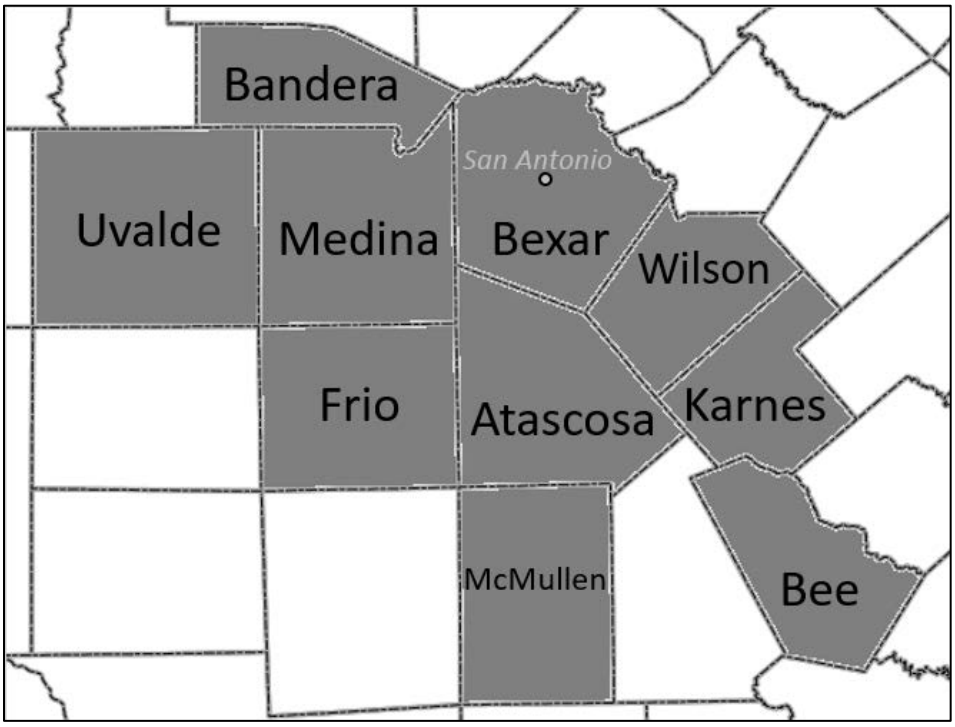
2017 Annual Report for South Texas Weather Modification Association



South Texas Weather Modification Association
110 Wyoming Blvd.
Pleasanton, TX 78064

South Texas Weather Modification Association 2017 Operations Summary

The 2017 cloud seeding operational season is the 20th consecutive season of weather modification operations in the south Texas region. The main objective across south Texas is the enhancement of convective precipitation, with hail suppression as a secondary objective. The season began on April 11 in Atascosa, Karnes, Medina and Wilson counties, and ended on October 3 in Frio and Medina counties. There were 41 operation days (average is 39), 71 seeding flights, 11 recon flights with no seeding, and a total of 197.91 hours of flight time. Both glaciogenic and hygroscopic flares were used the entire season, with a total of 2,279 glaciogenic and 169 hygroscopic flares burned during the season.

Staff remained the same this season with Craig Funke as Project Manager, Kendell LaRoche as Project Meteorologist, and pilots Butch Card and Mark Opiela.

Across the operational area, rainfall from Hurricane Harvey had a strong influence on the yearly rain total for Bee, Karnes, and Wilson. However even with the heavy rain from Harvey, large areas of the operational area were at or below the normal yearly rainfall amount. Bandera county seemed to have the greatest departure from normal, with some areas estimated to be 8-12 inches below normal. Locations within the operational area which received above average precipitation for 2017 include parts of Uvalde, Frio, and Atascosa counties; southern McMullen county; and eastern Bexar, Bee, Karnes, and Wilson counties[1]. The weather pattern during the operational period (March – October) seemed to alternate between long periods of no rain, followed by several days of rain. The 2017 global weather pattern began the year with a neutral to weak La Nina pattern in the Pacific, which became a more neutral pattern by summer. The ocean temperature pattern stayed neutral for the rest of 2017 but would fluctuate between slightly more positive to slightly more negative. Cloud seeding operations were only suspended during and after Hurricane Harvey.

The STWMA annual evaluation conducted by Arquímedes Ruiz-Columbié from Texas Tech University reported 250 seeded clouds, with 203 small seeded clouds, 29 large clouds, and 18 type B clouds. Small clouds are defined as clouds with a precipitation mass (amount of precipitation in a cloud) less than 10,000 kilotons (kton), large clouds are clouds with a precipitation mass greater than 10,000 kton, and type B clouds are clouds which were seeded when they were one hour old or older. Seeded small clouds provided an additional ~197,599 acre-feet of water, large clouds provided an additional ~567,241 acre-feet of water, and type B clouds proved an additional ~90,645 acre-feet of water, respectively. Over the entire operational region, cloud seeding activities brought an additional ~855,485 acre-feet of water; along with an average 1.48 inches of additional precipitation, or an average 10.3% increase over the seasonal value.

When looking at specific variables, small clouds had a precipitation flux (amount of precipitation falling from a storm over certain time period) increase of 39% and a precipitation mass increase of 120%. Large clouds had a precipitation flux increase of 22% and a precipitation mass increase of 57%. Type B clouds had precipitation flux increases of 7% and precipitation mass increases of 15%. There were also notable increases for cloud lifetime, area, and volume for small, large, and type B clouds.

ANNUAL EVALUATION REPORT 2017 STWMA (Pleasanton)

Dr. Arquímedes Ruiz-Columbié
Active Influence & Scientific Management

Cloud seeding operations 2017 began over South Texas Weather Modification Association target area in April. This annual report serves as a summary of results. A total of **250 clouds** were seeded and identified by TITAN in **41 operational days**. Table 1 in page 1 summarizes the general figures:

Table 1: Generalities

First operational day: **April 11th, 2017**
Last operational day: **October 3rd, 2017**

Number of operational days: 41
(One in April, five in May, seven in June, twelve in July, eight in August, seven in September, and one in October)

According to the daily reports operational days were qualified as:
Twenty-nine with excellent performance
Eight with very good performance
Four with good performance

Number of seeded clouds: 250
(203 small seeded clouds, 29 large seeded clouds, 18 type B seeded clouds)

Flares used: 2279 AgI-BIP plus 169 HYG

Missed Opportunities: none (with lifetime longer than 45 minutes)

Small Clouds

Evaluations were done using TITAN and NEXRAD data.

Table 2 shows the results from the classic TITAN evaluation for the 203 small seeded clouds which obtained proper control clouds.

Table 2: Seeded Sample versus Control Sample (203 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	65 min	40 min	1.63	63 (**44**)
Area	67.2 km^2	43.1 km^2	1.56	56 (**38**)
Volume	192.5 km^3	124.3 km^3	1.55	55 (**39**)
Top Height	7.7 km	7.2 km	1.07	7 (**3**)
Max dBz	52.2	51.1	1.02	2 (**2**)
Top Height of max dBz	3.5 km	3.5 km	1.00	0 (**0**)
Volume Above 6 km	34.3 km^3	19.9 km^3	1.72	72 (**37**)
Prec.Flux	534.6 m^3/s	317.9 m^3/s	1.68	68 (**39**)
Prec.Mass	2342.9 kton	1000.2 kton	2.34	134 (**120**)
CloudMass	176.8 kton	109.8 kton	1.61	61 (**40**)
η	13.3	9.1	1.46	46 (**58**)

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 **1597 AgI-BIP and 80 Hygroscopic flares** were used in this sub-sample with an excellent timing (**94 %)** for an average effective silver iodide dose of about **60 ice-nuclei per liter**. The seeding operation for small clouds lasted about **7 minutes** on average. An excellent increase of 120 % in precipitation mass together with an increase of 58 % 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 (44 %), in area (38 %), in volume (39 %), in volume above 6 km (37 %), and in precipitation flux (39 %) are notable. There were slight increases in top height (3 %) and in maximum reflectivity (2 %). The seeded sub-sample was 58 % more efficient than the control sub-sample. Results are evaluated as **excellent** for this subsample.

An increase of 120 % in precipitation mass for a control value of 1000.2 kton in 203 cases means:

Δ_1 = 203 x 1.20 x 1000.2 kton ≈ 243 649 kton ≈ 197 599 ac-f (layer: 17.9 mm ≈ 0.70 in)

Report continued on next page

Large Clouds

The sub-sample of 29 large seeded clouds received a synergetic analysis. On average, the seeding operations on these large clouds affected 83 % of their whole volume with an excellent timing (99 % of the material went to the clouds in their first half-lifetime). A total of **571 AgI-BIP and 70 Hygroscopic flares** were used in this sub-sample for an average effective silver iodide dose of about **100 ice-nuclei per liter**.

Also on average, large clouds were 24 minutes old when the operations took place; the operation lasted about 30 minutes, and the large seeded clouds lived 230 minutes.

Table 3 shows the corresponding results:

Table 3: Large Seeded Sample versus Virtual Control Sample (29 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	250 min	210 min	1.19	19
Area	1014 km^2	838 km^2	1.21	21
Volume	3689 km^3	3036 km^3	1.21	21
Volume Above 6 km	1106 km^3	881 km^3	1.26	26
Prec.Flux	13226 m^3/s	10809 m^3/s	1.22	22
Prec.Mass	66 431 kton	42 313 kton	1.57	57

An increase of 57 % in precipitation mass for a control value of 42 313 kton in 29 cases may mean:

Δ_2 = 29 x 0.57 x 42 313 kton ≈ 699 434 kton ≈ 567 241 ac-f (layer: 23.8 m ≈ 0.94 in)

Type B Clouds

The sub-sample of 18 type B seeded clouds also received a synergetic analysis. On average, the seeding operations on these type B clouds affected 25 % of their whole volume with a very good timing (85 % of the material went to the clouds in their first half-lifetime). A total of **111 AgI-BIP and 19 Hygroscopic flares** were used in this sub-sample for an average effective silver iodide dose of about **120 ice-nuclei per liter.**

Also on average, type B clouds were 100 minutes old when the operations took place; the operation lasted about 30 minutes, and the type B seeded clouds lived 300 minutes.

Table 4 shows the results:

Table 4: Type B Seeded Sample versus Virtual Control Sample (18 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	300 min	285 min	1.05	5
Area	933 km^2	876 km^2	1.07	7
Volume	5702 km^3	5346 km^3	1.07	7
Volume Above 6 km	833 km^3	787 km^3	1.06	6
Prec.Flux	8234 m^3/s	7687 m^3/s	1.07	7
Prec.Mass	47 605 kton	41 396 kton	1.15	15

An increase of 15 % in precipitation mass for a control value of 41 396 kton in 18 cases may mean:

Δ_3 = 18 x 0.15 x 41 396 kton ≈ 111 769 kton ≈ 90 645 ac-f (layer: 6.66 mm≈ 0.26 in)

The total increase: $\Delta = \Delta_1 + \Delta_2 + \Delta_3$ = 855 485 ac-f

(~ 973 ac-f per small, 19 560 ac-f per large, 5 036 ac-f per type B)

Micro-regionalization

Increases in precipitation mass were analyzed county by county in an attempt to better describe the performance and corresponding results. **Table 5** below offers the details:

County Seeding	Initial Seeding	Extended (increase)	Acre-feet (increase)	Inches (increase)	Rain Gage (season value)	% (increase)
Uvalde	**33**	**39**	**83 100**	**0.97**	**16.33 in**	**5.9**
Bandera	**14**	**15**	**51 500**	**1.42**	**17.05 in**	**8.3**
Medina	**40**	**52**	**106 500**	**1.39**	**13.51 in**	**10.3**
Bexar	**7**	**9**	**21 800**	**0.33**	**12.14 in**	**2.7**
Frío	**20**	**28**	**73 900**	**1.27**	**15.37 in**	**8.3**
Atascosa	**42**	**49**	**154 100**	**2.32**	**11.84 in**	**19.6**
McMullen	**18**	**20**	**47 500**	**0.80**	**11.30 in**	**7.1**
Wilson	**23**	**26**	**86 300**	**2.03**	**14.15 in**	**14.3**
Karnes	**19**	**21**	**76 600**	**1.93**	**15.79 in**	**12.2**
Bee	**25**	**26**	**108 500**	**2.31**	**16.78 in**	**13.8**
Outside	9	10	45 500 (~ 5 % of total)			
Total	**250**	**295**	**809 800**			
Average				**1.48**	**14.42 in**	**10.3**

(**Initial seeding** means the counties were the operations began, whereas **extended seeding** means the counties favored by seeding after the initial operations took place).

Seasonal precipitation values do not include rainfall associated with Hurricane Harvey (August 24 - 28)

Final Comments

1) Results are evaluated as **excellent**.

2) The micro-regionalization analysis showed increases per county; different zones received downwind benefits; the average increase in precipitation, referred to rain gage seasonal value, is about 10 **%**;

3) Radar estimations of precipitation should be considered as measurements of trend. Clearly, seeding operations improved the dynamics of seeded clouds.

4) In 2017, the total increase in the region, estimated in about 0.86 million acre-feet, should be considered as a great help to fresh water natural resources.

5) Dual seeding was properly used in the operations, as the following small table indicates:

Type of storm	AgI-flares used	Hygroscopic flares used
Small	1597 (~ 7.8 per storm)	80 (~ 0.4 per storm)
Large	571 (~ 19.7 per storm)	70 (~ 2.4 per storm)
Type B	111 (~ 6.2 per storm)	19 (~ 1.1 per storm)

Those data show that Large and Type B storms received a more dual treatment than the small ones.

Note: Some over-seeding situations were detected on small storms during the first half of the season. This over-seeding did not hurt the clouds, adjustments were made and over-seeding was absent for the rest of the season.

The ocean temperature phase in the Pacific at began of 2017 was a near neutral / weak La Nina pattern. The weak La Nina pattern began transiting to a more neutral pattern during late spring / early summer. The first cloud seeding mission for 2017 began on April 11th as a weak cold front passed through the region, however starting in mid-April low clouds and rain occurring after sunset meant no other cloud seeding operations were conducted until the end of May.

At the end of May a strong trough stalled over the Texas region, which helped many shortwaves pass through the region. These shortwaves, along with a stationary front, caused multiple days of showers and thunderstorms across the region. The trough eventually moved east, and a strong ridge of high pressure sat over the region beginning in early June. The strong ridge persisted across southern TX until the last weekend in June, with a cold front stalled across the region bringing 4 days of rain and cloud seeding.

July began with another ridge of high pressure across the region, until about a week into July when morning and afternoon seabreeze thunderstorms became more common. Most of July consisted afternoon seabreeze showers and storms which would dissipate with the loss of daytime heating. There were multiple days with no rain, however an occasional weak low pressure would form west of the border in Mexico and move north along the Rio Grande Plains, helping showers and storms develop. Also, weak troughs would move into central TX and occasionally as far south as San Antonio and hill country, helping generated showers and storms.

By the end of July / beginning of August a strong trough / cold front moved through then stalled across the region, bringing multiple days of isolated and scattered showers and storms. After August 10, a strong high pressure system developed over the Gulf, and pushed all moisture further east to eastern TX and Louisiana, while leaving south TX dry. The end of August saw hurricane Harvey make landfall northeast of Corpus Christ, dumping tremendous amounts of rain mainly east of the I-35 corridor. Cloud seeding was suspended for multiple days while the region dried out.

Cloud seeding resumed in early September, however other than Sept. 4-5 the region was dominated by high pressure and slightly cooler temperatures. Near the end of September, a strong high pressure stalled over the southeastern US, which brought warm and humid conditions to south TX. Chance of rain increased the last 2 weeks of September, with isolated to scattered showers and storms.

A few rain chances extended into early October, however seeding only took place on Oct. 3. Most of October then became dry with a few cold fronts moving through the region. However most of these cold fronts were either took weak, or too dry to generate significant rainfall. The only strong front to generate rain on October 31 produced stratiform rain with low visibilities. Pilot was launched and attempted to investigate, but low ceilings and poor visibility made even getting close to the rain dangerous. The beginning of November was dominated by warm but very dry conditions, and operations ended for the season in early November. The Pacific Ocean temperatures were near-to-below average by the time seeding ended in early Nov.

2017 Events Summary

The winter months before cloud seeding began were spent repairing aircraft equipment, updating computer software, and exploring new research possibilities. A 'weather workshop' was held in San Angelo at the West Texas Weather Modification Association (WTWMA) January 20-22. Topics included 2016 summaries for each cloud seeding operation across TX, flare dosage adjustments, and possible research techniques. March was spent testing aircraft and equipment for the upcoming season. During the end of March / beginning of April, the longtime C-band radar at the Pleasanton airport, which had been used for seeding operations, was dismantled and removed. Representatives from STWMA, WTWMA, and Texas Tech attended the Weather Modification Association Annual Meeting in Boise near the end of April. Presentations were given by the meteorologist from WTWMA and STWMA on hygroscopic flare usage and Texas rainfall enhancement results from 2016. In mid-July Archie, weather modification researcher, visited STWMA to offer guidance and test project evaluation programs on the computers at the Pleasanton Airport. A weather modification workshop was held in San Angelo August 8-10, with discussions on season results, new technology, and modification of seeding techniques.

South Texas Weather Modification Association										
2017 Flight Summary										
April										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)***	**Seeded ****	**Pilot**
4/11/2017	1	160P	19:13	21:12	1.98	60	6	330	AT, KA, WI	Butch
4/11/2017	2	57AA	19:42	21:25	1.72	10	4	55	ME	Mark
Month Total					**3.7**	**70**	**10**	**385**		
Subtotal					**3.7**	**70**	**10**	**385**		
May										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**
5/11/2017	3	160P	21:11	23:07	1.9	0	0	0	Recon	Butch
5/20/2017	4	160P	16:36	19:24	2.8	0	0	0	Recon	Butch
5/20/2017	5	160P	19:55	21:38	1.7	0	0	0	Recon	Butch
5/21/2017	6	160P	18:08	20:59	2.9	57	4	313.5	AT, BE, LO, KA	Butch
5/21/2017	7	57AA	18:58	21:20	2.4	28	5	154	ME	Mark
5/21/2017	8	57AA	22:24	23:27	1.1	15	2	82.5	WI	Mark
5/23/2017	9	57AA	22:11	23:36	1.4	31	6	170.5	AT	Mark
5/23/2017	10	160P	22:25	01:07	2.7	60	6	330	AT, BE, LO, MC	Butch

5/28/2017	11	160P	19:35	00:44	5.2	24	3	132	BA, Kerr, FR	Butch
5/30/2017	12	57AA	19:55	22:50	2.9	42	4	231	AT, ME, UV, WI	Mark
5/30/2017	13	160P	18:05	20:11	2.1	60	6	330	BA, BX, ME	Butch
5/31/2017	14	57AA	17:44	19:08	1.4	41	5	225.5	AT, FR	Mark
5/31/2017	15	57AA	20:48	22:13	1.4	29	6	159.5	AT, KA, MC	Mark
5/31/2017	16	160P	18:28	20:43	2.3	54	5	297	AT, ME, WI	Butch
Month Total					**32.2**	**441**	**52**	**2425.5**		
Subtotal					**35.9**	**511**	**62**	**2810.5**		
June										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**
6/2/2017	17	57AA	22:10	23:20	1.2	45	2	247.5	AT, FR, ME	Mark
6/3/2017	18	57AA	00:03	01:22	1.3	0	0	0	Recon	Mark
6/4/2017	19	57AA	18:39	21:15	2.6	42	5	231	BA, ME, UV	Mark
6/4/2017	20	160P	22:06	23:38	1.5	62	5	341	BE, DW, KA	Butch
6/4/2017	21	57AA	23:16	01:00	1.7	33	3	181.5	BE	Mark
6/5/2017	22	57AA	21:21	23:56	2.6	37	3	203.5	AT, BA, BX, ME	Mark
6/5/2017	23	160P	23:09	01:11	2.03	64	6	352	AT, FR, WI	Butch
6/24/2017	24	57AA	17:20	20:00	2.7	57	0	313.5	AT, FR, ME	Mark
6/24/2017	25	160P	18:55	20:40	1.8	18	2	99	MC	Butch
6/25/2017	26	57AA	17:27	19:43	2.3	46	0	253	FR, ME, AT	Mark
6/25/2017	27	57AA	21:09	00:42	3.6	38	0	209	FR, KA, BE,	Mark

									ME, UV	
6/25/2017	28	160P	17:38	19:02	1.4	62	6	341	GL, BE, KA, WI	Butch
6/25/2017	29	160P	20:29	22:27	1.97	62	6	341	DW, KA, GL	Butch
Month Total					**43.5**	**817**	**43**	**4493.5**		
Subtotal					**79.4**	**1328**	**105**	**7304**		
July										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**
7/6/2017	30	160P	18:23	20:52	2.48	18	1	99	BE, KA	Butch
7/6/2017	31	160P	21:20	23:25	2.1	24	2	132	BE, KA	Butch
7/7/2017	32	160P	18:05	21:21	3.3	62	4	341	AT, BE, KA, LO	Butch
7/12/2017	33	160P	18:10	20:31	2.4	54	2	297	AT, BX, KA, WI	Butch
7/12/2017	34	47P	20:25	21:11	0.8	8	3	44	AT, KA	Craig
7/12/2017	35	160P	20:57	23:34	2.6	26	2	143	AT, KA, LO, ME	Butch
7/13/2017	36	160P	17:47	21:49	4.03	38	2	209	KA, ME, UV, WI	Butch
7/13/2017	37	57AA	18:52	20:52	2.0	40	0	220	AT	Mark
7/14/2017	38	160P	20:20	22:53	2.6	10	0	55	BE, ME	Butch
7/15/2017	39	57AA	21:04	00:38	3.1	28	0	154	BA, ME, UV, WI	Mark
7/16/2017	40	57AA	20:55	01:08	4.2	23	0	126.5	UV	Mark
7/17/2017	41	57AA	19:40	23:37	3.95	21	1	115.5	ME, UV	Mark
7/17/2017	42	160P	17:57	21:56	3.98	31	4	170.5	BA, ME, UV	Butch
7/17/2017	43	160P	22:26	23:32	1.1	2	0	11	AT	Butch
7/19/2017	44	160P	18:55	23:38	4.7	19	1	104.5	BE, KA,	Butch

									LO, MC	
7/23/2017	45	57AA	21:22	00:51	3.48	16	1	88	BA, FR	Mark
7/26/2017	46	160P	20:57	23:57	3	22	1	121	AT, BE, KA, ME, WI	Butch
7/26/2017	47	57AA	21:29	00:44	3.3	16	1	88	FR, LS, ME	Mark
7/31/2017	48	57AA	21:17	00:03	2.8	12	2	66	AT, MC, ME	Mark
Month Total					**55.92**	**470**	**27**	**2585**		
Subtotal					**135.32**	**1798**	**132**	**9889**		
August										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**
8/1/2017	49	160P	21:11	23:44	2.6	0	0	0	Recon	Butch
8/2/2017	50	57AA	19:51	00:24	4.6	28	2	154	AT, BA, FR, ME	Mark
8/2/2017	51	160P	21:16	23:06	1.83	0	0	0	Recon	Butch
8/3/2017	52	57AA	21:55	00:48	2.88	22	2	121	ME, UV, WI	Mark
8/3/2017	53	160P	22:51	00:22	1.52	8	1	44	KA, WI	Butch
8/4/2017	54	57AA	21:58	23:39	1.7	4	1	22	UV	Mark
8/4/2017	55	160P	19:22	22:10	2.8	10	3	55	BE, LO	Butch
8/4/2017	56	160P	22:32	23:21	0.8	0	0	0	Recon	Butch
8/10/2017	57	57AA	21:03	23:14	2.2	47	2	258.5	AT, BX, FR, ME	Mark
8/11/2017	58	160P	22:06	22:52	0.8	6	1	33	BE	Butch
8/21/2017	59	160P	21:00	23:07	2.1	14	2	77	AT, FR, MC	Butch
8/22/2017	60	160P	21:15	23:35	2.3	22	2	121	BE, LO	Butch
8/23/2017	61	160P	18:22	20:47	2.4	24	3	132	BA, UV	Butch
Month Total					**28.53**	**185**	**19**	**1017.5**		
Subtotal					**163.9**	**1983**	**151**	**10906.5**		
September										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**

9/4/2017	62	160P	18:57	20:46	1.8	10	2	55	AT, MC	Butch
9/4/2017	63	160P	21:25	22:40	1.25	0	0	0	Recon	Butch
9/5/2017	64	160P	21:20	23:44	2.4	10	1	55	UV	Butch
9/18/2017	65	160P	18:20	20:52	2.53	36	4	198	BE, KA	Butch
9/19/2017	66	57AA	21:28	00:00	2.53	10	1	55	UV	Mark
9/21/2017	67	160P	19:20	22:18	2.97	34	1	187	BE, KA, LO, MC	Butch
9/21/2017	68	57AA	21:30	23:50	2.3	44	2	242	AT, FR, KA	Mark
9/22/2017	69	160P	19:23	23:32	4.2	42	0	231	AT, FR, MC, ME, UV	Butch
9/22/2017	70	57AA	19:27	22:48	3.4	42	3	231	AT, FR, ME, ZA	Mark
9/25/2017	71	160P	18:38	21:20	2.7	14	1	77	AT, WI	Butch
9/25/2017	72	160P	21:50	00:13	2.4	17	0	93.5	BX, ME	Butch
Month Total					**28.48**	**259**	**15**	**1424.5**		
Subtotal					**192.3**	**2242**	**166**	**12331**		
October										
Date	**No.**	**Call Sign**	**Takeoff (UTC)**	**Landing**	**Dur.**	**#GL**	**#HY**	**AgI (g)**	**Seeded**	**Pilot**
10/3/2017	73	160P	19:15	19:55	0.67	0	0	0	Recon	Butch
10/3/2017	74	160P	20:20	21:39	1.3	0	0	0	Recon	Butch
10/3/2017	75	57AA	18:51	21:53	3.03	37	3	203.5	FR, ME, ZA	Mark
10/31/2017	76	57AA	20:44	21:19	0.58	0	0	0	Recon	Mark
Month Total					**5.58**	**37**	**3**	**203.5**		
Final Total					**197.9**	**2279**	**169**	**12534.5**		

* #GL means number of glaciogenic flares burned, #HY means number of hygroscopic flares burned, AgI (g) means the amount of glaciogenic material burned.

** Counties: AT = Atascosa, BA = Bandera, BE = Bee, BX = Bexar, DW = DeWitt, FR = Frio, GL = Goliad, KA = Karnes, LO = Live Oak, LS = La Salle, MC = McMullen, ME = Medina, UV = Uvalde, WI = Wilson, ZA = Zavala

2017 Monthly Temperature and Precipitation Summary for San Antonio*						
Month	**Average Monthly Temp. (F)**	**Normal Monthly Temp. (F)**	**Monthly Temp. Departure from Normal (F)**	**Total Month Precipitation (In.)**	**Normal Month Precip. (In.)**	**Month Precip. Departure from Normal (In.)**
April	71.1	69.3	+1.8	2.89	2.10	+0.79
May	75.6	76.9	-1.3	1.76	4.01	-2.25
June	83.3	82.4	+0.9	0.40	4.14	-3.74
July	87.6	84.6	+3.0	0.16	2.74	-2.58
Aug.	84.6	85.3	-0.7	5.87	2.09	+3.78
Sept.	79.4	79.7	-0.3	2.80	3.03	-0.23
Oct.	70.4	71.2	-0.8	0.46	4.11	-3.65

* San Antonio International Airport station

2017 Monthly Temperature and Precipitation Summary for Del Rio*						
Month	**Average Monthly Temp. (F)**	**Normal Monthly Temp. (F)**	**Monthly Temp. Departure from Normal (F)**	**Total Month Precipitation (In.)**	**Normal Month Precip. (In.)**	**Month Precip. Departure from Normal (In.)**
April	72.2	71.6	+0.6	5.64	1.65	+3.99
May	76.8	78.9	-2.1	3.97	2.81	+1.16
June	83.8	84	-0.2	2.46	2.35	+0.11
July	87.8	85.9	+1.9	0.66	1.78	-1.12
Aug.	86.5	86.2	+0.3	1.68	2.18	-0.50
Sept.	81.4	80.3	+1.1	6.33	2.2	+4.13
Oct.	69.8	71.7	-1.9	0.43	2.23	-1.80

*Del Rio International Airport station

2017 Monthly Temperature and Precipitation Summary for Corpus Christi*						
Month	**Average Monthly Temp. (F)**	**Normal Monthly Temp. (F)**	**Monthly Temp. Departure from Normal (F)**	**Total Month Precipitation (In.)**	**Normal Month Precip. (In.)**	**Month Precip. Departure from Normal (In.)**
April	74.9	72.4	+2.5	2.22	1.84	+0.38
May	78.1	78.3	-0.2	3.22	3.07	+0.15
June	83.8	82.4	+1.4	1.93	3.36	-1.43
July	84.3	83.9	+0.4	1.27	2.79	-1.52
Aug.	84.6	84.7	-0.1	5.89	2.92	+2.97
Sept.	81.4	81.0	0.4	1.46	4.98	-3.52
Oct.	73.9	74.6	-0.7	2.47	3.64	-1.17

*Corpus Christi International Airport station

April 2017 Operations Report

April 11, 2017 - Seeding operations were conducted over Atascosa (20 + 2H), Karnes (10 + 1H), Medina (10 + 4H), and Wilson (30 + 3H) counties. 70 flares plus 10 hygroscopic flares were burned within 6 clouds.

The month of April contained 1 day of operations:

Date	**Number of Flares**	**Counites Seeded**
11	70 AgI + 10 H	Atascosa, Karnes, Medina and Wilson
TOTAL	**70 AgI + 10 H**	

While several rounds of rain occurred across south TX throughout the month of April, most of these events were after dark, or covered in low clouds which made flying too dangerous for the pilots. Across the operational area, wide areas of Bandera, Bexar, Atascosa, McMullen, Wilson, Karnes, and Bee received average to below average rain. Meanwhile Uvalde, Medina, southern McMullen, southern Bee, northern Bexar, and isolated spots in Atascosa received above average rainfall (radar/rain gauge multisensor field amounts)[1]. April 2017 was not a very active cloud seeding month, and had only one operation. The operation itself was busy, with 70 glaciogenic and 10 hygroscopic flares burned in 6 storms. Two flights recorded a total 3.7 hours of flight time across the operational area.

The April operation occurred as a weak cold front passed through the region on April 11th. Storms began early in the day over central TX, then slowly moved south with the front. Cloud seeding continued throughout the day until skies began to darken and widespread rain made for low visibility. For the rest of April, a few more rain events occurred, however these events occurred with low clouds or after dark.

The season began with slightly warmer than average temperatures for Corpus Christ, Del Rio, and San Antonio and slightly above average precipitation at San Antonio and Corpus Christi. Areas along the US / Mexico border recorded above average monthly rainfall (including Uvalde and Medina counites), with Del Rio recording 5.64 inches (almost 4 inches above normal). Weather stations located across each of the ten participating counties were examined for total rainfall amounts during the month of April. Areas within and near Hill County generally received more precipitation than locations south of Hill County, except for far eastern Karnes county.

April 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	2.67
Medina	Hondo Municipal Airport Station	2.71
Bexar	San Antonio International Airport Station	2.89
Bexar	Stinson Municipal Airport Station	1.66
Atascosa	Pleasanton Municipal Airport Station	1.06
Wilson	Floresville, TX	1.44
Karnes	Runge, TX	2.02
Bee	Station 5 miles northeast of Beeville	1.21
McMullen	Cross, TX	1.74
Frio	Pearsall, TX	1.25
Bandera	Station 1 mile northeast of Medina, TX	2.53

May 2017 Operations Report

May 21, 2017 - Seeding operations were conducted over Atascosa (10 + 0H), Bee (10 + 0H), Karnes (30 + 2H), Live Oak (7 + 2H), Medina (28 + 5H), and Wilson (15 + 2H) counties. 100 flares plus 11 hygroscopic flares were burned within 3 clouds.

May 23, 2017 – Seeding operations were conducted over Atascosa (55 + 8H), Bee (10 + 1H), Live Oak (2 + 1H), and McMullen (22 + 2H) counties. 91 flares plus 12 hygroscopic flares were burned within 1+ cloud.

May 28, 2017 – Seeding operations were conducted over Bandera (18 + 2H), Frio (4 + 1H), and Kerr (2 + 0H) counties. 24 flares plus 3 hygroscopic flares were burned within 2 clouds.

May 30, 2017 – Seeding operations were conducted over Atascosa (4 + 0H), Bandera (10 + 1H), Bexar (6 + 0H), Medina (54 + 6H), Uvalde (20 + 2H), and Wilson (8 + 1H) counties. 102 flares plus 10 hygroscopic flares were burned within 2+ clouds.

May 31, 2017 – Seeding operations were conducted over Atascosa (82 + 7H), Frio (20 + 3H), Karnes (2 + 0H), McMullen (10 + 6H), Medina (8 + 0H), and Wilson (2 + 0H) counties. 124 flares plus 16 hygroscopic flares were burned within 3 clouds.

The month of May contained 5 days of operations:

Date	**Number of Flares**	**Counites Seeded**
21	100 AgI + 11 Hygro	Atascosa, Bee, Karnes, Live Oak, Medina, and Wilson
23	91 AgI + 12 Hygro	Atascosa, Bee, Live Oak, and McMullen
28	24 AgI + 3 Hygro	Bandera, Frio, and Kerr
30	102 AgI + 10 Hygro	Atascosa, Bandera, Bexar, Medina, Uvalde, and Wilson
31	124 AgI + 16 Hygro	Atascosa, Frio, Karnes, McMullen, Medina, and Wilson
Total	**441 AgI + 52 Hygro**	

Most of May was dry with high pressure over the region, before a strong trough stalled over the state near the end of the month. Multiple shortwave systems then passed through the region, interacting with a stationary front drifting around south Texas. The operational area had a mix of above average and below average monthly precipitation. Most of Frio and Karnes received above average precipitation while parts of Uvalde, southwestern Medina, eastern Atascosa, and northern Live Oak / Bee counties also received above average monthly precipitation. Wide areas of Bandera, Bexar, Atascosa, Bee, McMullen, northern Uvalde, and Wilson counties recorded below average monthly precipitation[1]. May 2017 had 5 operational days with 441 glaciogenic and 52 hygroscopic flares burned. Fourteen flights (including 3 recon flights) recorded 32.2 hours across the operational area.

Again, the month of May up until the 21st was dominated by high pressure with no seeding opportunities. Moisture returned to the south TX region by May 21 as a weak warm

front was moving north through southern TX. Cloud seeding began in the early afternoon as showers formed along the warm front, and seeding seemed to have moderate success, especially on early afternoon storms. Seeding ended as storms dissipated by the late afternoon hours.

A strong cold front was pushing south through the region on May 23. Isolated convection developed sooner than anticipated across hill country and the northern operational area, thus seeding began with scattered storms moving through Atascosa county. Storms quickly formed into a line, however operations continued until sunset. There were multiple Severe Thunderstorm Warnings, which limited a few seeding opportunities.

