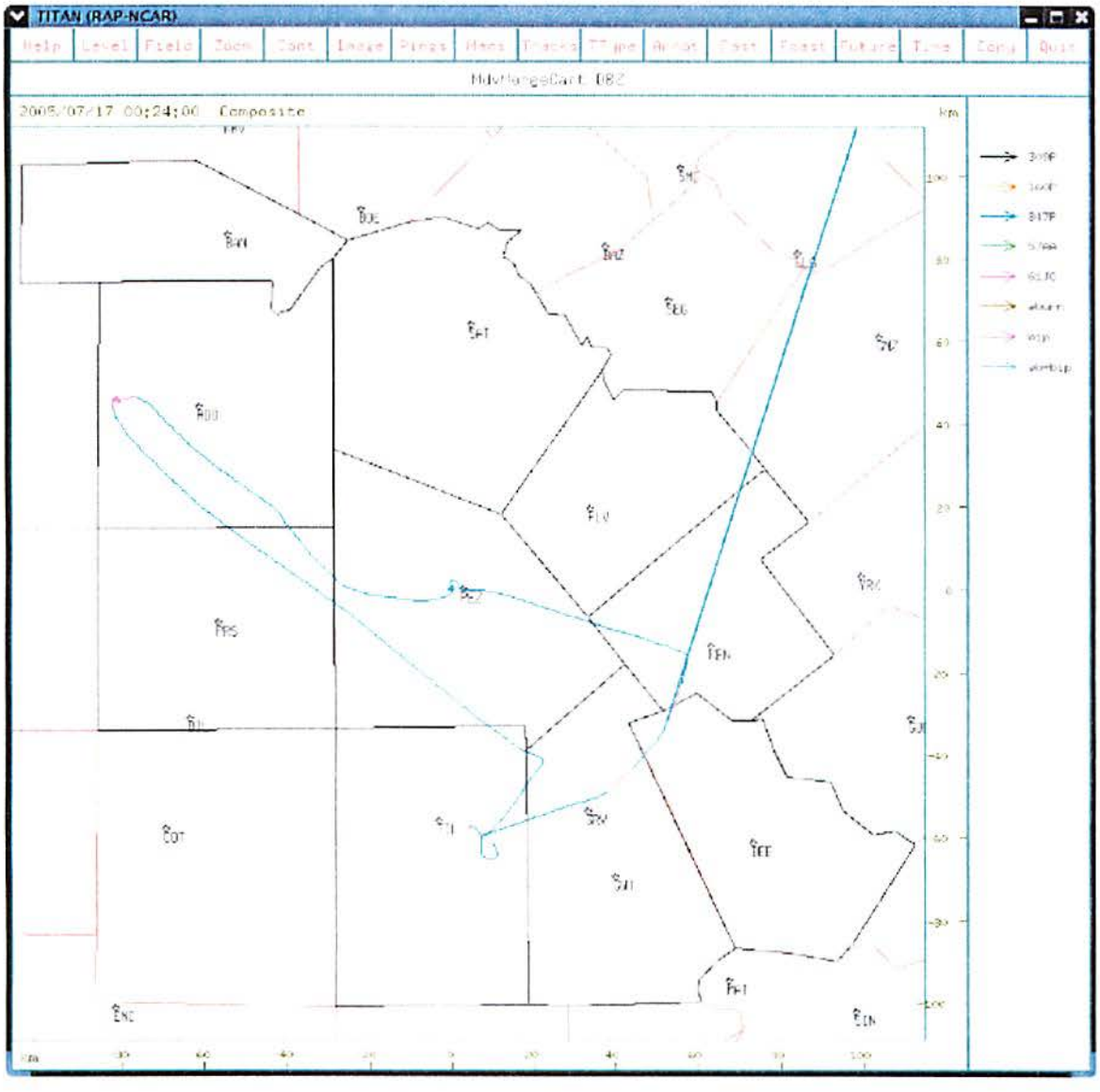
24 flares (6x40g; 18x80g) were burned (Bandera - 1; Bexar - 6; Medina - 17), totaling 1680g of AgI.



JULY 16

A very moist and unstable airmass was situated over south Texas. An upper low was in the vicinity, with a shortwave rotating around the base of the low across the area. Early in the morning, a shortwave crossed the eastern target area, sparking a cluster of showers and thunderstorms that spread north across the eastern counties. This convection stabilized the airmass over much of the target area, sending out an outflow boundary westward into the SWTREA target area. For much of the day, convection remained west of the target area. Late in the afternoon, activity from Zavala and Uvalde counties began to enter western Medina County, and a flight was launched to seed the incoming activity. Results were fair.

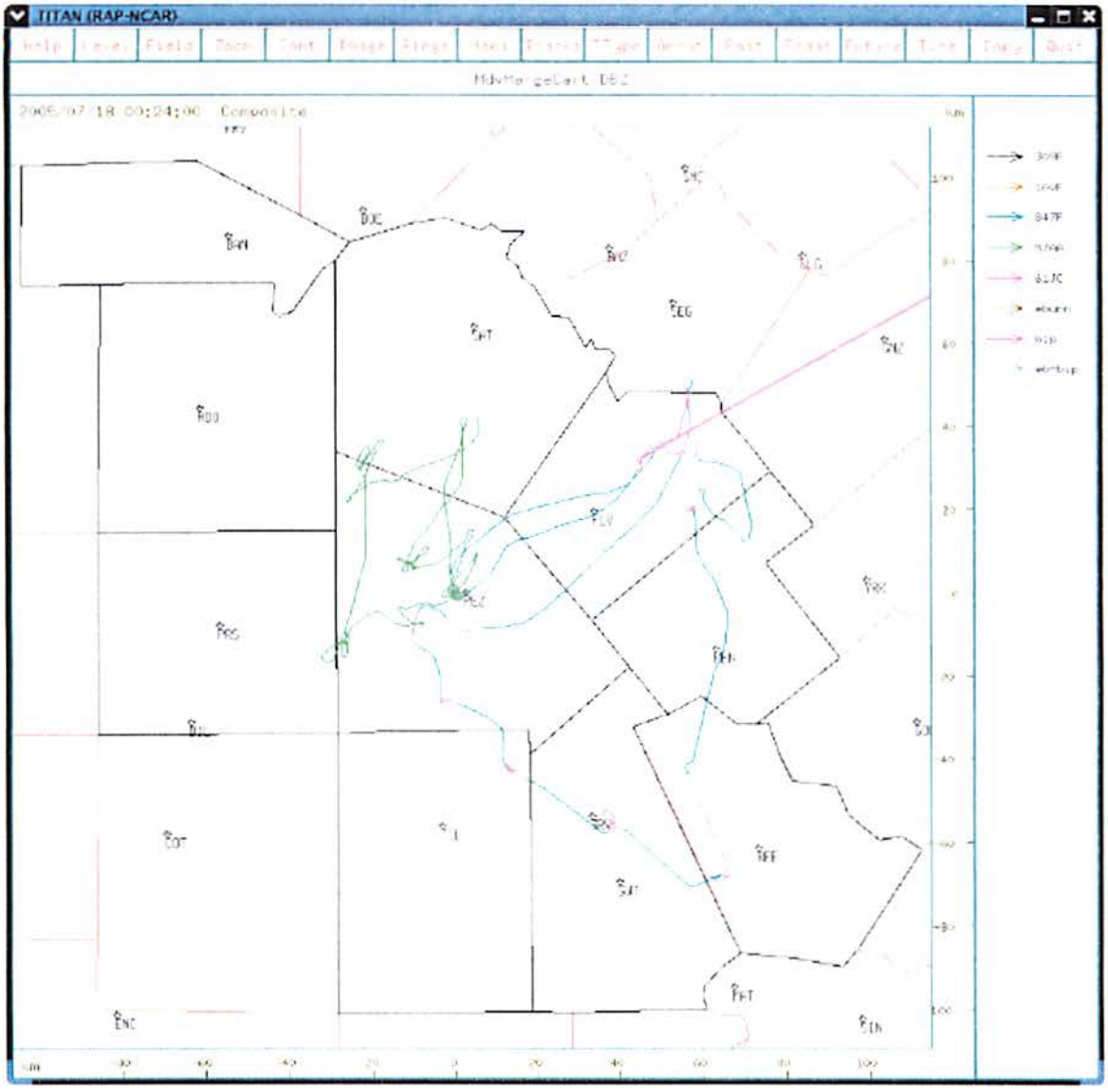
Three flares were burned in Medina County, totaling 120g of AgI.



JULY 17

A tropical airmass was in place over south Texas. Just north of the target area, an upper level low and elongated trough was present over the region. The combination of these resulted in shower and thunderstorm development throughout the day south and east of San Antonio. As the activity moved further north and west, Bexar County also saw scattered showers and thunderstorms. One flight was launched to seed the incoming activity into southern Bexar County.

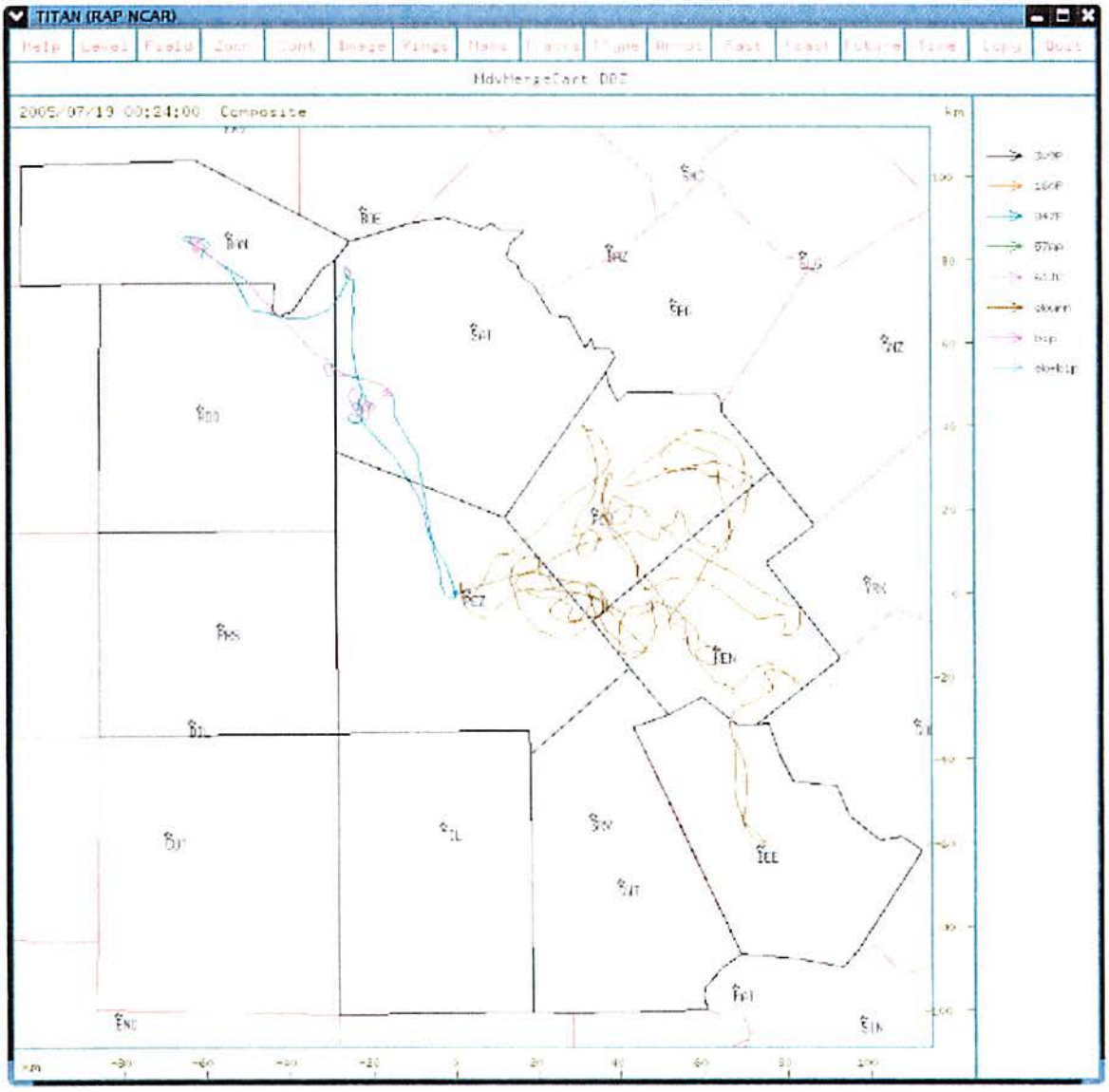
Two flares were burned in Bexar County, totaling 80g of AgI.



