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Consolidated Nuclear Security, LLC

The Pantex Lightning Mapping Array (LMA)

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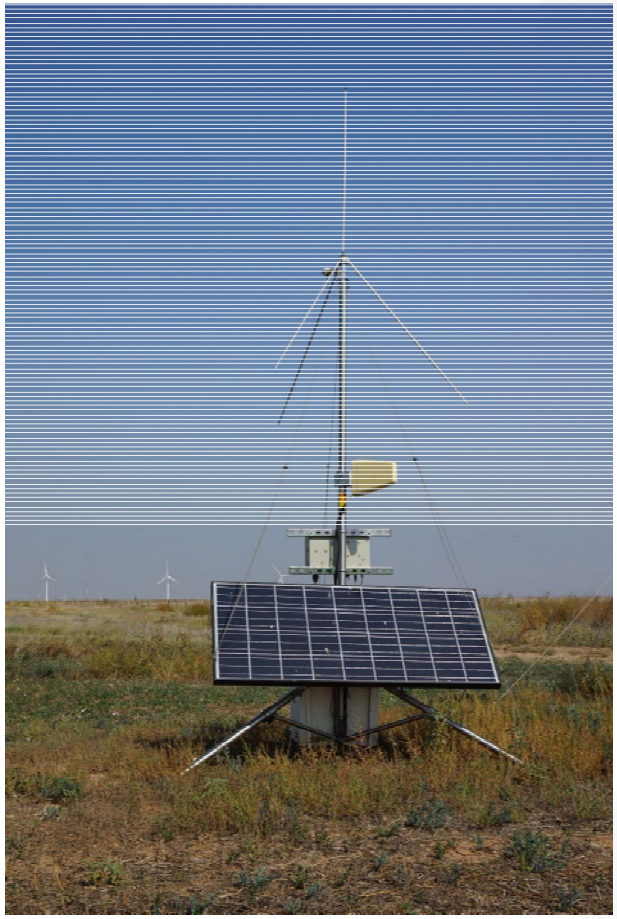
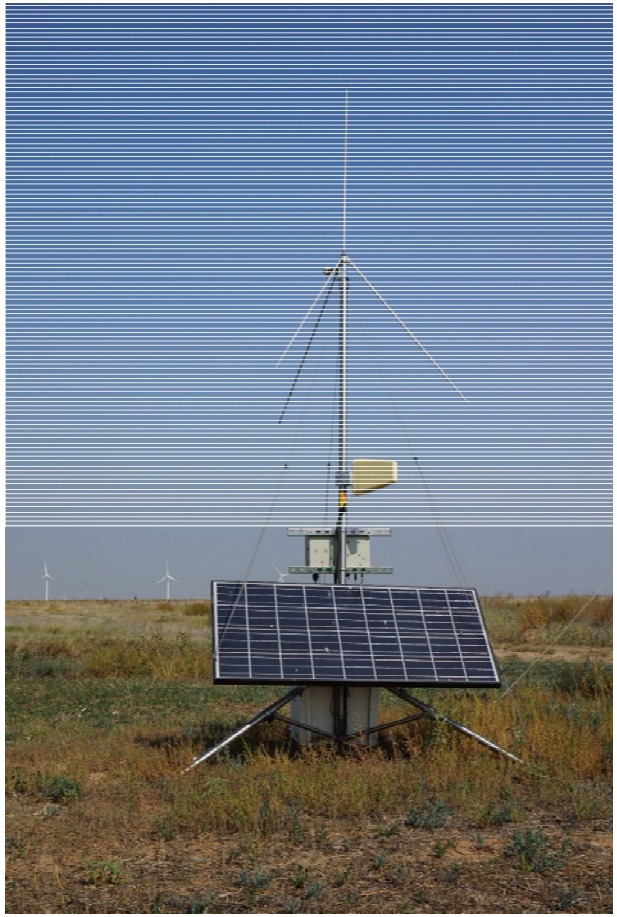
April 14, 2021

The Pantex Lightning Mapping Array



The Pantex LMA located east of the John C. Drummond Center (JCDC)

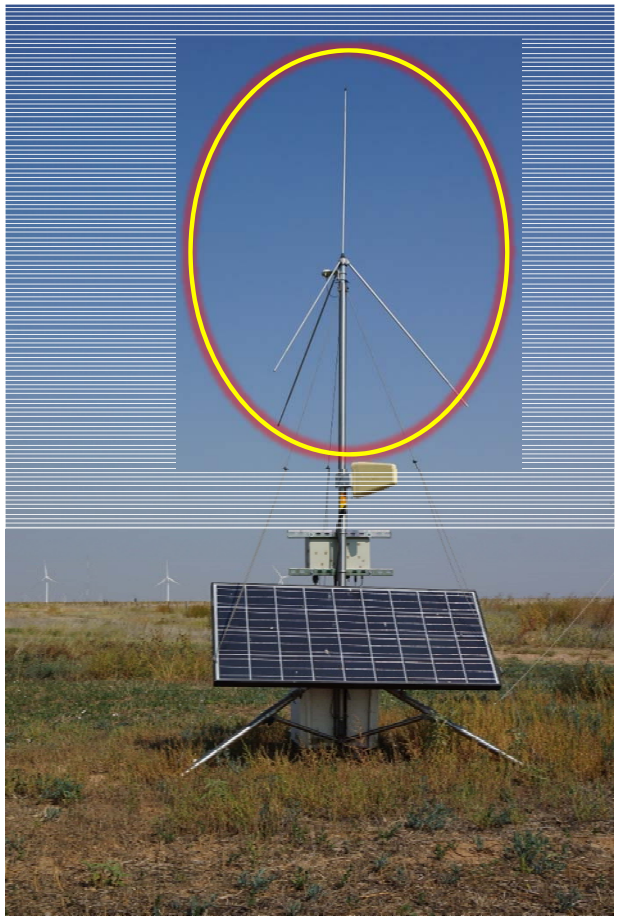
The Pantex Lightning Mapping Array



The LMA is made up of three main parts.