Seeding continued on May 28, but clouds delayed storm formation until the afternoon, and low clouds and multiple Severe Thunderstorm Warnings delayed the pilot from seeding until the late afternoon. Storms was seeded in Bandera county, before these storms began moving out of the operational area. A few flares were added to storms in Frio county, but severe turbulence made flying too hazardous.

A weak mesoscale convective system moving through the region on May 30 provided numerous seeding opportunities from the early to late afternoon. Severe thunderstorms interrupted seeded only once.

Finally, the last day in May finished with more seeding. A warm front, weak mesoscale convective system, and daytime heating helped develop several thunderstorms throughout the afternoon, some of which were severe and delayed seeding. While numerous clouds were seeded, operations were hampered by equipment problems on one of the planes.

For the month of May, Del Rio and San Antonio had below average monthly temperatures while Corpus Christi was slightly below average. Monthly average precipitation showed the local variation mentioned above with San Antonio recording below average precipitation, Del Rio recorded above average precipitation, and Corpus Christi recorded slightly above average monthly precipitation. May recorded precipitation was relatively uniform across the 10 recording stations; with a low of 1.76 inches at the San Antonio International Airport to a high of over 4 inches in Karnes county.

May 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	3.70
Medina	Hondo Municipal Airport Station	2.81
Bexar	San Antonio International Airport Station	1.76
Bexar	Stinson Municipal Airport Station	2.86
Atascosa	Pleasanton Municipal Airport Station	2.15
Wilson	Floresville, TX	3.04
Karnes	Runge, TX	4.30
Bee	Station 5 miles northeast of Beeville	2.01
McMullen	Cross, TX	2.51
Frio	Pearsall, TX	2.85
Bandera	Station 1 mile northeast of Medina, TX	2.73

June 2017 Operations Report

June 2, 2017 – Seeding operations were conducted over Atascosa (15 + 1H), Frio (3 + 0H), and Medina (27 + 1H) counties. 45 flares plus 2 hygroscopic flares were burned within 1 cloud.

June 4, 2017 – Seeding operations were conducted over Bandera (13 + 1H), Bee (53 + 5H), De Witt (4 + 0H), Karnes (38 + 3H), Medina (23 + 4H), and Uvalde (6 + 0H) counties. 137 flares plus 13 hygroscopic flares were burned within 6 clouds.

June 5, 2017 – Seeding operations were conducted over Atascosa (42 + 3H), Bandera (2 + 0H), Bexar (2 + 1H), Frio (22 + 2H), Medina (13 + 1H), and Wilson (20 + 2H) counties. 101 flares plus 9 hygroscopic flares were burned within 6+ clouds.

June 24, 2017 – Seeding operations were conducted over Atascosa (36 + 0H), Frio (6 + 0H), McMullen (18 + 2H), and Medina (15 + 0H) counties. 75 flares plus 2 hygroscopic flares were burned within 4+ clouds.

June 25, 2017 – Seeding operations were conducted over Atascosa (11 + 0H), Bee (20 + 1H), De Witt (24 + 3H), Frio (32 + 0H), Goliad (18 + 1H), Karnes (68 + 6H), Medina (23 + 0H), Uvalde (4 + 0H), and Wilson (8 + 1H) counties. 208 flares plus 12 hygroscopic flares were burned within 15 clouds.

June 26, 2017 – Seeding operations were conducted over Atascosa (21 + 1H), McMullen (30 + 0H), Medina (10 + 0H), Uvalde (14 + 0H), and Wilson (8 + 0H) counties. 83 flares plus 1 hygroscopic flare were burned within 15 clouds.

June 27, 2017 – Seeding operations were conducted over Atascosa (56 + 1H), Frio (6 + 1H), Karnes (20 + 2H), La Salle (8 + 0H), McMullen (10 + 0H), Medina (50 + 0H), and Wilson (18 + 0H) counties. 168 flares plus 4 hygroscopic flares were burned within 12 clouds.

The month of June contained 7 days of operations:

Date	Number of Flares	Counites Seeded
2	45 AgI + 2 Hygro	Atascosa, Frio, and Medina
4	137 AgI + 13 Hygro	Bandera, Bee, De Witt, Karnes, Medina, and Uvalde
5	101 AgI + 9 Hygro	Atascosa, Bandera, Bexar, Frio, Medina, and Wilson
24	75 AgI + 2 Hygro	Atascosa, Frio, McMullen, and Medina
25	208 AgI + 12 Hygro	Atascosa, Bee, De Witt, Frio, Goliad, Karnes, Medina, Uvalde, and Wilson
26	83 AgI + 1 Hygro	Atascosa, McMullen, Medina, Uvalde, and Wilson
27	168 AgI + 4 Hygro	Atascosa, Frio, Karnes, La Salle, McMullen, Medina, and Wilson
Total	**817 AgI + 43 Hygro**	

June began with stormy weather from the stalled trough and lingering stationary front from late May. Cloud seeding operations took place June 2, 4, and 5 with a recon mission on June 3. The trough then moved east on June 6 and was replaced by a strong ridge of high pressure. This ridge persisted across the region until the end of June when a strong cold front moved in and stalled over the south TX region. June ended with seeding operations taking place between June 24 – 27. Across the operational area June was still a relatively dry month. Large expanses of Atascosa, Bandera, Bexar, McMullen, Medina, and Uvalde counites had below average recorded monthly precipitation. Parts of Bexar were 3-4 inches below normal. Parts of Wilson, Karnes, and Bee counties were also below normal, but these counties also had scattered areas of slightly above average precipitation. The areas with slightly above average precipitation in Wilson, Karnes, and Bee were mostly on the eastern side, areas more likely to experience seabreeze thunderstorms. Elsewhere across the area, northern Medina, southern Bandera, and northeastern Uvalde county recorded above average precipitation[1]. June 2017 had 7 operational days with 817 glaciogenic and 43 hygroscopic flares burned. Nineteen flights (including 1 recon flight) recorded 43.5 hours across the operational area.

Operations began on June 2 with limited seeding across Atascosa, Frio, and Medina counties. Storms did not form until the late afternoon hours, and even then, storms were very weak.

On June 4 daytime heating and a surface trough helped initiate storms across the northern operational area. The northern storms did not last very long and seeding eventually took place across Karnes and Bee counties as outflow boundaries helped initiate additional storms. The storms across Bee county were intense, with very strong inflow and Severe Thunderstorm Warnings.

High moisture values continued across the region on June 5, with seeding beginning on weak storms over the northern operational area. Showers and storms did not intensify until the late afternoon when stronger storms developed over Bexar and Atascosa counties. Seeding continued into the evening hours in Frio county until nightfall.

A cold front broke the stagnate weather pattern which dominated most of June, and seeding operations continued June 24. Widespread morning rain kept most of the area under low clouds and poor visibility until the early afternoon hours. Multiple storms were seeded across the operational area until all storms dissipated in the late afternoon.

By June 25, the cold front had stalled across the region and daytime heating brought numerous showers and storms to the area. Seeding began in the early afternoon and continued until sunset. Similar conditions continued June 26, with numerous early afternoon showers, most of which lasted less than one hour. Seeding operations had better results starting in the midafternoon and would continue until sunset.

The last operational day in June began with a weak mesoscale convective system moving onshore from the Gulf. Seeding began in the early afternoon and lasted until storms began dissipating after 21Z. After a short break seeding resumed on stronger storms north of Pleasanton in the late afternoon and early evening hours.

During June, both San Antonio and Corpus Christi had above average monthly temperatures and below average monthly precipitation; with San Antonio over 3 inches below normal. Del Rio recorded slightly below average temperature and slightly above average precipitation. Stations in Wilson, Bee, McMullen, and Bandera recorded greater amounts of precipitation in June, while the other 6 stations recorded only limited amounts of precipitation.

June 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	0.77
Medina	Hondo Municipal Airport Station	1.94
Bexar	San Antonio International Airport Station	0.40
Bexar	Stinson Municipal Airport Station	0.42
Atascosa	Pleasanton Municipal Airport Station	1.07
Wilson	Floresville, TX	3.24
Karnes	Runge, TX	1.29
Bee	Station 5 miles northeast of Beeville	3.43
McMullen	Cross, TX	2.10
Frio	Pearsall, TX	1.76
Bandera	Station 1 mile northeast of Medina, TX	4.25

July 2017 Operations Report

July 6, 2017 – Seeding operations were conducted over Bee (16 + 1H) and Karnes (26 + 2H) counties. 42 flares plus 3 hygroscopic flares were burned within 6 clouds.

July 7, 2017 – Seeding operations were conducted over Atascosa (4 + 0H), Bee (30 + 2H) Karnes (26 + 2H), and Live Oak (2 + 0H) counties. 62 flares plus 4 hygroscopic flares were burned within 6 clouds.

July 12, 2017 – Seeding operations were conducted over Atascosa (14 + 3H), Bexar (16 + 1H), Karnes (18 + 1H), Live Oak (6 + 1H), Medina (4 + 0H), and Wilson (30 + 1H) counties. 88 flares plus 7 hygroscopic flares were burned within 11+ clouds.

July 13, 2017 – Seeding operations were conducted over Atascosa (40 + 0H), Karnes (2 + 0H), Medina (10 + 1H), Uvalde (10 + 1H), and Wilson (16 + 0H) counties. 78 flares plus 2 hygroscopic flares were burned within 9 clouds.

July 14, 2017 – Seeding operations were conducted over Bee (10 + 1H) and McMullen (16 + 0H) counties. 10 flares plus 0 hygroscopic flares were burned within 5 clouds.

July 15, 2017 – Seeding operations were conducted over Bandera (7 + 0H), Medina (11 + 0H), Uvalde (6 + 0H), and Wilson (4 + 0H) counties. 28 flares plus 0 hygroscopic flares were burned within 12 clouds.

July 16, 2017 – Seeding operations were conducted over Uvalde (23 + 0H) county. 23 flares plus 0 hygroscopic flares were burned within 6 clouds.

July 17, 2017 – Seeding operations were conducted over Atascosa (2 + 0H), Bandera (4 + 0H), Medina (24 + 4H), and Uvalde (24 + 1H) counties. 54 flares plus 5 hygroscopic flares were burned within 21 clouds.

July 19, 2017 – Seeding operations were conducted over Bee (9 + 0H), Karnes (4 + 1H), Live Oak (2 + 0H), and McMullen (4 + 0H) counties. 19 flares plus 1 hygroscopic flares were burned within 7+ clouds.

July 23, 2017 – Seeding operations were conducted over Bandera (9 + 1H), and Frio (7 + 0H) counties. 16 flares plus 1 hygroscopic flares were burned within 5+ clouds.

July 26, 2017 – Seeding operations were conducted over Atascosa (2 + 0H), Bee (2 + 0H), Frio (9 + 1H), Karnes (8 + 1H), La Salle (2 + 0H), Medina (12 + 0H), and Wilson (3 + 0H) counties. 38 flares plus 2 hygroscopic flares were burned within 19+ clouds.

July 31, 2017 – Seeding operations were conducted over Atascosa (4 + 0H), McMullen (5 + 1H), and Medina (3 + 1H) counties. 12 flares plus 2 hygroscopic flares were burned within 4+ clouds.

The month of July contained 12 days of operations:

Date	Number of Flares	Counites Seeded
6	42 AgI + 3 Hygro	Bee and Karnes
7	62 AgI + 4 Hygro	Atascosa, Bee, Karnes, and Live Oak
12	88 AgI + 7 Hygro	Atascosa, Bexar, Karnes, Live Oak, Medina, and Wilson
13	78 AgI + 2 Hygro	Atascosa, Karnes, Medina, Uvalde, and Wilson
14	10 AgI + 0 Hygro	Bee and McMullen
15	28 AgI + 0 Hygro	Bandera, Medina, Uvalde, and Wilson
16	23 AgI + 0 Hygro	Uvalde
17	54 AgI + 5 Hygro	Atascosa, Bandera, Medina, and Uvalde
19	19 AgI + 1 Hygro	Bee, Karnes, Live Oak, and McMullen
23	16 AgI + 1 Hygro	Bandera and Frio
26	38 AgI + 2 Hygro	Atascosa, Bee, Frio, Karnes, La Salle, Medina, and Wilson
31	12 AgI + 2 Hygro	Atascosa, McMullen, and Medina
Total	**470 AgI + 27 Hygro**	

A short-term ridge of high pressure was present across the south TX region the first few days of July before moving off to the east. About a week into July, late morning and afternoon seabreeze thunderstorms became more common mostly east and southeast of San Antonio. Occasionally weak troughs moving south through TX or east from Mexico would help showers and storms develop. Showers and storms developed across the region off and on throughout most of July until the end of the month when a strong weather system moved through then stalled across the region. The end of July was marked with multiple days of isolated and scattered showers and storms. Rainfall across the south TX region was either at or below the monthly average across the entire operational area, except for central and northwestern Bee county which received slightly above average. Wide areas saw 2 – 3 inches below average precipitation[1]. July had 12 operational day with 470 glaciogenic and 27 hygroscopic flares burned. Nineteen flights recorded 55.92 hours across the operational area.

Seeding operations began on the July 6 when a weak seabreeze began generating multiple afternoon showers and storms across the eastern operational area. Multiple clouds were seeded, however most of the storms were very weak and did not last long even when seeded. Seeding continued into the late afternoon and early evening before storms began dissipating with the loss of daytime heating.

July 7 saw a late morning seabreeze push into the region with multiple small, weak showers through the afternoon. The pilot was launched to investigate but most showers only had small areas of weak inflow. By the early afternoon a stronger band of rain began moving in from the south, with stronger storms over Bee county. The stronger band could have been from a

Tropical Wave which came onshore near Brownsville. Strong storms over the southeastern operational area were seeded until the late afternoon hours, after which storms began weakening.

After a few days of high pressure, seeding resumed on July 12 when high moisture and daytime heating helped initiate scattered thunderstorms across the operational area. Seeding took place with planes 160P and 47P from around midday to the late afternoon. July 13 saw similar activity with multiple afternoon showers and storms seeded as high moisture continued to linger across the region. Strong outflow winds from one storm impacted the Pleasanton Airport, lifting the open hanger door but no serious damage.

Late afternoon seeding was done on July 14 and 15. A few weak storms formed southeast of San Antonio on the 14th but did not last long. By the 15th a strong southward moving outflow boundary helped generate storms over hill country in the afternoon. By the late afternoon hours storms were moving south into the operational area and continued to strengthen. Seeding continued on numerous storms through the evening hours before widespread rain began surrounding the airport. Pilot was recalled because of lowering visibility.

Seeding continued across Uvalde county on July 16. A strong inversion meant storms did not form until the late afternoon. Seeding continued through the late evening in Uvalde county. Ample moisture helped lead to numerous showers and storms on July 17. Both pilots seeded multiple storms throughout the afternoon and early evening. Most of the storms did not last long even with added seeding material.

July 19 saw several weak afternoon showers which were seeded. However, it was not until the late afternoon hours when stronger storms developed and seeding seemed to have more of an effect.

July 23 had numerous showers initiate throughout the day but even with seeding nothing really developed. Had better luck with scattered showers and storms which developed on July 26. Some storms were surrounded by severe turbulence and the pilot could not fly into the inflow. Seeding continued into the early evening. July ended with isolated then scattered showers and storms in late afternoon hours on the 31st. Seeding occurred with possible success.

During July San Antonio, Del Rio, and Corpus Christi all recorded warmer than average monthly temperatures and below average precipitation. San Antonio was 2.58 inches below average during July. Station data continues to show how little precipitation was recorded for July, except for Bee county.

July 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	0.51
Medina	Hondo Municipal Airport Station	0.38
Bexar	San Antonio International Airport Station	0.16
Bexar	Stinson Municipal Airport Station	0.11
Atascosa	Pleasanton Municipal Airport Station	0.50
Wilson	Floresville, TX	1.39
Karnes	Runge, TX	0.89
Bee	Station 5 miles northeast of Beeville	4.27
McMullen	Cross, TX	0.51
Frio	Pearsall, TX	0.07
Bandera	Station 1 mile northeast of Medina, TX	0.10

August 2017 Operations Report

August 2, 2017 – Seeding operations were conducted over Atascosa (5 + 0H), Bandera (4 + 0H), Frio (3 + 0H), and Medina (16 + 2H) counties. 28 flares plus 2 hygroscopic flares were burned within 13+ clouds.

August 3, 2017 – Seeding operations were conducted over Karnes (2 + 0H), Medina (2 + 1H), Uvalde (6 + 0H), and Wilson (20 + 2H) counties. 30 flares plus 3 hygroscopic flares were burned within 6+ clouds.

August 4, 2017 – Seeding operations were conducted over Bee (8 + 3H), Live Oak (2 + 0H), and Uvalde (4 + 1H) counties. 14 flares plus 4 hygroscopic flares were burned within 5 clouds.

August 10, 2017 – Seeding operations were conducted over Atascosa (12 + 1H), Bexar (7 + 0H), Frio (24 + 1H), and Medina (4 + 0H) counties. 47 flares plus 2 hygroscopic flares were burned within 9 clouds.

August 11, 2017 – Seeding operations were conducted over Bee (6 + 1H) county. 6 flares plus 1 hygroscopic flare were burned within 1 clouds.

August 21, 2017 – Seeding operations were conducted over Atascosa (6 + 0H), Frio (4 + 1H), and McMullen (4 + 1H) counties. 14 flares plus 2 hygroscopic flares were burned within 3 clouds.

August 22, 2017 – Seeding operations were conducted over Bee (14 + 1H), and Live Oak (8 + 1H) counties. 22 flares plus 2 hygroscopic flares were burned within 2 clouds.

August 23, 2017 – Seeding operations were conducted over Bandera (6 + 1H), and Uvalde (18 + 2H) counties. 24 flares plus 3 hygroscopic flares were burned within 7 clouds.

The month of August contained 8 days of operations:

Date	**Number of Flares**	**Counites Seeded**
2	28 AgI + 2 Hygro	Atascosa, Bandera, Frio, and Medina
3	30 AgI + 3 Hygro	Karnes, Medina, Uvalde, and Wilson
4	14 AgI + 4 Hygro	Bee, Live Oak, and Uvalde
10	47 AgI + 2 Hygro	Atascosa, Bexar, Frio, and Medina
11	6 AgI + 1 Hygro	Bee
21	14 AgI + 2 Hygro	Atascosa, Frio, and McMullen
22	22 AgI + 2 Hygro	Bee, and Live Oak
23	24 AgI + 3 Hygro	Bandera, and Uvalde
Total	**185 AgI + 19 Hygro**	

The stationary front and deep trough from the end of July continued to bring a chance of rain to the south TX region during the first few days of August. Cloud seeding operations were conducted August 2 – 4 with multiple recon flights also taking place during this time. By August 5 the region began drying out as the trough moved off to the east. Cloud seeding operations continued August 10 – 11 on seabreeze storms, after which strong high pressure settled over the Texas Gulf coast region. The high pressure system weakened and moved off to the northeast by August 21, resulting in a few days of seeding operations. The end of August saw hurricane Harvey impact the coast near Corpus Christ, dumping tremendous amounts of rain mainly east of the I-35 corridor. Cloud seeding was suspended for multiple days while the region dried out. The rainfall amounts for August are strongly affected by Hurricane Harvey, with wide areas recording greatly above average precipitation amounts. Parts of Wilson, Karnes, Atascosa, and Bee counties were greater than 8 inches above normal. Above normal amounts were recorded from Bandera, Medina, Frio, McMullen east through the operational area. Only scattered areas of Uvalde and southwestern Bandera had below normal precipitation in the operational area for the month of August[1]. August had 8 days of seeding operations with 185 glaciogenic and 19 hygroscopic flares burned. Thirteen flights (including 3 recon flights) recorded 28.53 hours across the operational area.

Late afternoon seeding took place on August 2 as a weak trough brought showers and storms to the northern part of the operational area. Multiple storms were seeded throughout the late afternoon and evening in Atascosa, Bandera, Frio, and Medina counties before widespread rain and low visibility ended operations.

As the trough which had been over the region for a while continued to weaken, more seeding was done on August 3. Afternoon storms began forming north of San Antonio, then progressed off to the southeast and into the operational area by the late afternoon. Seeding was conducted across the eastern portion of the operational area in the late afternoon, then a few weak storms were seeded across the western portion in the evening.

Lingering moisture helped generate additional showers and storms August 4, with seeding taking place from the early to late afternoon. While most of the storms were weak a few seemed to respond well with the material added.

A strong seabreeze helped generate several thunderstorms across the region on August 10. Storms seemed to respond very well with seeding material, with seeded storms growing taller, covering more area, and lasting longer than similar unseeded storms. A few storms tried to form under a strong cap of warm air on August 11 but were very weak. Seeding was attempted on a single storm, but storm did not develop. Strong high pressure moved into the region beginning August 12.

As high pressure began to weaken across the region, August 21 saw scattered showers and storms develop across the operational area in the afternoon hours. However, storm development was limited by a strong cap of warm air, and seeding ended in the late afternoon.

Additional storms developed on August 22, with seeding taking place across the southeastern portion of the area in the afternoon. August seeding concluded on the 23 when a cold front helped generate scattered showers and storms in the early afternoon. Seeding was done across Bandera and Uvalde; however, storms dissipated by the midafternoon.

For August San Antonio and Corpus Christi recorded slightly below average monthly temperatures and above average precipitation. Del Rio recorded slightly above average temperature and slightly below average precipitation. Del Rio was too far west to be impacted by Hurricane Harvey. Wide areas of eastern TX received tremendous amounts of rain. August

had the strongest recorded variation for 2017 with eastern counties receiving tremendous amounts of precipitation (over 10 inches in Wilson) while western counties generally received much less (less than 1 inch in Uvalde).

August 2017 Reported Gauge Measurements[2] (Harvey Rainfall Included)		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	0.71
Medina	Hondo Municipal Airport Station	1.83
Bexar	San Antonio International Airport Station	5.87
Bexar	Stinson Municipal Airport Station	6.21
Atascosa	Pleasanton, TX**	4.84
Wilson	Floresville, TX	10.17
Karnes	Runge, TX	8.55
Bee	Station 5 miles northeast of Beeville	8.30
McMullen	Cross, TX	1.60
Frio	Pearsall, TX	4.21
Bandera	Station 1 mile northeast of Medina, TX	3.29

** August data missing for Pleasanton Municipal Airport Station

August 2017 Reported Gauge Measurements[2] * (Harvey Rainfall Removed)		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	0.41
Medina	Hondo Municipal Airport Station	1.77
Bexar	San Antonio International Airport Station	3.68
Bexar	Stinson Municipal Airport Station	4.58
Atascosa	Pleasanton, TX (airport missing data)	2.81
Wilson	Floresville, TX	2.96
Karnes	Runge, TX	3.10
Bee	Station 5 miles northeast of Beeville	2.74
McMullen	Cross, TX	0.55
Frio	Pearsall, TX	3.99
Bandera	Station 1 mile northeast of Medina, TX	2.41

- August 24-28 rain data removed from all stations because of hurricane Harvey

September 2017 Operations Report

September 4, 2017 – Seeding operations were conducted over Atascosa (6 + 2H), and McMullen (4 + 0H) counties. 10 flares plus 2 hygroscopic flares were burned within 3 clouds.

September 5, 2017 – Seeding operations were conducted over Uvalde (10 + 1H) county. 10 flares plus 1 hygroscopic flares were burned within 2 clouds.

September 18, 2017 – Seeding operations were conducted over Bee (18 + 3H), and Karnes (18 + 1H) counties. 36 flares plus 4 hygroscopic flares were burned within 6 clouds.

September 19, 2017 – Seeding operations were conducted over Uvalde (18 + 3H) county. 10 flares plus 1 hygroscopic flares were burned within 1 cloud.

September 21, 2017 – Seeding operations were conducted over Atascosa (26 + 2H), Bee (6 + 0H), Frio (2 + 0H), Karnes (16 + 0H), Live Oak (2 + 0H), McMullen (24 + 1H) counties. 78 flares plus 3 hygroscopic flares were burned within 14+ clouds.

September 22, 2017 – Seeding operations were conducted over Atascosa (14 + 2H), Frio (36 + 1H), McMullen (10 + 0H), Medina (14 + 0H), Uvalde (2 + 0H), and Zavala (8 + 0H) counties. 84 flares plus 3 hygroscopic flares were burned within 13 clouds.

September 25, 2017 – Seeding operations were conducted over Atascosa (8 + 1H), Bexar (3 + 0H), Medina (14 + 0H), and Wilson (6 + 0H) counties. 31 flares plus 1 hygroscopic flares were burned within 6 clouds.

The month of September contained 7 days of operations:

Date	**Number of Flares**	**Counites Seeded**
4	10 AgI + 2 Hygro	Atascosa, and McMullen
5	10 AgI + 1 Hygro	Uvalde
18	36 AgI + 4 Hygro	Bee, and Karnes
19	10 AgI + 1 Hygro	Uvalde
21	78 AgI + 3 Hygro	Atascosa, Bee, Frio, Karnes, Live Oak, McMullen
22	84 AgI + 3 Hygro	Atascosa, Frio, McMullen, Medina, Uvalde, and Zavala
25	31 AgI + 1 Hygro	Atascosa, Bexar, Medina, and Wilson
Total	**259 AgI + 15 Hygro**	

The weather pattern which dominate most of September included high pressure with cool temperatures thanks to multiple weak cold fronts which moved through the region. Limited seeding took place Sept. 4 – 5 as daytime heating and a weak seabreeze generated isolated to scattered showers and storms. As the end of September approached, a strong ridge set up over the southeastern US, sending warm humid air into the south TX region. Seabreeze activity and convection over Mexico helped develop scattered storms Sept. 18 – 19 which lead to more seeding. As the end of September approached a weak trough passed through the region, helping

to generated showers and storms. Meanwhile abundant moisture was moving into the region from the Gulf as well as moisture from the Pacific Ocean. This added moisture helped make for some busy cloud seeding days near the end of the month. The central and western counties of the operational area had above average precipitation, with significant portions of Uvalde, Frio and McMullen counties recording 4+ inches above the monthly normal. Atascosa, western Bexar, and central / eastern Bandera and most of Medina also recorded above average monthly precipitation as well. Bee and Wilson counties were a mixture of above and below average precipitation; while western Bandera, northwestern Medina, eastern Bexar, and Karnes recorded below average precipitation[1]. September had 7 seeding operational days with 259 glaciogenic and 15 hygroscopic flares burned. Eleven flights (including 1 recon) recorded 28.48 hours of flight time.

September seeding operations began on the 4th when multiple weak storms were seeded. None of the storms lasted very long and operations were over by the early evening when all storms were dissipating. Seeding was attempted again the next day (Sept. 5) however storms did not develop until the late afternoon and did not last long.

After a dull period in the weather, seeding resume on September 18. Showers began forming in the early afternoon as a seabreeze began moving rain from south / southeast in a northerly direction. Seeding began in Bee county and continued into Karnes county. By mid afternoon the seabreeze weakened and all storms dissipated.

September 19 began with a complex of storms moving east from Mexico. By mid afternoon isolated showers and storms began forming in Uvalde county. Initial seeding seemed to have a positive effect on the first storm, however that storm quickly lost inflow. A few more flares were burned on another storm, and that storm merged with many other storms. Pilot circled the mass of storms but did not find any suitable areas for seeding. Operations ended shortly after as daylight decreased.

A better day for seeding occurred on September 21 with a possible weak trough helping aid in storm development. Storms began in the early afternoon but did not last long. Seeding continued in the mid afternoon, with the best storm of the day forming in Atascosa county. Seeding continued on this and other storms through the late afternoon when conditions became unsafe for pilots to fly.

Seeding continued September 22 across the central and western portions of the operational area. Several storms formed from outflow boundaries. Seeding seemed to have a positive effect on some storms, especially storms which merged. Operations continued until nightfall.

The final seeding day in September (25th) began with high moisture streaming into the region from both the Gulf and in the upper levels of the atmosphere from the Pacific. By the early afternoon widespread rain was moving into Uvalde county, so operations were concentrated east of the rain. Several storms were seeded in the early afternoon southeast of San Antonio, then operations were changed to a line of storms just to the west of San Antonio in the mid afternoon. These storms were seeded until they moved out of the area.

Across the region San Antonio was slightly below the monthly average temperature and slightly below average precipitation. Del Rio recorded warmer than average temperature while it and most of the Rio Grande Valley region had above average precipitation. Finally, Corpus Christi had slightly above average temperature and had below average monthly precipitation. Recorded station measurements for September show significant precipitation across the

operational area. Uvalde had above average amounts for September with over 8 inches of recorded precipitation.

September 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	8.27
Medina	Hondo Municipal Airport Station	3.90
Bexar	San Antonio International Airport Station	2.80
Bexar	Stinson Municipal Airport Station	2.94
Atascosa	Pleasanton Municipal Airport Station	4.25
Wilson	Floresville, TX	2.08
Karnes	Runge, TX	4.19
Bee	Station 5 miles northeast of Beeville	3.12
McMullen	Cross, TX	3.89
Frio	Pearsall, TX	5.45
Bandera	Station 1 mile northeast of Medina, TX	5.03

October 2017 Operations Report

October 3, 2017 – Seeding operations were conducted over Frio (19 + 2H), Medina (16 + 1H), and Zavala (2 + 0H) counties. 37 flares plus 3 hygroscopic flares were burned within 2+ clouds.

The month of October contained 1 day of operations:

Date	**Number of Flares**	**Counites Seeded**
3	37 AgI + 3 Hygro	Frio, Medina, and Zavala
Total	**37 AgI + 3 Hygro**	

October only had one seeding operation which took place on the October 3. Enough energy was present to generate scattered showers and storms across the area. After that the month of October was dry with only a few cold fronts. These cold fronts were either too weak to generate storms, or any rain moved through in the overnight hours. One pilot was launched and investigated developing showers on October 31 however no seeding was done. The entire operational area recorded below average precipitation for October. Wide areas had precipitation 3 – 4 inches below normal[1]. October had 1 seeding operational day with 37 glaciogenic and 3 hygroscopic flares burned. Four flight (including 3 recon) recorded 5.58 hours of flight time.

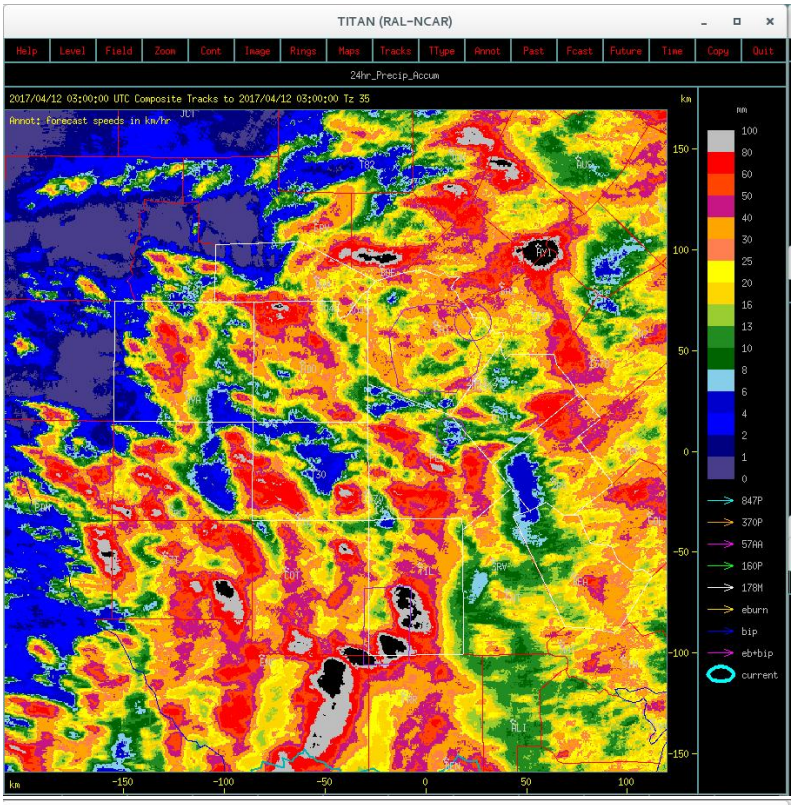
Abundant moisture and a weak trough helped initiate scattered showers and storms across the region, however low clouds prevented flying until the early afternoon. Scattered showers and storms developed in the early through mid afternoon, however storms were weak and low clouds prevented seeding from being very effective. Pilot had better luck in the late afternoon when stronger storms developed in Frio county. Both pilots landed when widespread rain made flying too hazardous.

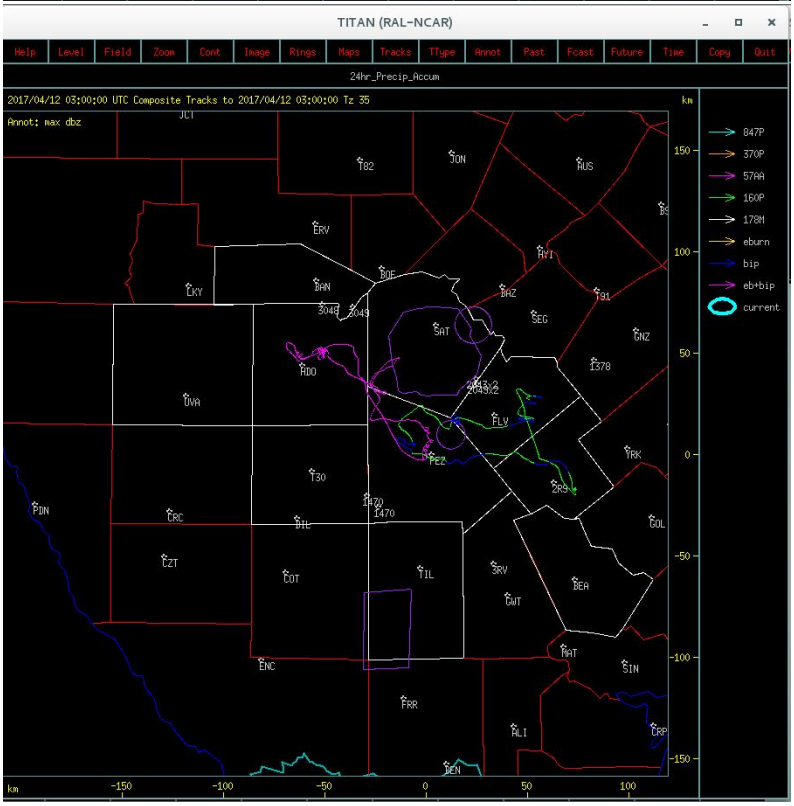
For October, San Antonio recorded a slightly below average monthly temperature and below average precipitation. Both Del Rio and Corpus Christi recorded below average temperatures and precipitation. Most stations barely recorded any precipitation for the month of October. Garner Field Airport in Uvalde county and Pearsall in Frio county did not record any precipitation during this month.