JULY 18

As had been the case for the past week or so, a tropical-like airmass was situated over south Texas. During the afternoon, as the flow off the Gulf began to increase ahead of Hurricane Emily, showers and thunderstorms developed southeast of the target area, moving northwest. A flight was launched to seed this activity, with very good to excellent results noted, particularly across Bexar County. Just as seeding halted for the day, a flood advisory was issued as the seeded activity traversed Bexar, Medina and Bandera counties.

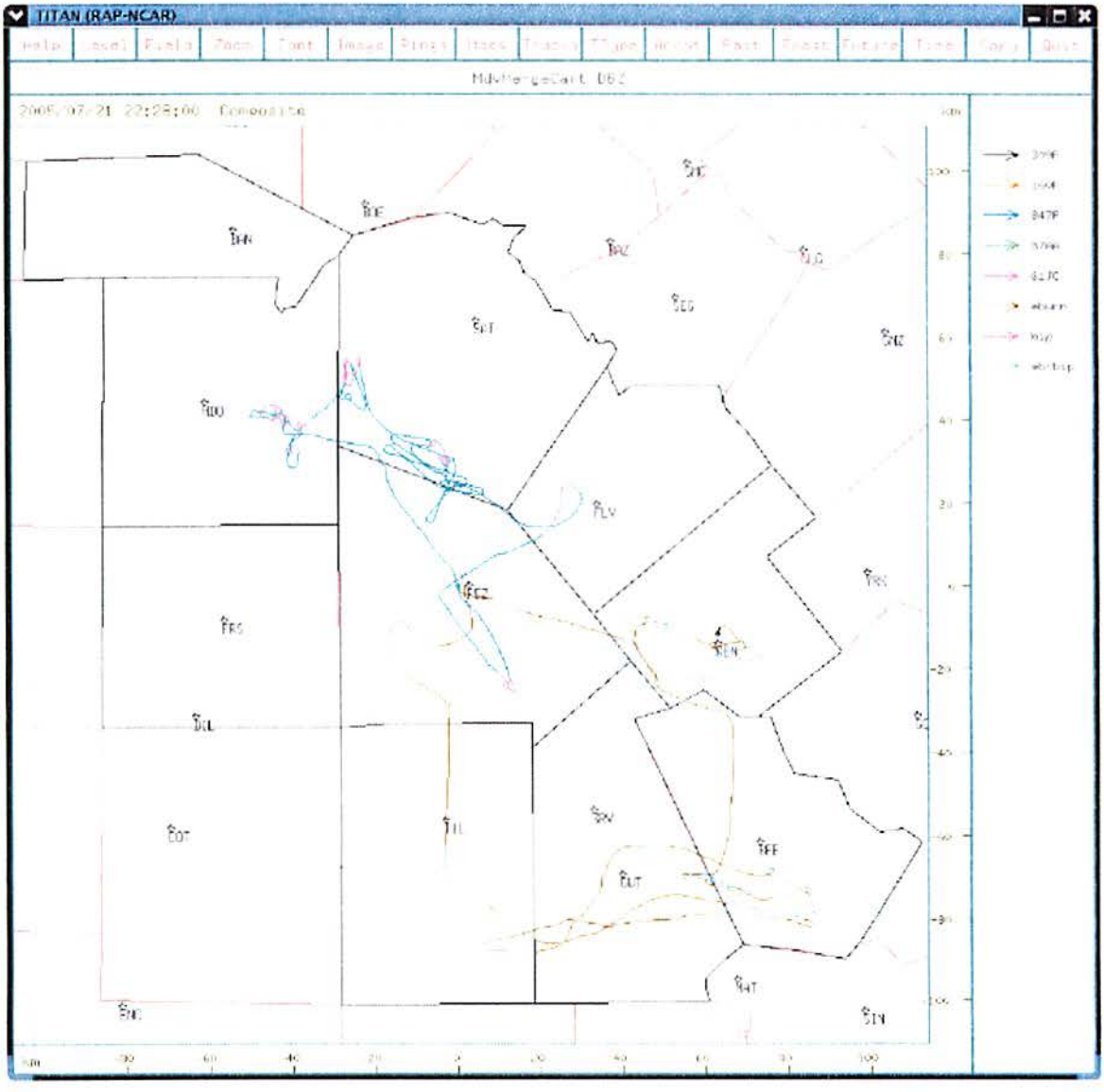
16 flares were burned (Bandera - 3; Bexar - 12; Medina - 1), totaling 640g of AgI.



JULY 21

Overnight, Emily had weakened from hurricane status and was now just a depression southwest of Saltillo, Mexico. In her wake, abundant tropical moisture was in place, and the atmosphere was only weakly capped. A building ridge of high pressure was to the north and small shortwaves were rotating around the ridge, moving westward across south Texas. These subtle disturbances, along with daytime heating of the unstable atmosphere, helped spark showers and thunderstorms across south Texas. Initial convection was southeast of San Antonio, spreading north and west over the course of the afternoon. A flight was launched during the day to seed the convection, with excellent results noted on radar. Lifetimes were certainly longer than unseeded clouds, and intensities and areal coverage change were significant when compared with untreated clouds. Up to this point, today was probably one of the best days so far this season.

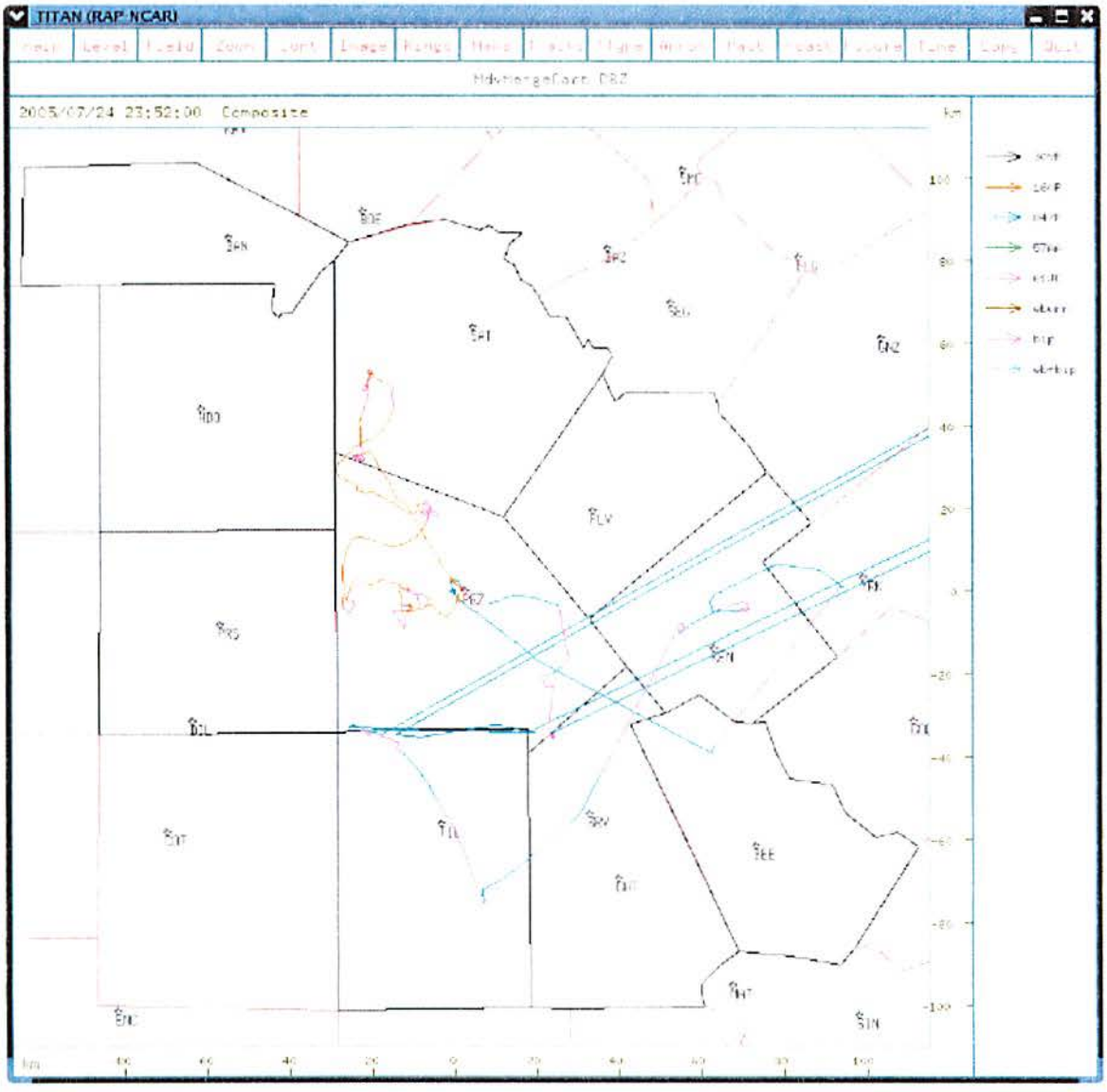
18 flares were burned (Bexar - 10; Medina - 8), totaling 720g of AgI.



JULY 24

The area was partially under the influence of Tropical Storm Gert as it was off the Mexican coast near Tampico. This gave the area a slight increase in moisture. During the afternoon hours, as daytime heating was reaching its peak and the seabreeze boundary pushed in, convection was initiating southeast of the target area. The seabreeze was substantially enhanced today and was evident by the scattered nature of the convection. As this activity approached the EAA target area late in the afternoon, a flight was launched. Apparent seeding effects as indicated by radar trends showed a good response, with areal coverage increasing.

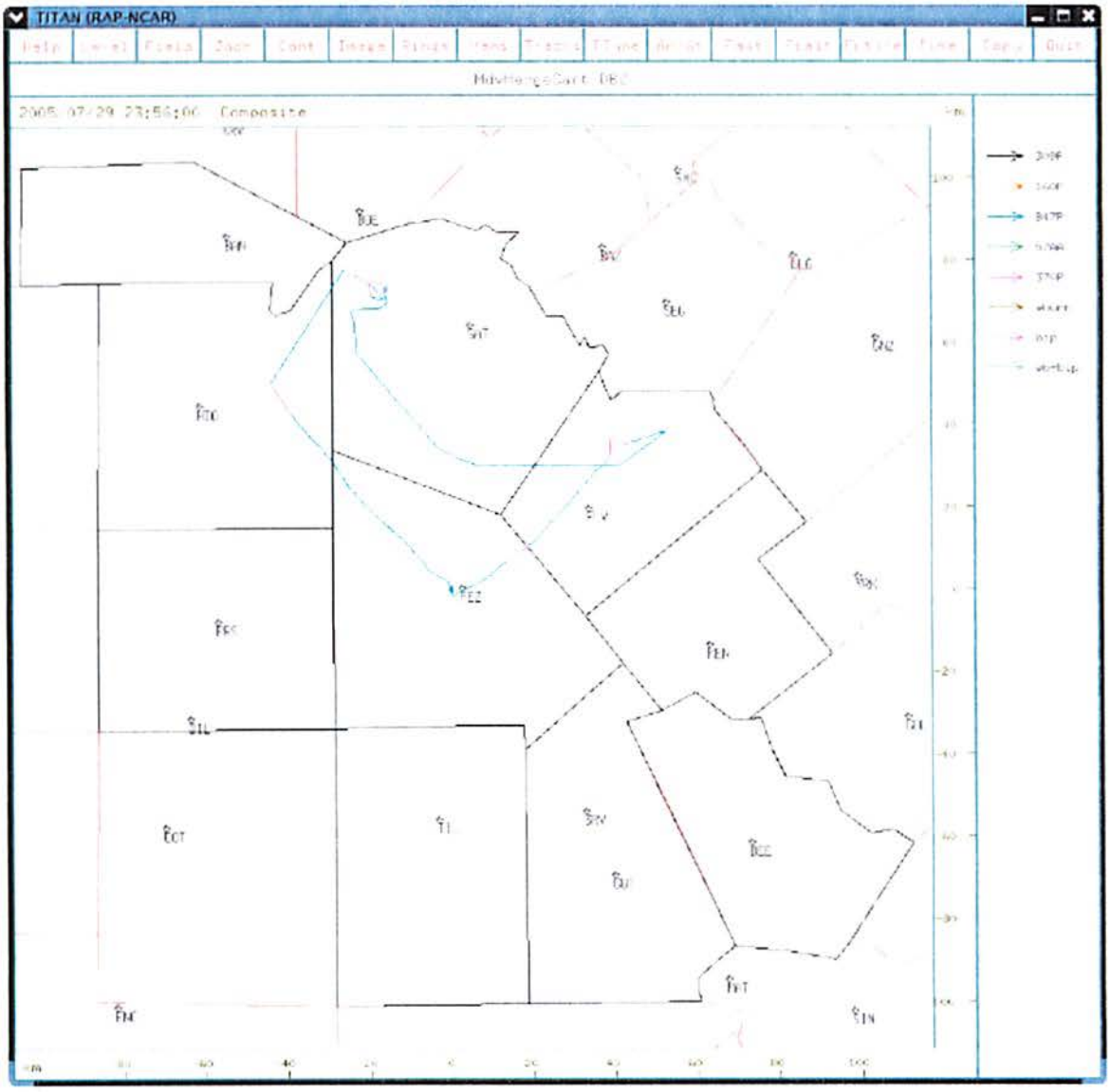
12 flares were burned in Bexar County, totaling 480g of AgI.