1) Data collection
2) Communication
3) Power & processing

The Pantex Lightning Mapping Array

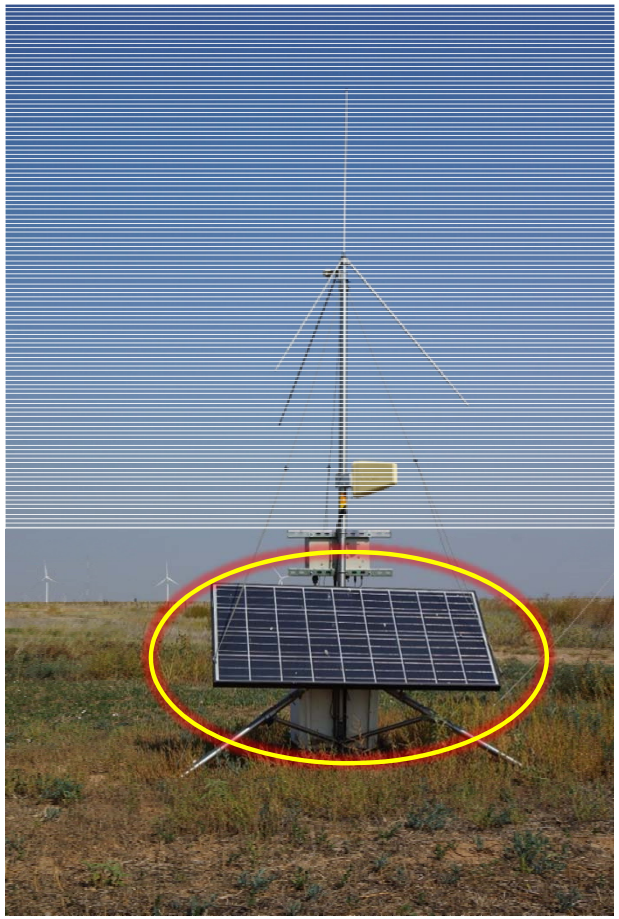


The antenna is located at the top of the LMA and is the way the device “listens” for static discharges that are occurring inside clouds.

The LMA can pick up the smallest static discharge ongoing inside developing thunderstorms that could be the precursor to a future cloud-to-cloud or cloud-to-ground lightning strike.

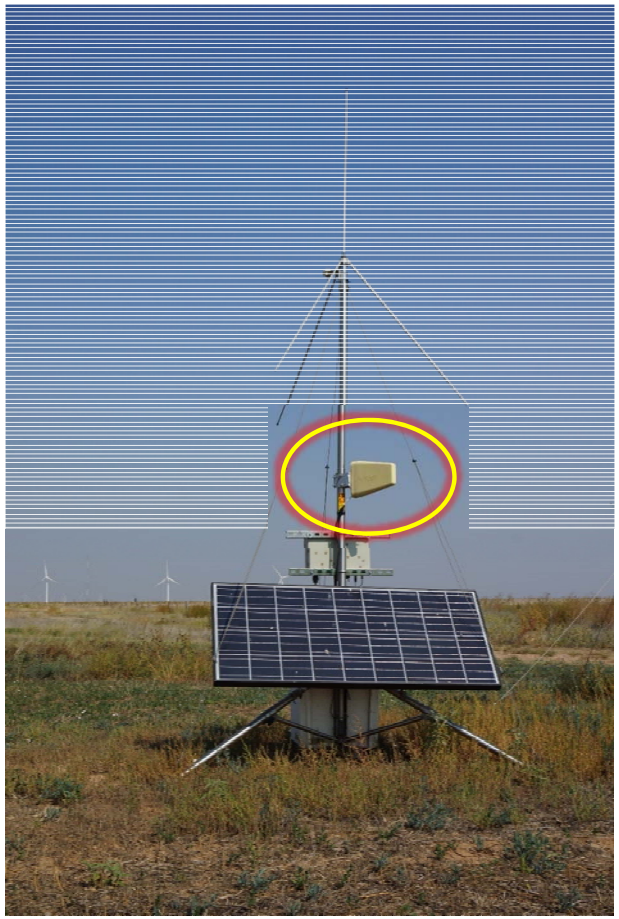
Research done at Pantex in 2020 of 20 different storms from February through November showed an average lead time of around 20 minutes from when “source densities” were detected inside developing thunderstorms over the Texas Panhandle to when the first cloud-to-cloud or cloud-to-ground lightning strike occurred.

The Pantex Lightning Mapping Array



Power for the Pantex LMA is through the solar panel, located on the front of the device. The boxes below the solar panel house the processing unit and the battery, which is connected to the solar panel.