October 2017 Reported Gauge Measurements[2]		
County	Station Location	Recorded Precipitation for Month (In.)
Uvalde	Garner Field Airport Station near Uvalde	0.00
Medina	Hondo Municipal Airport Station	0.13
Bexar	San Antonio International Airport Station	0.46
Bexar	Stinson Municipal Airport Station	0.67
Atascosa	Pleasanton Municipal Airport Station	1.02
Wilson	Floresville, TX	0.53
Karnes	Runge, TX	0.62
Bee	Station 5 miles northeast of Beeville	0.97
McMullen	Cross, TX	0.45
Frio	Pearsall, TX	0.00
Bandera	Station 1 mile northeast of Medina, TX	0.86

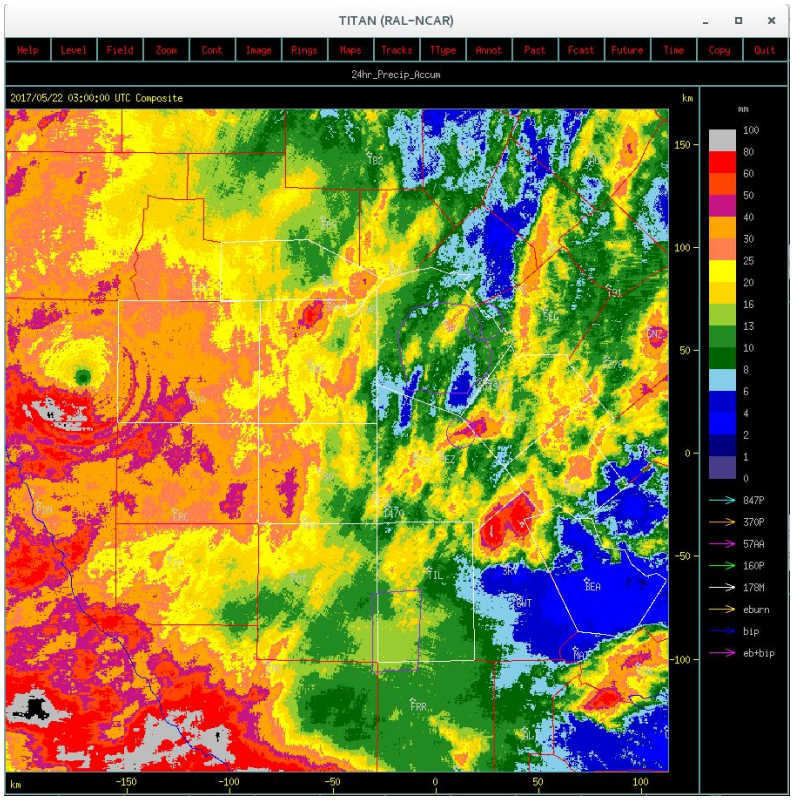
Operational TITAN Images

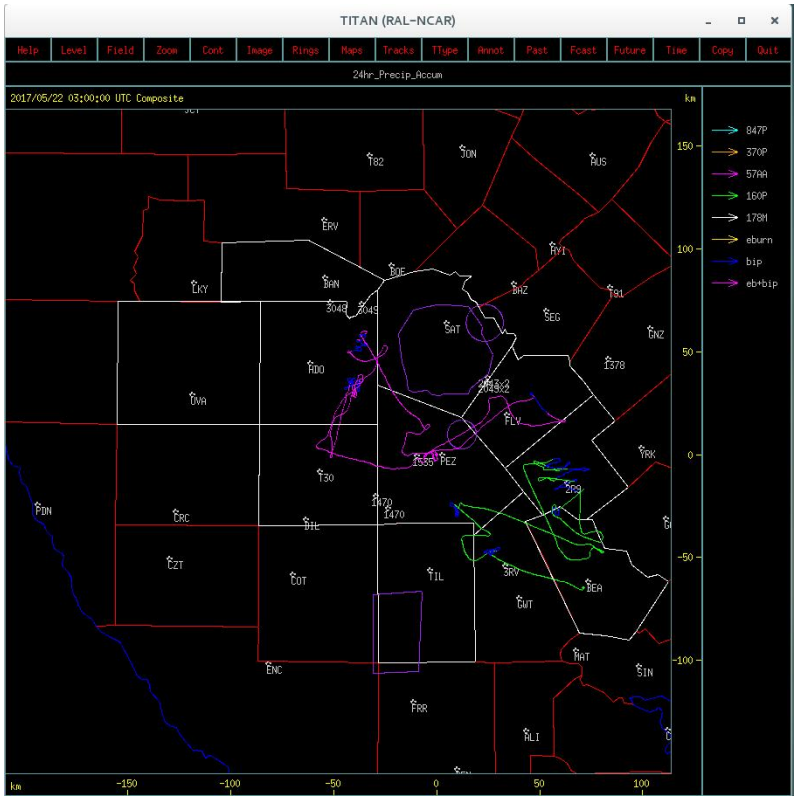
April 11, 2017



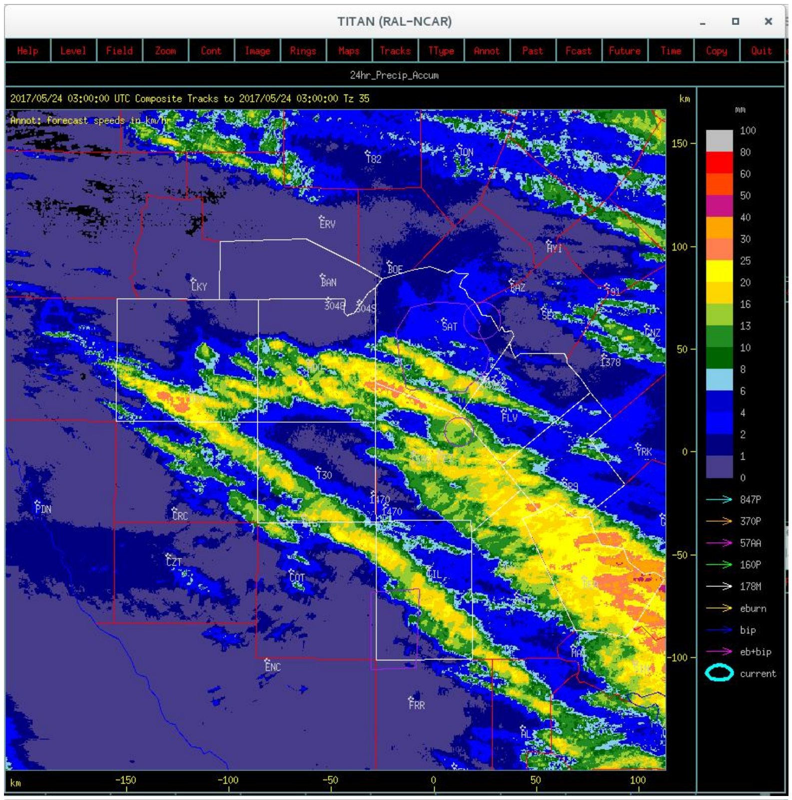


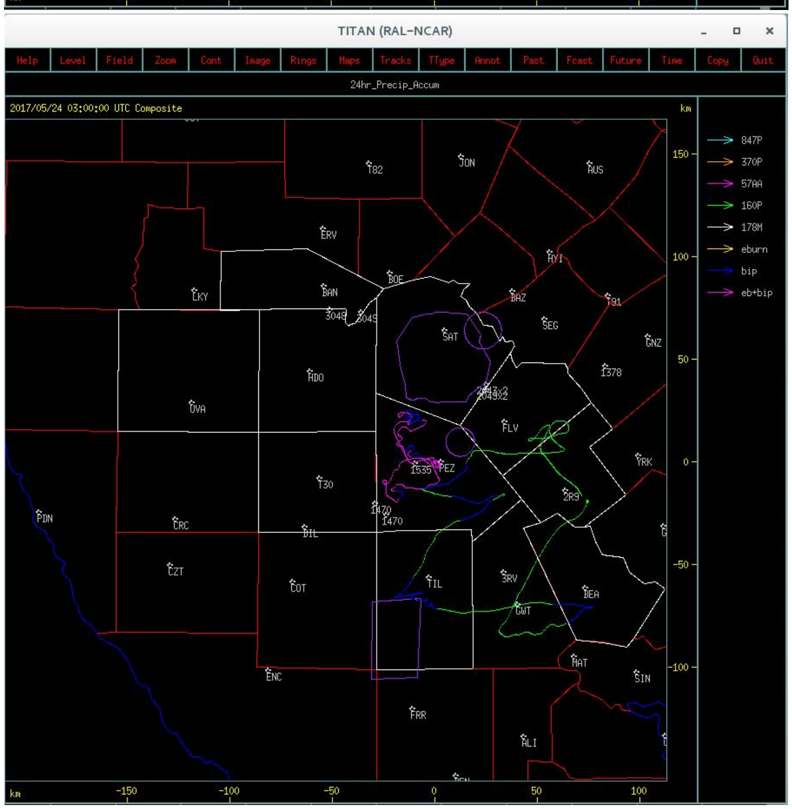
May 21, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/22 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

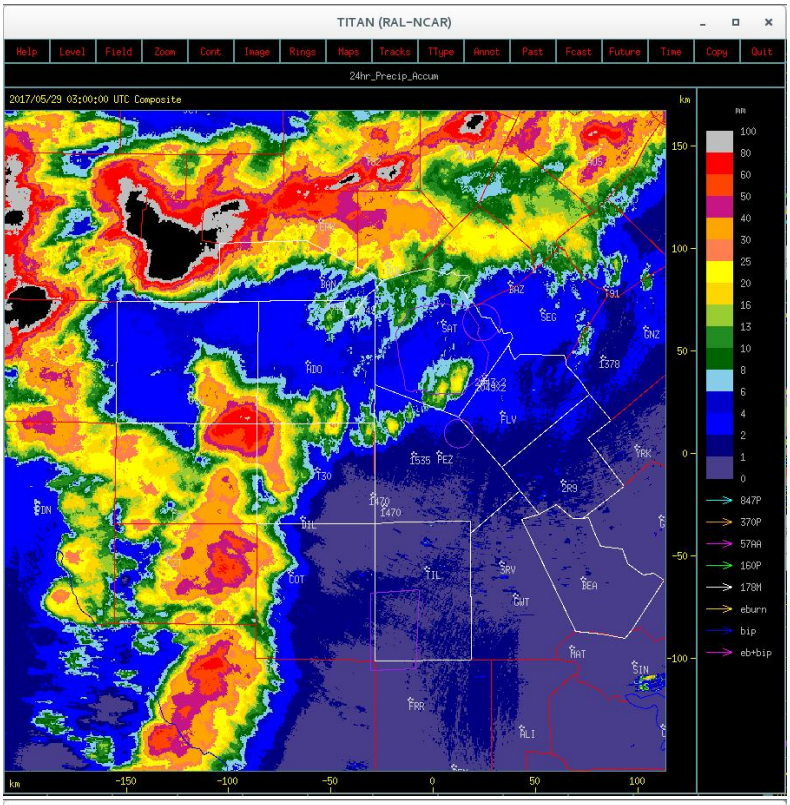

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/22 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

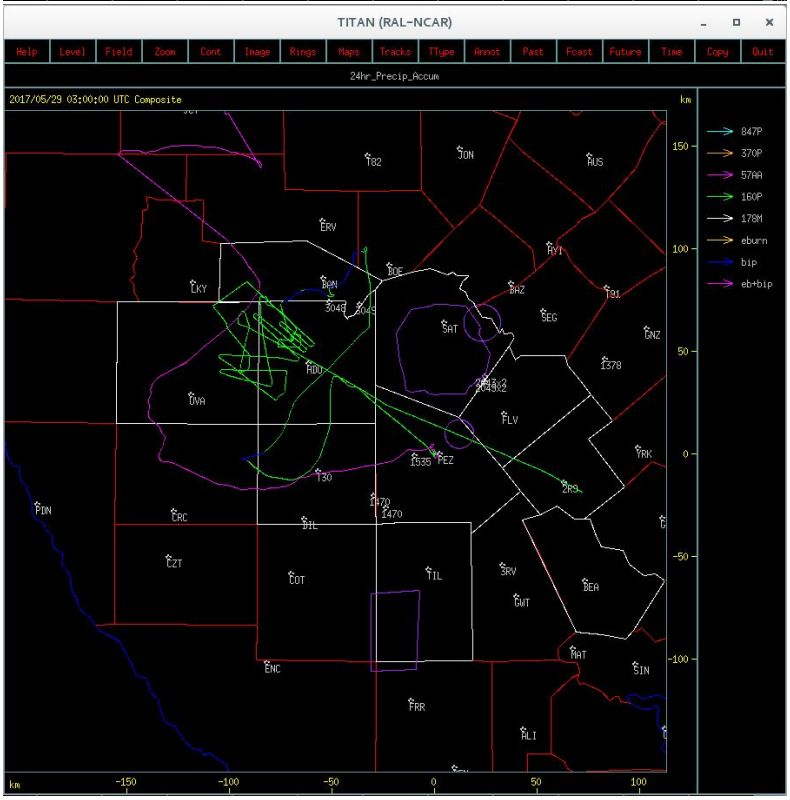
May 23, 2017


TITAN (RAL–NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/24 03:00:00 UTC Composite Tracks to 2017/05/24 03:00:00 Tz 35
Annot: Forecast speeds in km/hr
km
mm
100 80 60 50 40 30 25 20 16 13 10 8 6 4 2 1 0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
-150 -100 -50 0 50 100
150 100 50 0 -50 -100

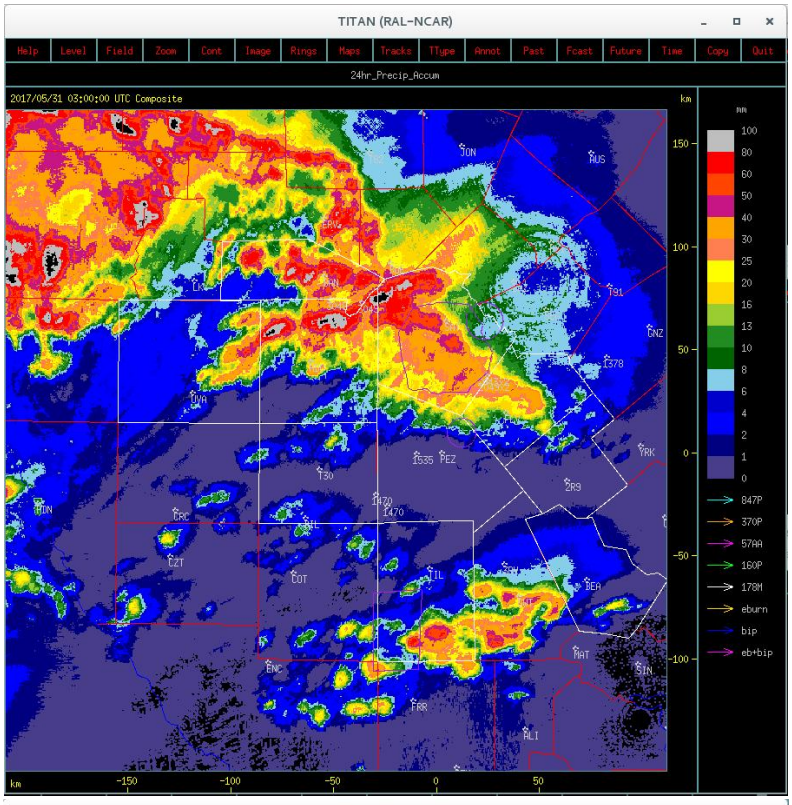

TITAN (RAL–NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/24 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
-150 -100 -50 0 50 100
150 100 50 0 -50 -100

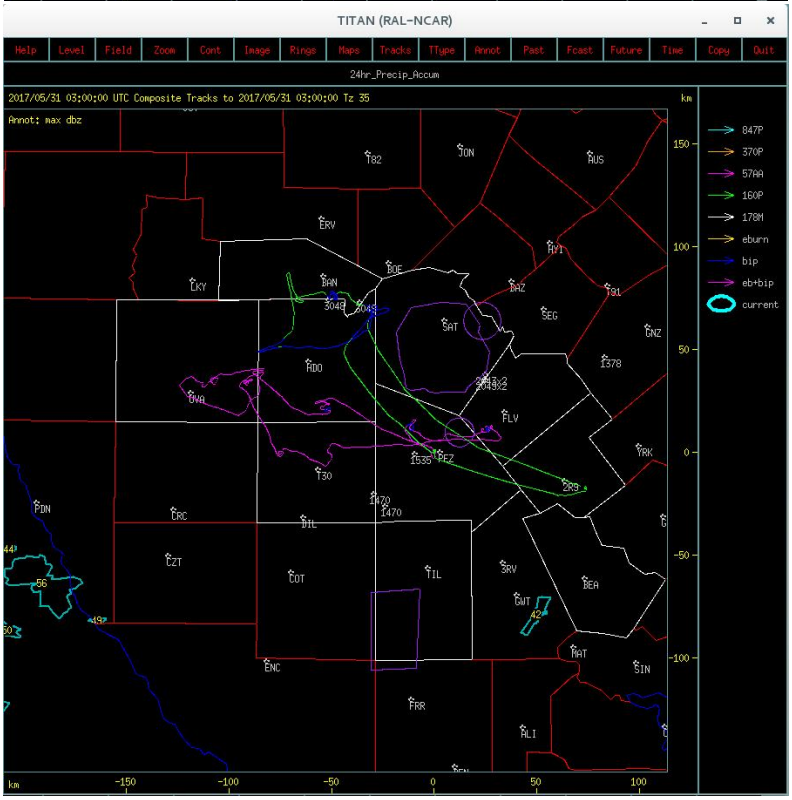
May 28, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/29 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

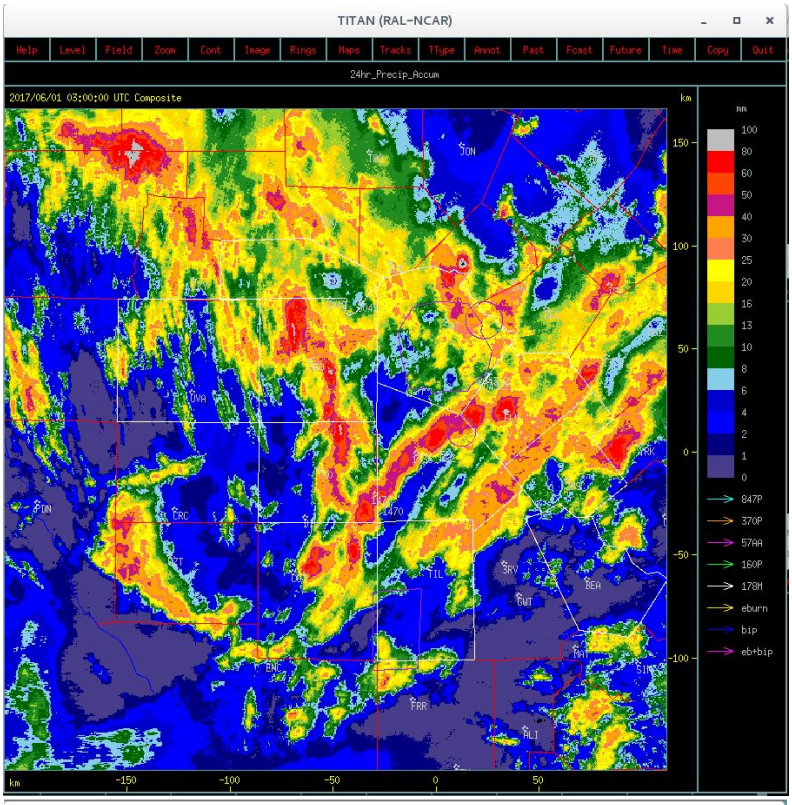

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/05/29 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

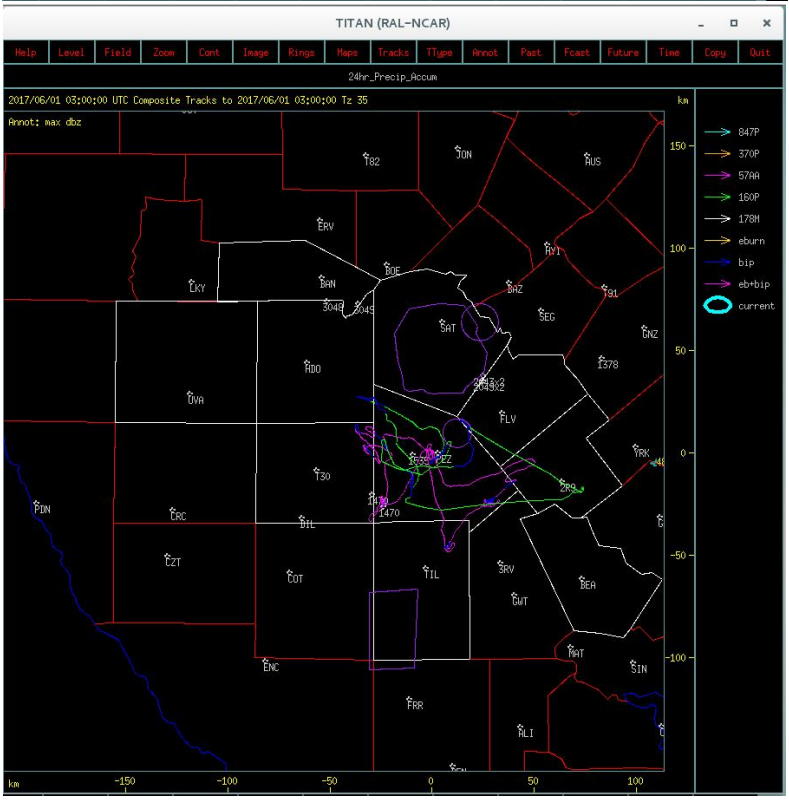
May 30, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Feast Future Time Copy Quit
24hr_Precip_Accum
2017/05/31 03:00:00 UTC Composite
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
km
150
100
50
0
-50
-100
-150

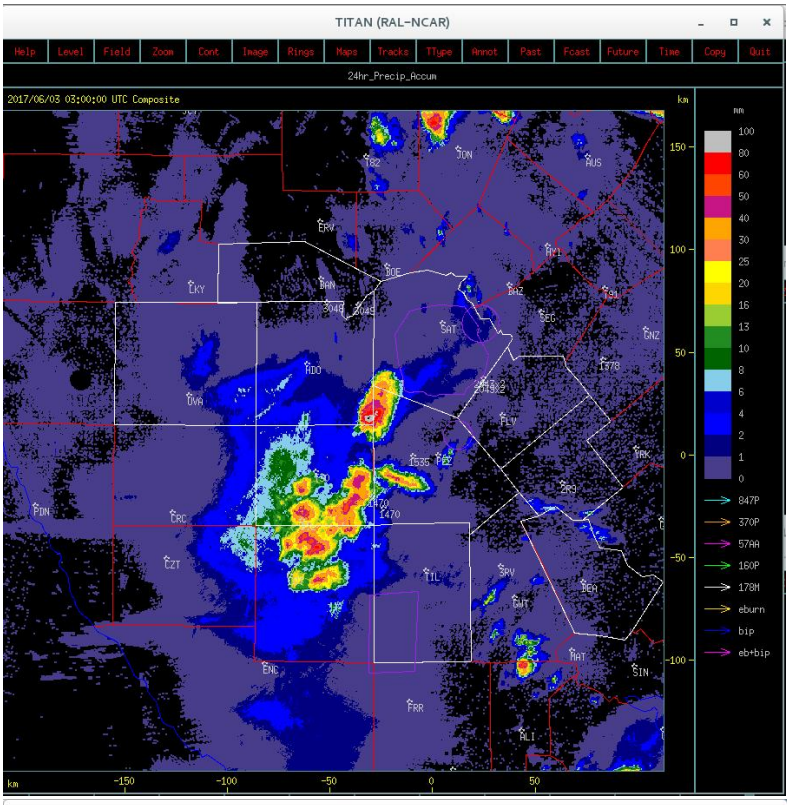

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Feast Future Time Copy Quit
24hr_Precip_Accum
2017/05/31 03:00:00 UTC Composite Tracks to 2017/05/31 03:00:00 Tz 35
Annot: max dbz
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
km
150
100
50
0
-50
-100
-150

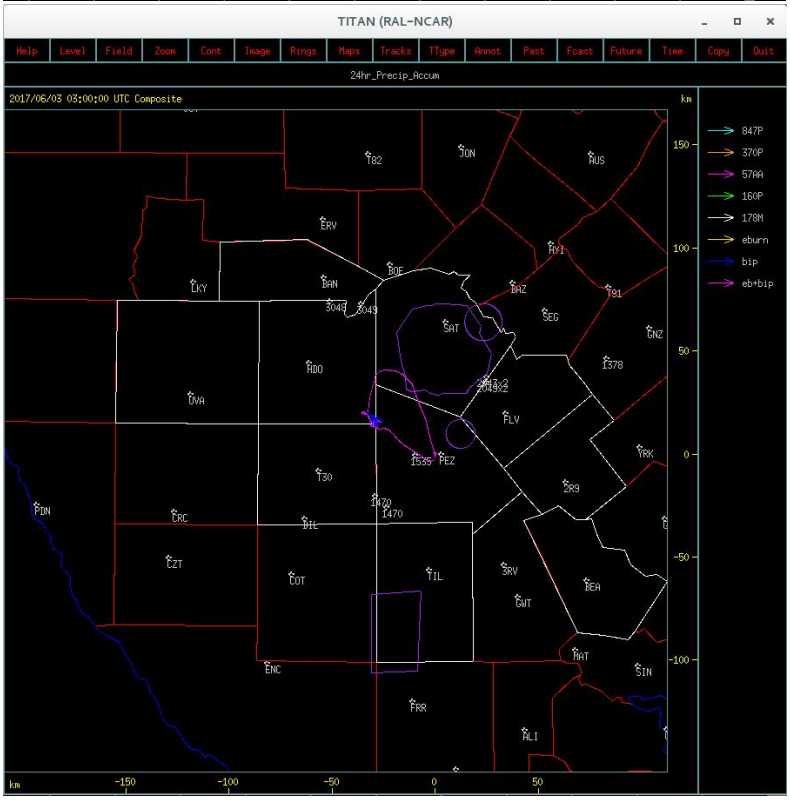
May 31, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/01 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150
-100
-50
0
50

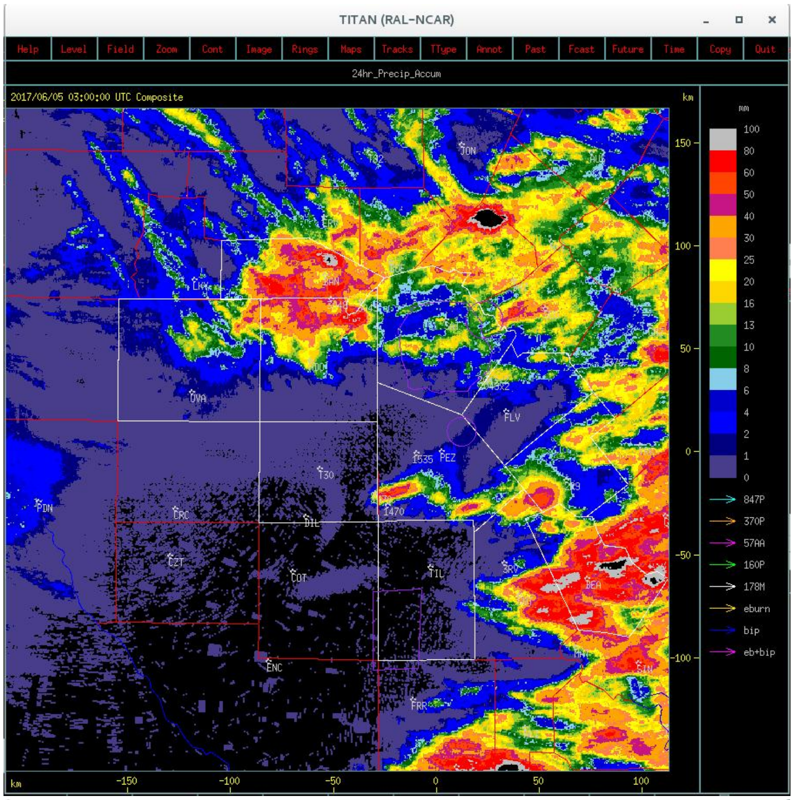

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/01 03:00:00 UTC Composite Tracks to 2017/06/01 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150
-100
-50
0
50
100

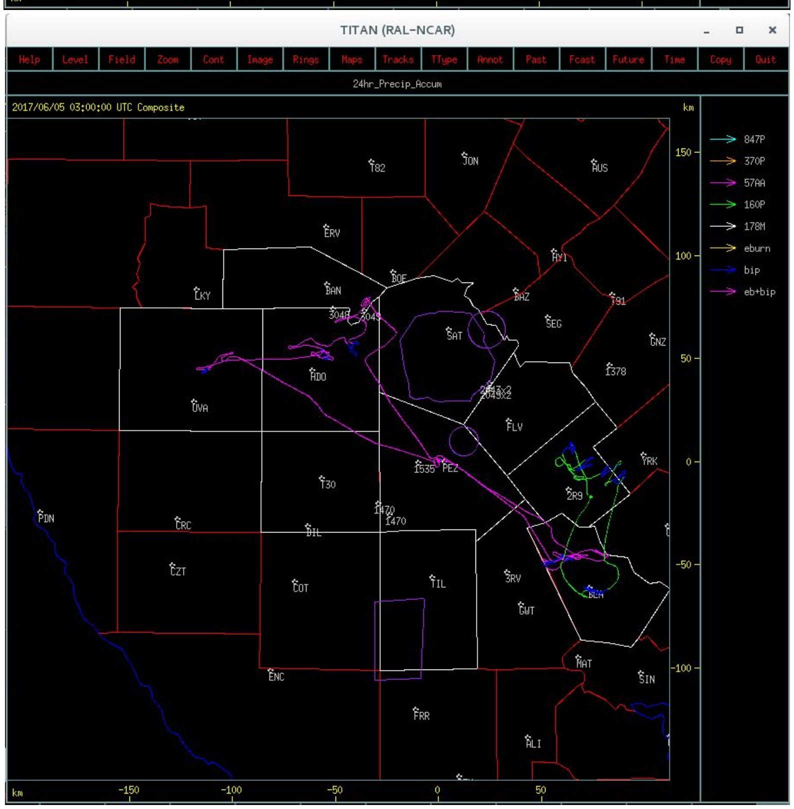
June 2, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/03 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

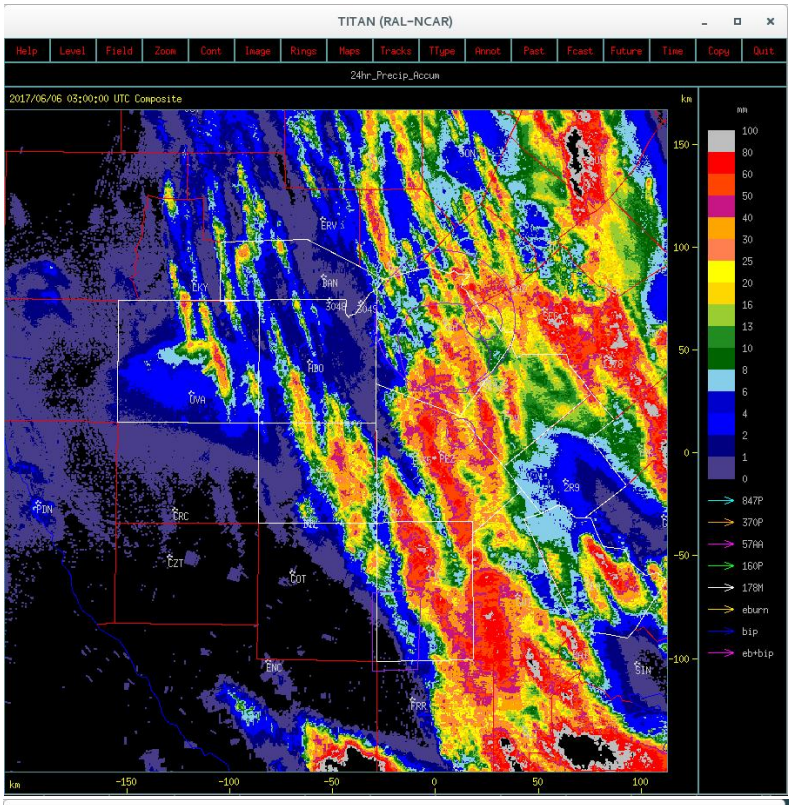

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/03 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

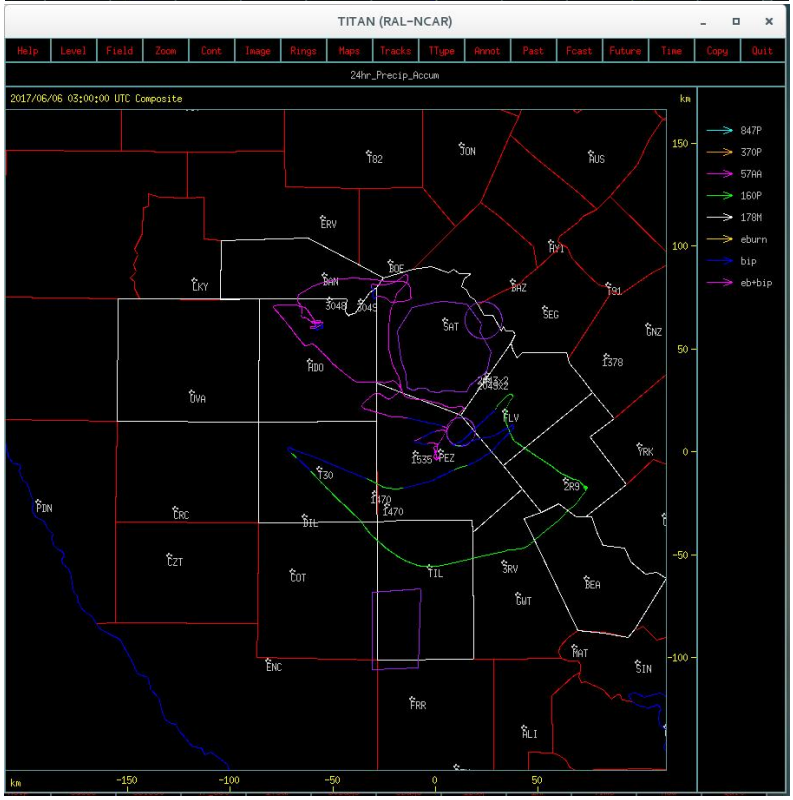
June 4, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/05 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