JULY 29

The cold front that arrived several days earlier had weakened and was an ill-defined boundary stretching from near Junction to just south of Houston. In addition, a weak easterly wave over southeast Texas was slowly moving to the southwest. As daytime heating progressed, showers and thunderstorms developed near the boundary, with a slow drift to the southwest. As the activity approached northern Bexar County, a flight was launched to investigate. Decent inflow was found, and seeding of the incoming activity was done. An outflow boundary had developed and pushed out ahead of the activity, which eventually cut off the moisture supply to the convection. The activity weakened as a result. Because of this, the day received only a fair rating.

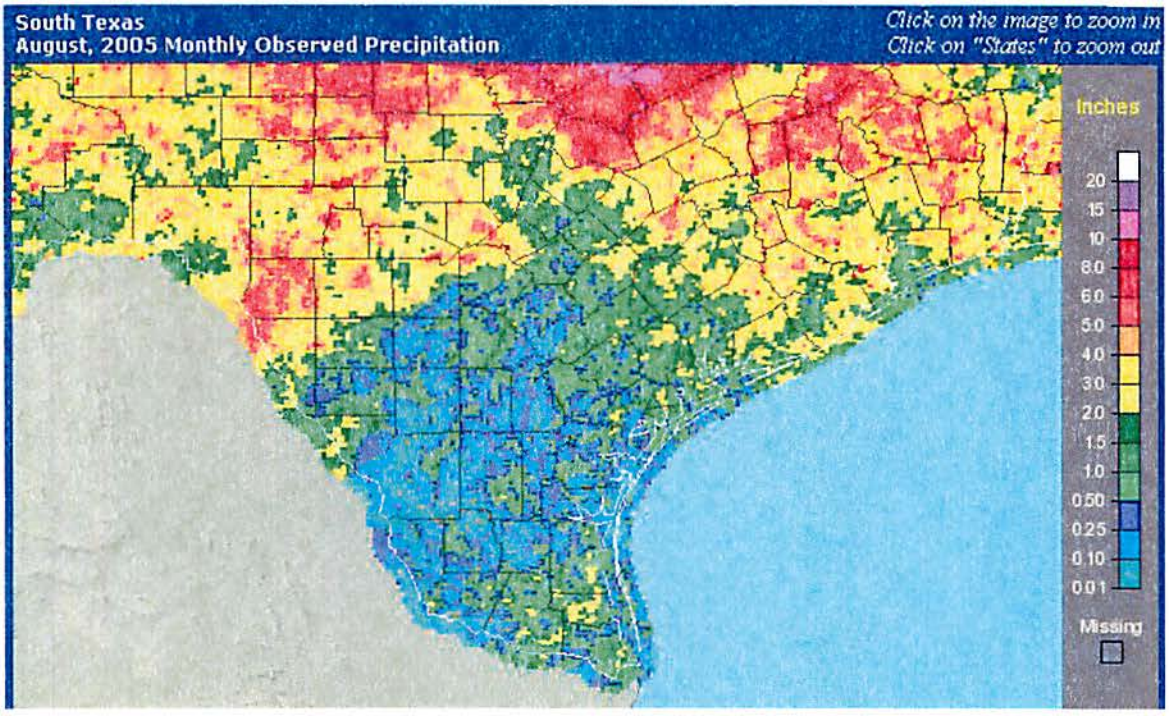
Five flares were burned (Bexar - 4; Medina - 1), totaling 200g of AgI.



AUGUST 2005

The busy weather pattern experienced during July 2005 continued through August, although there were a few more days with no activity. Several Tropical Upper Tropospheric Troughs, or TUTTs affected the area, although so far in 2005 it appears they lack the abundant convection that they have provided in years past. Some of the seeding missions appear to have really benefited the convection, particularly on the 19th, when clusters of small showers merged together to form a larger, longer-lasting area of rain. On the other hand, there were a few days on which seeding effects appeared to be minimal, most likely related to the short lifespans of the convective cells.

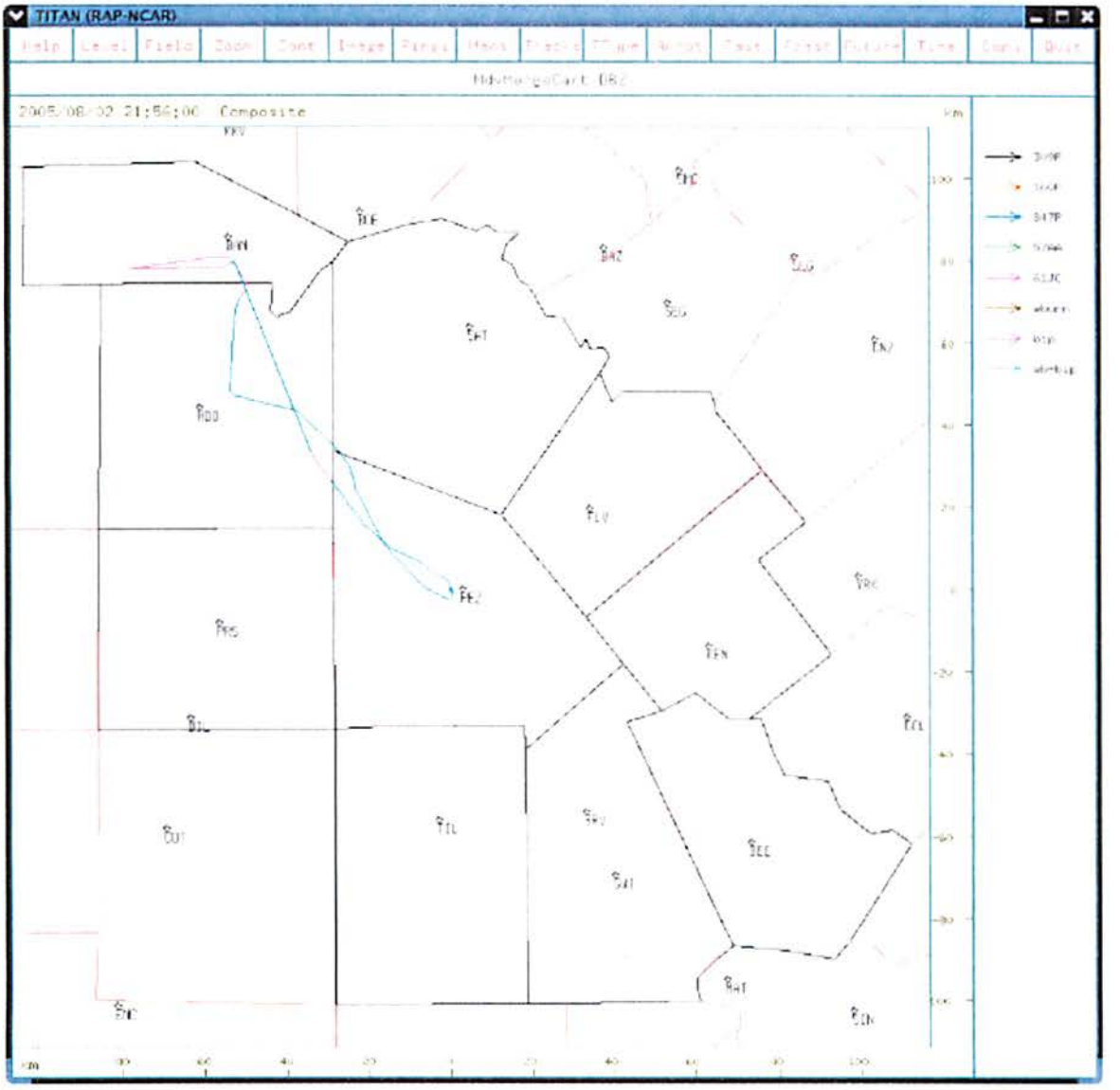
For the month, there were seven days on which seeding took place. A total of eight flights were logged. 94 flares (Bandera - 24; Bexar - 13; Medina - 49; Uvalde - 8) were used for seeding, totaling 3840g of AgI.



AUGUST 2

A TUTT (Tropical Upper Tropospheric Trough) was located near Brownsville, with a very slow movement to the northwest. Close to the center of the low, subsidence was preventing convection from developing. Some of this area of subsidence affected the central and southern portions of the target area, with no convection. However, by mid-afternoon, with sufficient daytime heating, a few showers began to develop in Bandera County, so a flight was launched. The pilot reported a reduction in visibility due to the dust. A few cells were treated with silver iodide, but it appeared that the cells in general were not lasting very long, possibly due to the eventual northward expansion of the subsidence area. Overall not one of the better days for seeding, with only a fair rating.

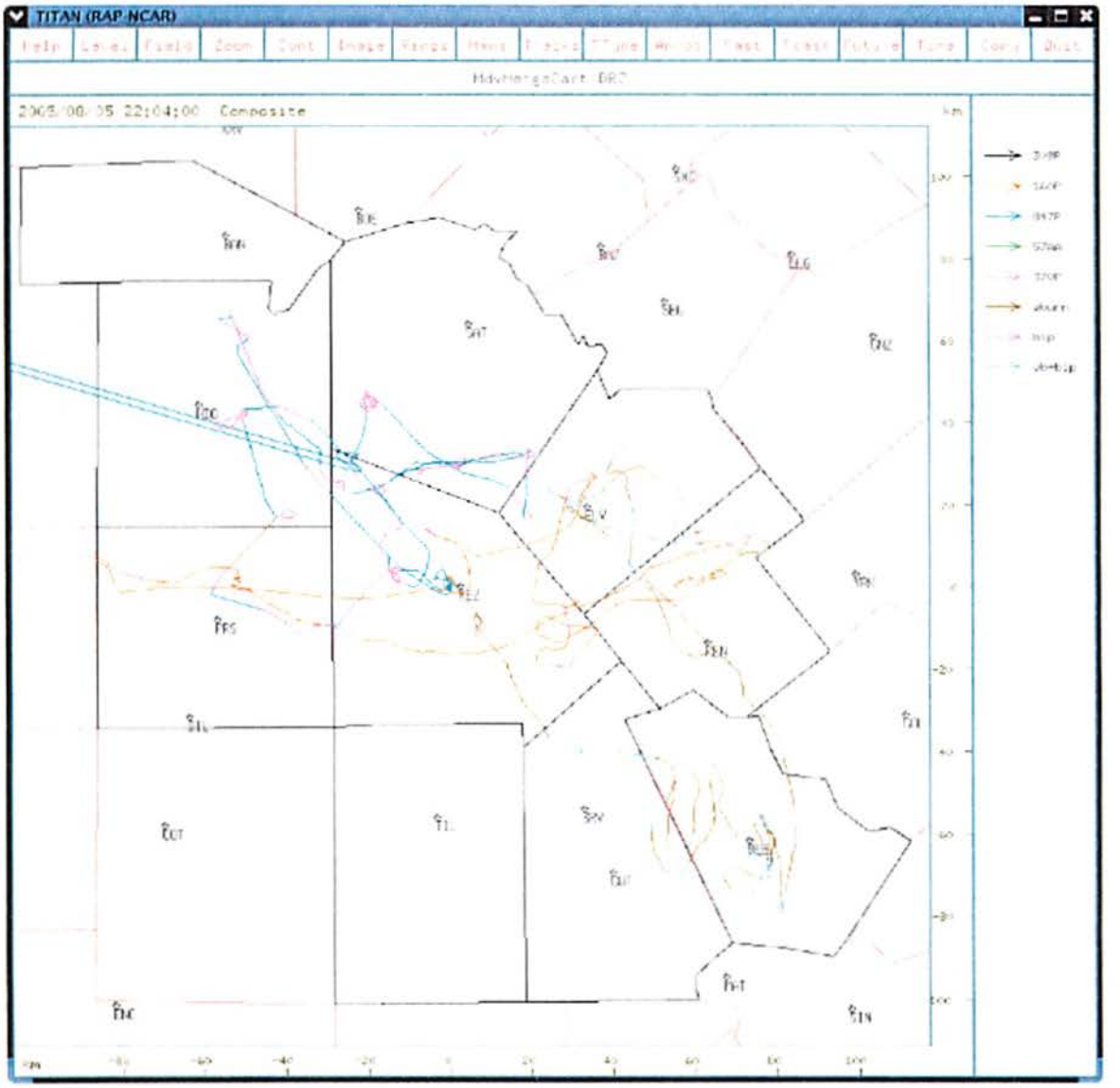
Seven flares (Bandera - 5; Medina - 2) were used for seeding, totaling 280g of AgI.