The Pantex Lightning Mapping Array

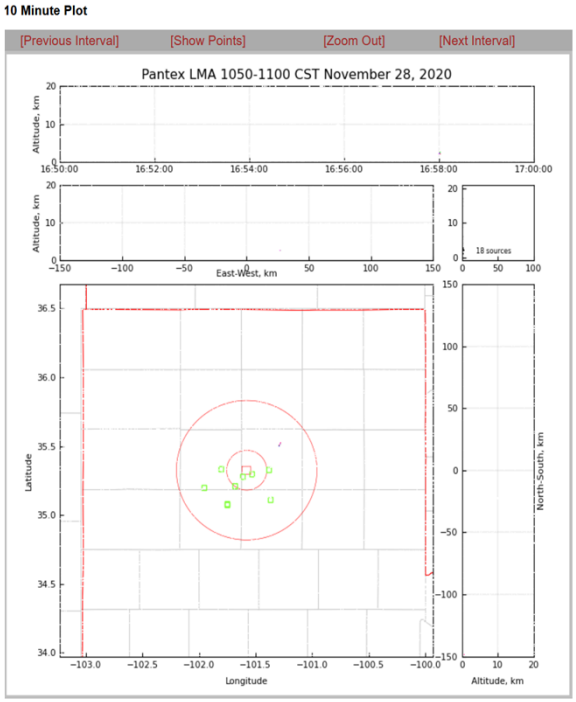


Communication occurs via the Yagi antenna that is connected to the mast. This cellular antenna sends the data from each LMA to the network hub at LMA Tech, who houses the data from Pantex's network of sensors.

This data is then displayed on Pantex's LMA website

http://www.lma-tech.com/pntxlma

The Pantex Lightning Mapping Array Website

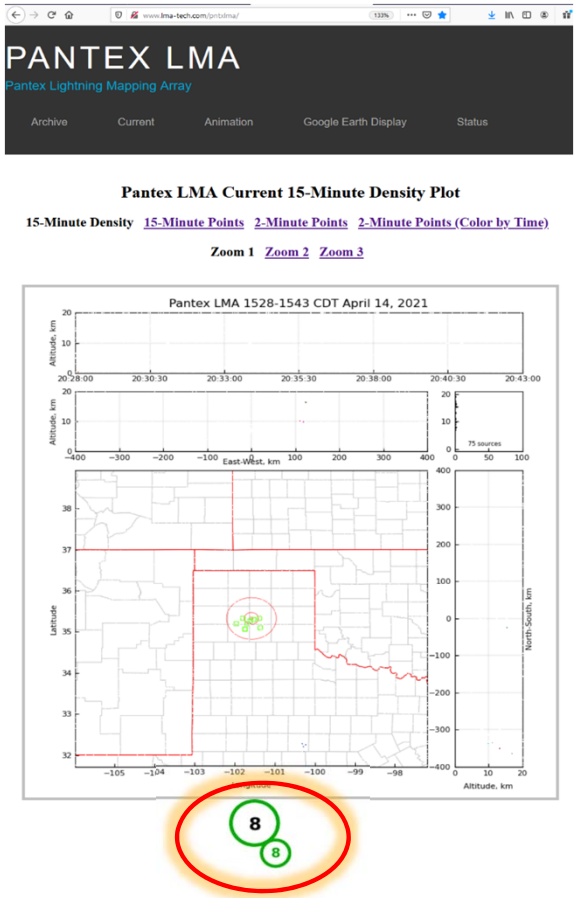


http://www.lma-tech.com/pntxlma

Through this website, you can access the Pantex LMA's data.

When you first pull the site up, there are some things you will notice immediately.

The Pantex Lightning Mapping Array Website



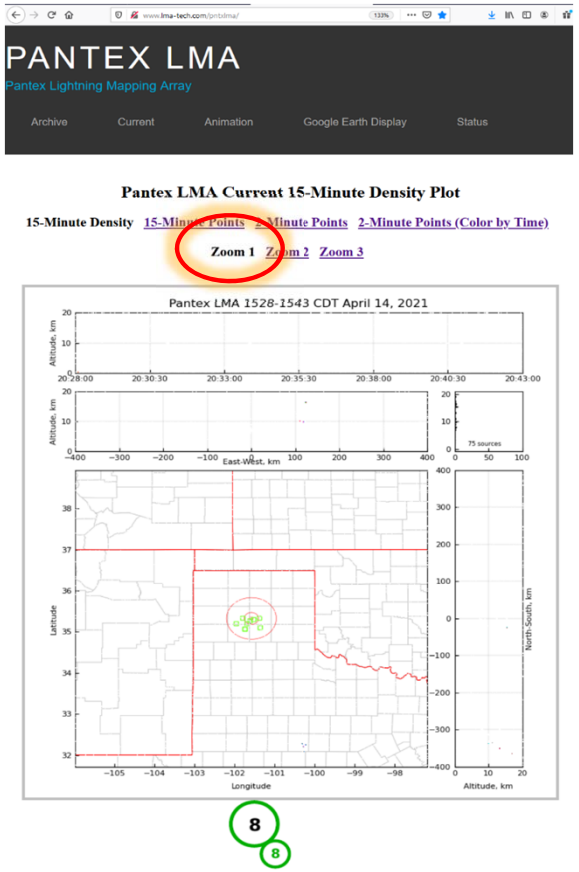
http://www.lma-tech.com/pntxlma

The first thing to take note of are the colored circles at the bottom or the right of the map (depending on whether or not you are viewing the LMA vertically or horizontally on your monitor)

The top number shows how many sensors are currently deployed on the Pantex LMA. As of this presentation, we have 8 LMA sensors that make up our network. We are looking to expand the network to as many as 18 sensors over the next year or so.

The bottom number shows how many sensors are currently sending data to the LMA data hub. The minimum number of sensors to collect “quality data” is 7. The color of the circles will stay green until the number of sensors currently sending data drops to 6, then it turns yellow. If that number drops to 4, the color turns red. So, the data is considered “quality” at 7 or above.