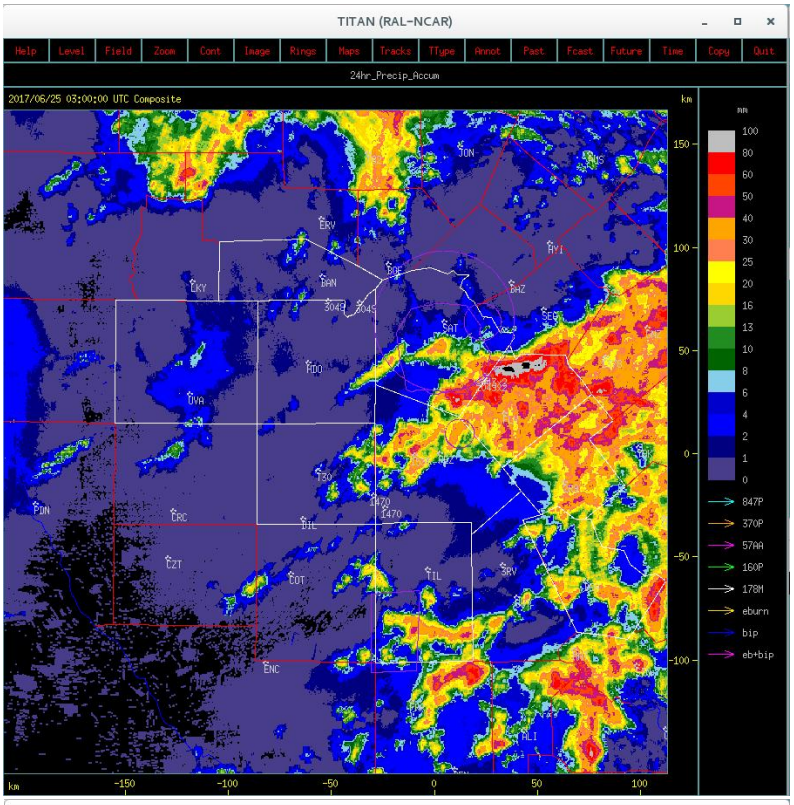

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/05 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

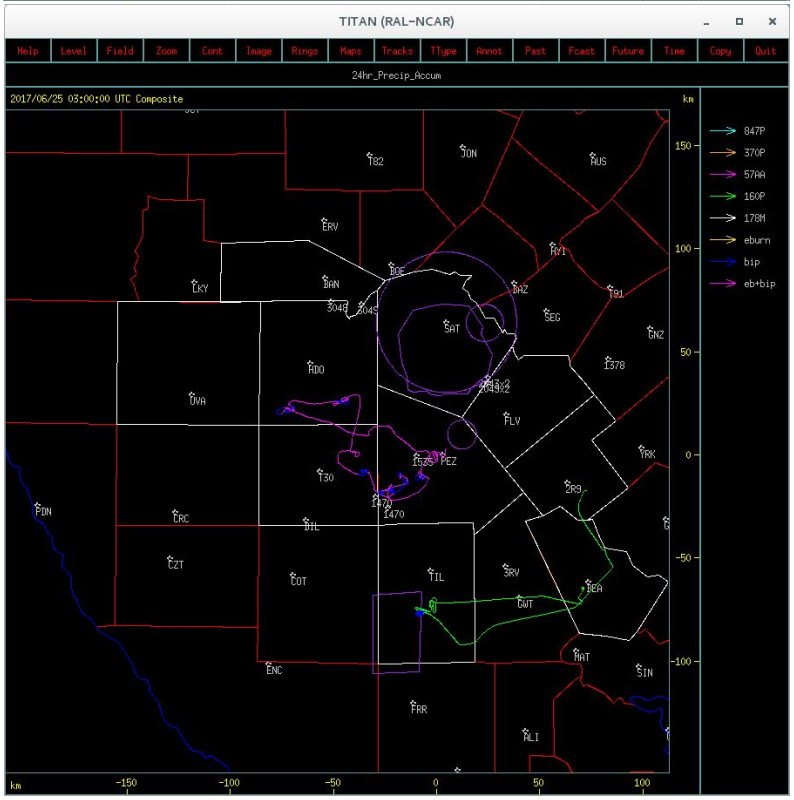
June 5, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/06 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

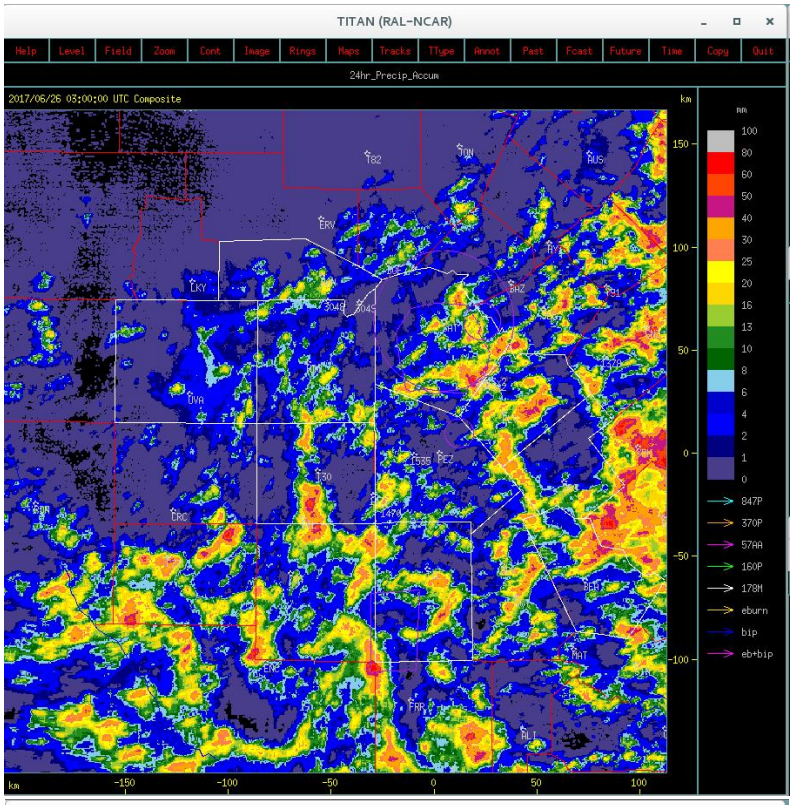

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/06 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

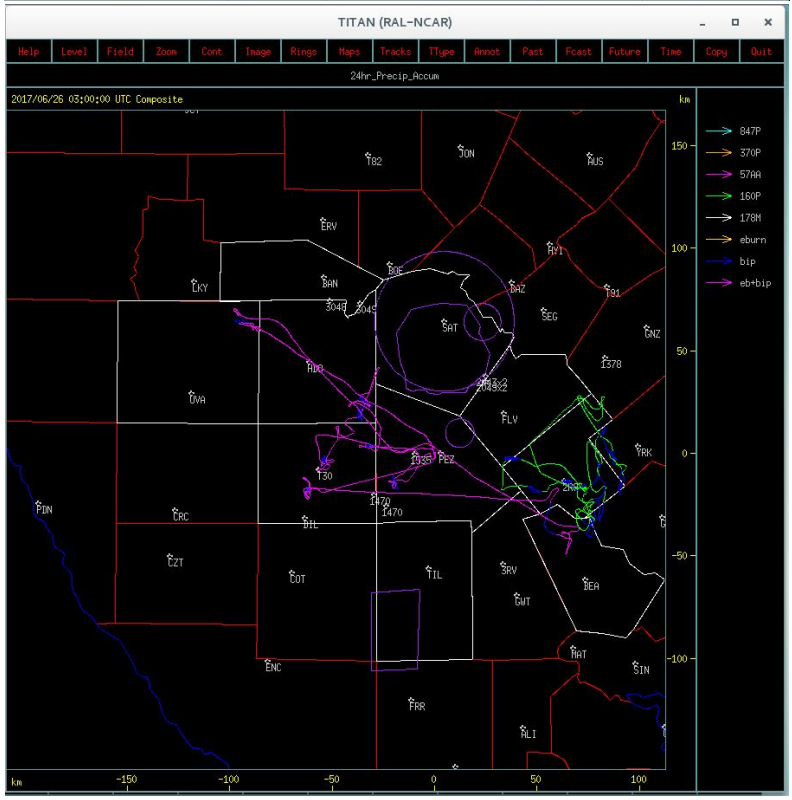
June 24, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/25 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

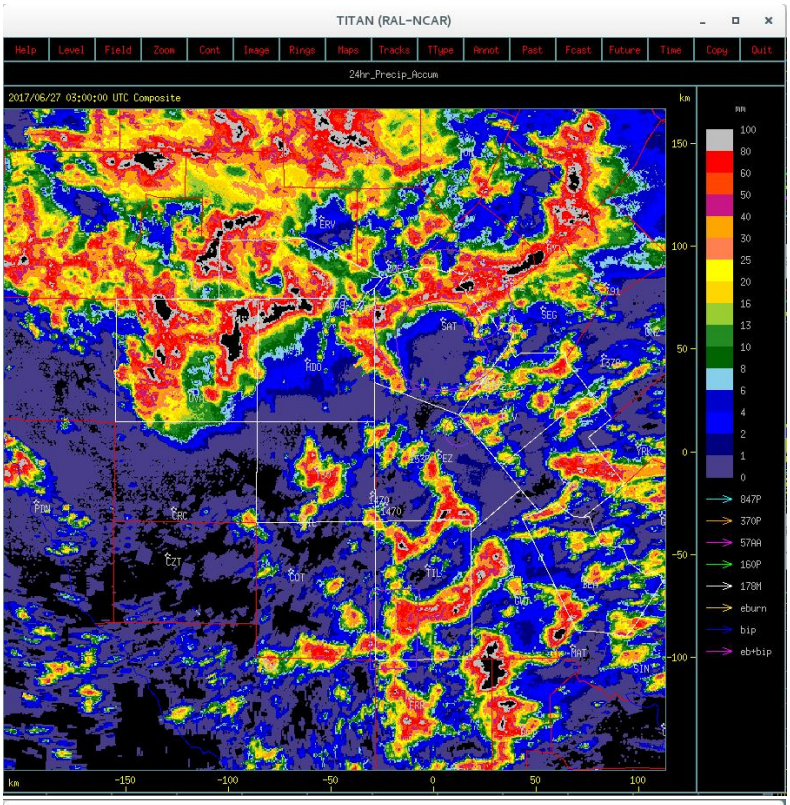

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/25 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

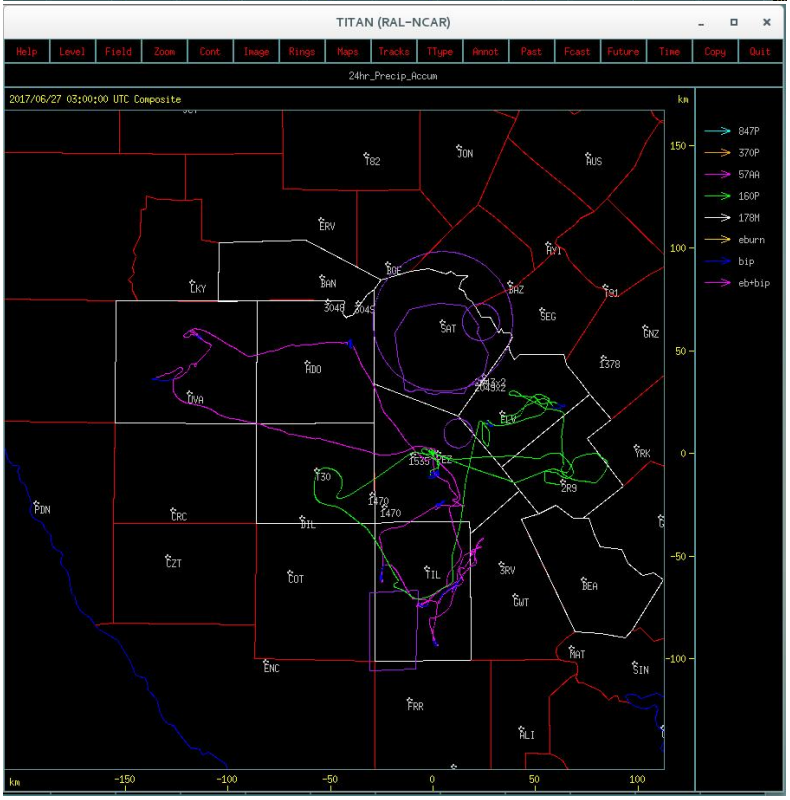
June 25, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/26 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57HA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

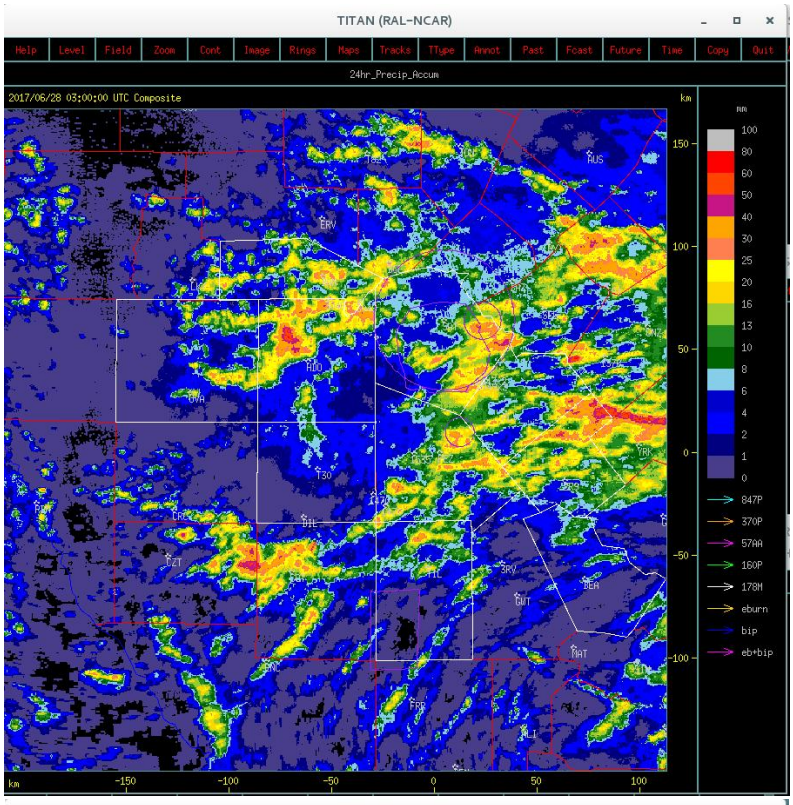

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/26 03:00:00 UTC Composite
km
847P
370P
57HA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

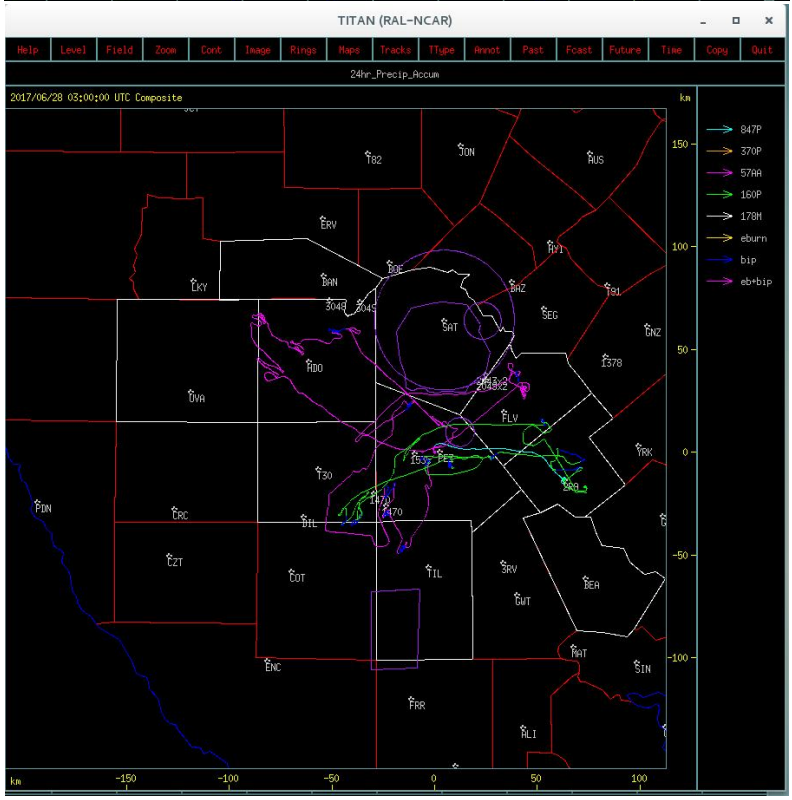
June 26, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/27 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

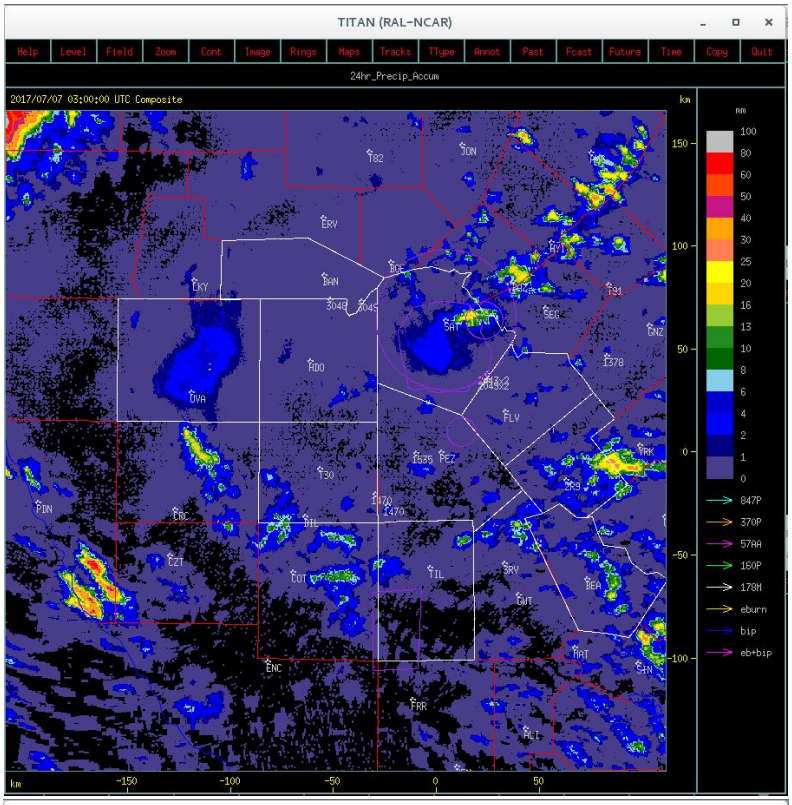

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/27 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

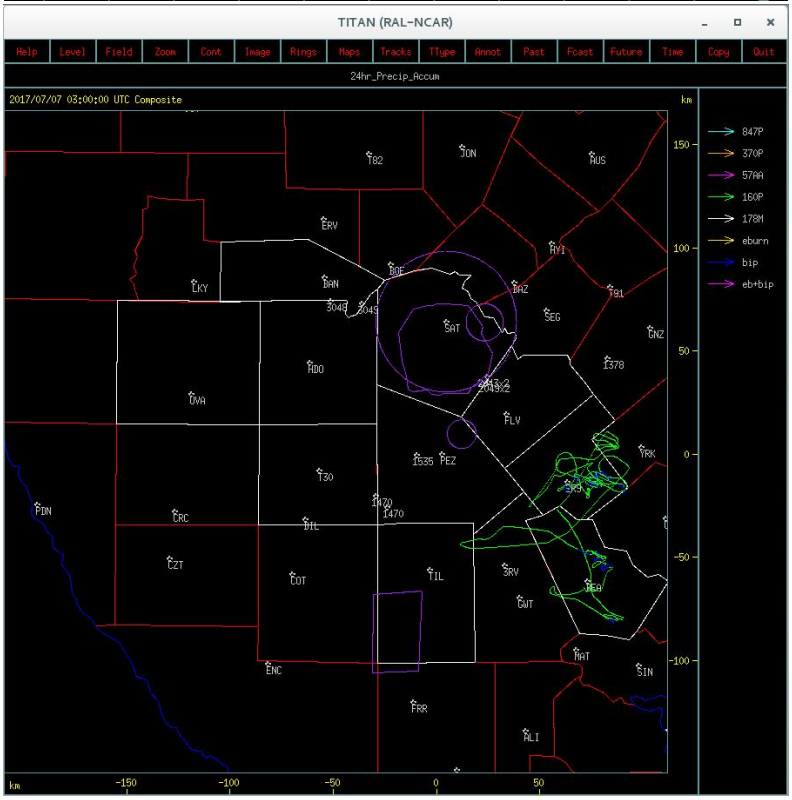
June 27, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/28 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

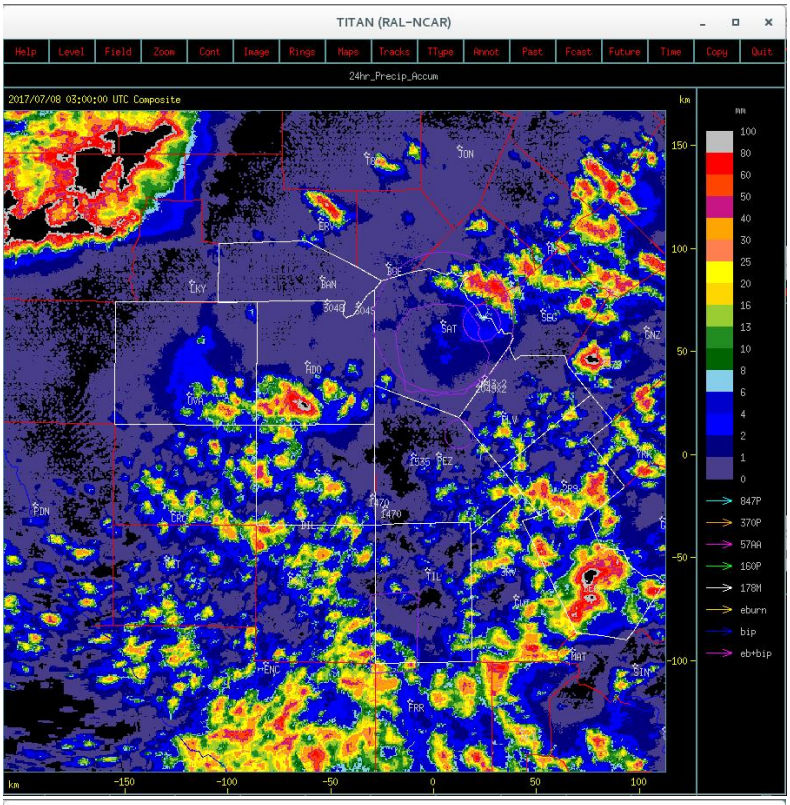

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/06/28 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

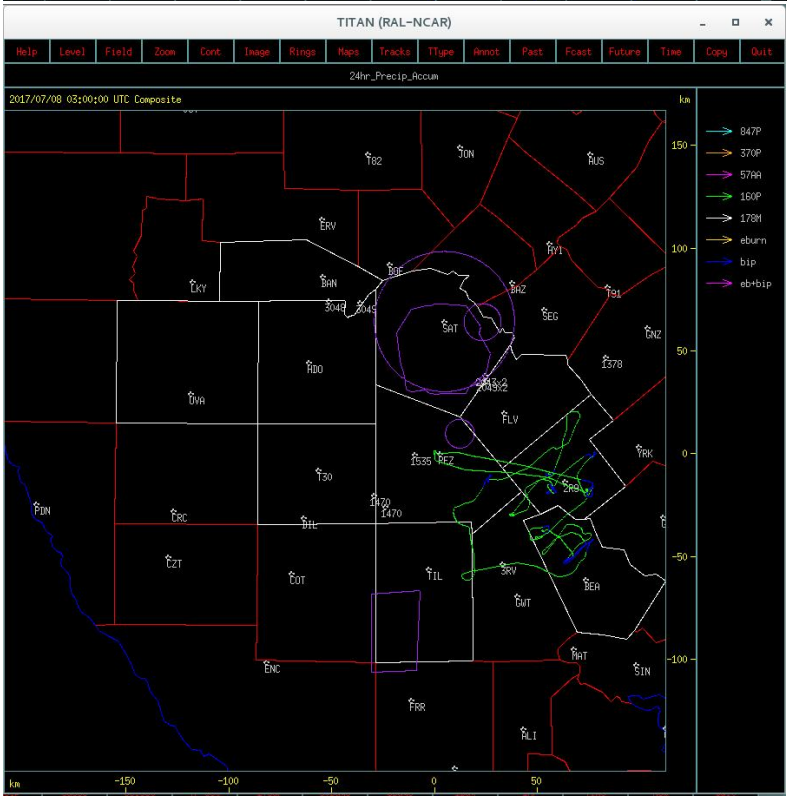
July 6, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/07 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

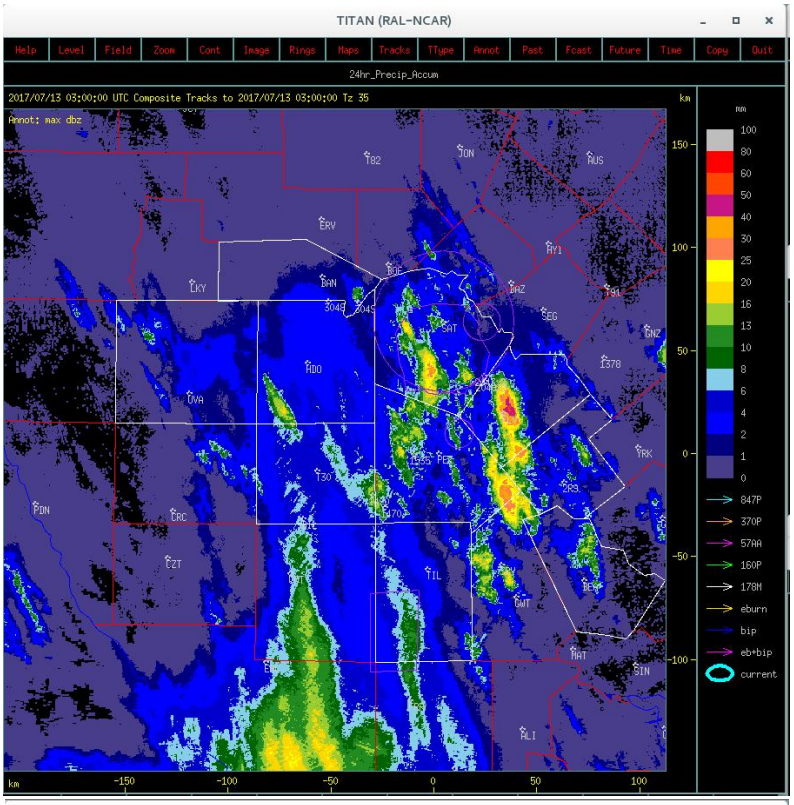

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/07 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

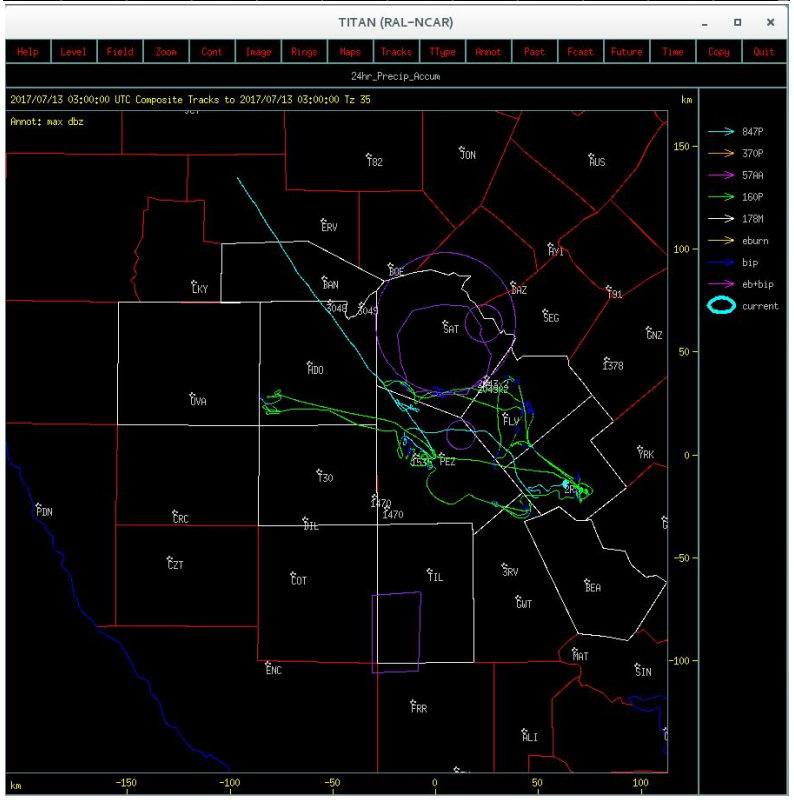
July 7, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/08 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

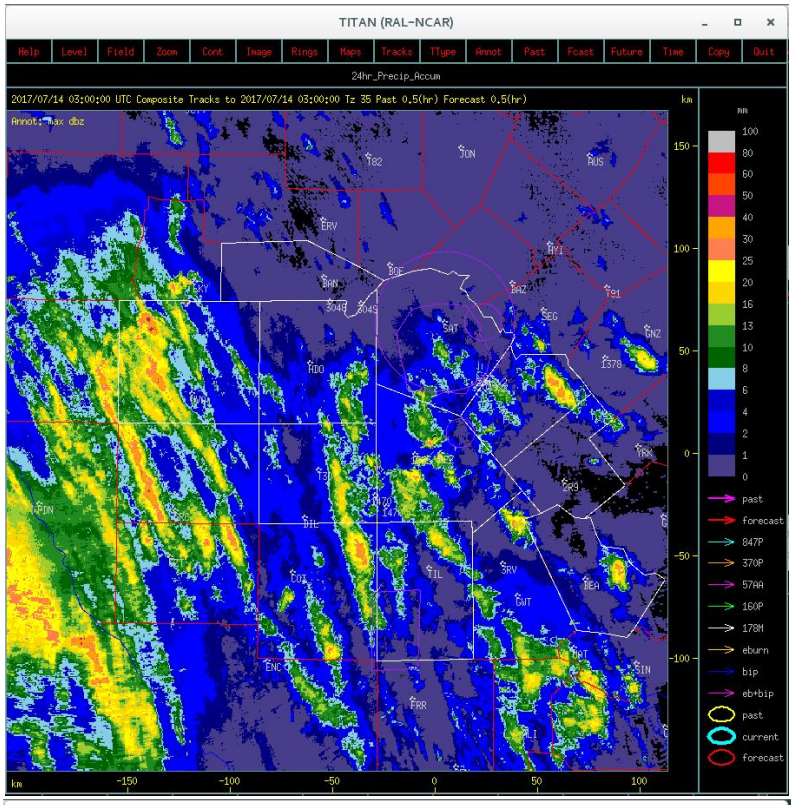

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/08 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

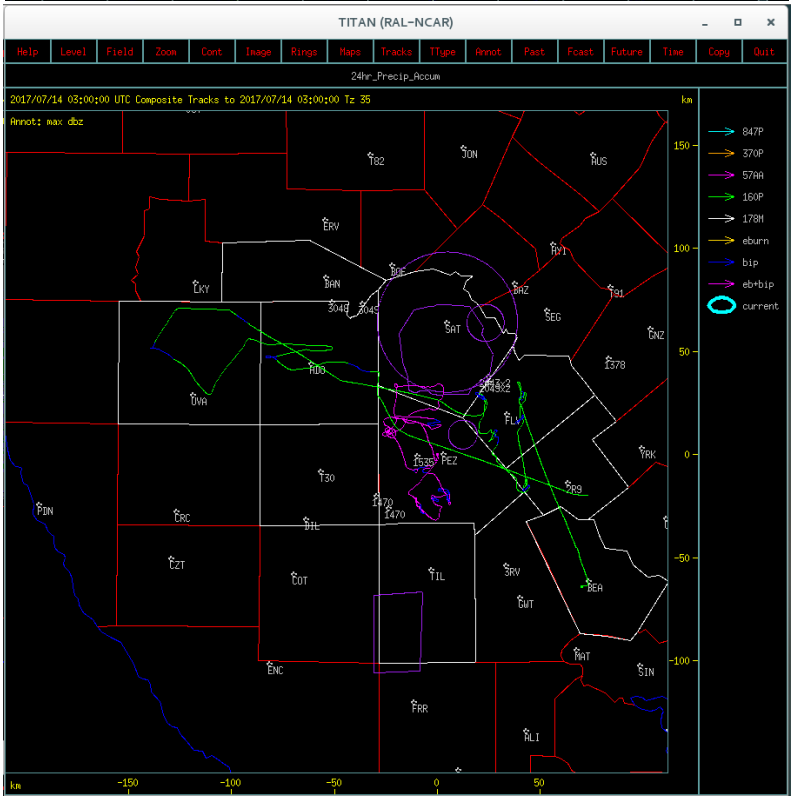
July 12, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/13 03:00:00 UTC Composite Tracks to 2017/07/13 03:00:00 Tz 35
Annot: max dbz
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
-150 -100 -50 0 50 100

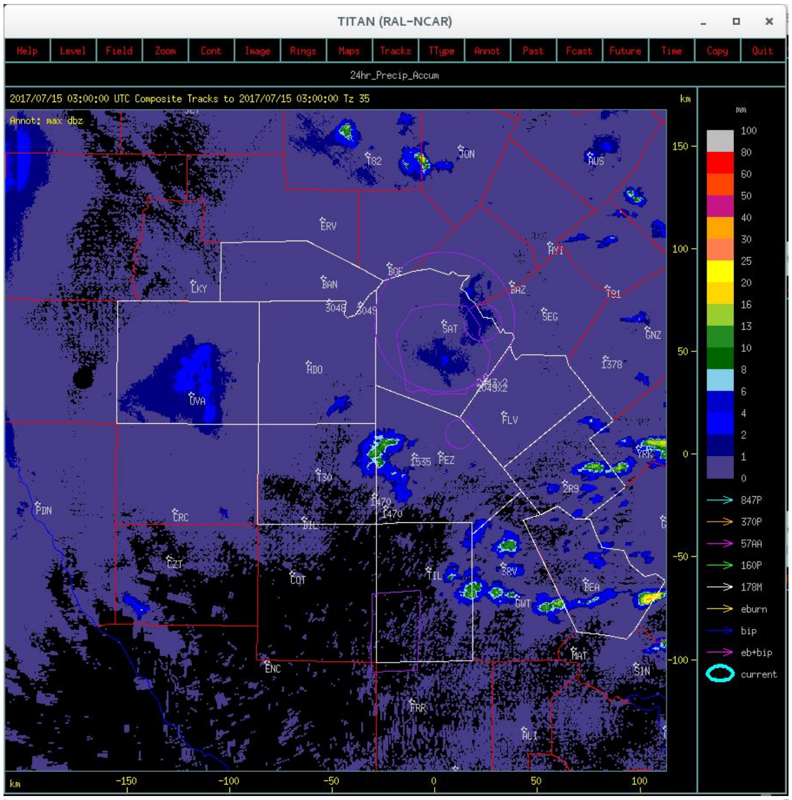

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/13 03:00:00 UTC Composite Tracks to 2017/07/13 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
-150 -100 -50 0 50 100