AUGUST 5

Moisture and instability levels were higher than the past few days, according to morning soundings from Corpus Christi and Del Rio. With convective temperatures relatively low (around 91°F), convection began to develop quickly before noon. The first flight was launched to look at development in Bandera and Medina counties. This activity didn't appear to fare too well on radar, with short lifespans making seeding difficult in this area. As activity developed in Bexar County, a second flight was launched. The activity in this area appeared to respond much better to the seeding. It was a successful and busy day.

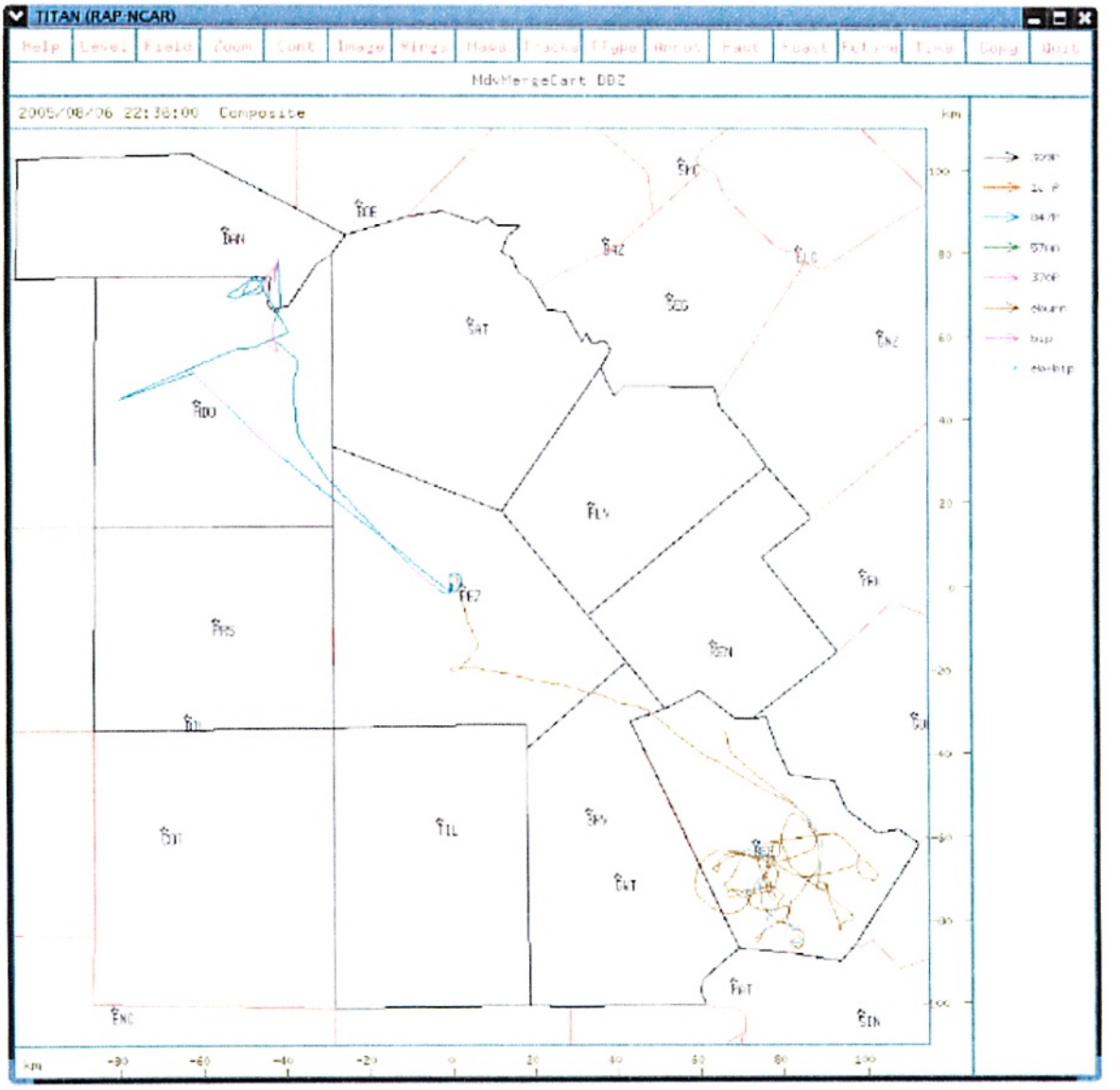
20 flares (Bexar - 11; Medina - 9) were used for seeding, totaling 800g of AgI.



AUGUST 6

With the ridge of high pressure to our northwest and an upper low over the southeastern U.S., upper level flow across Texas was northerly (or, at least had a northerly component). Disturbances riding around both pressure systems were traversing the state from north to south. One such shortwave was crossing south Texas just west of the target area during the afternoon hours, with convection developing once convective temperatures in the mid to upper 80s were reached. Convection developed in Bandera and Medina counties, with 47P being dispatched to that area. Seeding of this activity did not appear to have much of an effect, with the showers dissipating after about a half hour.

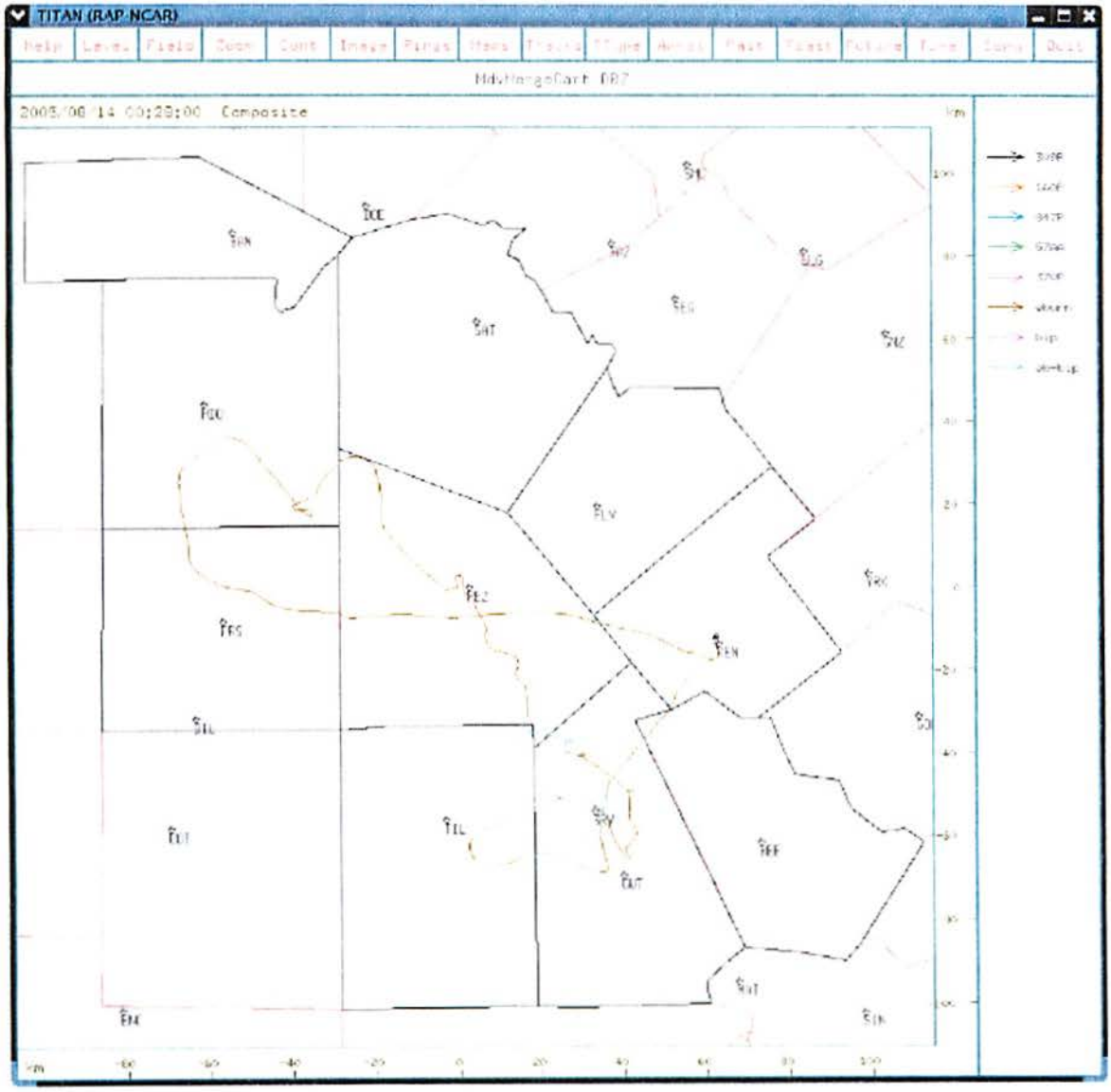
14 flares (Bandera - 8; Medina - 4; Uvalde - 2) were used for seeding, totaling 560g of AgI.



AUGUST 13

For the first part of the day, mid- and high-level cloudiness covered much of the target area, limiting heating. This convective debris was coming from Mexico on SW winds aloft. As the clouds began to mix out and dissipate, areas of sun and heating helped destabilize the atmosphere. Seeding was conducted south of the EAA target area, and this activity pushed all the way north into Medina County, with "maintenance seeding" (additional seeding of activity that had been previously treated) of this activity taking place. The maintenance seeding on this activity appeared to prove beneficial.

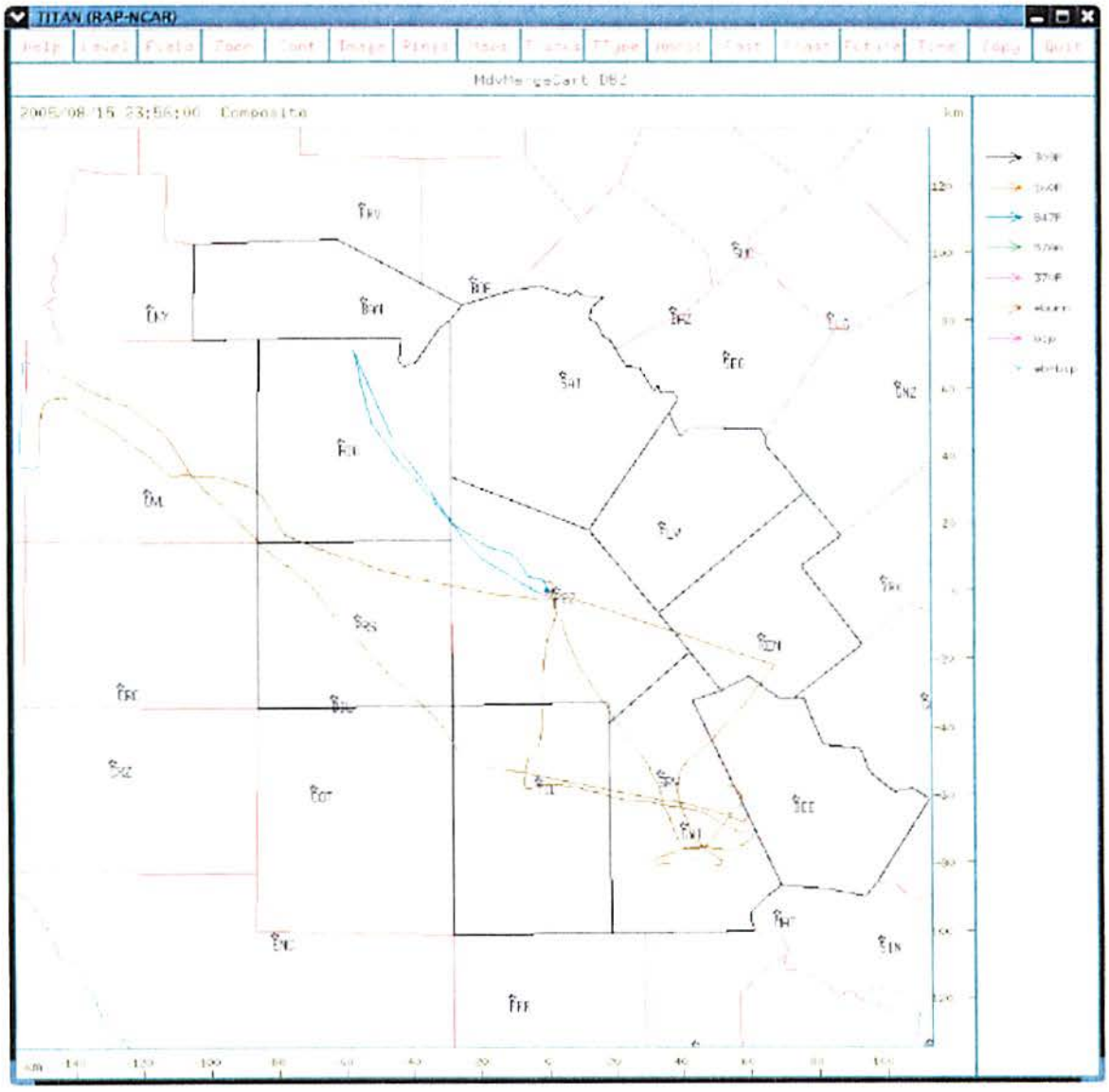
Three flares were used for seeding in Medina County, totaling 120g of AgI.