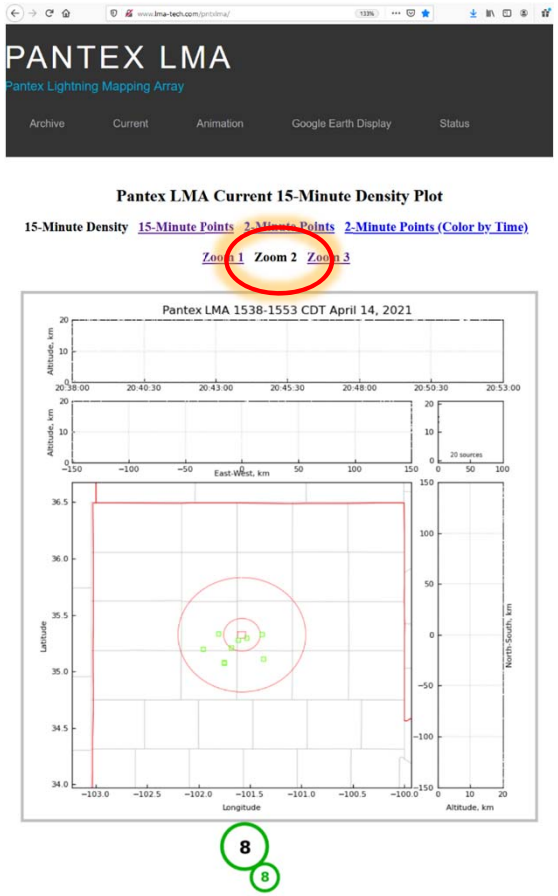
The Pantex Lightning Mapping Array Website



http://www.lma-tech.com/pntxlma

When you first load the Pantex LMA, it defaults to “Zoom 1”, which is a map showing a roughly 250-300 mile radius around Pantex.

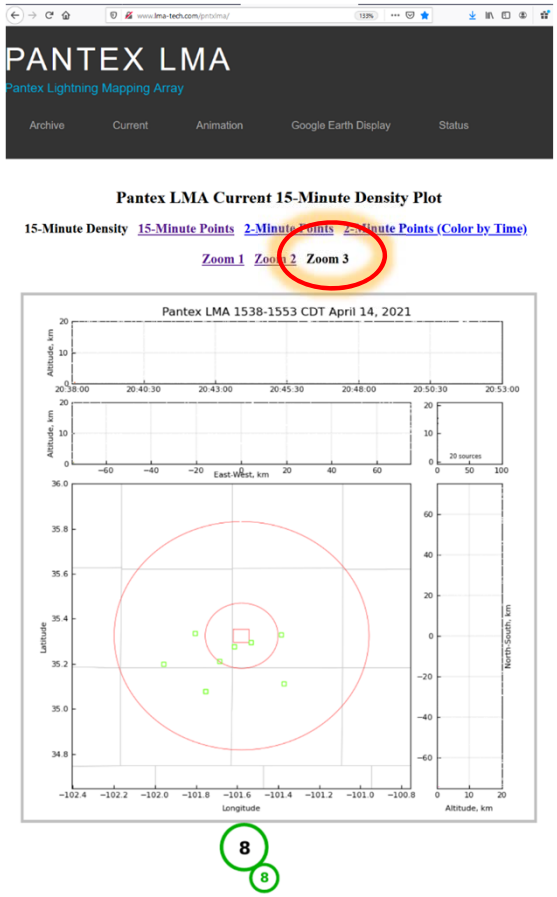
The Pantex Lightning Mapping Array Website



http://www.lma-tech.com/pntxlma

If you click on “Zoom 2”, the map changes to a closer, roughly 100-125 mile radius map of Pantex. This covers the entire Texas Panhandle and small parts of the Oklahoma Panhandle and Eastern New Mexico.

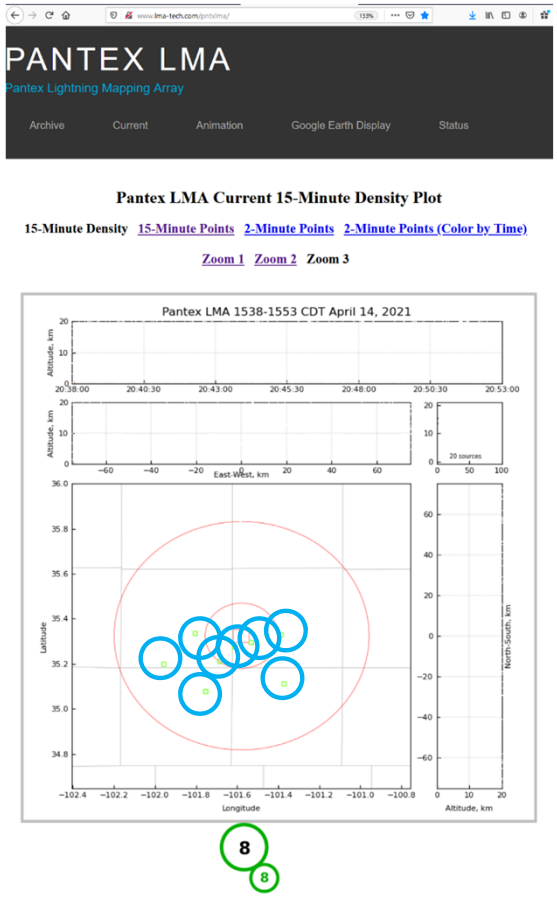
The Pantex Lightning Mapping Array Website



http://www.lma-tech.com/pntxlma

If you click on “Zoom 3”, the map gets even closer and shows a map that is roughly a 50 mile radius map from Pantex.