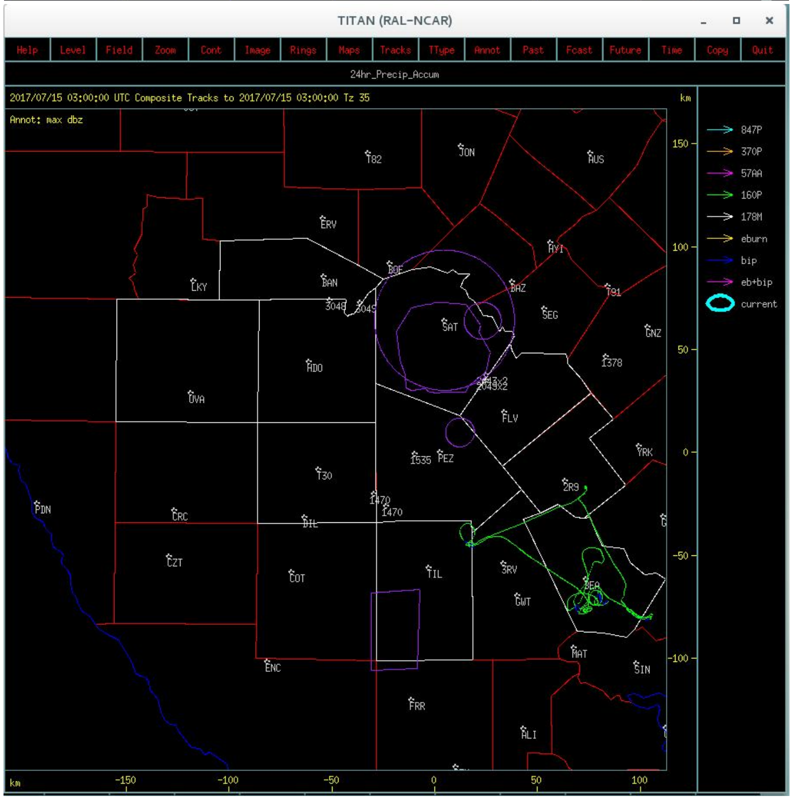
July 13, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/14 03:00:00 UTC Composite Tracks to 2017/07/14 03:00:00 Tz 35 Past 0.5(hr) Forecast 0.5(hr)
Annot: max dbz
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
past
forecast
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
past
current
forecast

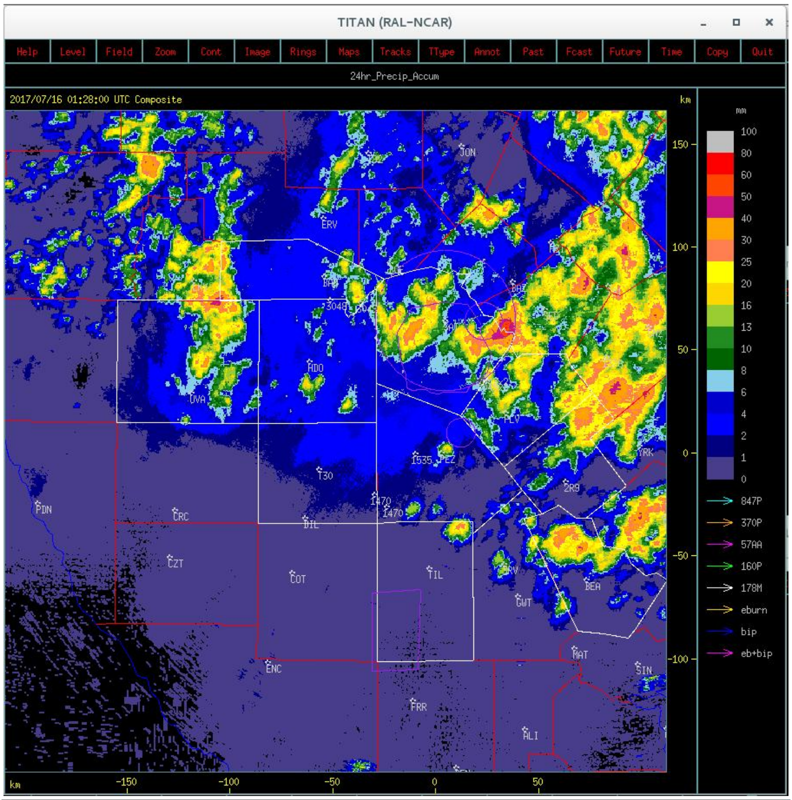

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/14 03:00:00 UTC Composite Tracks to 2017/07/14 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current

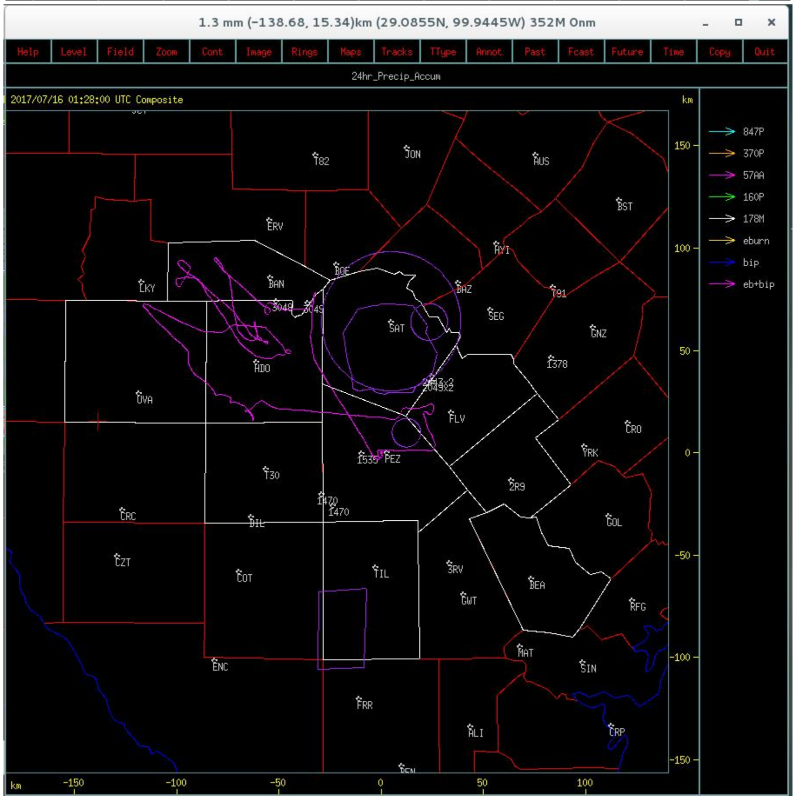
July 14, 2017


TITAN (RAL–NCAR)
Help
Level
Field
Zoom
Cont
Image
Rings
Maps
Tracks
TType
Annot
Past
Fcast
Future
Time
Copy
Quit
24hr_Precip_Accum
2017/07/15 03:00:00 UTC Composite Tracks to 2017/07/15 03:00:00 Tz 35
Annot: max dbz
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current

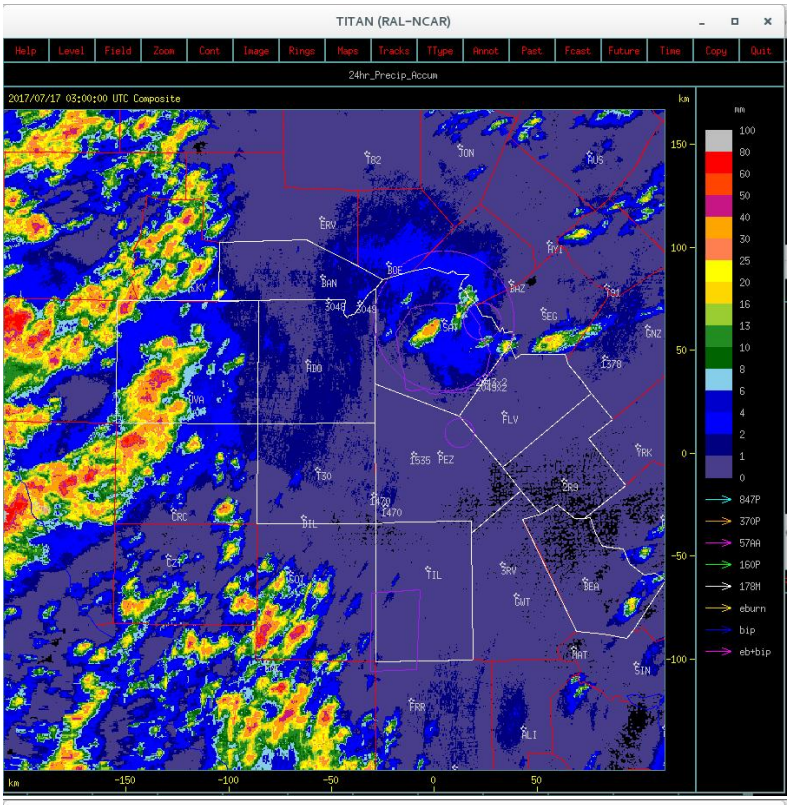

TITAN (RAL–NCAR)
Help
Level
Field
Zoom
Cont
Image
Rings
Maps
Tracks
TType
Annot
Past
Fcast
Future
Time
Copy
Quit
24hr_Precip_Accum
2017/07/15 03:00:00 UTC Composite Tracks to 2017/07/15 03:00:00 Tz 35
Annot: max dbz
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current

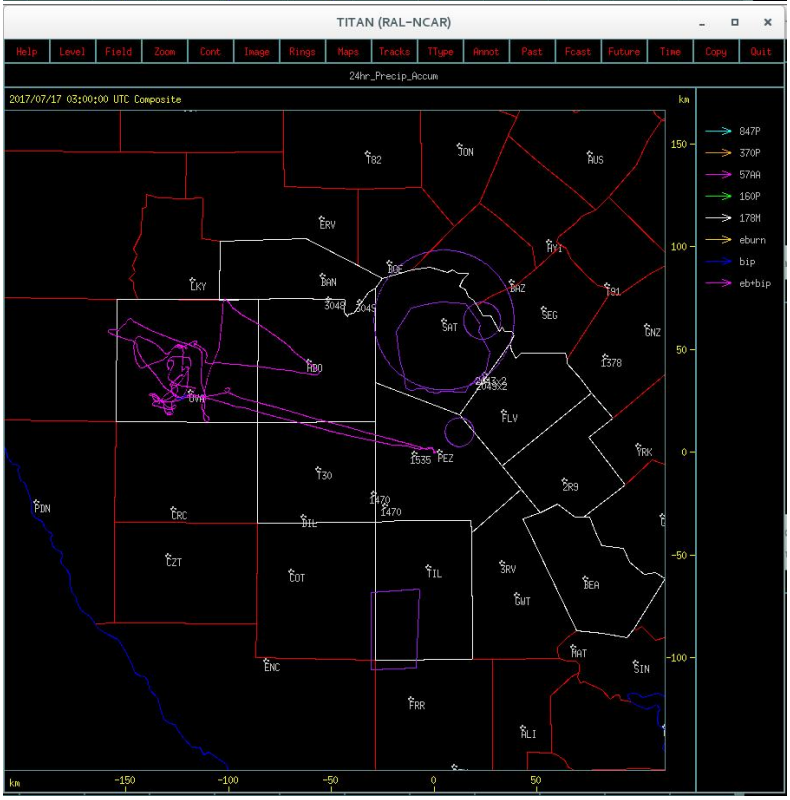
July 15, 2017


TITAN (RAL-NCAR)
Help
Level
Field
Zoom
Cont
Image
Rings
Maps
Tracks
TType
Annot
Past
Fcast
Future
Time
Copy
Quit
24hr_Precip_Accum
2017/07/16 01:28:00 UTC Composite
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip

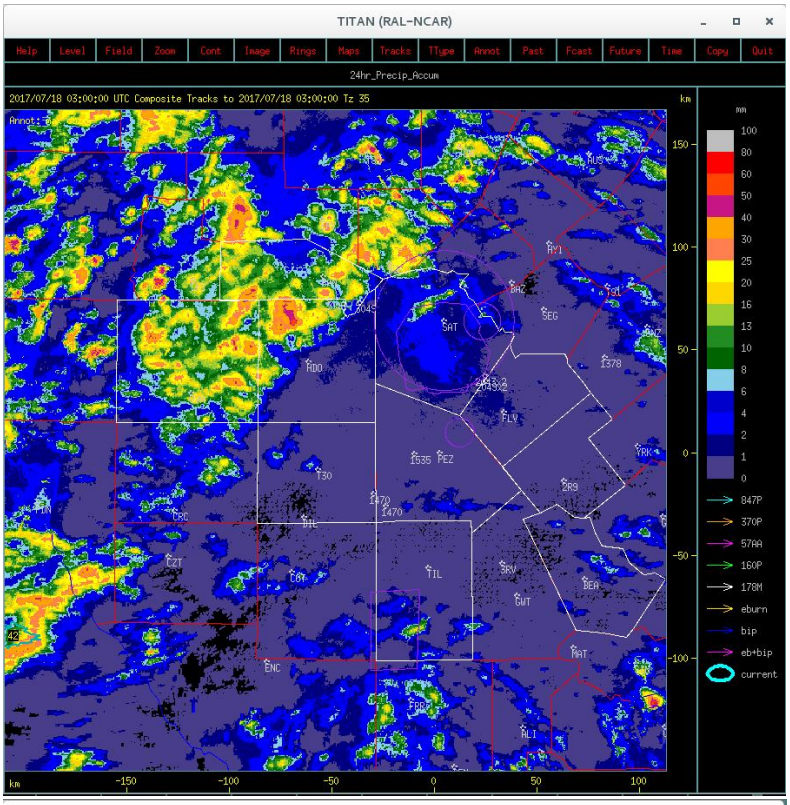

1.3 mm (-138.68, 15.34)km (29.0855N, 99.9445W) 352M 0nm
Help
Level
Field
Zoom
Cont
Image
Rings
Maps
Tracks
TType
Annot
Past
Fcast
Future
Time
Copy
Quit
24hr_Precip_Accum
2017/07/16 01:28:00 UTC Composite
847P
370P
57AA
160P
178M
eburn
bip
eb+bip

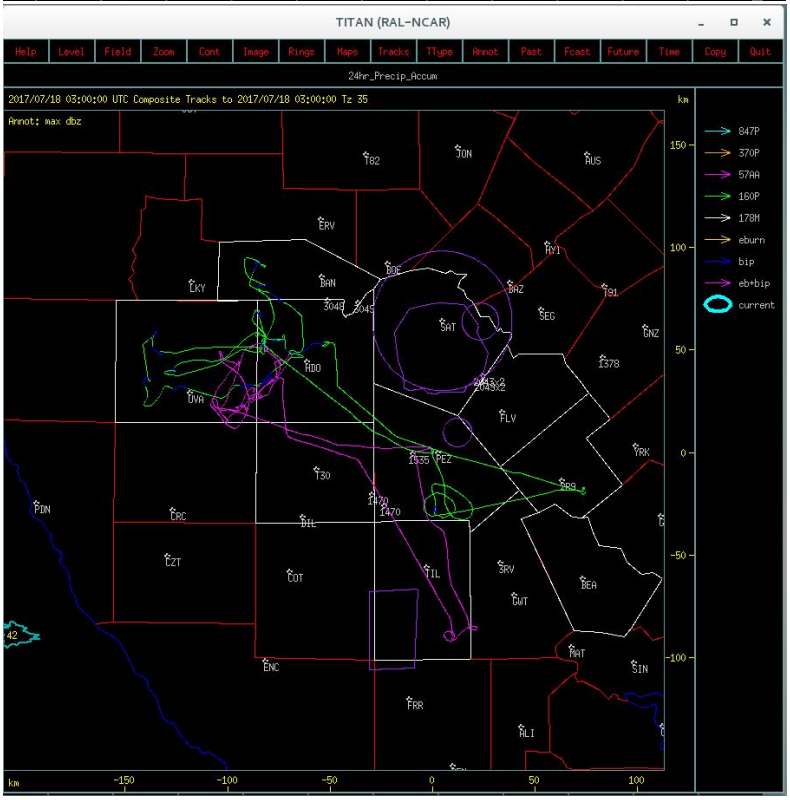
July 16, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/17 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

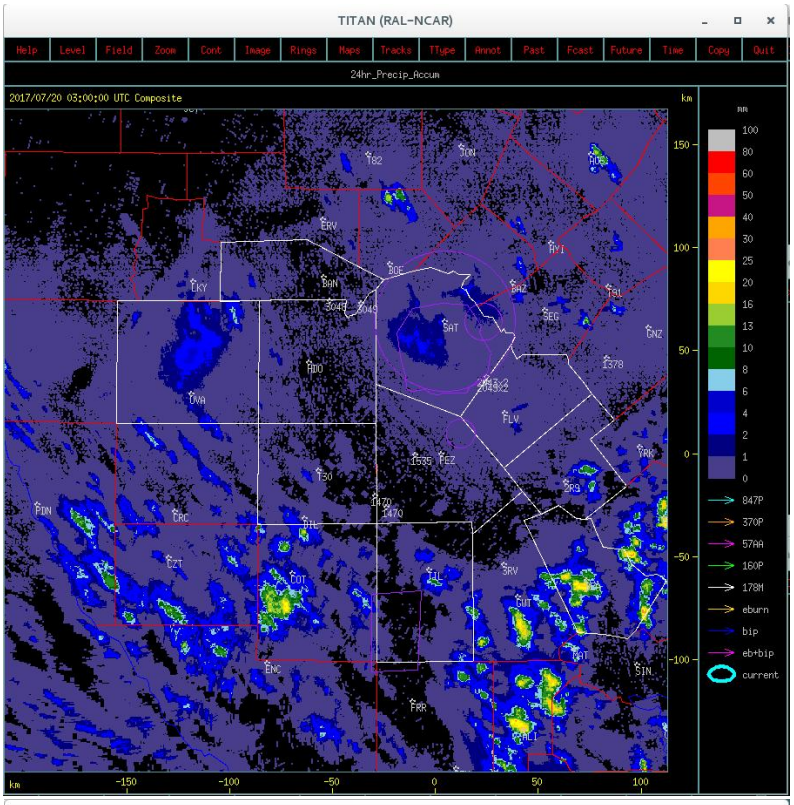

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/17 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
150
100
50
0
-50
-100
-150

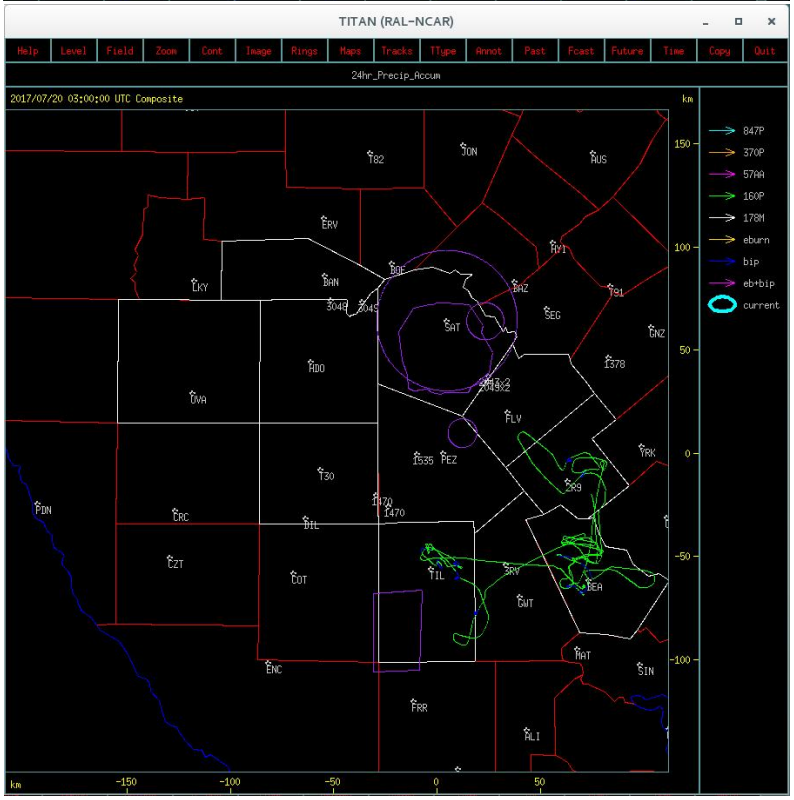
July 17, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/18 03:00:00 UTC Composite Tracks to 2017/07/18 03:00:00 Tz 35
Annot:
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

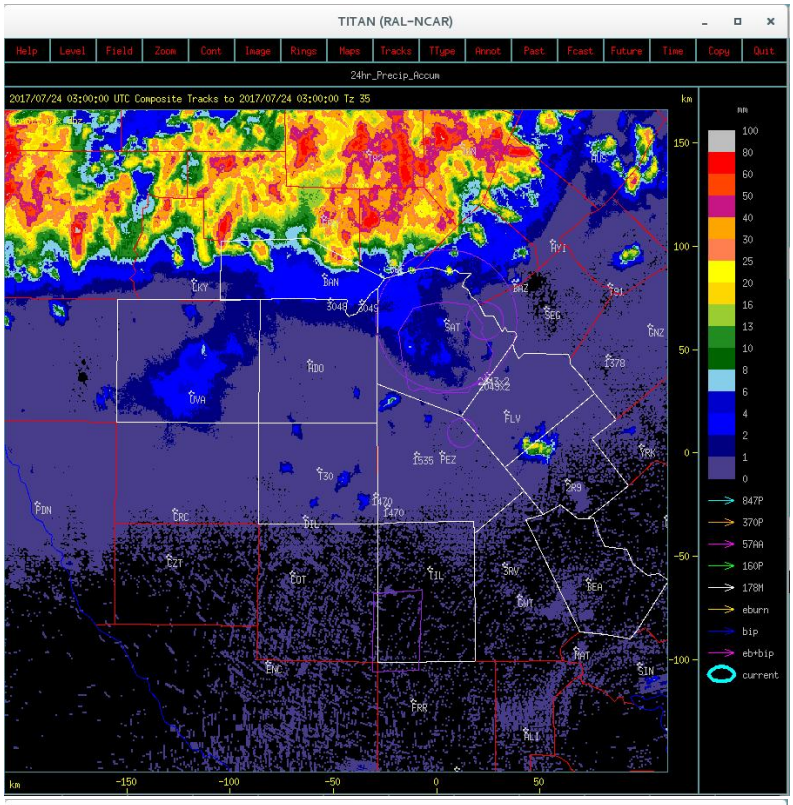

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/18 03:00:00 UTC Composite Tracks to 2017/07/18 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

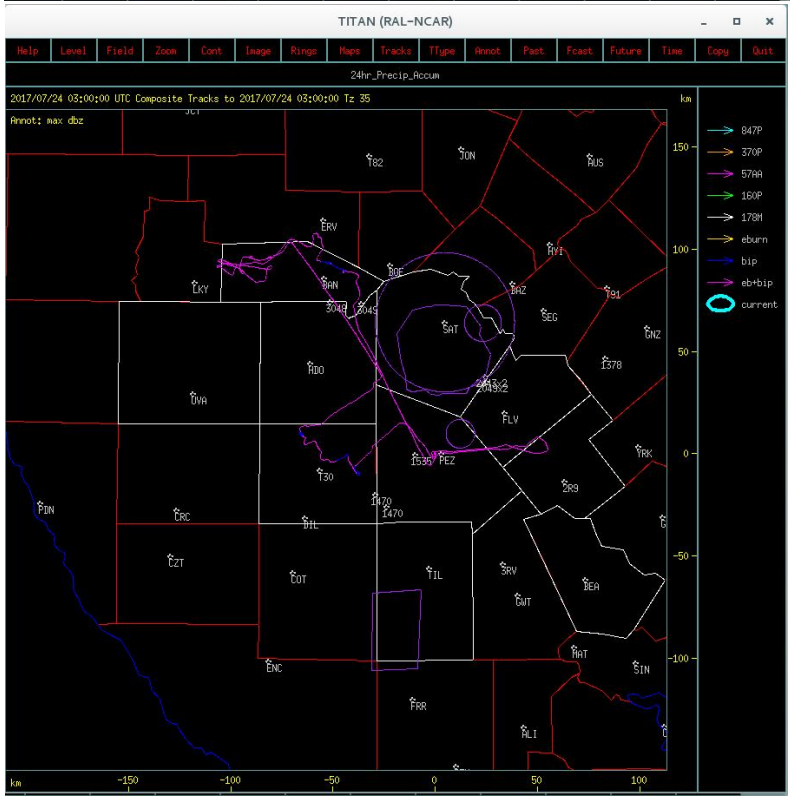
July 19, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/20 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

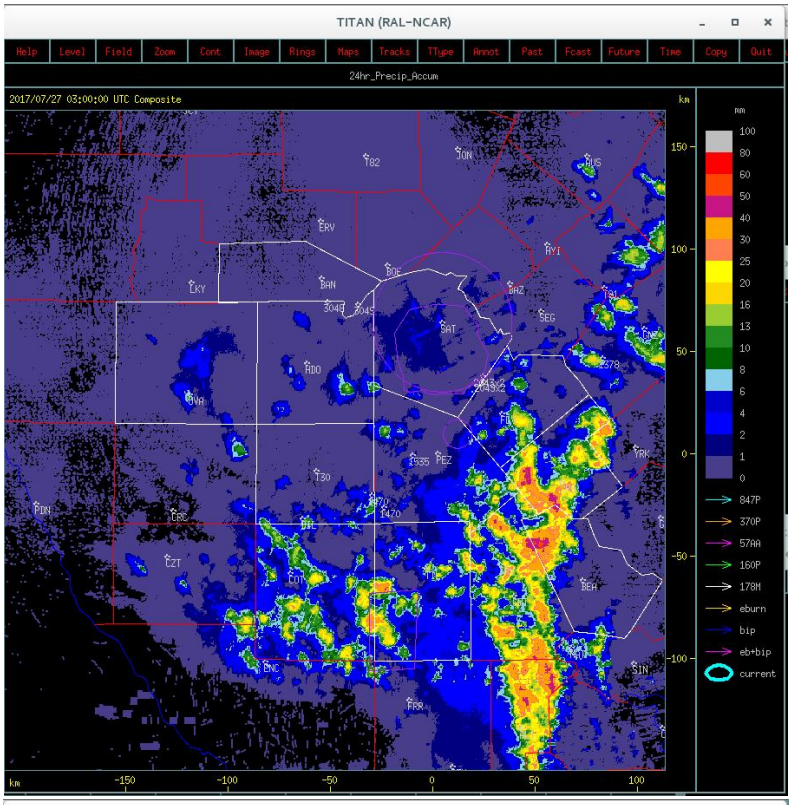

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/20 03:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

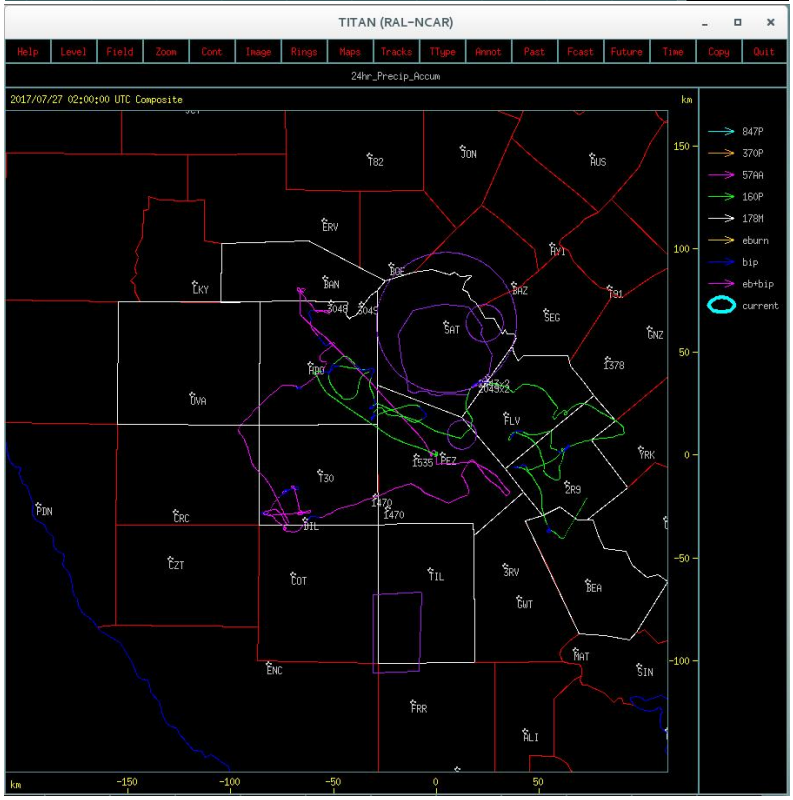
July 23, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/24 03:00:00 UTC Composite Tracks to 2017/07/24 03:00:00 Tz 35
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

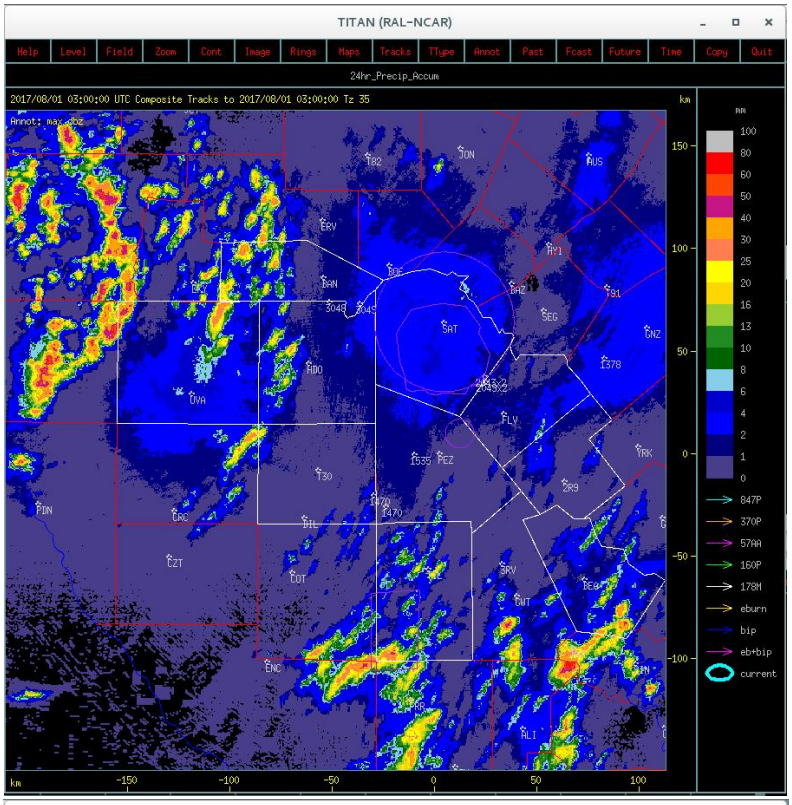

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/24 03:00:00 UTC Composite Tracks to 2017/07/24 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

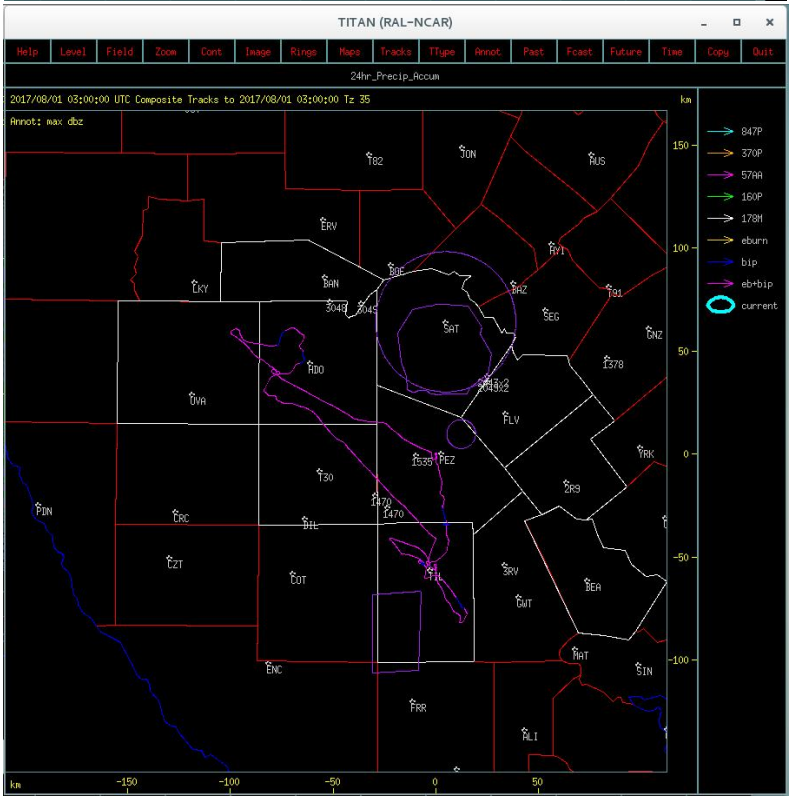
July 26, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/27 03:00:00 UTC Composite
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

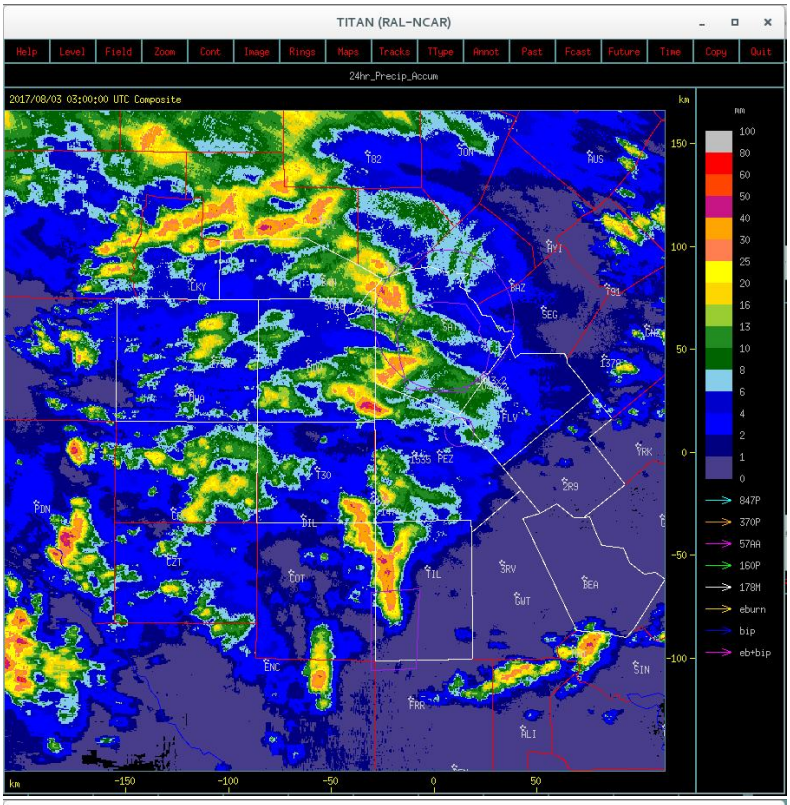

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Fcast Future Time Copy Quit
24hr_Precip_Accum
2017/07/27 02:00:00 UTC Composite
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