AUGUST 15

South Texas was being influenced by a tropical airmass, the same airmass that had produced quite a bit of rainfall over west-central Texas. Deep southerly flow transitioned to northeasterly flow at high levels. With little in the way of a cap and more than enough moisture in place, showers and thunderstorms began to develop after the noon hour near the coast as well as over the northwestern target area, in Medina County. A flight was launched to perform seeding operations. Unfortunately, the activity did not last long. Later in the afternoon, 09P flew to Uvalde County for SWTREA and seeded some activity near the Uvalde/Kinney County line, with one cell appearing to fare well as far as lifetime is concerned, and a second cell not lasting long at all.

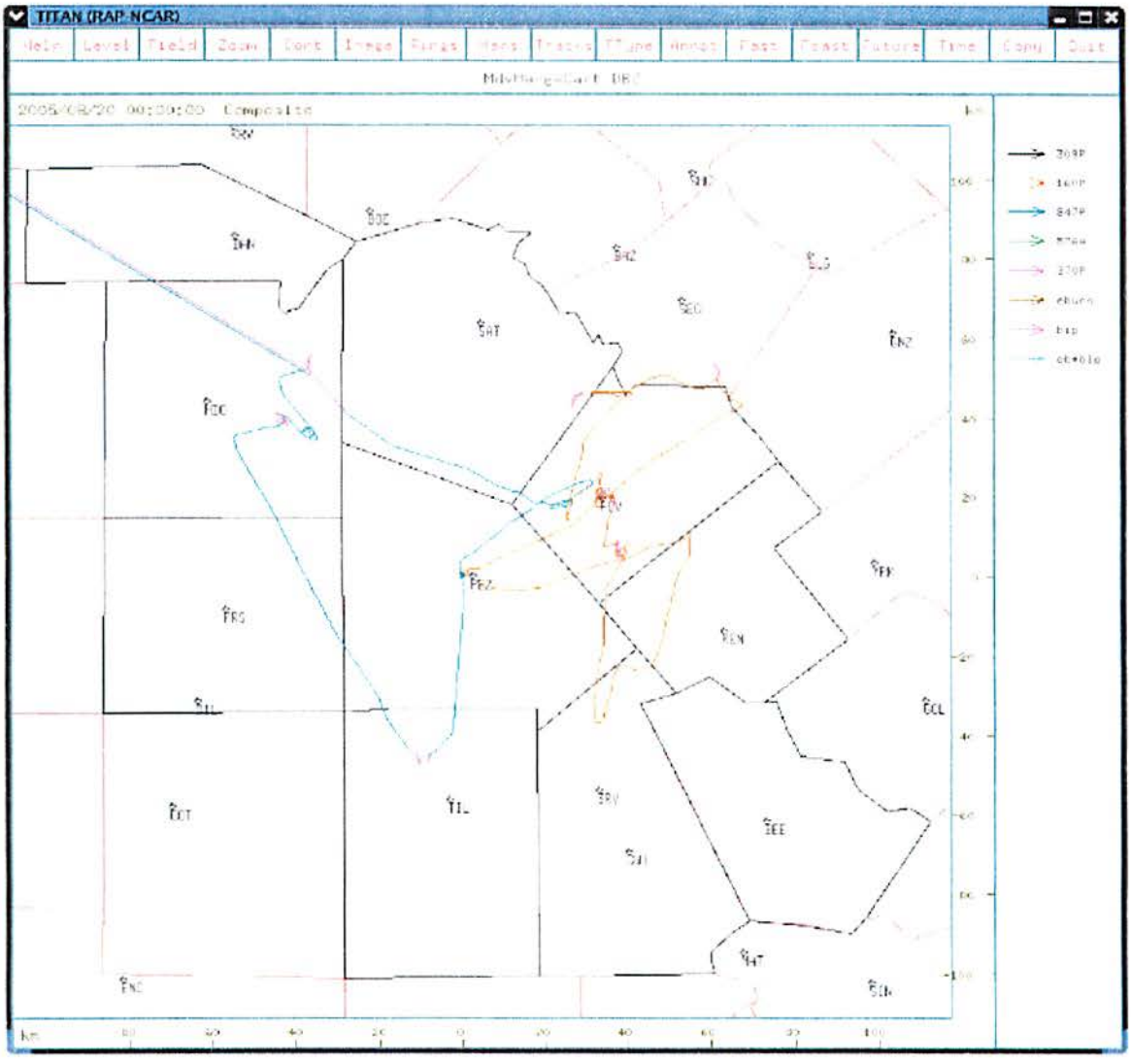
15 flares (Bandera - 9; Uvalde - 6) were used for seeding, totaling 600g of AgI.



AUGUST 19

A TUTT moved into south Texas during the early morning hours, and by late morning was centered over Frio County, moving northwest. A moisture surge pushed up along the east side of the low, moving across the area in the afternoon. With strong surface heating and broad lift on the east side of the low, showers and thunderstorms began developing at mid-afternoon just southeast of Bexar County. A flight was launched at mid-afternoon along with a research plane to look at developing cumulus towers, with one cell in Wilson County being seeded and doing very well when viewed on radar. Trends showed that the seeded cell continued to produce new convection on the upshear side, lasting for well over an hour as it moved north into Bexar County. Additional activity developed in Bexar and Medina counties as the area of convection continued to move northwest. Some rather large storms developed over Bexar and Medina counties in the evening, with the Medina County activity seeded early in the evening. This seeded activity moved north into Bandera County in the early evening.

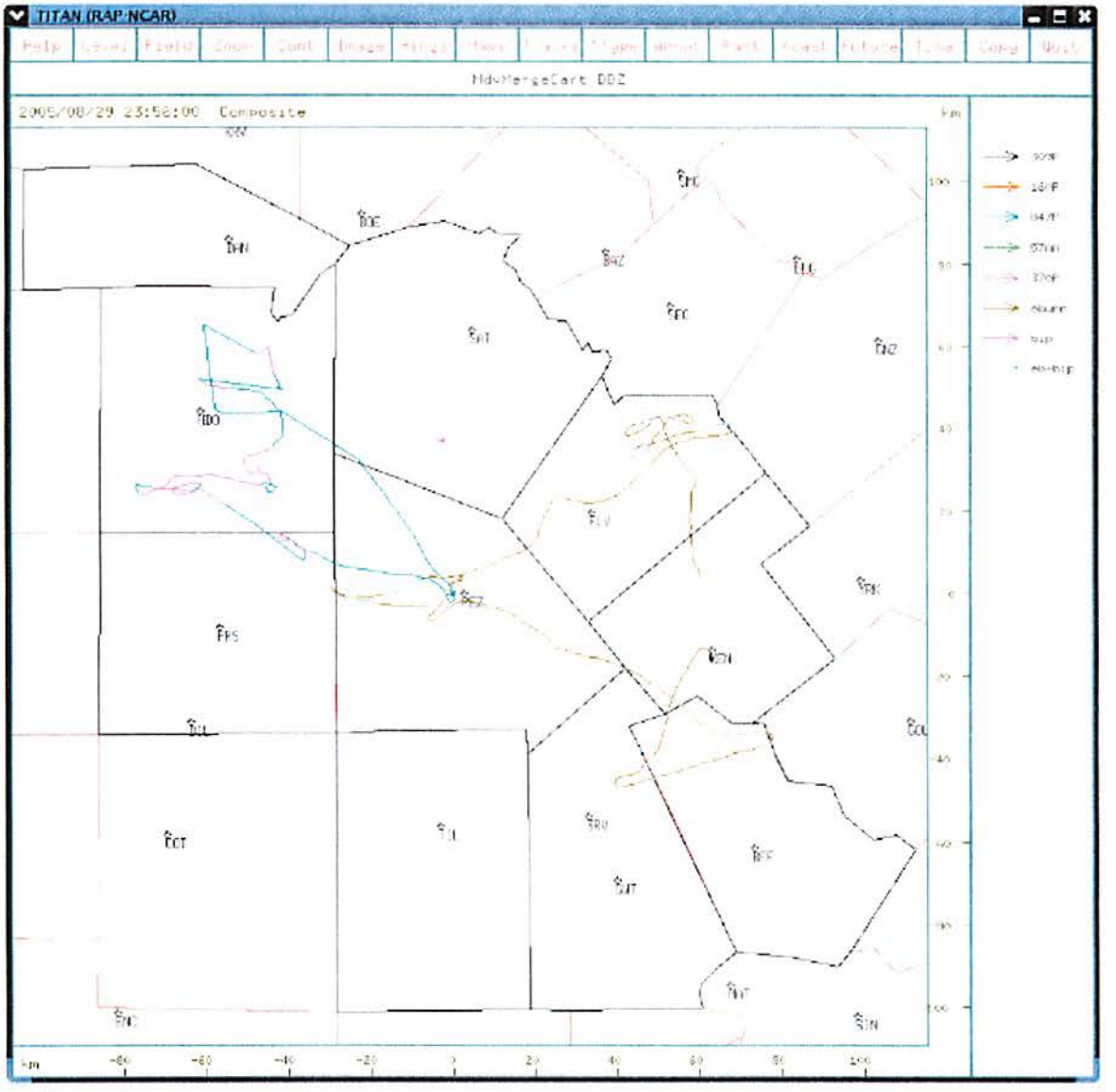
10 flares (Bexar - 2x80g; Medina - 8x40g) were used for seeding, totaling 480g of AgI.



AUGUST 29

Clearly the big story of the day concerned the landfall of Category four Hurricane Katrina near New Orleans. The effect of Katrina on our weather was to induce a north/northeasterly flow. It is noted that while subsidence usually exists on the periphery of tropical cyclones, a weak shortwave riding south between the high to our west and Katrina to the east negated this subsidence. With some heating, showers and thunderstorms developed over the northern parts of the target area, moving to the south and southeast. A flight was launched to investigate and seed the activity across the northwest half of the target area.

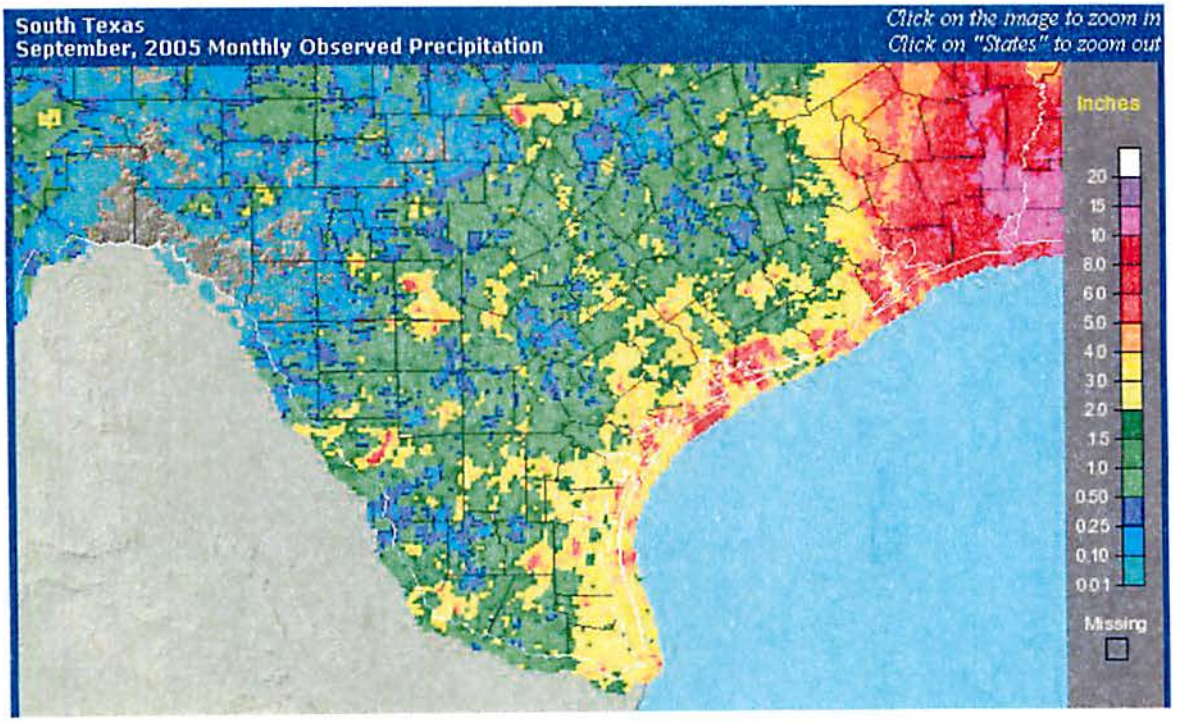
25 flares (Bandera - 2; Medina - 23) were used for seeding, totaling 1000g of AgI.