The Pantex Lightning Mapping Array Website



http://www.lma-tech.com/pntxlma

The green squares (circled in blue circles) on this map, indicate the location of the individual Pantex LMA stations. They are clustered together to help with the triangulation of the data collected by each sensor.

As more LMA sites are added to the network, more green circles will show up on the map.

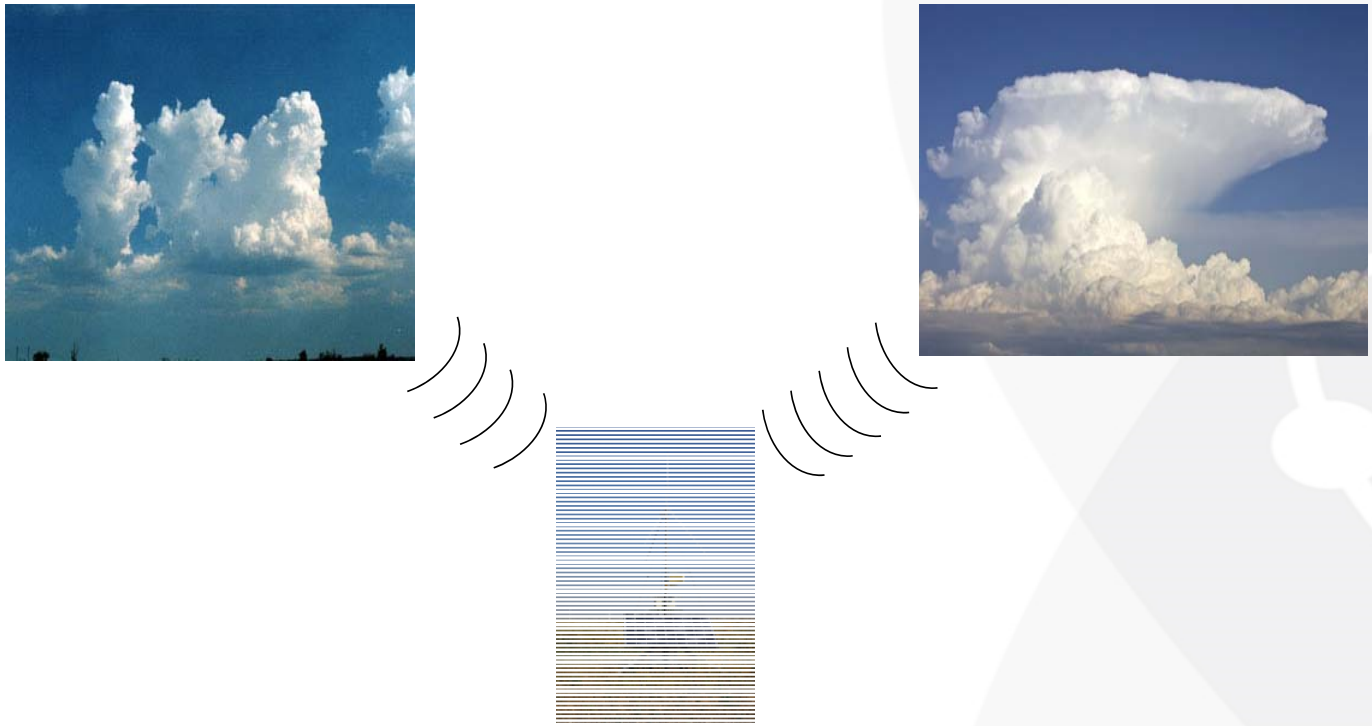
How The Pantex LMA Works

As clouds develop vertically and continue to push higher and higher into the atmosphere, the water droplets freeze and become graupel. The graupel collides with each other, helping to produce “static discharges” inside the cloud, which can be precursors to a cloud-to-cloud or cloud-to-ground lightning strike.

How The Pantex LMA Works

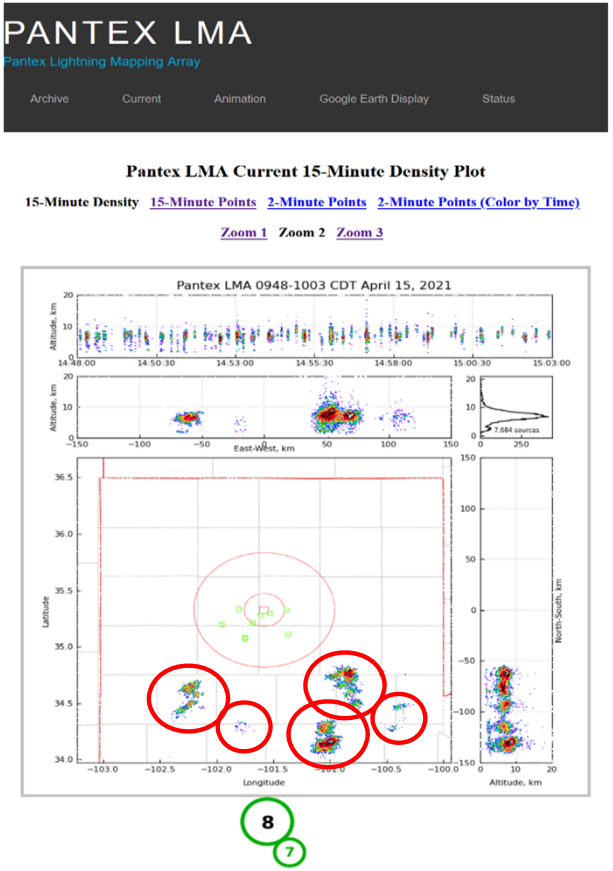
These “static discharges” can be “heard” by listening to an AM radio station (or tuning between AM radio stations) when thunderstorms are present or ongoing. Not all of the “static” that you hear on the AM radio are lightning strikes, most are static discharges coming from the clouds!