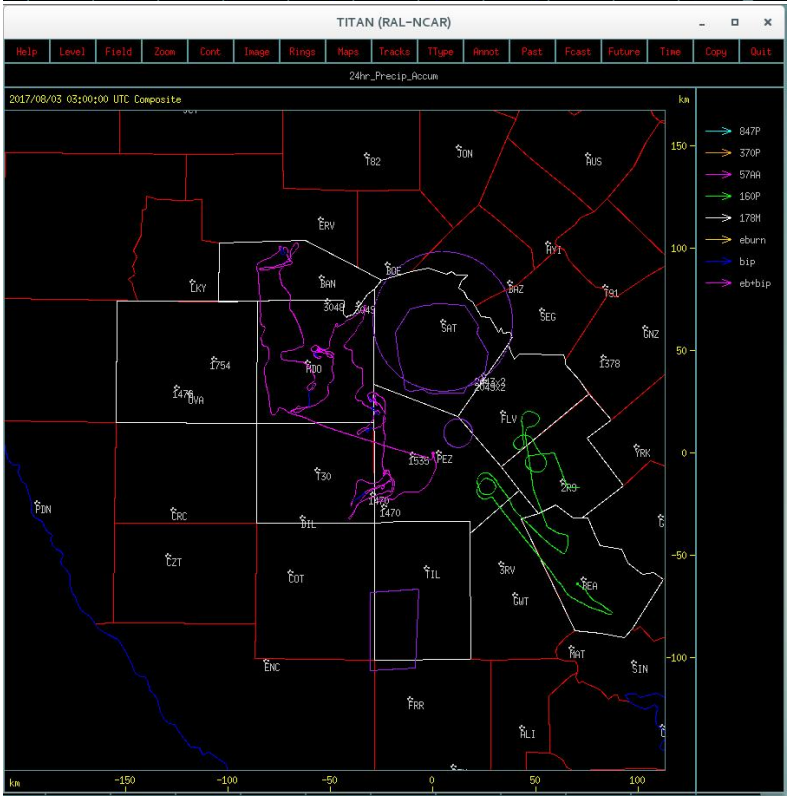
July 31, 2017


TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Feast Future Time Copy Quit
24hr_Precip_Accum
2017/08/01 03:00:00 UTC Composite Tracks to 2017/08/01 03:00:00 Tz 35
Annot: max dbz
km
mm
100
80
60
50
40
30
25
20
16
13
10
8
6
4
2
1
0
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

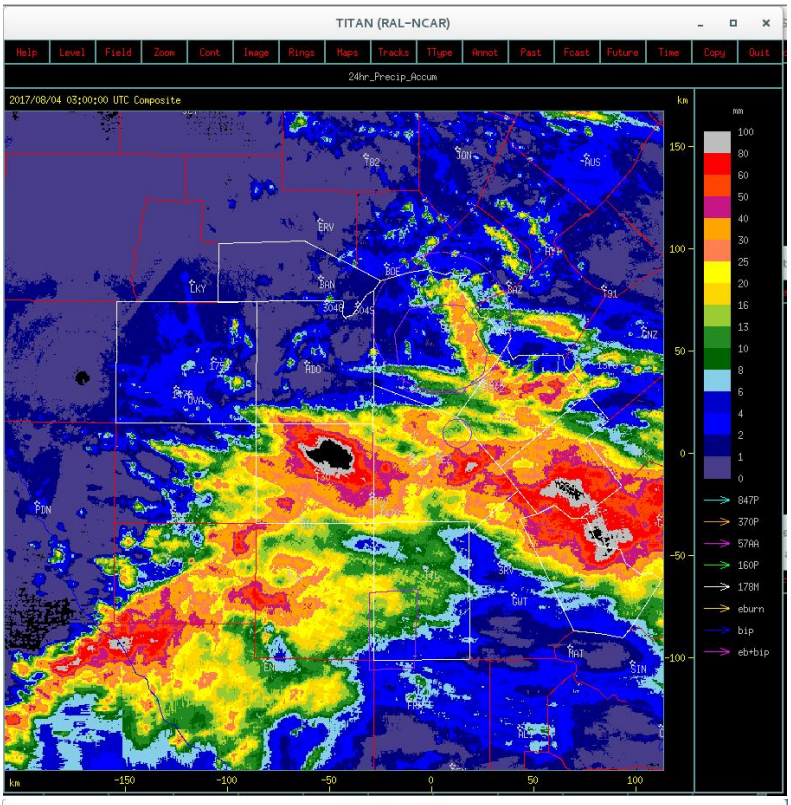

TITAN (RAL-NCAR)
Help Level Field Zoom Cont Image Rings Maps Tracks TType Annot Past Feast Future Time Copy Quit
24hr_Precip_Accum
2017/08/01 03:00:00 UTC Composite Tracks to 2017/08/01 03:00:00 Tz 35
Annot: max dbz
km
847P
370P
57AA
160P
178M
eburn
bip
eb+bip
current
150
100
50
0
-50
-100
-150