SEPTEMBER 2005

The busy weather pattern that was observed in July and August continued into the first part of September. Tropical airmasses were common for the first two weeks of the month, with local disturbances helping to generate shower and thunderstorm activity. All of the seeding missions in the EAA target area took place before the 15th, when the weather was most active. Unusually strong high pressure developed and situated itself over Texas for the second half of the month, with very hot temperatures and several records observed during the last week of the month. Rainfall for the month was below normal across the southern half of the state.

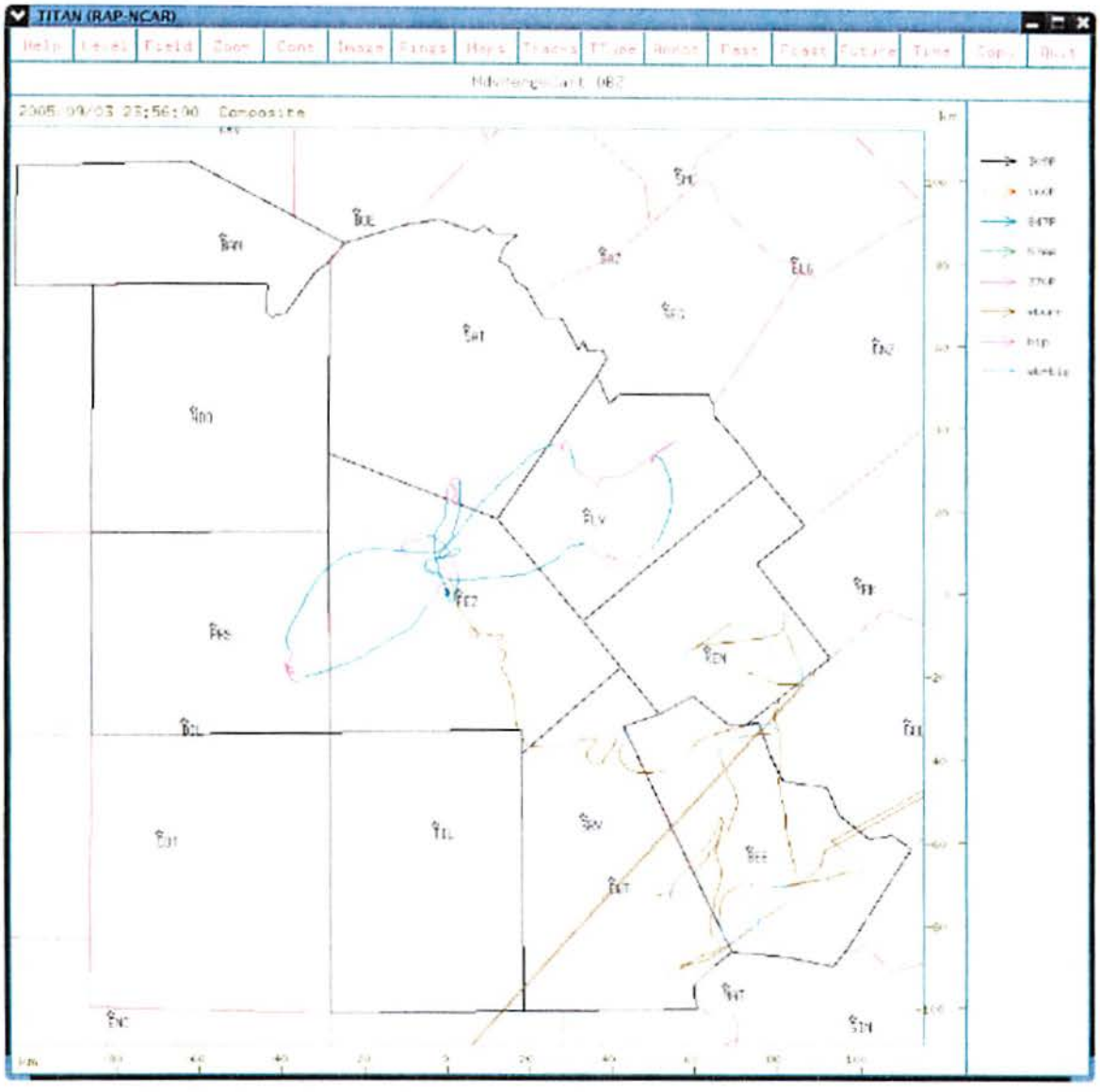
For the month, seeding took place on three days. Four flights were launched. 17 flares were used for seeding (Bexar - 9; Medina - 8), totaling 680g of AgI.



SEPTEMBER 3

With a tropical airmass in place over the region, showers and thunderstorms started to develop south and southeast of the target area in the early afternoon hours. Seeding flights were ongoing south of San Antonio as the activity developed further north and west. A plane from the SWTREA project seeded in Medina County before continuing on to their target area for seeding. Additional convection was seeded in Bexar County in the early evening hours. This mission was rated excellent due to positive responses observed from seeding.

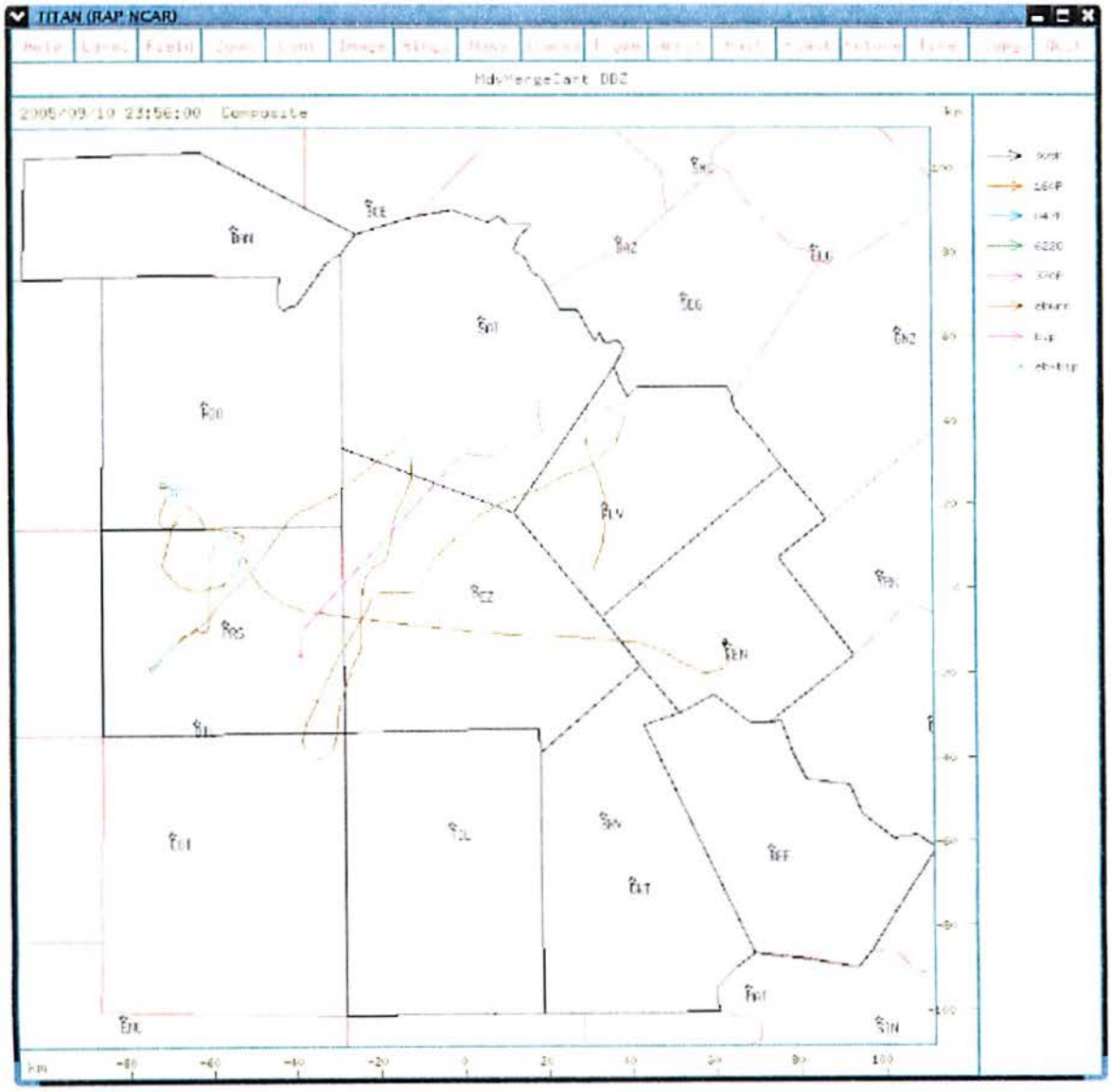
Three flares were used for seeding in Bexar County, totaling 120g of AgI.



SEPTEMBER 10

An upper low over north-central Mexico combined with high pressure over the lower Mississippi River valley to funnel deep tropical moisture into Texas. As daytime heating progressed and the convective temperature was reached, showers and thunderstorms began to blossom across the eastern part of the target area. A plane that was launched for activity in the neighboring SWTREA target area managed to seed a shower near Stinson Field before heading southwest, and this seeded shower grew and intensified over the next hour. A second plane was launched to seed activity in the central target area. Activity in southern Bexar County was seeded, with very good results. The activity merged with the previously seeded shower near Stinson Field, and this cluster of activity pushed across the San Antonio area. Other cells were seeded in Medina County, which also grew and merged together into a larger and more intense storm. Overall it was a very good day for seeding, with apparent radar trends suggesting positive effects.

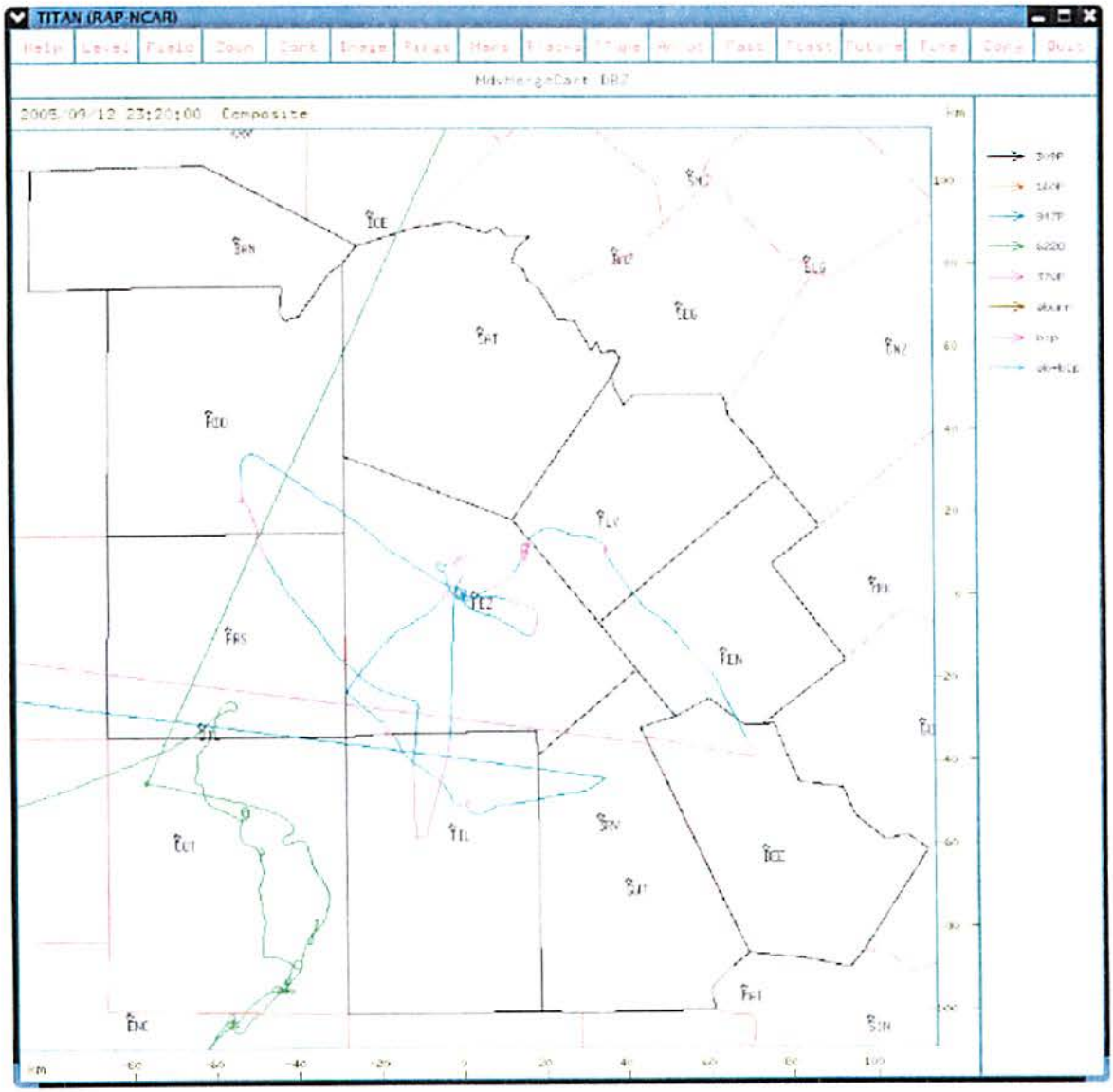
12 flares were used for seeding in Bexar (6) and Medina (6) counties, totaling 480g of AgI.