The Pantex Lightning Mapping Array



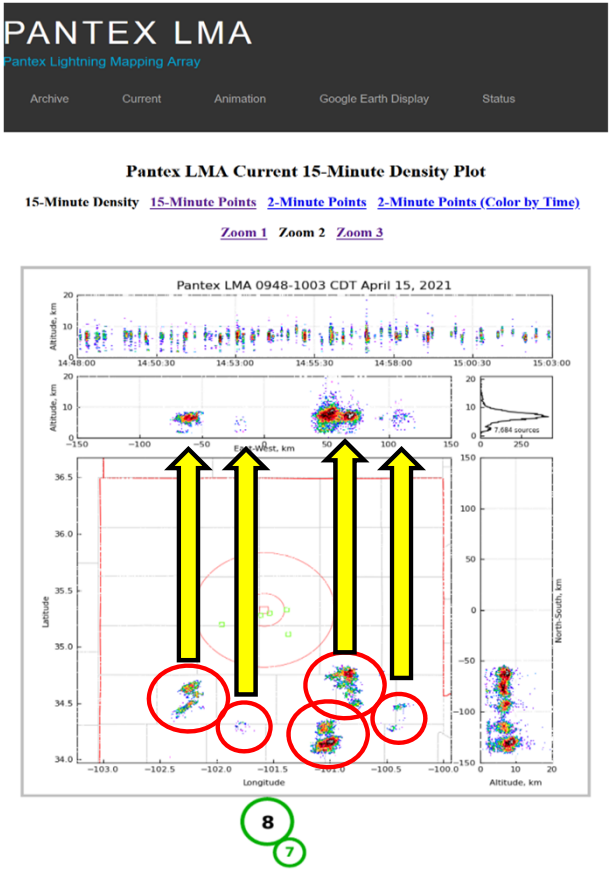
So, in essence, the Pantex LMA sits and “listens” for those static discharges and if there are a lot of them in a small, confined area (called a source density), it displays those on the Pantex LMA map.

How The Pantex LMA Works



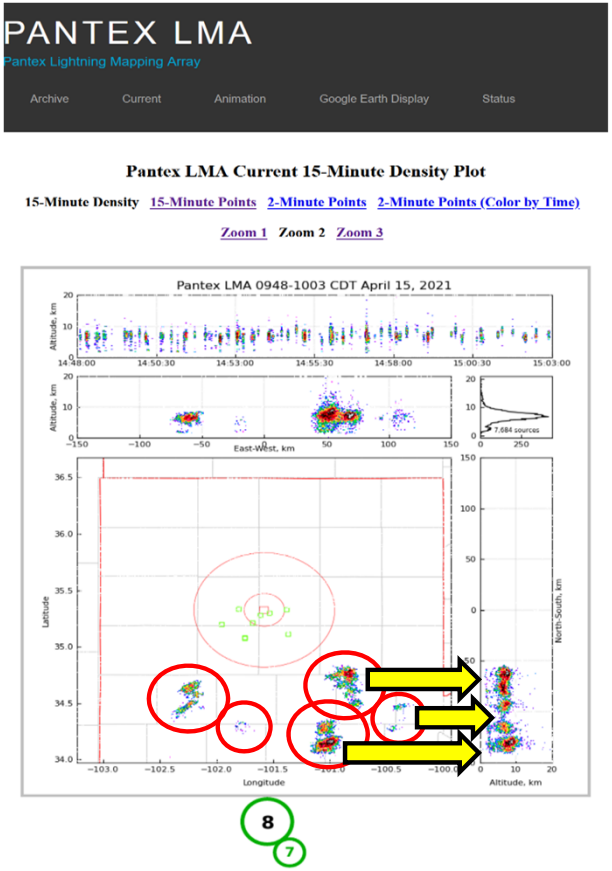
Here's what the "source densities" look like when plotted on the Pantex LMA map. When this snapshot was taken on the morning of April 15, 2021, we had an area of showers and thunderstorms over the southern Texas Panhandle. The "brighter colors" of red, yellow and white indicate very high source density areas.

How The Pantex LMA Works



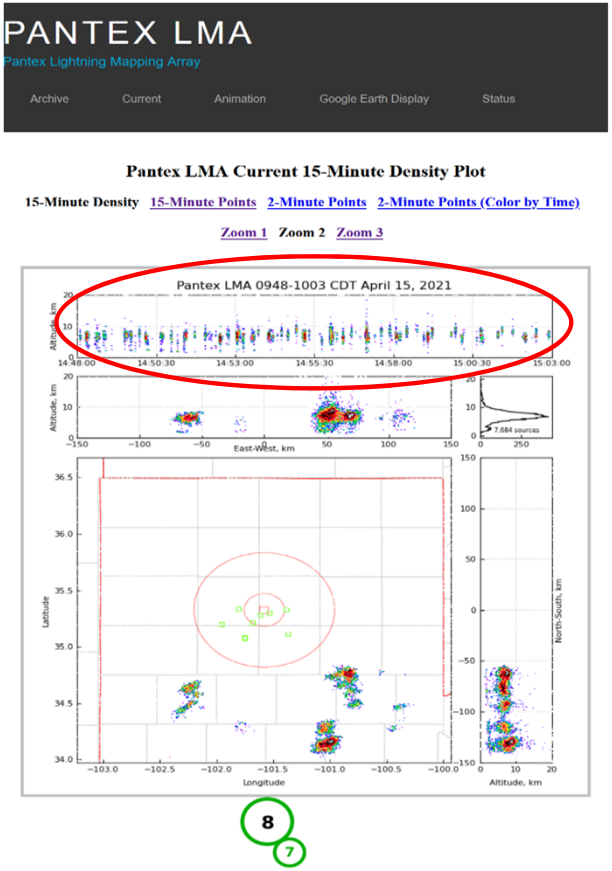
The source densities can be seen on a vertical scale as well, which lies just above the LMA map. The altitude scale is in kilometers, but will show you the height of the static discharges coming from the clouds.