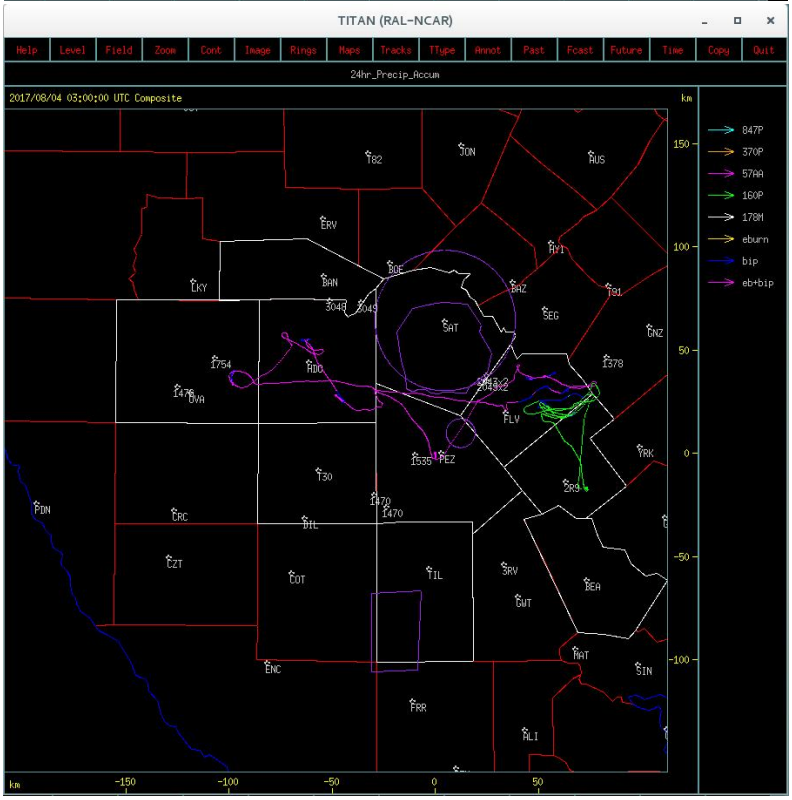
August 2, 2017



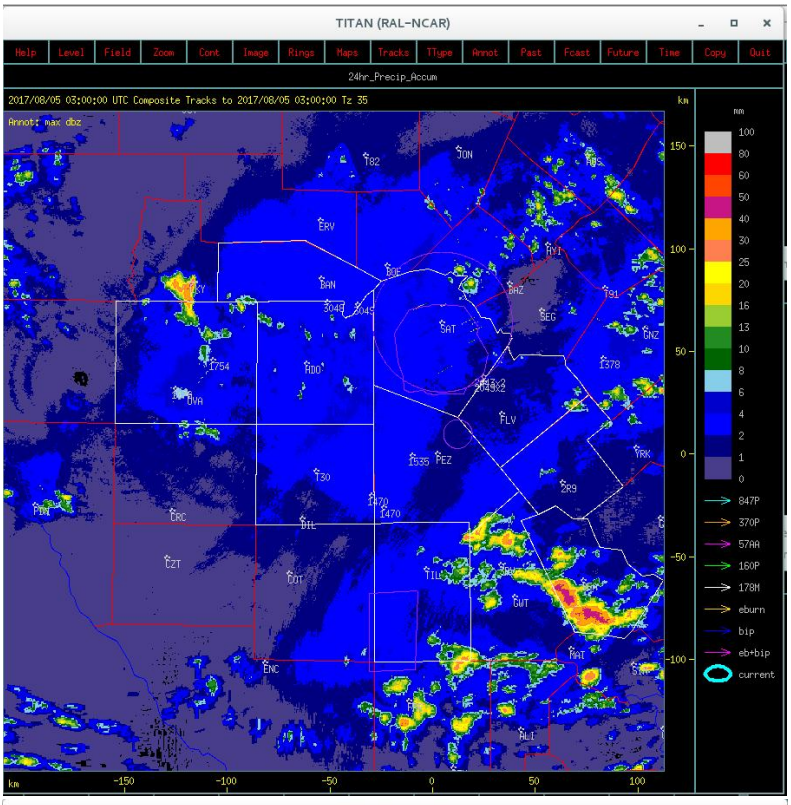


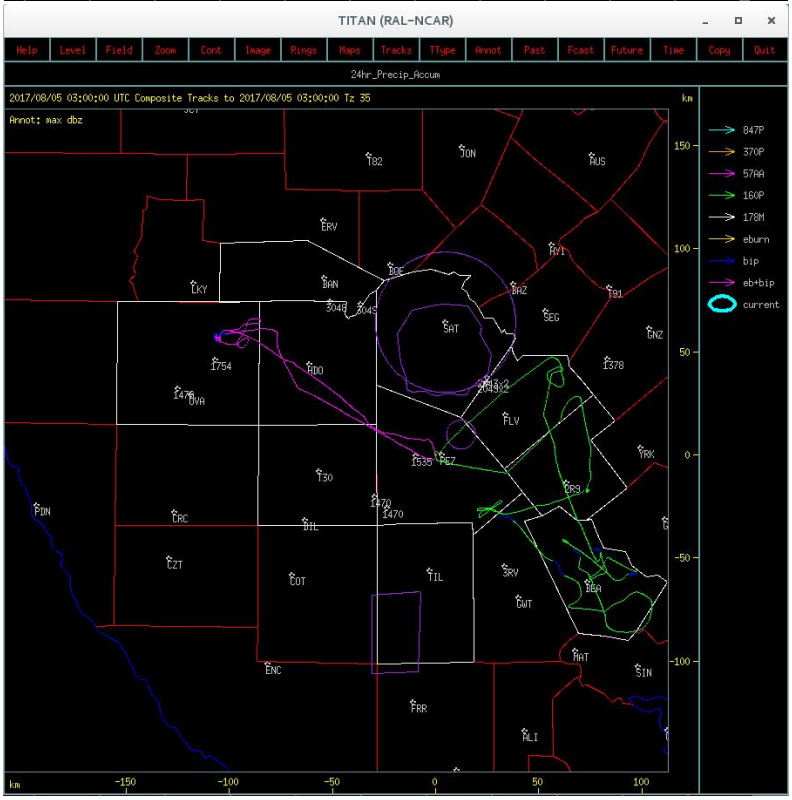
August 3, 2017



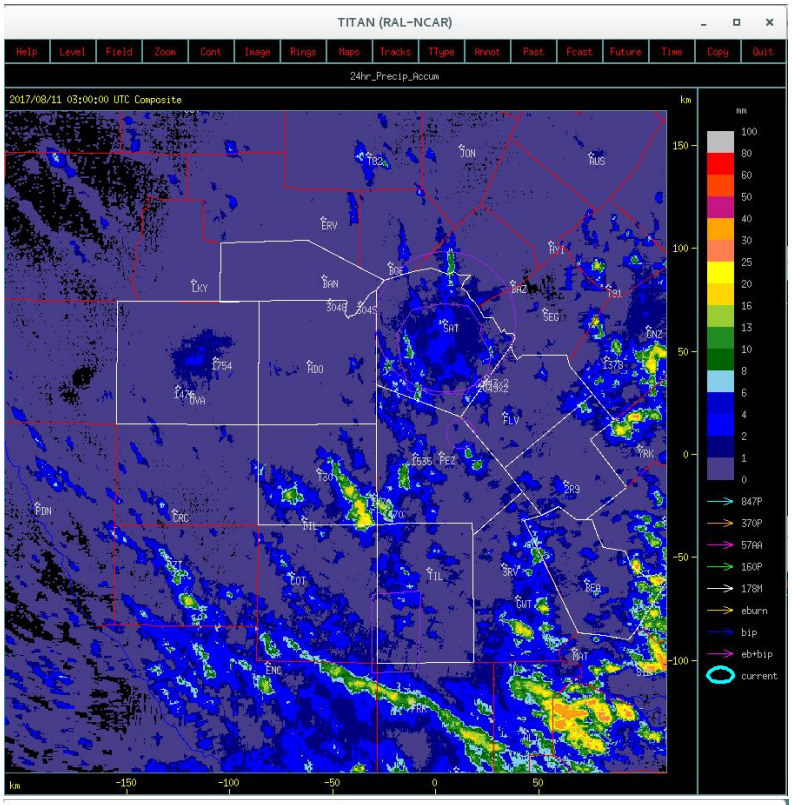


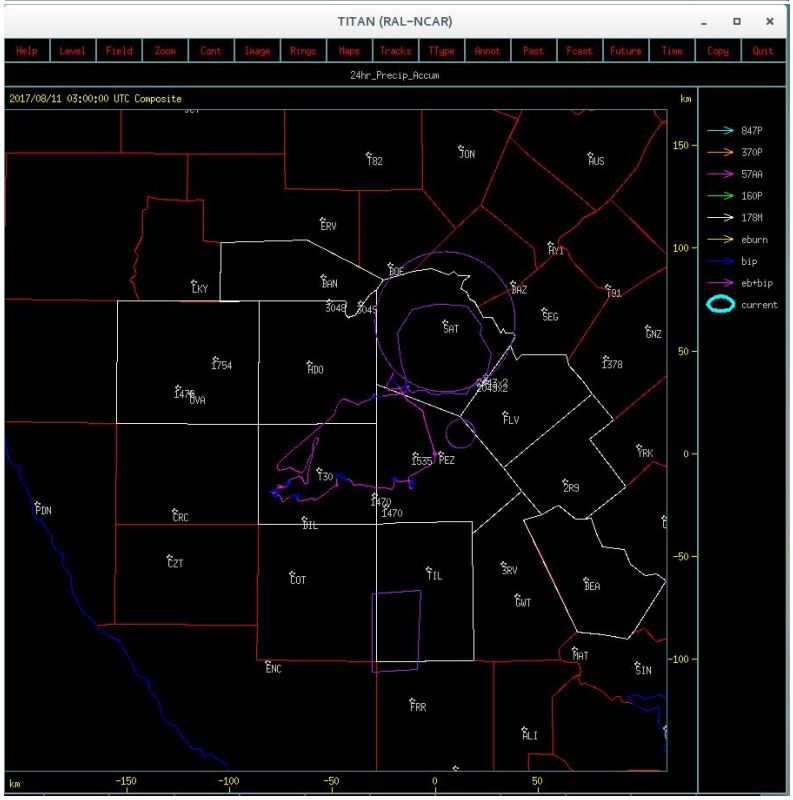
August 4, 2017



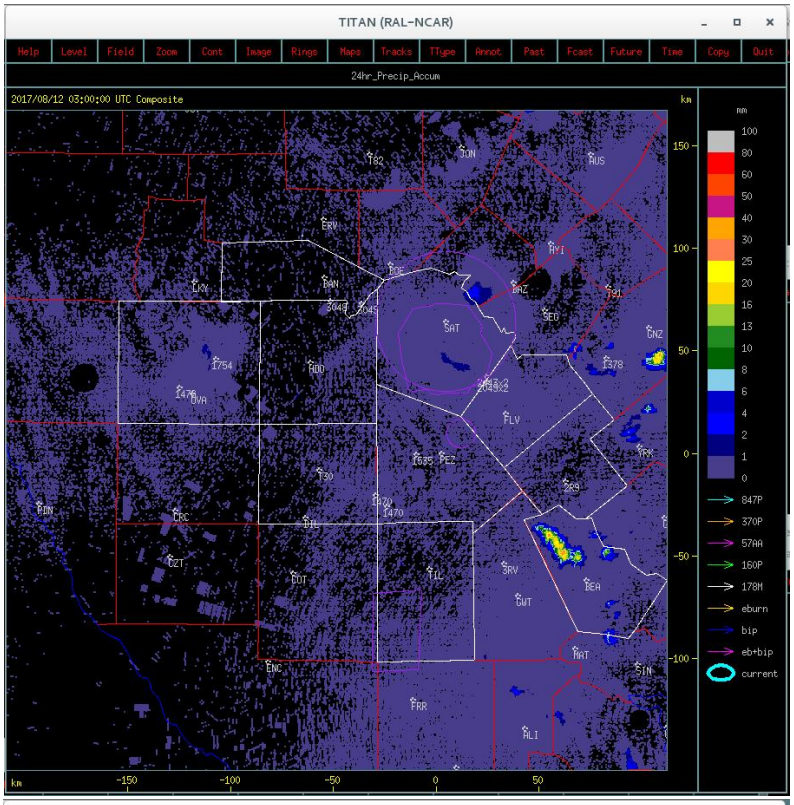


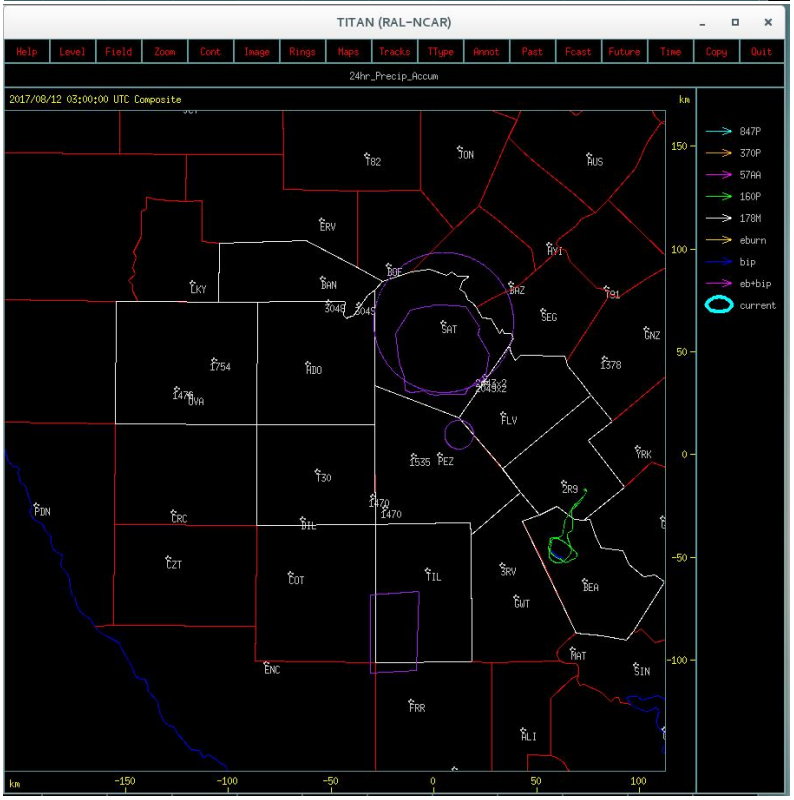
August 10, 2017



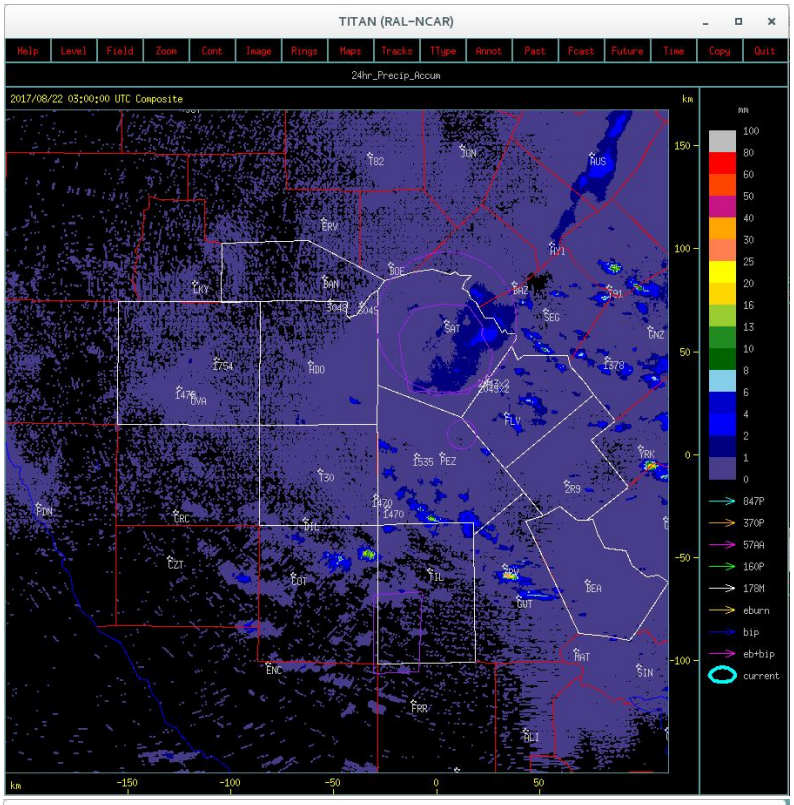


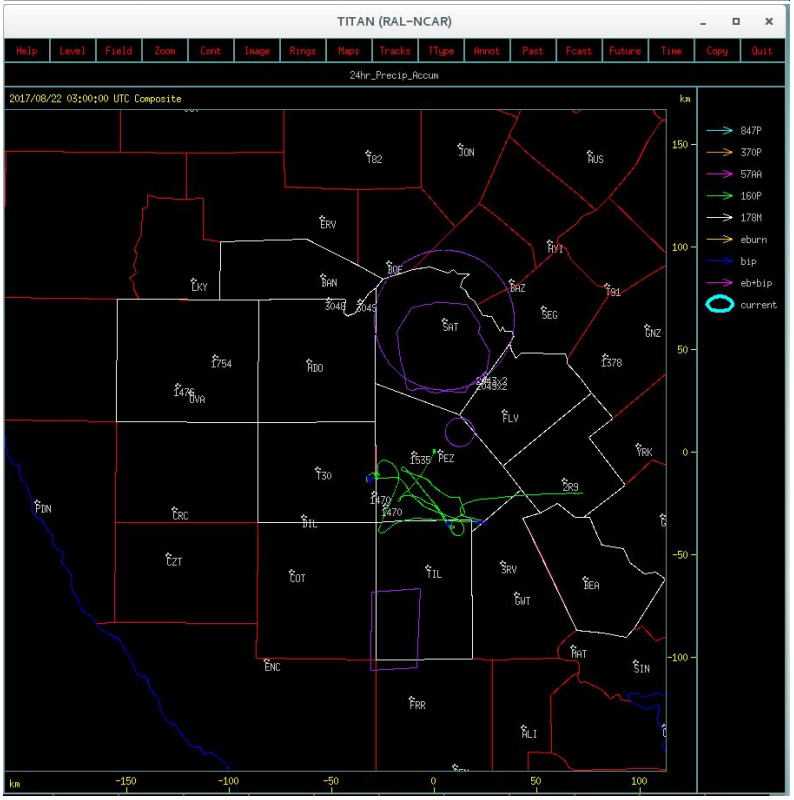
August 11, 2017



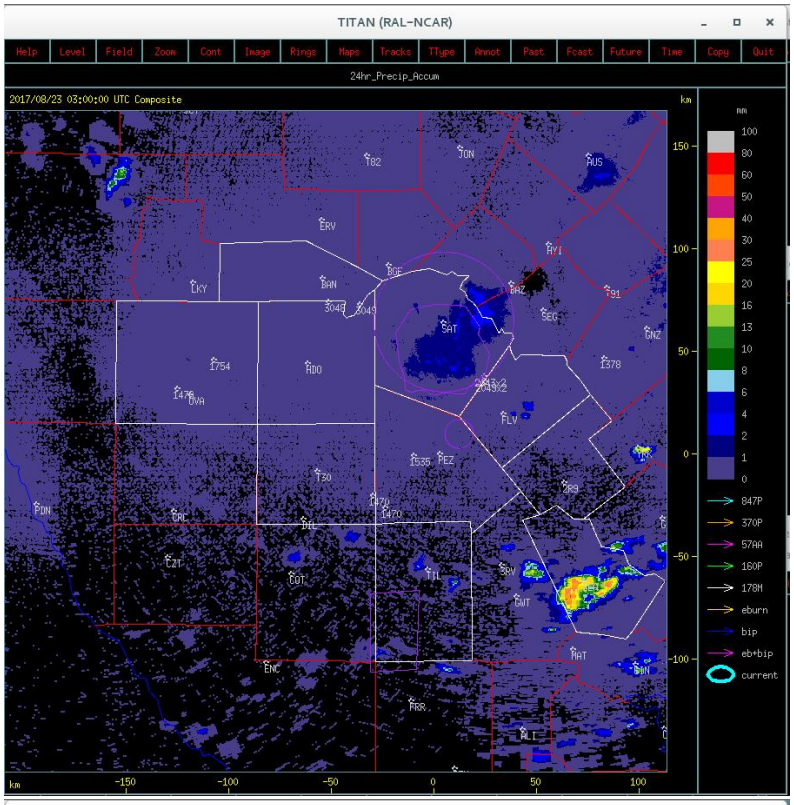


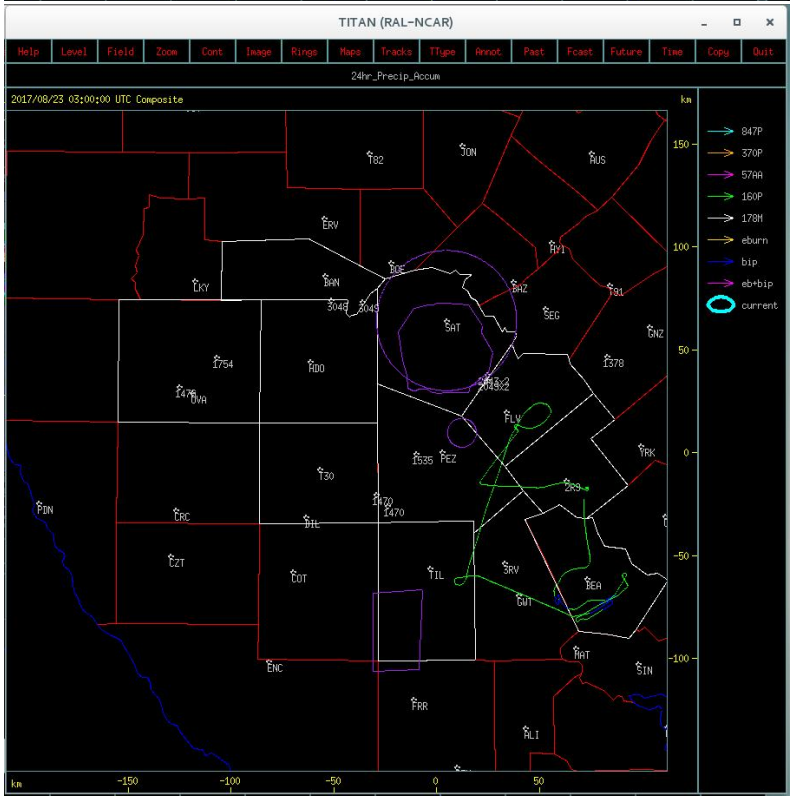
August 21, 2017



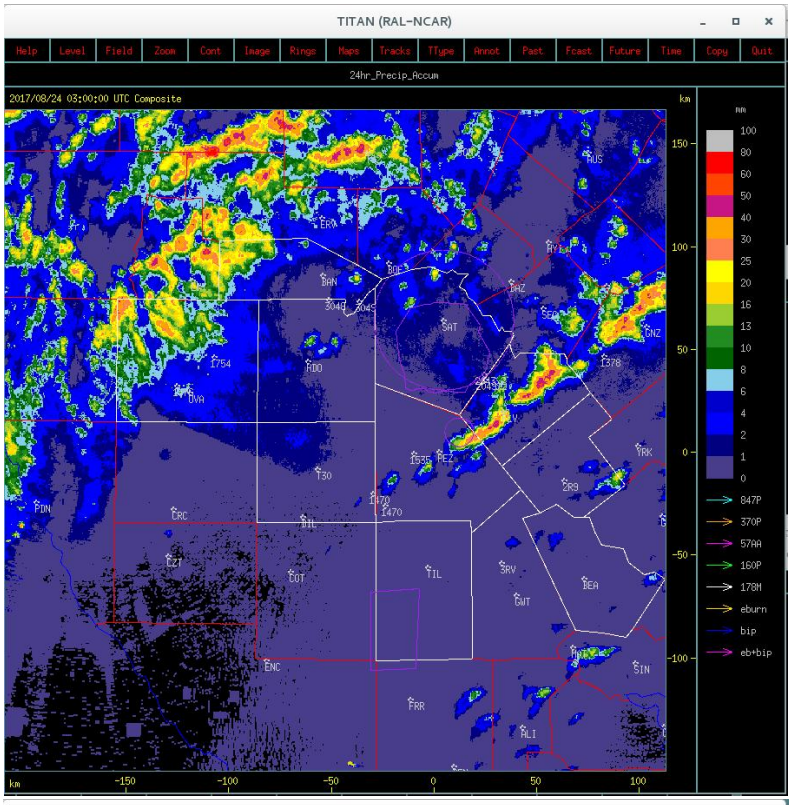


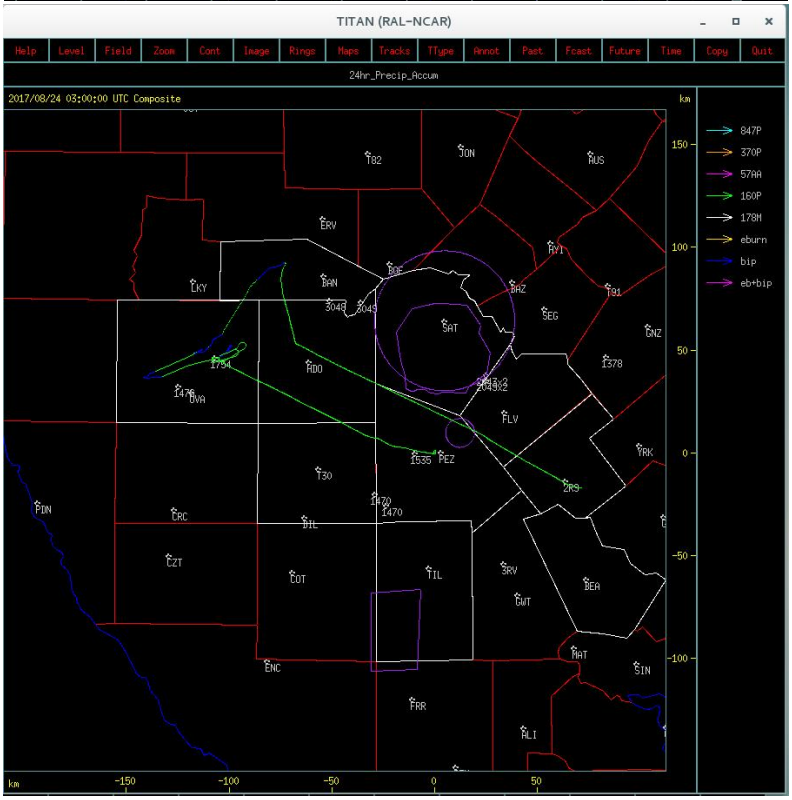
August 22, 2017



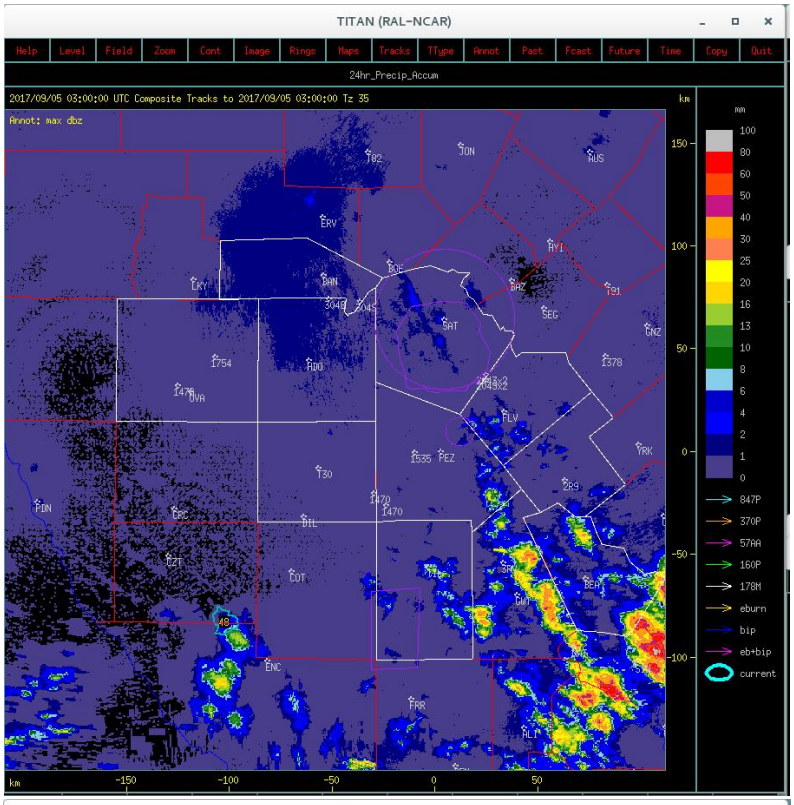


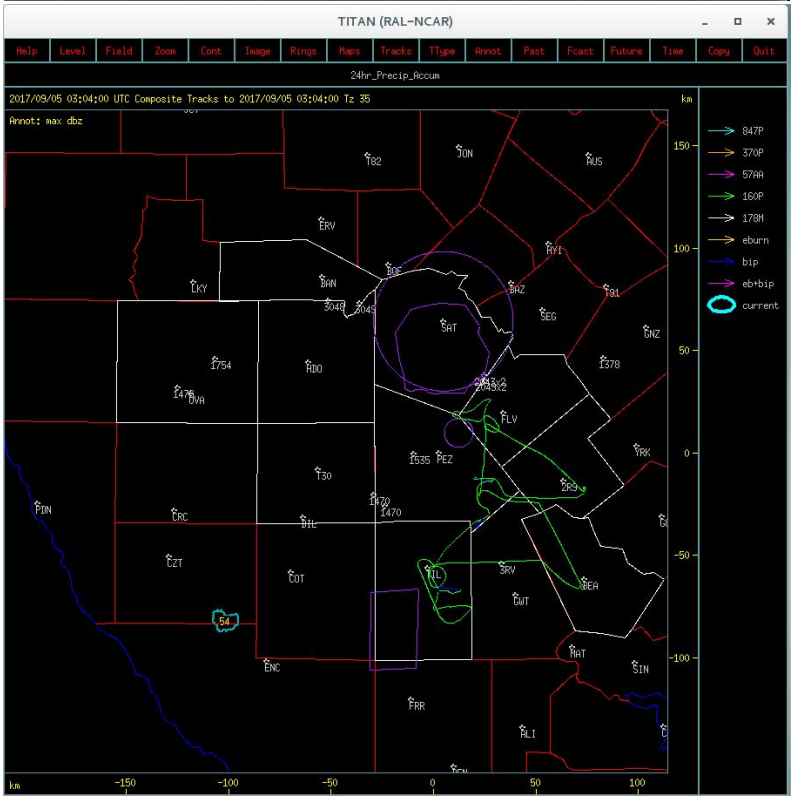
August 23, 2017



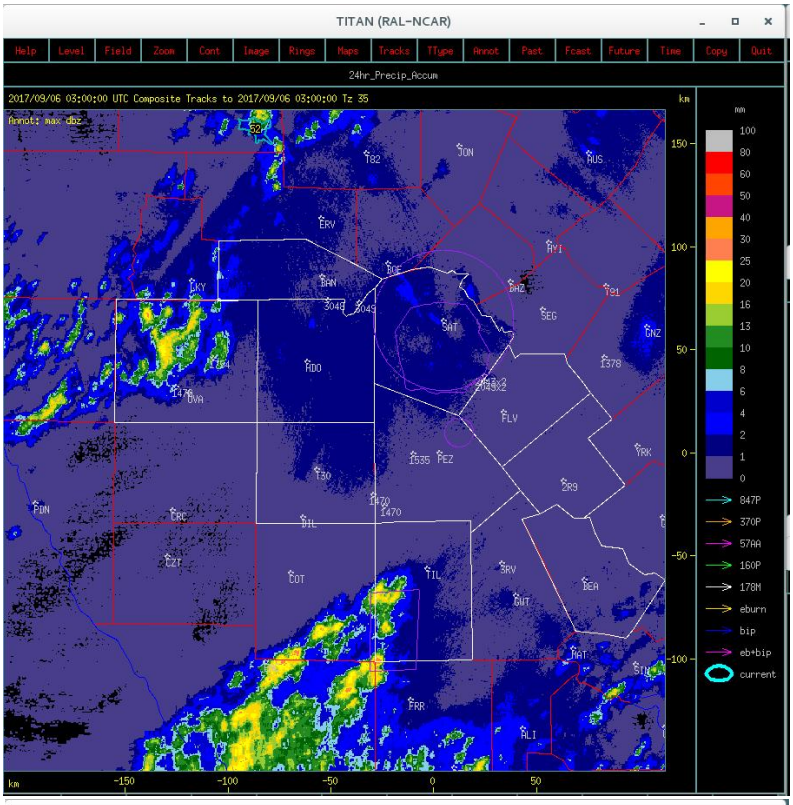


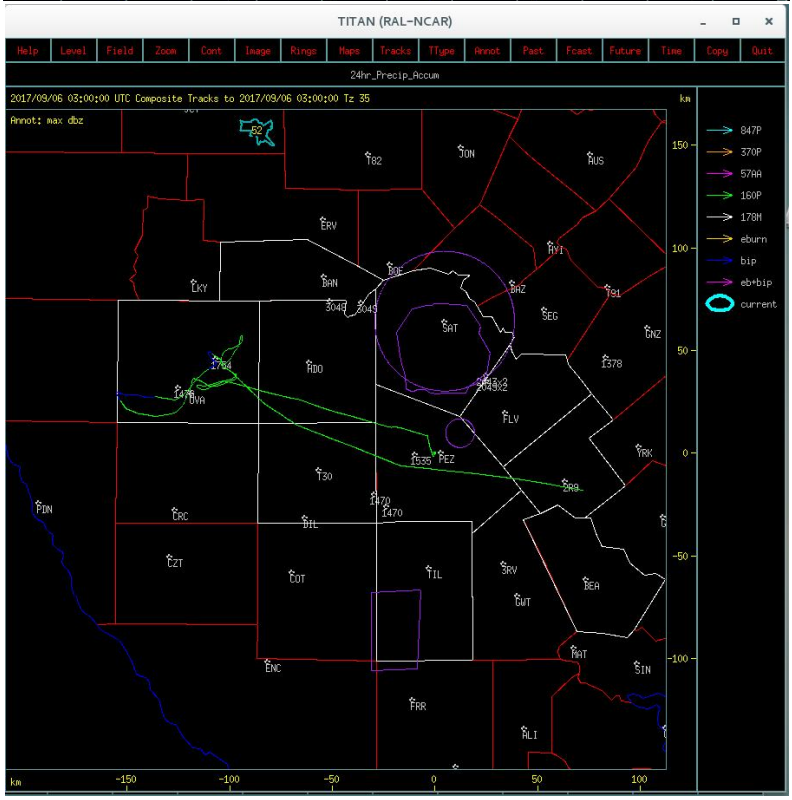
September 4, 2017



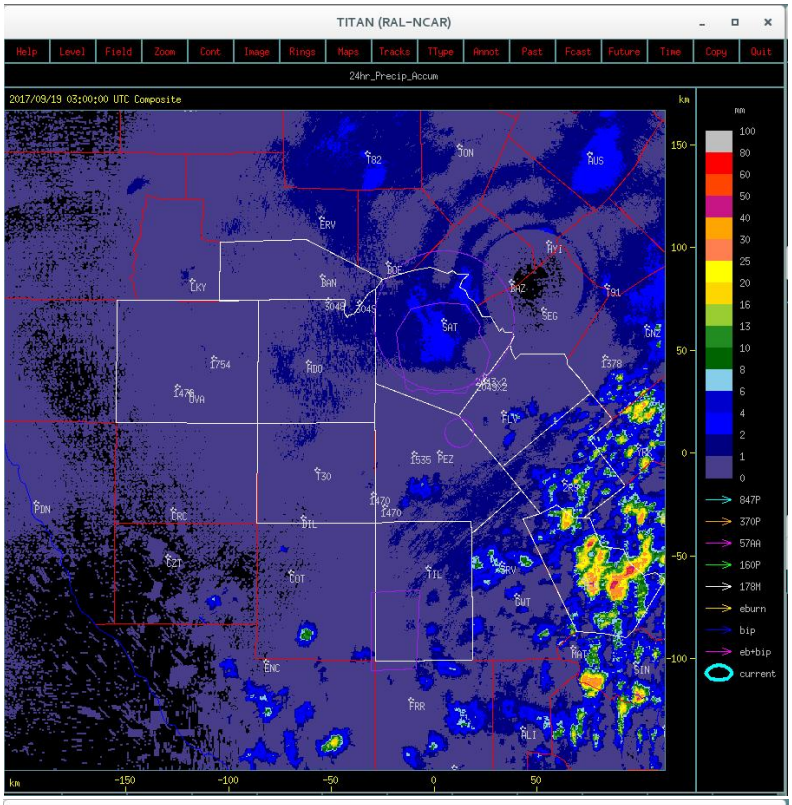


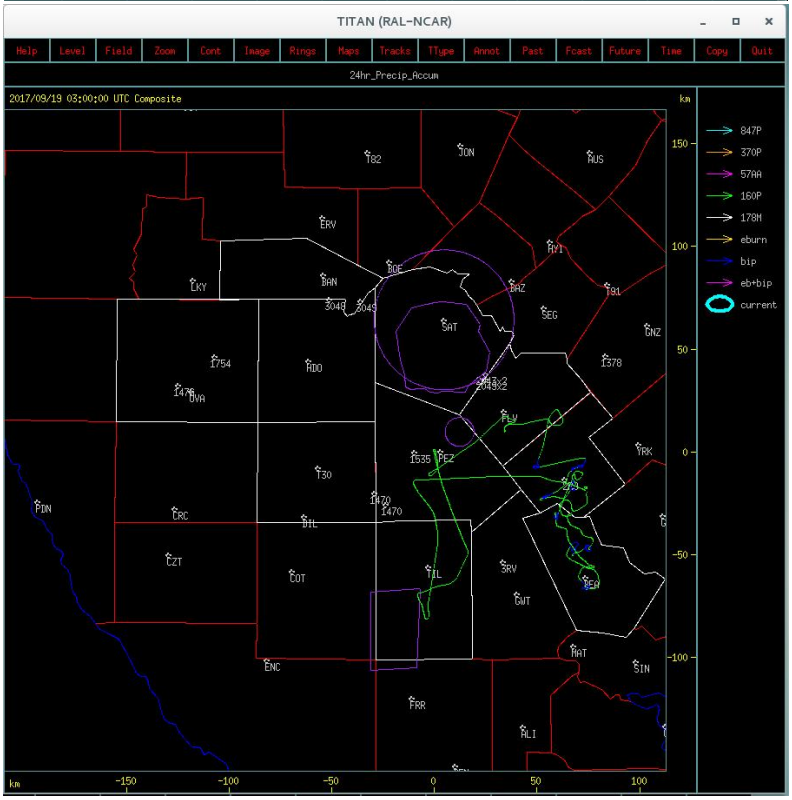
September 5, 2017



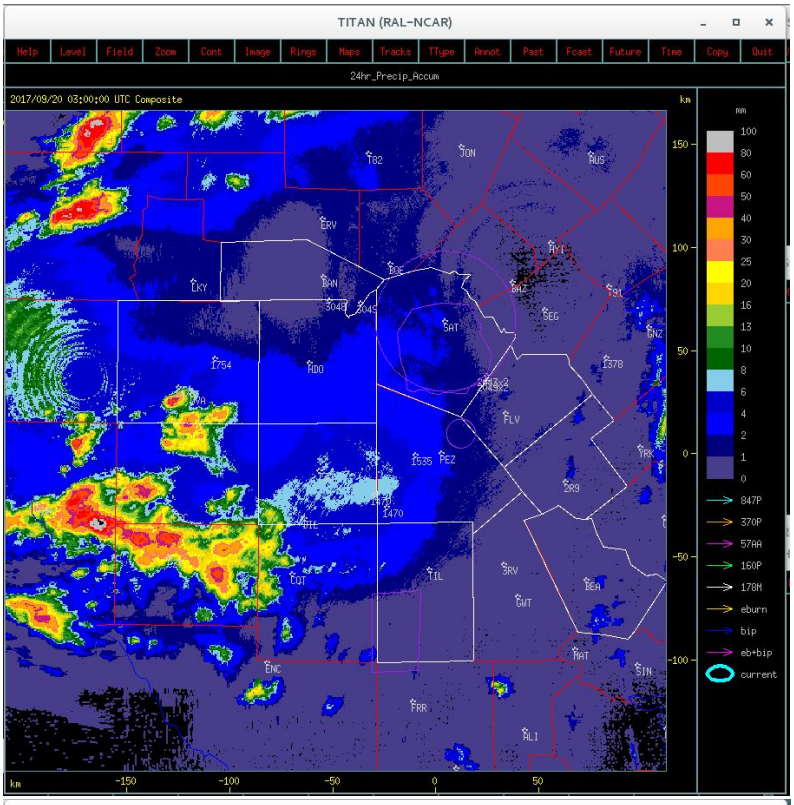


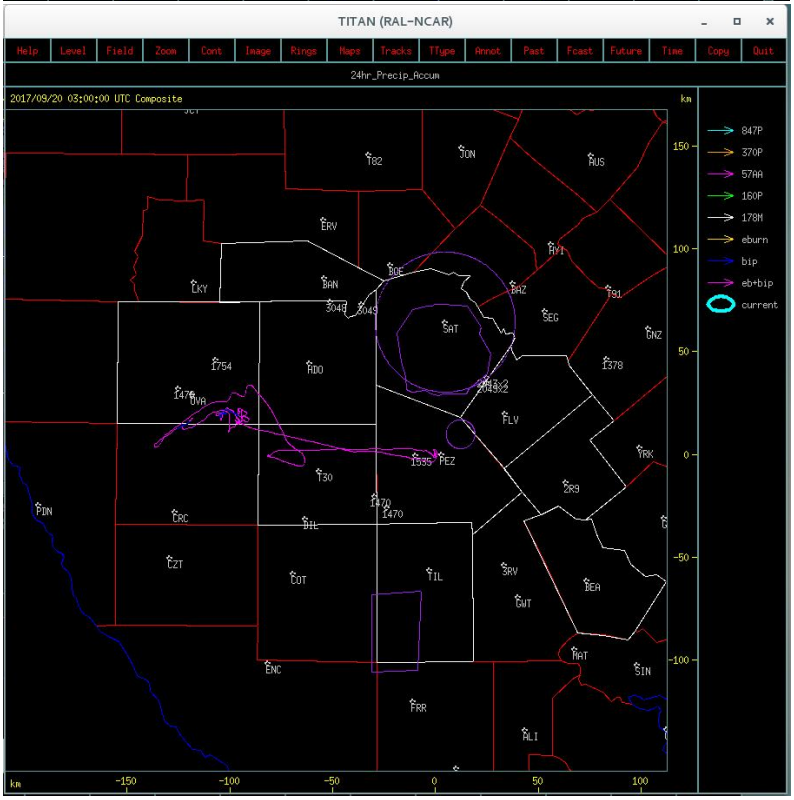
September 18, 2017



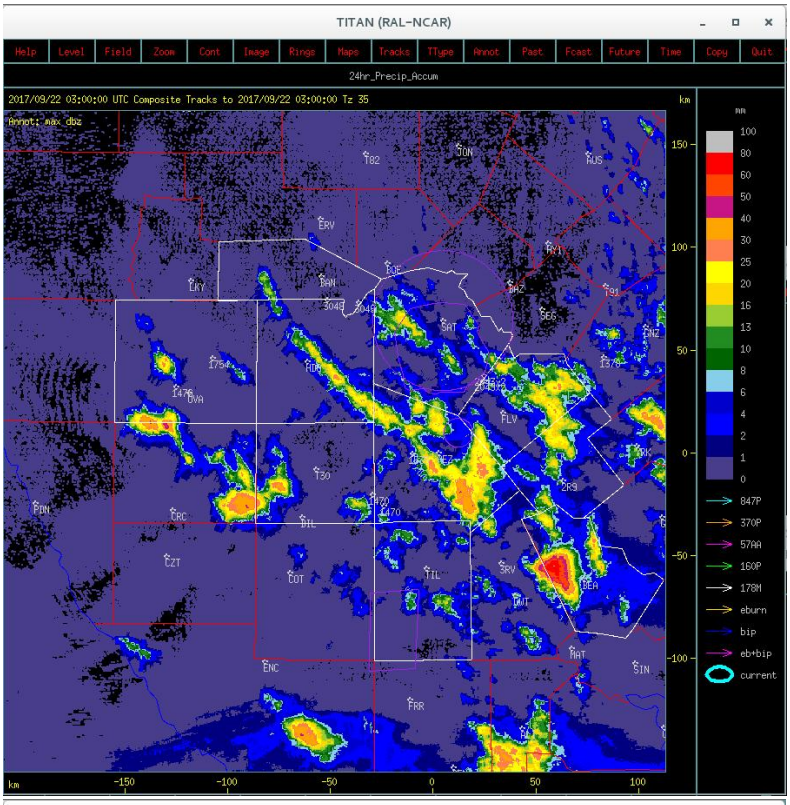


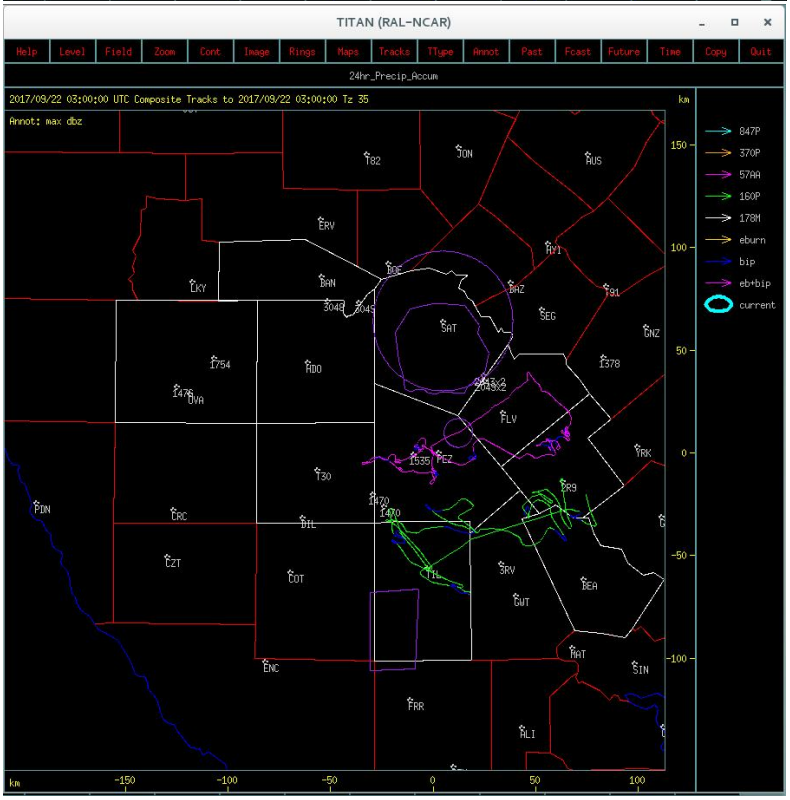
September 19, 2017



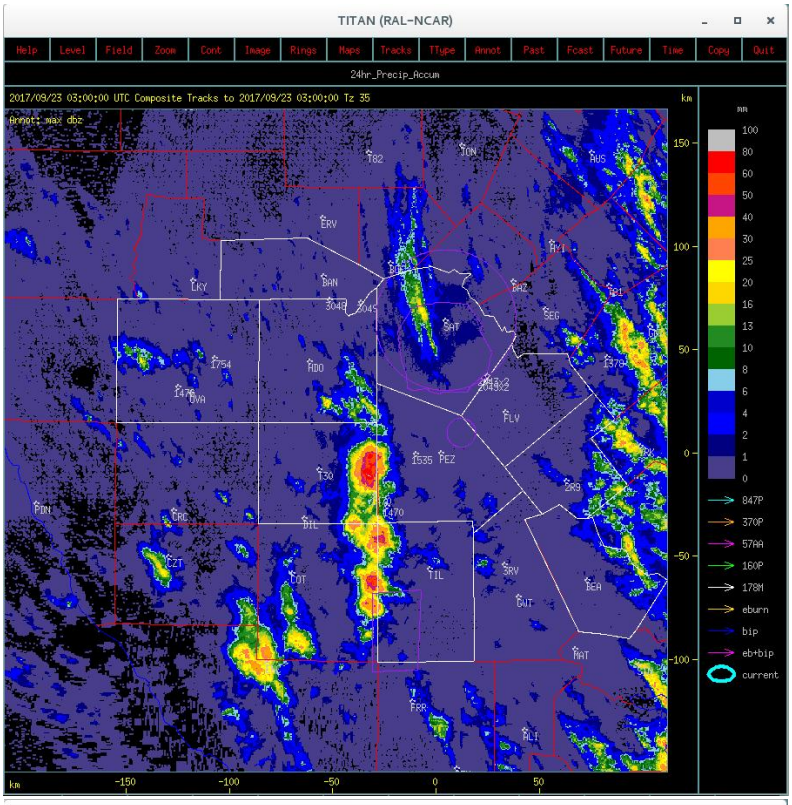


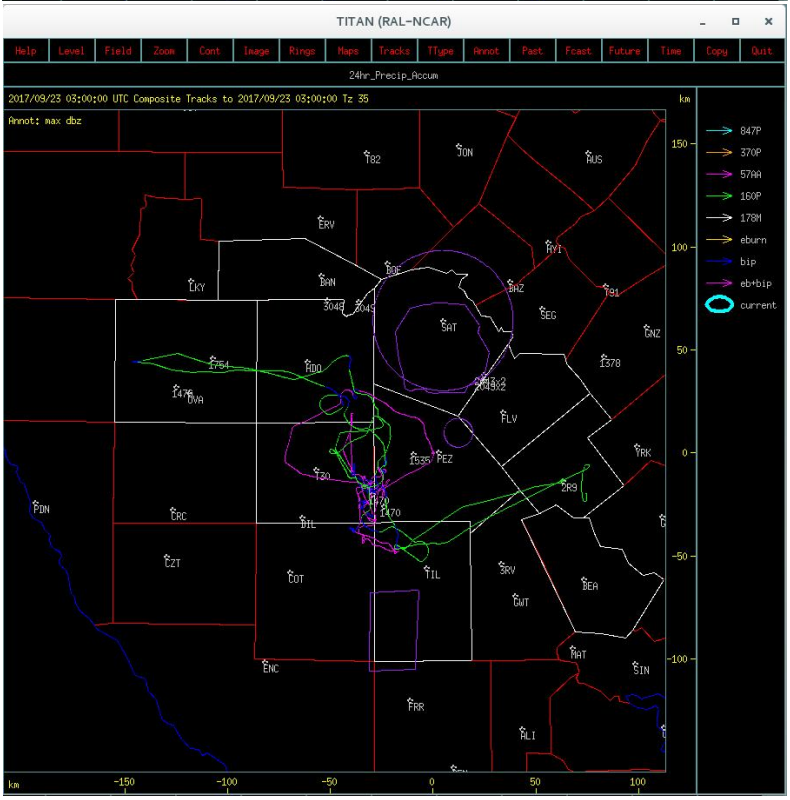
September 21, 2017



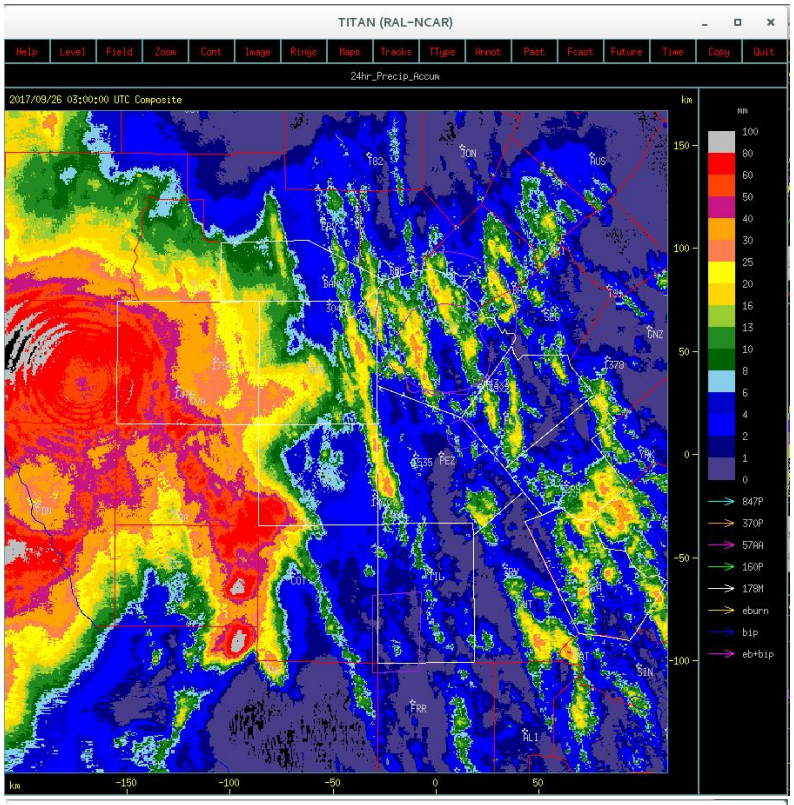


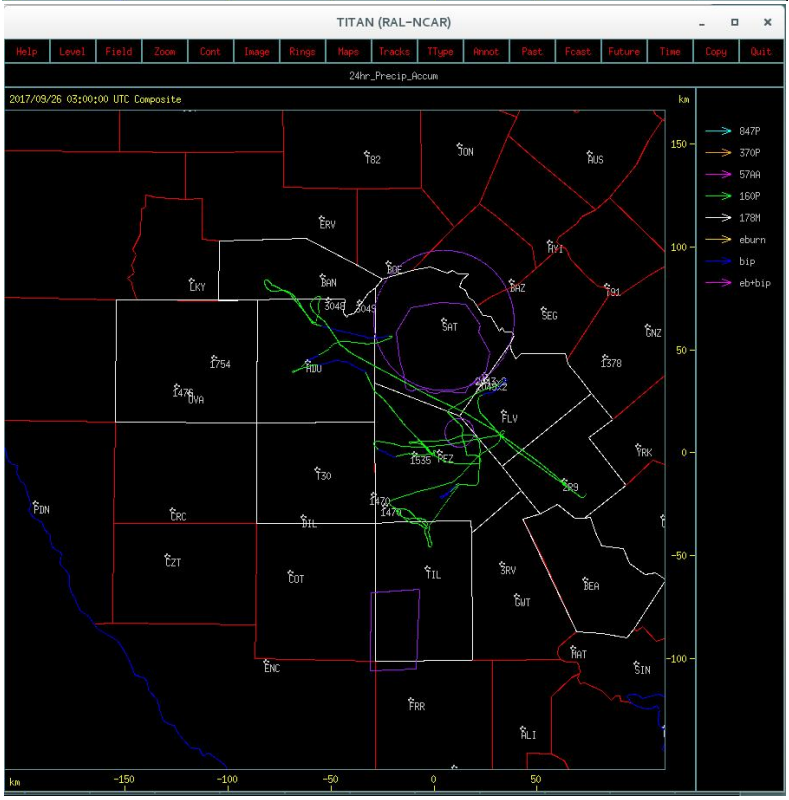
September 22, 2017



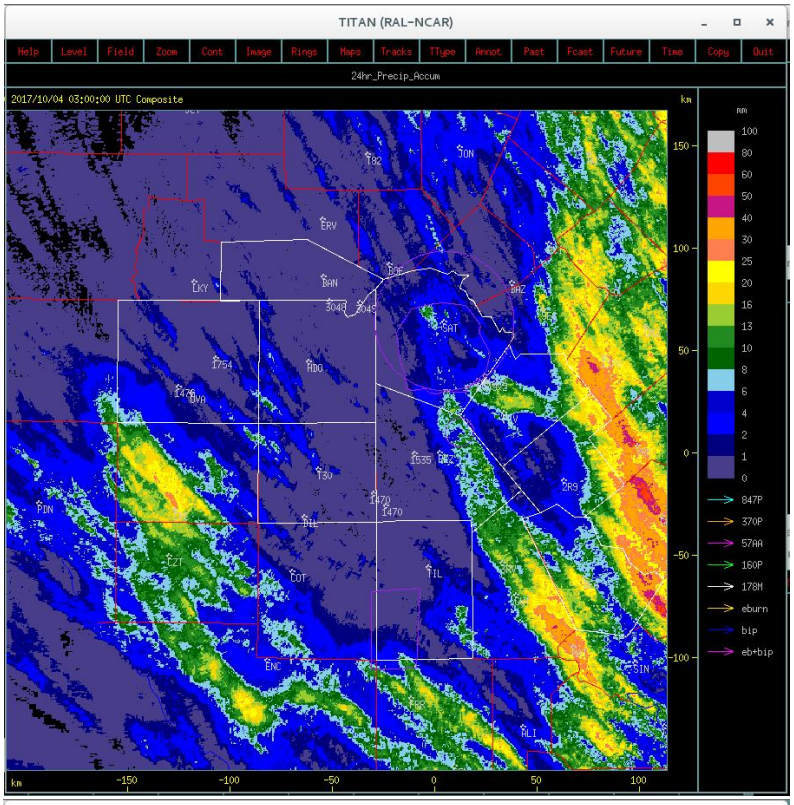


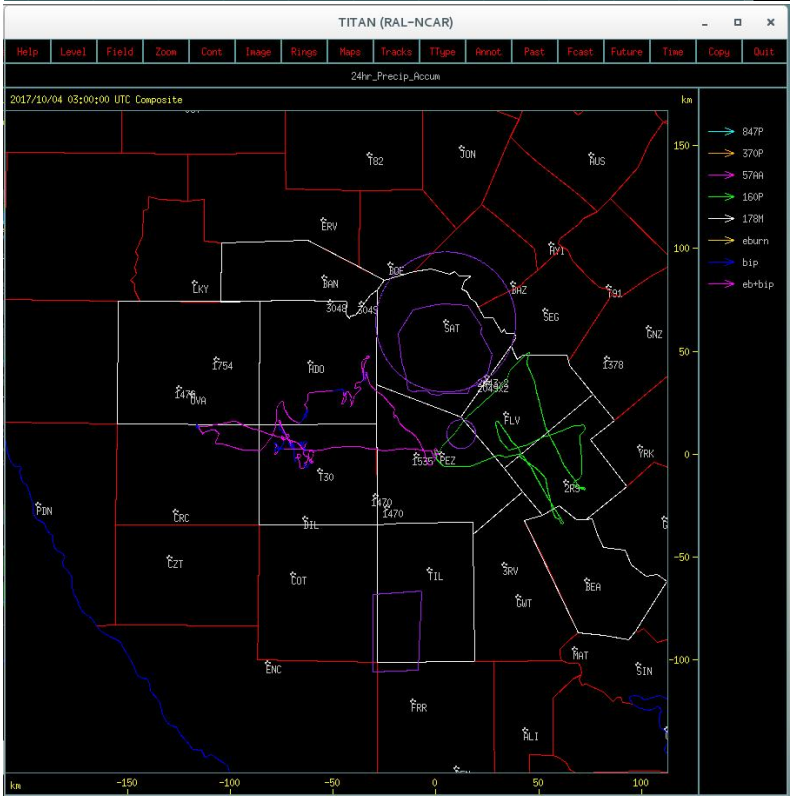
September 25, 2017





October 3, 2017

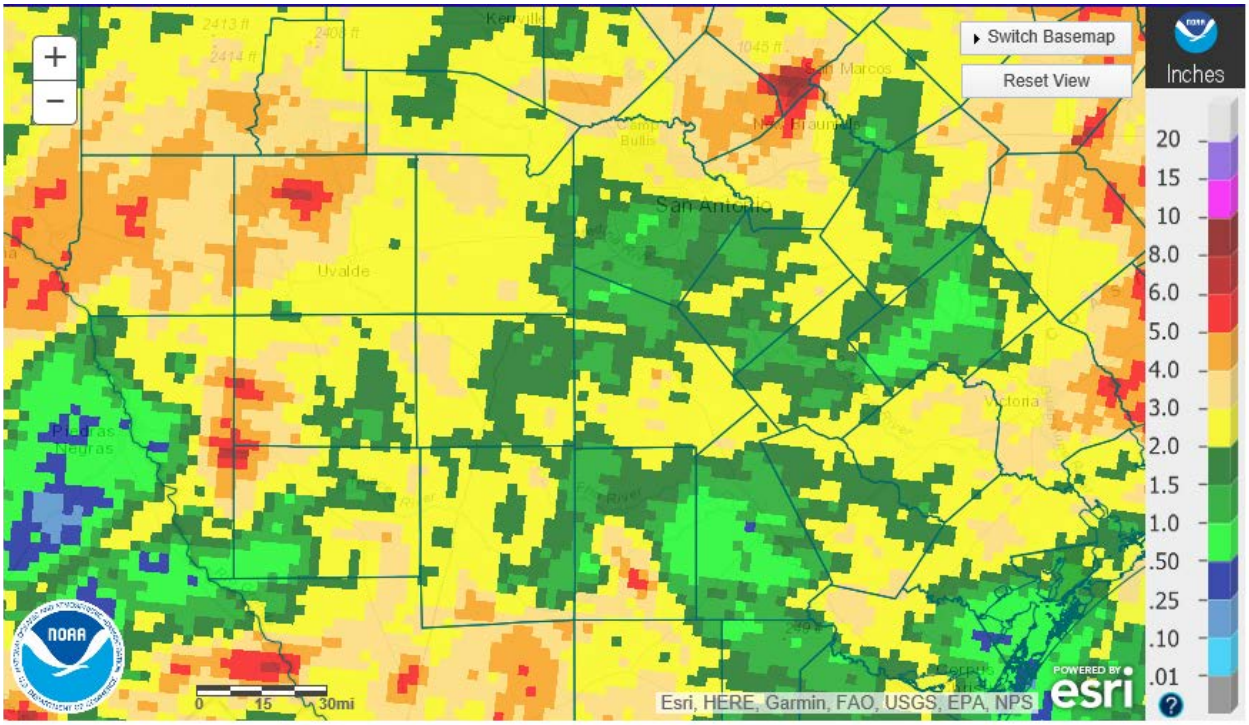




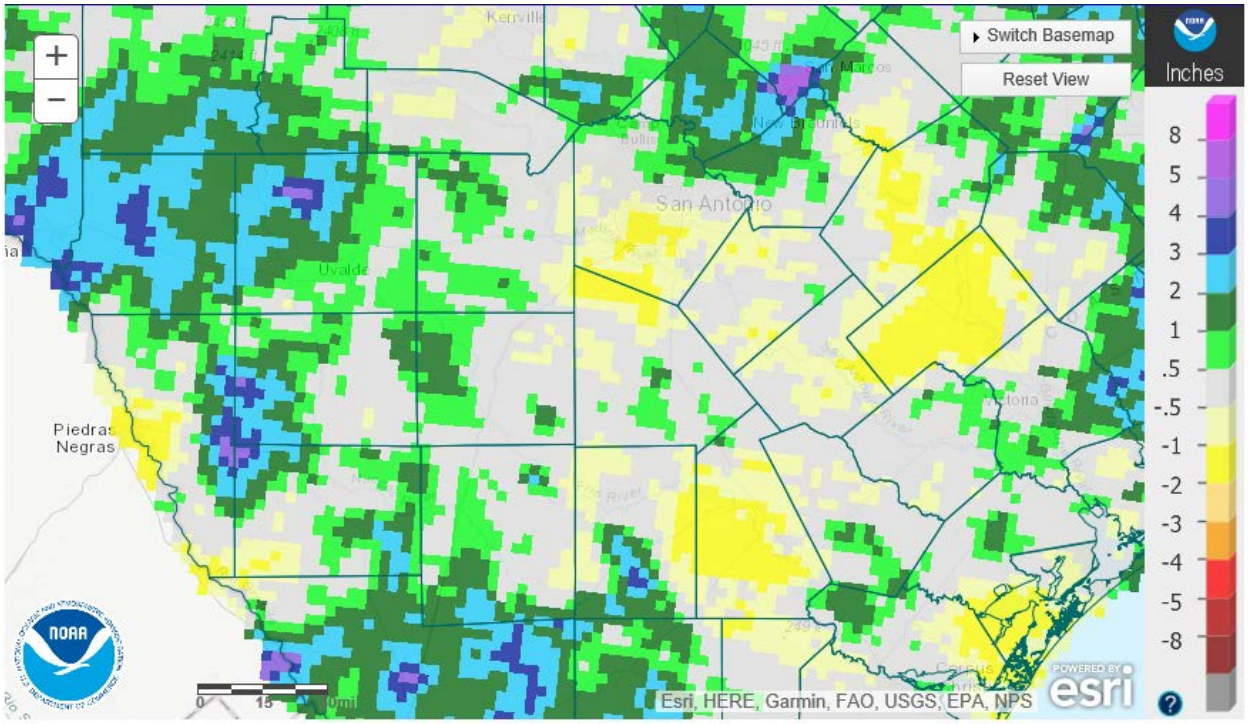
Monthly Rainfall Images: Observed and Departure from Normal Precipitation