SEPTEMBER 12

Deep tropical moisture was getting squeezed on both sides by developing high pressure, but for the time being, moisture continued to get funneled into south-central Texas. There was little in the way of a cap, and with strong heating taking place in an airmass with a low convective temperature, showers and thunderstorms blossomed once again south of the target area. A cell that was seeded near Pleasanton grew to twice its size prior to seeding, while heading north towards San Antonio. A flight into Medina County took place during the second launch of 09P, with a shower seeded there. Overall a very good day as far as perceived seeding effects based on radar trends.

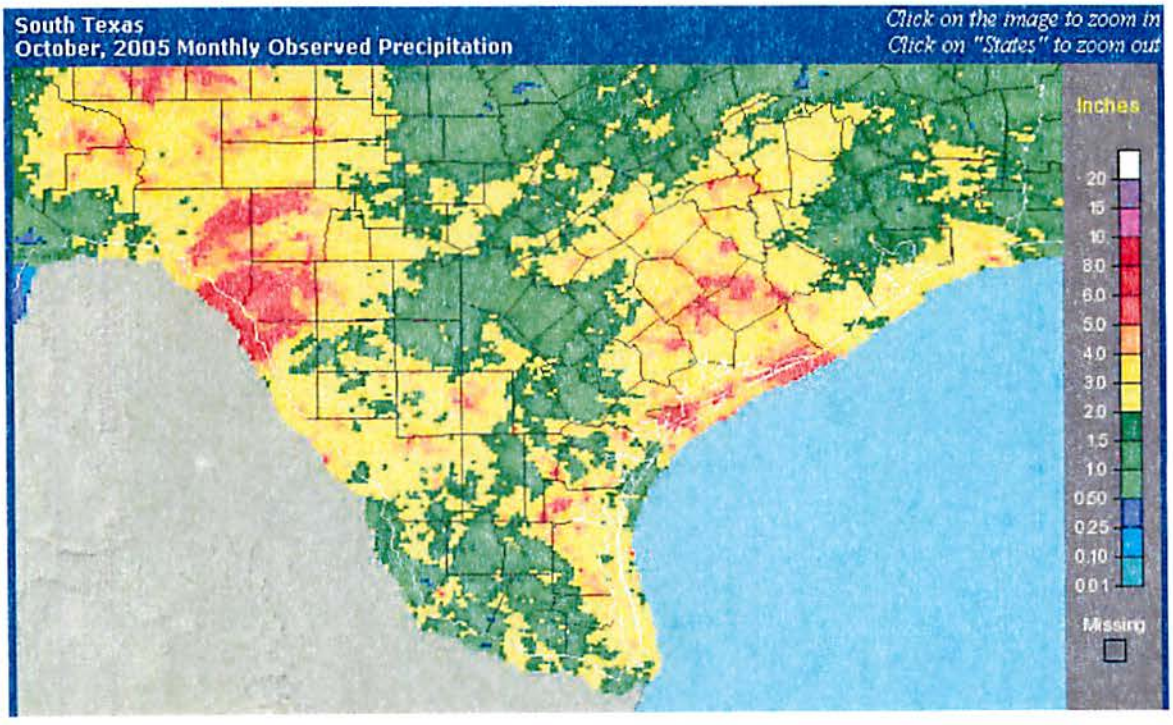
Two flares were used for seeding in Medina County, totaling 80g of AgI.



OCTOBER 2005

Seeding opportunities continued to show up in October, with two distinct "busy periods" in the weather - in the first week of the month and again in the last week. Moist and unstable conditions in the first week allowed for scattered popcorn-type convection to develop over the target area, and seeding appeared to help sustain the convection when looking at radar trends. During the last week, stronger convection in association with more intense disturbances affected parts of the area, with additional seeding being done.

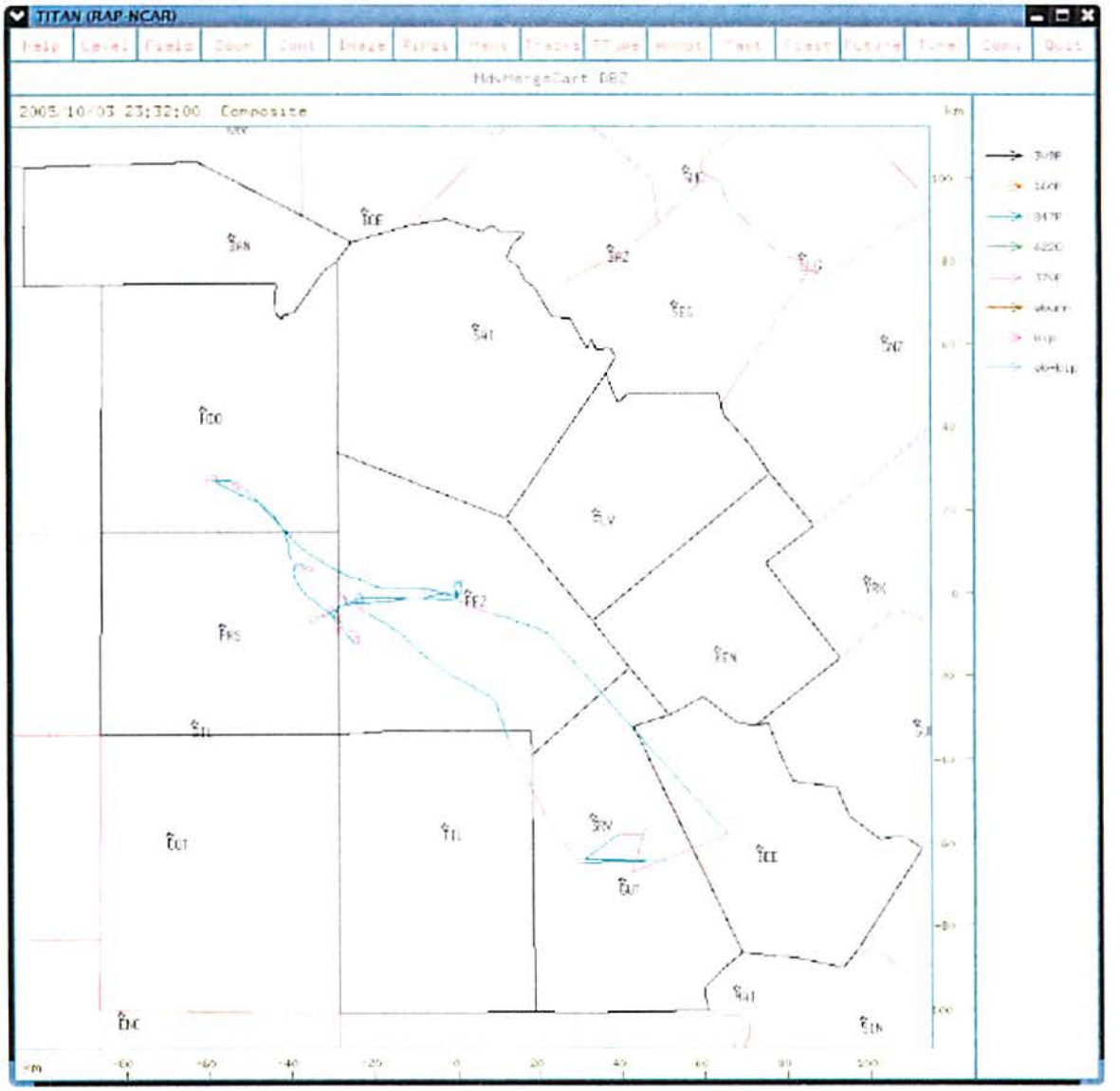
For the month, there were two days on which seeding took place. Two flights were dispatched - one for each day. A total of 25 flares were used for seeding (Bandera - 8; Medina - 17), totaling 1000g of AgI.



OCTOBER 3

High pressure centered over the east coast was providing an east to northeast flow off the Gulf, with a very warm and moist airmass over south Texas. Strong heating on an unstable atmosphere allowed for showers and a couple of thunderstorms to develop near the coast and push inland to the west during the late morning and early afternoon hours. The activity continued to develop and move northwest towards the target area, and a flight was dispatched at mid afternoon to seed activity in and near Medina County, with apparent good results noted from radar trends.

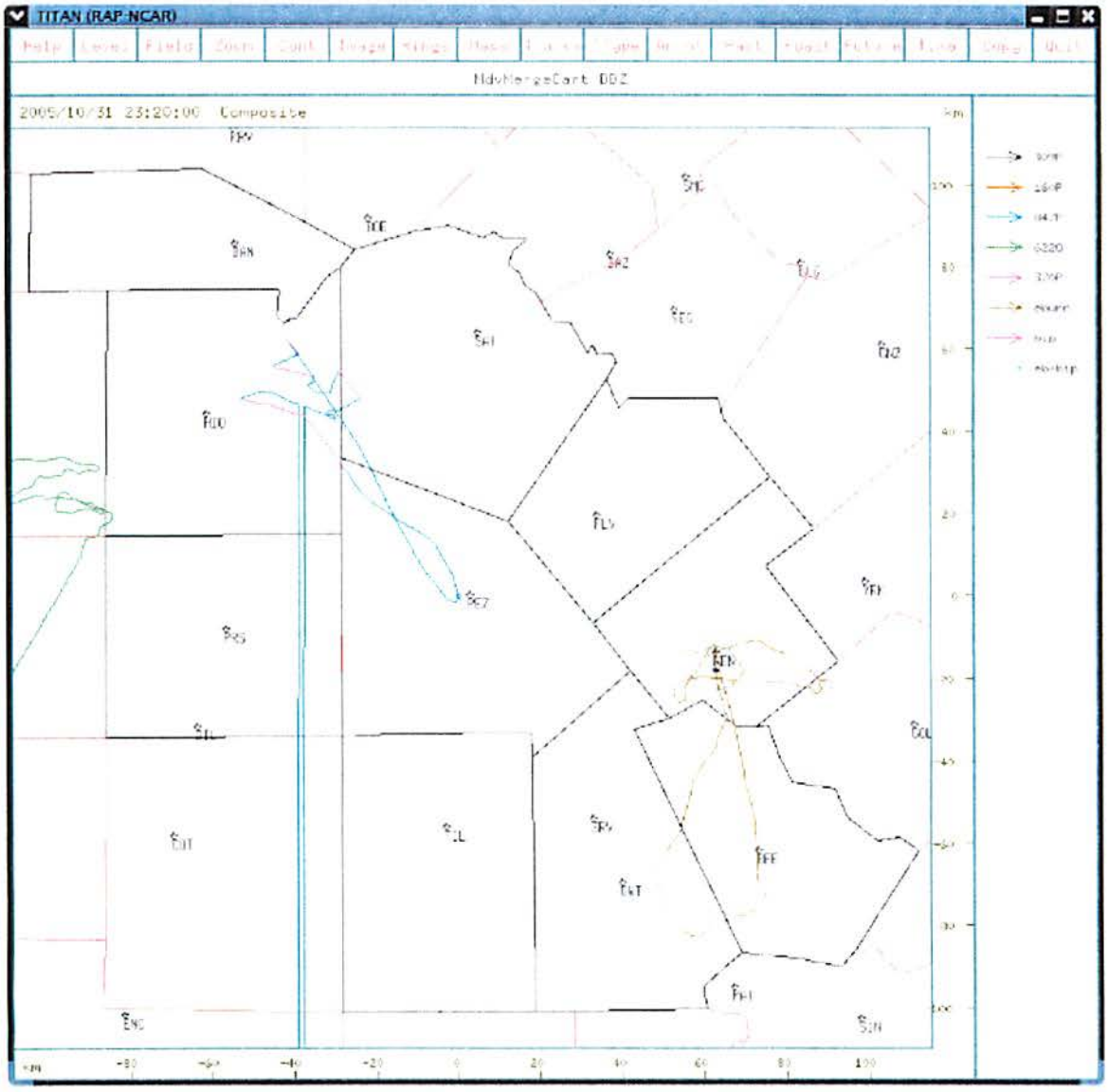
Five flares were used for seeding in Medina County, totaling 200g of AgI.