How The Pantex LMA Works



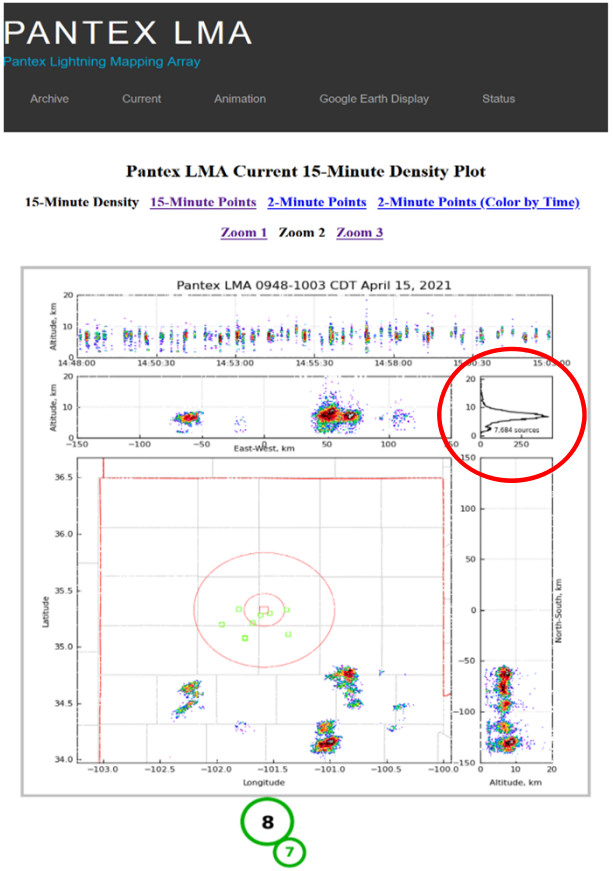
The source densities can be seen on a horizontal scale, which lies to the right of the LMA map. It shows how far away from Pantex the storms are located, in kilometers.

How The Pantex LMA Works



The scale just below the time, date and year of the data is the horizontal time scale. As source densities occur, this scale shows how many occurred and at what time. The oldest data is on the left with the newest data on the right.

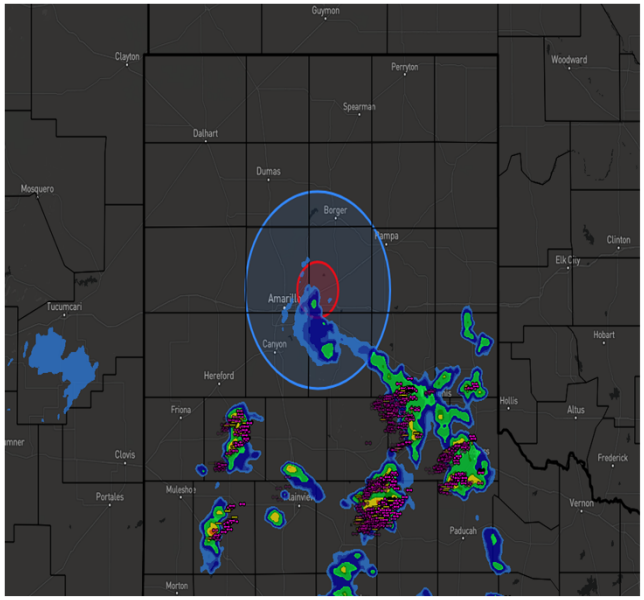
How The Pantex LMA Works



Lastly, the graph circled in red shows how many source densities were detected by the LMA over the last 15 minutes.

On this particular map, over 7,000 source densities were detected over the last 15 minutes!