April 2017[1]

Observed Precipitation (Inches)

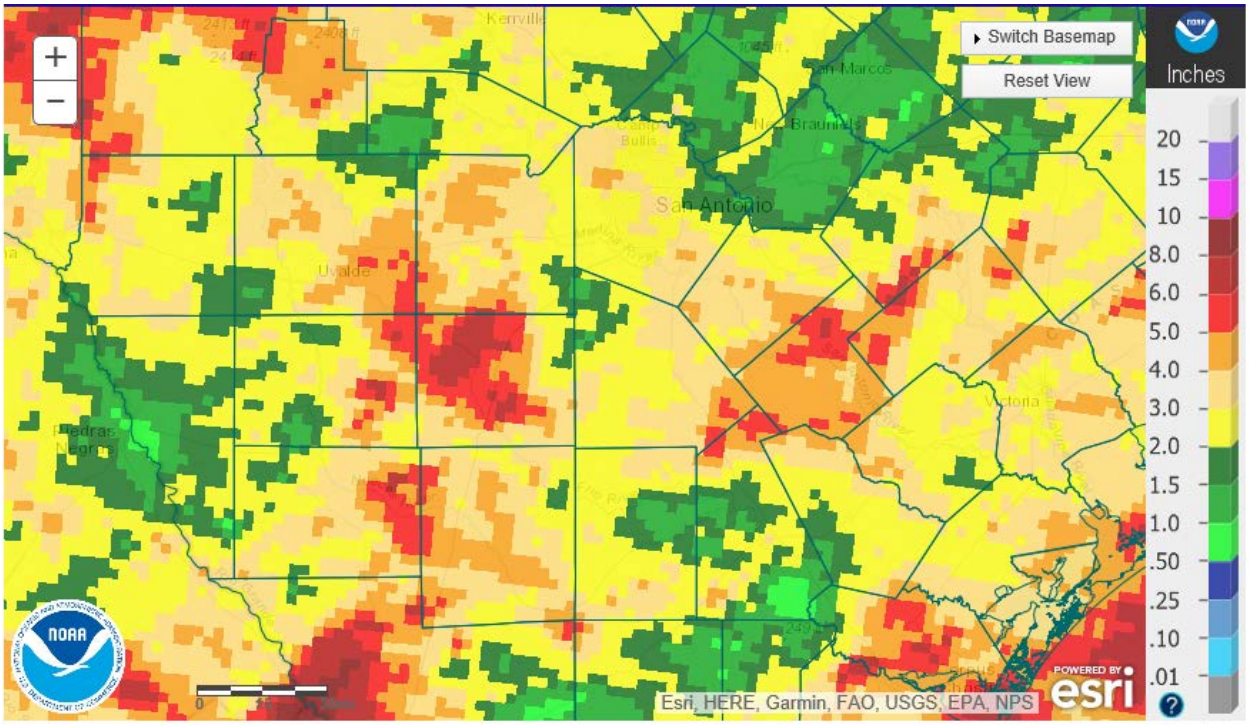


Departure from normal (inches)

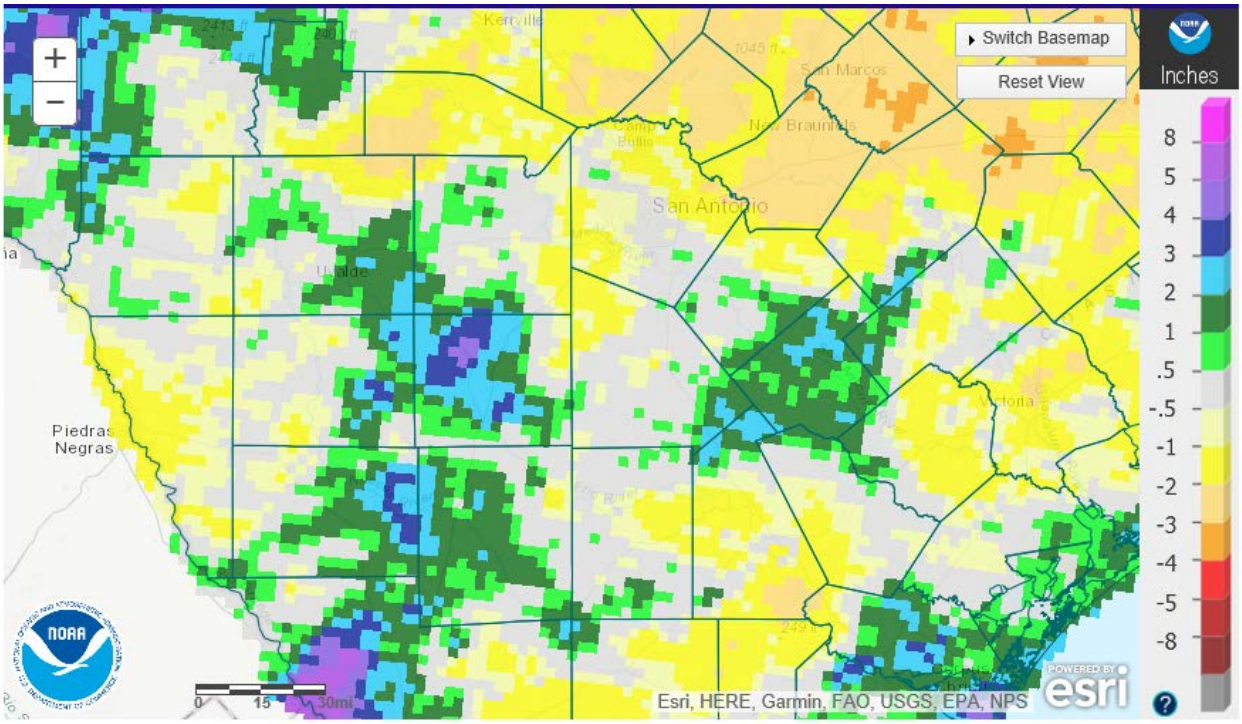


May 2017[1]

Observed Precipitation (Inches)

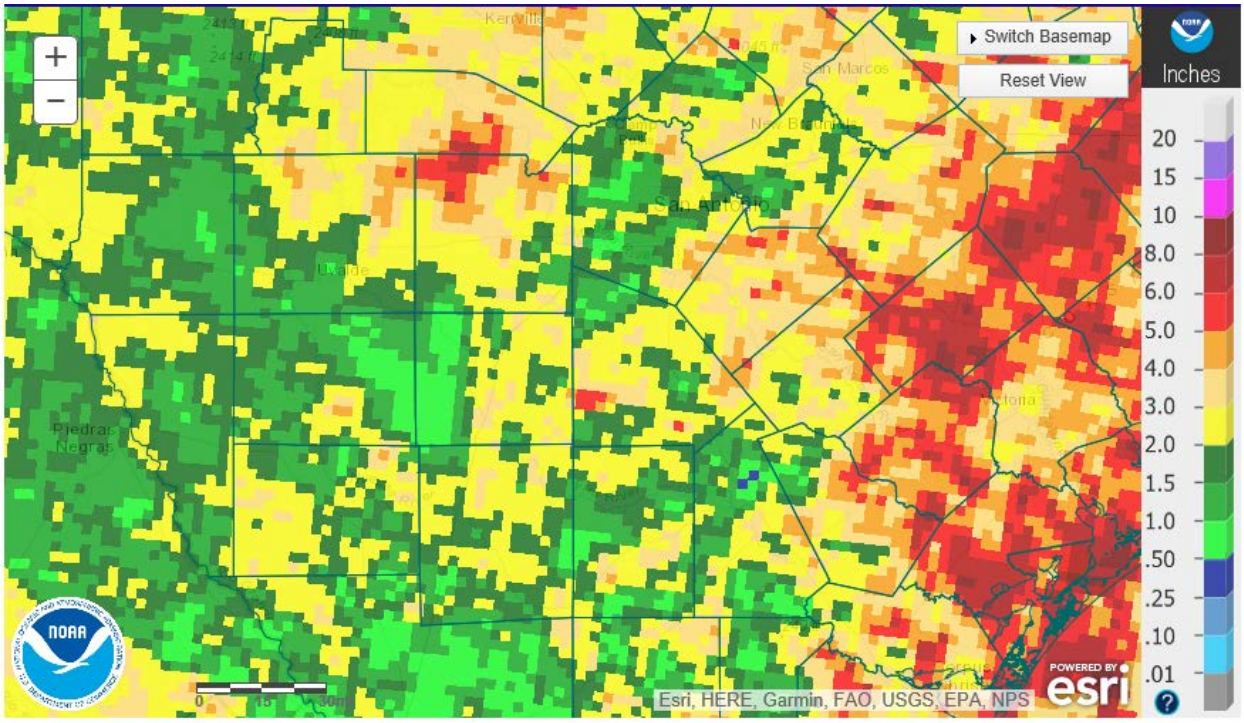


Departure from normal (inches)

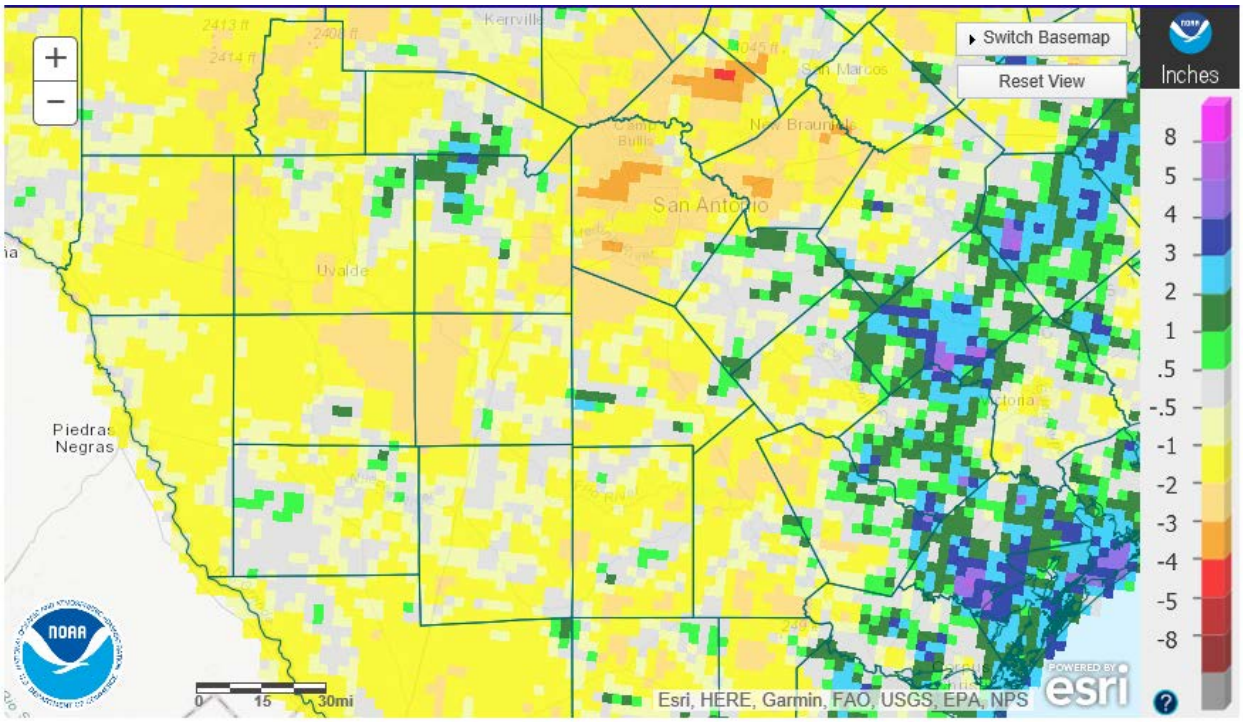


June 2017[1]

Observed Precipitation (Inches)

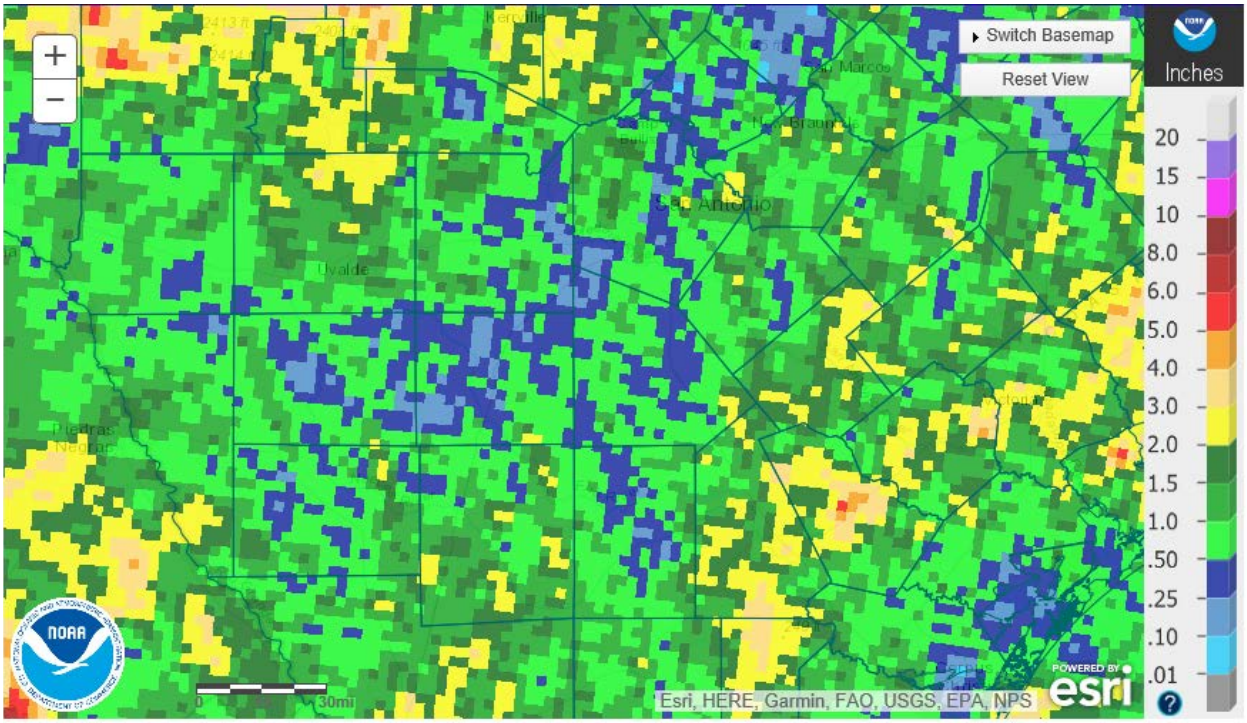


Departure from normal (inches)

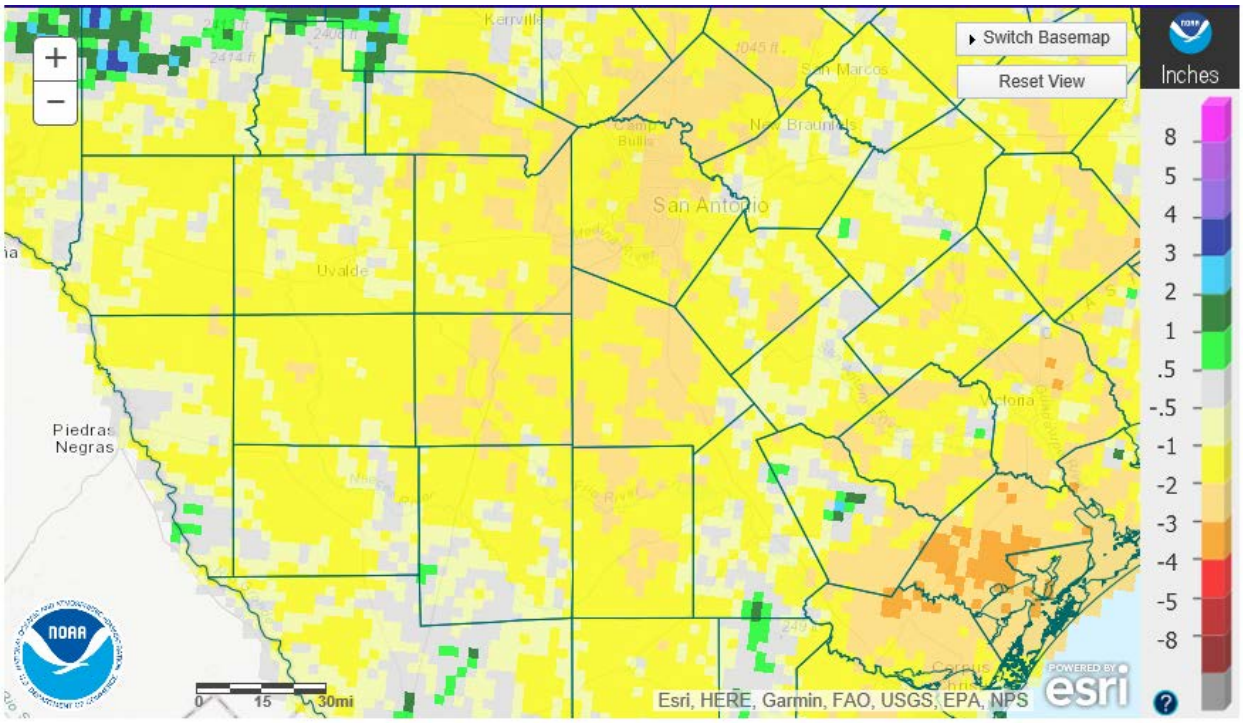


July 2017[1]

Observed Precipitation (Inches)

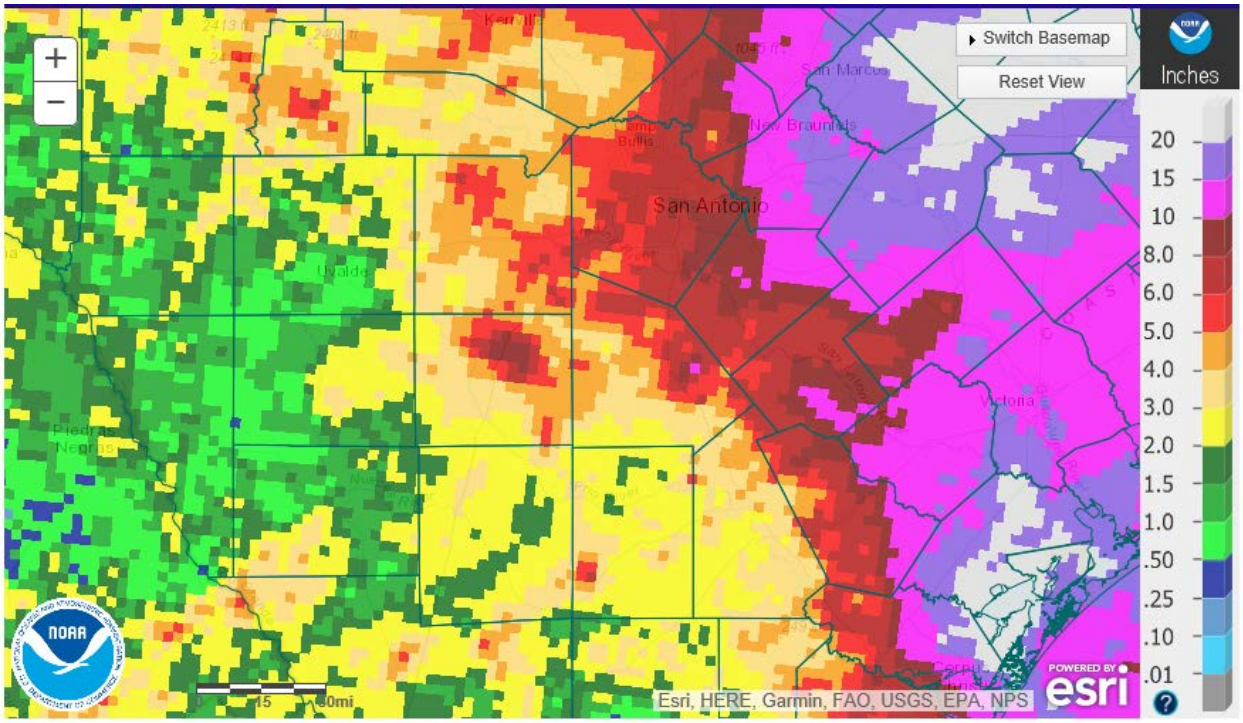


Departure from normal (inches)

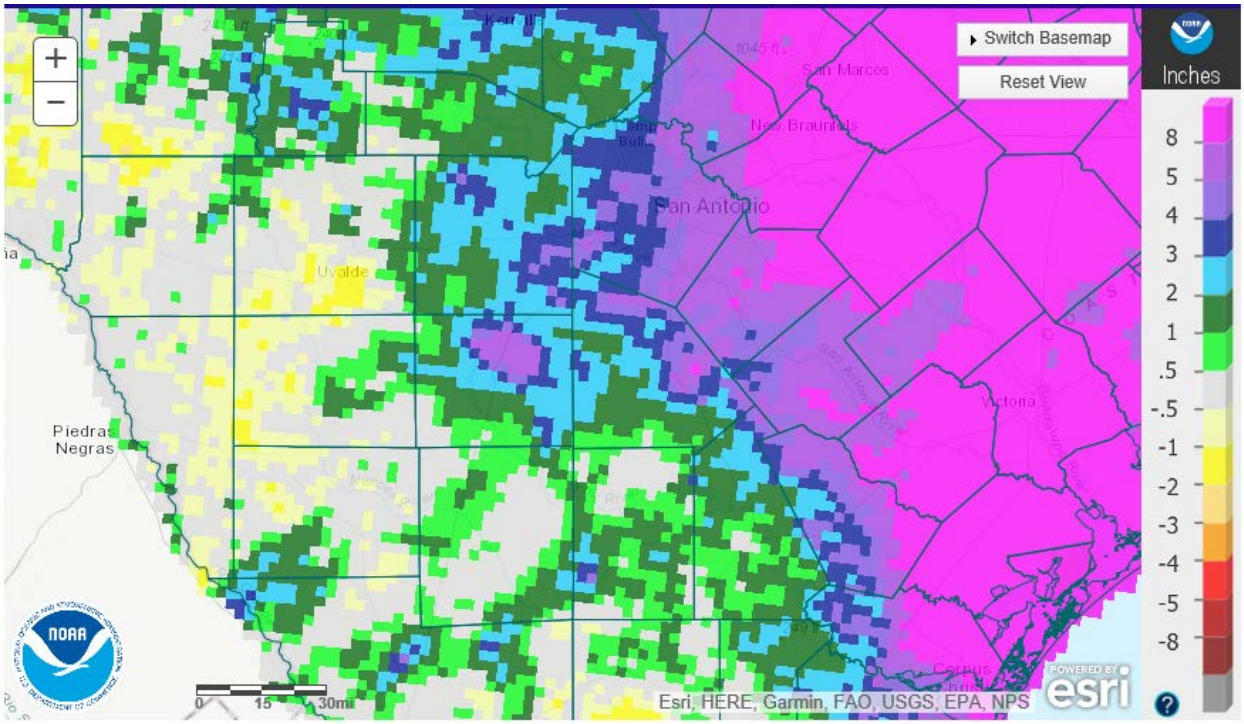


August 2017[1]

Observed Precipitation (Inches)

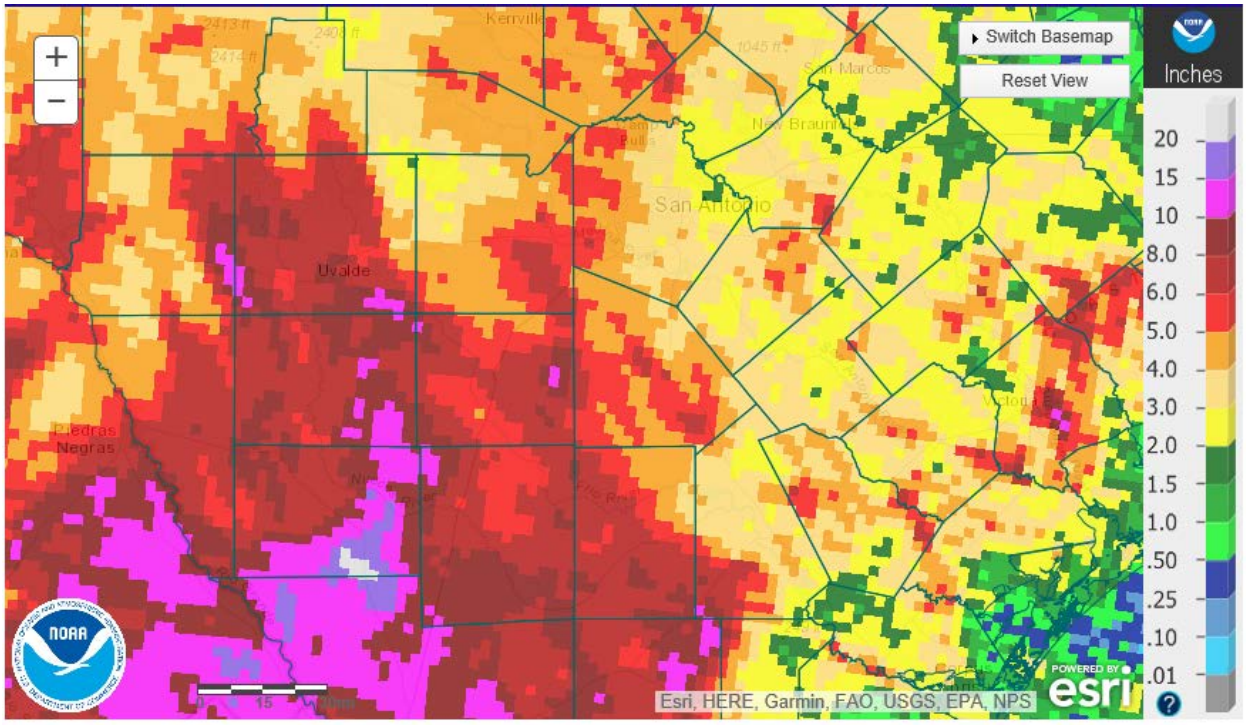


Departure from normal (inches)

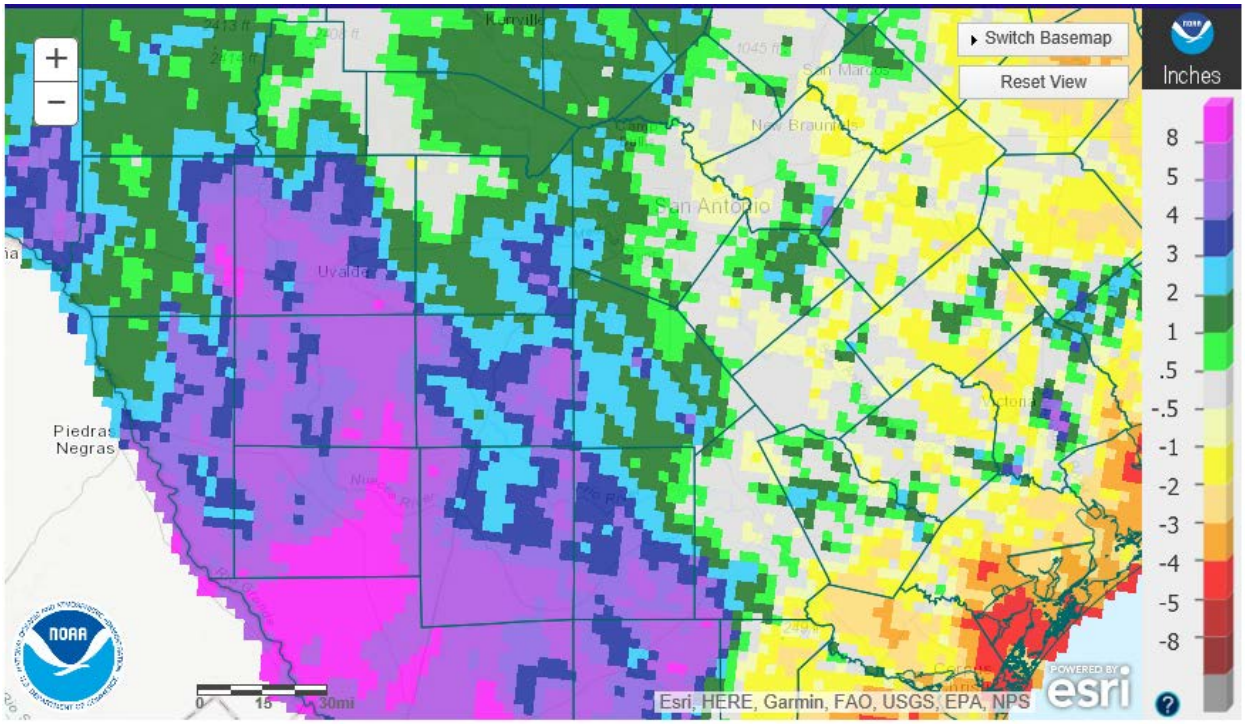


September 2017[1]

Observed Precipitation (Inches)

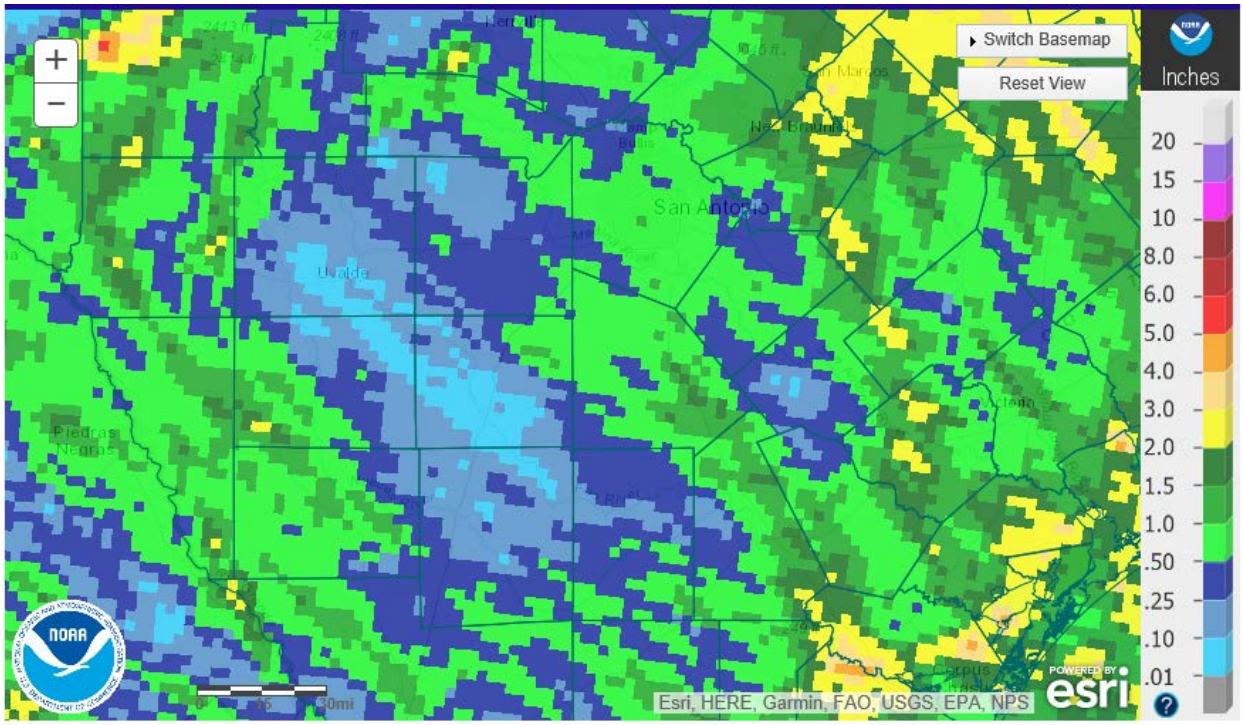


Departure from normal (inches)

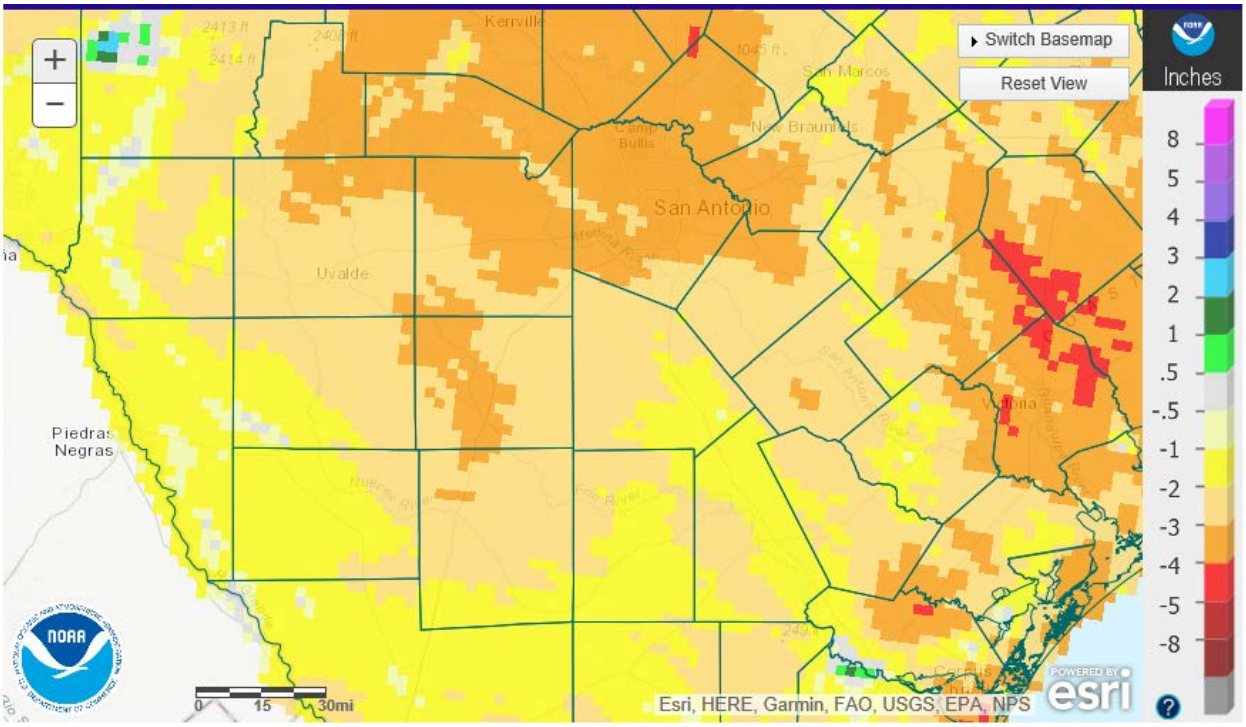


October 2017[1]

Observed Precipitation (Inches)



Departure from normal (inches)



Resources Cited

1: Advanced Hydrologic Prediction Service, Quantitative Precipitation Estimates. National Weather Service. National Oceanic and Atmospheric Administration. Accessed November 2016. http://water.weather.gov/precip/

2: Record of Climatological Observations per month. National Climatic Data Center. National Centers for Environmental Information. Accessed December 2017. https://www.ncdc.noaa.gov/data-access