OCTOBER 31

A cold front was slicing through the state and by late morning was poised about 50 miles north of the target area, pushing steadily southeast. A squall line was ongoing over central and northern Texas, with the line slowly building southwestward. Large scale lift ahead of the main trough/front was helping to generate showers and a few thunderstorms across the northern target area. A flight was launched early in the afternoon to investigate and eventually seed the convective activity over Bandera and Medina counties, with fair to good results noted, particularly with one small cell that was seeded in Medina County, pushing east across the northern sections of San Antonio. The tail end of the squall line entered Bandera County at mid-afternoon and this was seeded. This particular activity did not fare well, as additional thunderstorms developed ahead of this line, along the pre-frontal trough. This activity appeared to cut off any inflow to the tail end of the squall line, and it dissipated.

20 flares were used for seeding in Medina (12) and Bandera (8) counties, totaling 800g of AgI.



COMPARISON OF 2003, 2004 AND 2005 DATA FOR BANDERA, BEXAR AND MEDINA COUNTIES

YEAR	COUNTIES	SEEDING DAYS*	FLARES BURNED	AgI USED (g)	ENHANCED RAIN (ac-ft)
2003	Bandera	7	40	1840	
	Bexar	11	67	4000	
	Medina	18	113	6480	
	TOTALS	**36**	**220**	**12320**	**85,745**
2004	Bandera	10	38	1600	
	Bexar	10	37	1480	
	Medina	17	91	3920	
	TOTALS	**37**	**166**	**7000**	**350,716**
2005	Bandera	12	60	2520	
	Bexar	10	68	3040	
	Medina	19	124	5560	
	TOTALS	**41**	**252**	**11120**	**137,417**

*Note: Seeding days refers to the number of days on which seeding took place within the county, so while on one day alone, all three counties may have had seeding, the totals would be reflected as 3 days of seeding (one for each county).

METEOROLOGICAL PERSPECTIVE OF SEEDING IN 2005

In this section, the perceived effects of seeding as determined by radar trends will be summarized.

In May, both days on which seeding took place were Mesoscale Convective Systems that were approaching the target area. On the 15th, seeding in Medina County may have aided in areal expansion of the convection, which was noted on radar. On the 26th, seeding of a few cells in advance of the main area of rain resulted in cell mergers. Also, a convective cell seeded in southern Bexar County lasted for quite a while after treatment, with up to three inches of rain reported near Stinson Field.

High pressure sat over the area throughout June, resulting in very little precipitation in the target area. No seeding took place in Bandera, Bexar or Medina counties this month.

The quiet weather pattern of June came to an abrupt end in July, with a drastic upswing in convective activity. On July 6, several convective cells trained between Kerrville and western Bandera County. These cells were seeded, with fair results noted. The following day, high-based convection developed in the western target area. These cells were seeded, with some areal expansion of the convection noted. On July 9, convection broke out in Medina, Bandera and Uvalde counties. Initially the activity was scattered in nature, but seeding of the activity by both STWMA and SWTREA may have helped the cells merge into a line of storms that propagated southward across Medina and Uvalde counties. A similar situation occurred on the 14th, when activity congealed into a line of storms that moved southeast across the target area. The 15th through 18th brought more seedable clouds, with some increase in areal coverage and cell lifetime noted. The 18th was the best of these days, as tropical air ahead of Hurricane Emily provided plenty of fuel for storms to grow. On the 21st, south Texas continued to feel effects of now tropical depression Emily in Mexico, and convection that was seeded appeared to last much longer than adjacent areas of convection that were not treated. Towards the end of the month, there were a couple more convective events that were seeded, with perceived seeding effects not as favorable as previous days.

The busy weather pattern of July continued into August. The first week was rather active, with three days of seeding taking place. Radar trends did not indicate much change with the cell attributes during this time period. On the 13th, an area of convection that developed near Corpus Christi headed northwest towards the EAA target area. Seeding of this activity initially took place south of San Antonio, with the cluster continuing to precipitate well into the EAA target area some two hours after seeding commenced. Additional seeding took place as a few showers developed in Medina County, with radar trends suggesting an increase in the lifetime of the cell compared to nearby activity. Two days later, convection that was seeded in Bandera County did not appear to fare well, as the lifetime of the activity was fairly short. On the 19th, as a TUTT passed by the target area, convection developed in several areas in/near the EAA target area. One seeded cell near Floresville pushed into the eastern part of San Antonio and dropped between one half and one inch of rain across the eastern parts

of Bexar County. Additional convection was treated in Medina County, which grew in size and moved north into Bandera County. This turned out to be the best day of the month as far as perceived effects based on radar trends. The last day of seeding in August was on the 29th, when south Texas was being somewhat influenced by landfalling Hurricane Katrina. Convection over the northern target area was seeded, and radar trends indicated a mediocre response.

September had three days with seeding taking place, and all three days saw very good potential responses to treatment. On the 3rd, a tropical airmass was in place, and plenty of "garden variety" showers and thunderstorms developed across south Texas. Response to the seeding appeared to be very favorable, with increases in cell intensity and areal coverage compared with activity outside the target area. On the 10th, an upper low and abundant tropical moisture helped to generate convection across the area. Seeding of several cells resulted in these cells merging into larger clusters which dropped 1-3 inches of rainfall over the course of the day, particularly over San Antonio and in southern Medina County. Two days later on the 12th, tropical moisture and daytime heating helped generate showers and thunderstorms over south Texas. While most of the seeding on this day was south of the EAA target area, some of the seeded activity pushed into southern Bexar and Medina counties, with size increases noted as well as the formation of new activity adjacent to the ongoing convection.

October, the final month of the season, had two days on which seeding took place within the EAA target area. On the 3rd, showers and thunderstorms developed near the coast and pushed northwestward into the target area. The seeded activity in southern Medina County appeared to last a bit longer than other untreated activity seen on the radar. The last day of seeding for the year took place on the 31st. A squall line was approaching the area, with a few cells developing out ahead of it. These were seeded, but radar trends did not suggest much in the way of a response.

As a whole, 2005 was one of the best years as far as the availability of seedable clouds. Certainly, it has become apparent that the clouds in 2005 were not as large on average as those the year before. Archie Ruiz' radar evaluation further underscores this point. The amount of perceived "good days" versus "not so good days" this year are comparable to years past. Mergers, like last year, seemed to produce the best results when looking at cell radar trends. While the eastern part of the target area was much drier than normal for the year (deficit in excess of ten inches), the western half of the target area, where most of the convective activity took place, saw total rainfall amounts below normal as well, but much closer to the average yearly rainfall.

2005 RADAR ANALYSIS FOR THE EDWARDS AQUIFER AUTHORITY

The following is an excerpt from Archie Ruiz' 2005 radar analysis report for the EAA, which includes Bandera, Bexar, Medina and Uvalde counties:

A total of **48 clouds** were seeded and identified by TITAN in **26 operational days**. (NOTE: one other day on which seeding took place was not evaluated due to improper files in the archive or bad data).

Table 1. Small Seeded Sample versus Control Sample (30 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	65 min	45 min	1.44	44 **(30)**
Area	59.9 km^2	39.1 km^2	1.53	53 **(28)**
Volume	163.7 km^3	97.7 km^3	1.68	68 **(31)**
Top Height	7.6 km	7.2 km	1.05	5 **(2)**
Max dBZ	49.8	47.9	1.04	4 **(3)**
Max dBZ height	4.2 km	4.2 km	1.00	0 **(-1)**
Vol > 6km	12.1 km^3	4.8 km^3	2.52	152 **(83)**
Precip Flux	459.5 m^3/s	257.3 m^3/s	1.79	79 **(26)**
Precip Mass	1947.0 kton	787.7 kton	2.47	147 **(99)**
Cloud Mass	143.8 kton	78.0 kton	1.84	84 **(29)**
η	13.5	10.1	1.34	34 **(56)**

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 136 flares were used in this sub-sample with an excellent timing **(80%)** for an effective dose about **105 ice-nuclei per liter**. An excellent increase of 99% in precipitation mass together with an increase of 29% in cloud mass illustrates that the seeded clouds grew at expenses of the environmental moisture (they are open systems) and used only a fraction of this moisture for their own maintenance. The increases in lifetime (30%), area (28%) volume (31%), volume above 6 km (83%) and precipitation flux (26%) are notable. There were slight increases in maximum reflectivity (3%), and in top height (2%). The seeded sub-sample seemed 56% more efficient than the control sub-sample. Results are evaluated as **excellent**.

An increase of 99% in precipitation mass for a control value of 787.7 kton in 30 cases means:

Δ_1 = 30 x 0.99 x 787.7 kton = 23394.7 kton = 18,973 ac-ft

The sub-sample of 7 **large seeded clouds** received a synergetic analysis. On average, the seeding operations on these large clouds affected 65% of their whole volume; with a perfect timing (100% of the material went to the clouds in their first half-lifetime). A total of 85 flares were used in this sub-sample for an effective dose about **90 ice-nuclei per liter**.

Also on average, large clouds were 25 minutes old when the operations took place; the operation lasted about 50 minutes, and the large seeded clouds lived 145 minutes.

Table 2 shows the corresponding results:

Table 2. Large Seeded Sample versus Virtual Control Sample (7 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	145 min	120 min	1.21	21
Area	854 km^2	761 km^2	1.12	12
Precip Mass	29,806 kton	21,107 kton	1.41	41

Timing for this sub-sample was perfect (100%) and the increases are appreciable.

An increase of 41% in precipitation mass for a control value of 21,107 kton in 7 cases may mean:

Δ_2 = 7 x 0.41 x 21,107 kton = 60,577 kton = 49,128 ac-ft

The sub-sample of 9 type B seeded clouds received a synergetic analysis. On average, the seeding operations on these type B clouds affected 30% of their whole volume; with a very good timing (72% of the material went to the clouds in their first half-lifetime). A total of 203 flares were used in this sub-sample for an effective dose about **110 ice-nuclei per liter**.

Also on average, type B clouds were 100 minutes old when the operations took place; the operation lasted about 45 minutes, and the type B seeded clouds lived 225 minutes.

Table 3. Type B Seeded Sample versus Virtual Control Sample (9 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	225 min	220 min	1.02	2
Area	1122 km^2	1079 km^2	1.04	4
Precip Mass	72,808 kton	63,311 kton	1.15	15

An increase of 15% in precipitation mass for a control value of 63,311 kton in 9 cases may mean:

Δ_3 = 9 x 0.15 x 63,311 kton = 85,470 kton = 69,316 ac-ft

The total increase: $\Delta = \Delta_1 + \Delta_2 + \Delta_3$ = 137,417 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.

Vorticity maxima, or vort max as referred to in this report, is defined as a pocket of the atmosphere where rotation of the air about a vertical axis is maximized.

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.

ACKNOWLEDGEMENTS

2005 appeared to be yet another successful year of cloud seeding within the Edwards Aquifer Authority target area. Radar analysis showed that seeding effects this year were positive once again. The success of the project comes about through the hard work of many people, and it is here where gratitude must be expressed.

Our two "heads of state", if you will, Tommy Shearrer and Mike Mahoney, continue to do many hours of work to ensure that the project gets past any red tape and runs as smoothly and efficiently as possible. Many thanks go their way, as the project would likely be lost without them. Thanks also go to the board members who regularly meet to discuss purchases, improvements, seeding methods, and any other factors that affect the way the program is run. Their input in the past has helped run a successful program, and we hope they will continue their good work. We certainly couldn't have the great planes and the successful flights without the hard work of Tim Pickens, our chief pilot, and the four other pilots: Jim Transue, Larry Dement, Ron Merks and Mickey Chadwell. They deserve many thanks. We must also thank the mechanics who completed annuals on our planes, Dave Lavelle and Dave Hamilton. Thanks must also go out to Candi Gonzales, who handles much of the laborious paperwork for the project, and to Larry Akers, who keeps our radar in tip-top shape. Speaking of radars, we must thank Chip Barrere and the crew at WDT, Inc. for providing us with the NEXRAD feed. An expression of gratitude is extended to Archie Ruiz, who performs the ever-challenging radar analysis. With his work, we may yet find a way to prove once and for all the true success of cloud seeding. The cloud seeding projects may not be here had it not been for George Bomar, who works with the projects and the Department of Licensing and Regulations - thank you. A very important person in our project is James Hayden, who has kept the computers working wonderfully, and has given much help in the continued running of our web site; many thanks to him. Thanks also to Rick Illgner, Bob Hall and the EAA for working with us this year and in the years to come. Finally, thanks go out to the public, most of who continue to believe in our project and our mission. Without your approval, our project would cease to exist. Thank you all!

Rainfall maps for 2005 came from the following website:
http://www.srh.noaa.gov/rfcshare/precip_analysis_new.php

Radar analysis numbers came from Archie Ruiz's final report of the 2005 season for the EAA (5 pp).