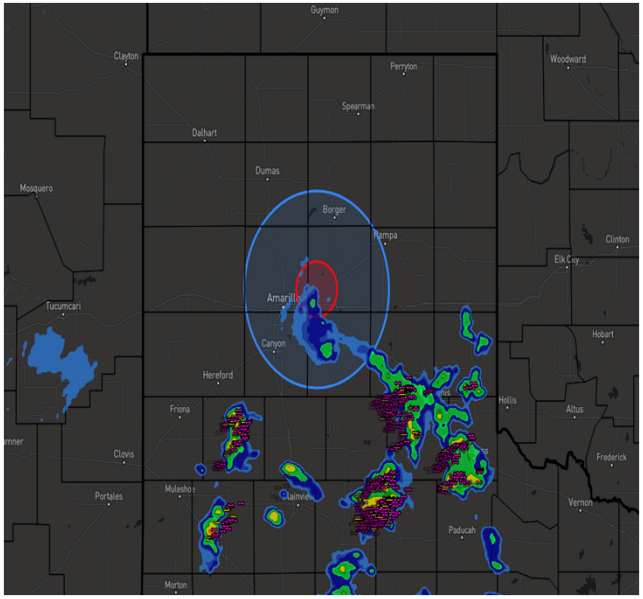
How The Pantex LMA Works

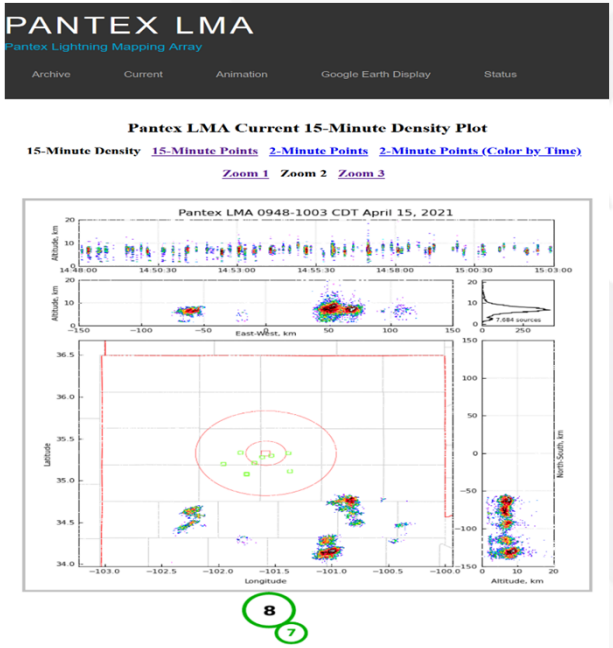


Let’s compare the Pantex LMA data to the CQ’d composite reflectivity from the KAMA WSR-88D with the Earth Networks (ENTLN) lightning data. The cloud-to-cloud strikes are in purple while the cloud-to-ground strikes are in yellow.

How The Pantex LMA Works

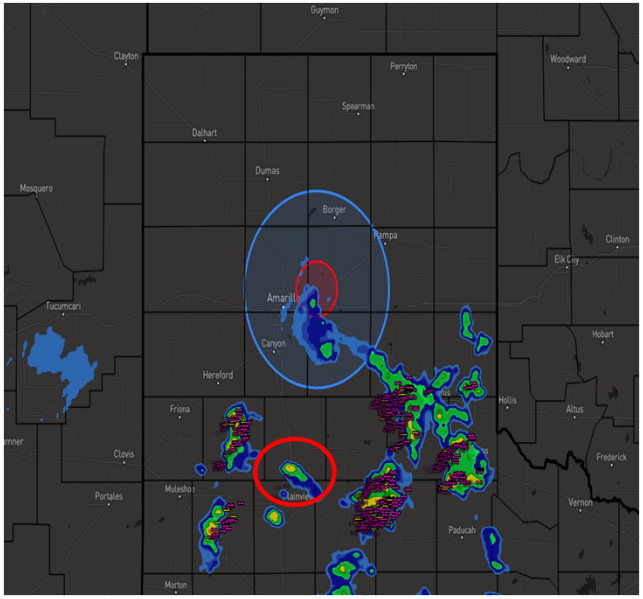
Putting them side-by-side, you can see that the LMA detects one shower that is producing static discharges, but hasn't produced a any lightning strikes yet. Can you find it?

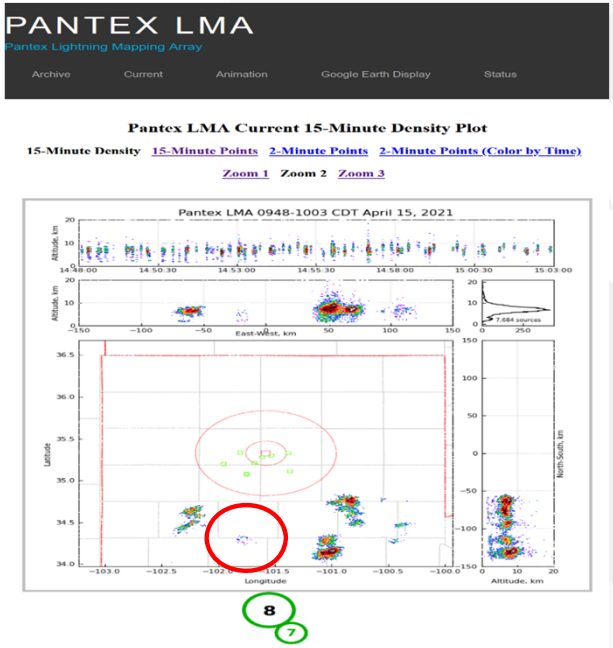




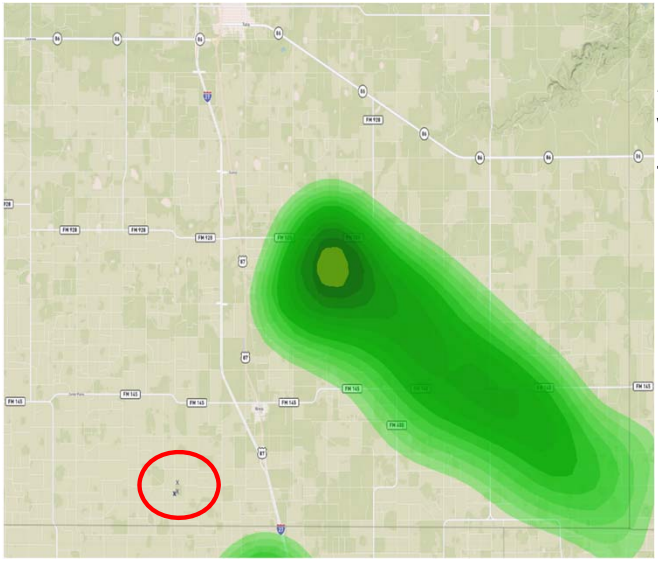
How The Pantex LMA Works

The Pantex LMA detected static discharges coming from this shower near Kress, along Interstate 27. Did this shower go on and produce lightning strikes?





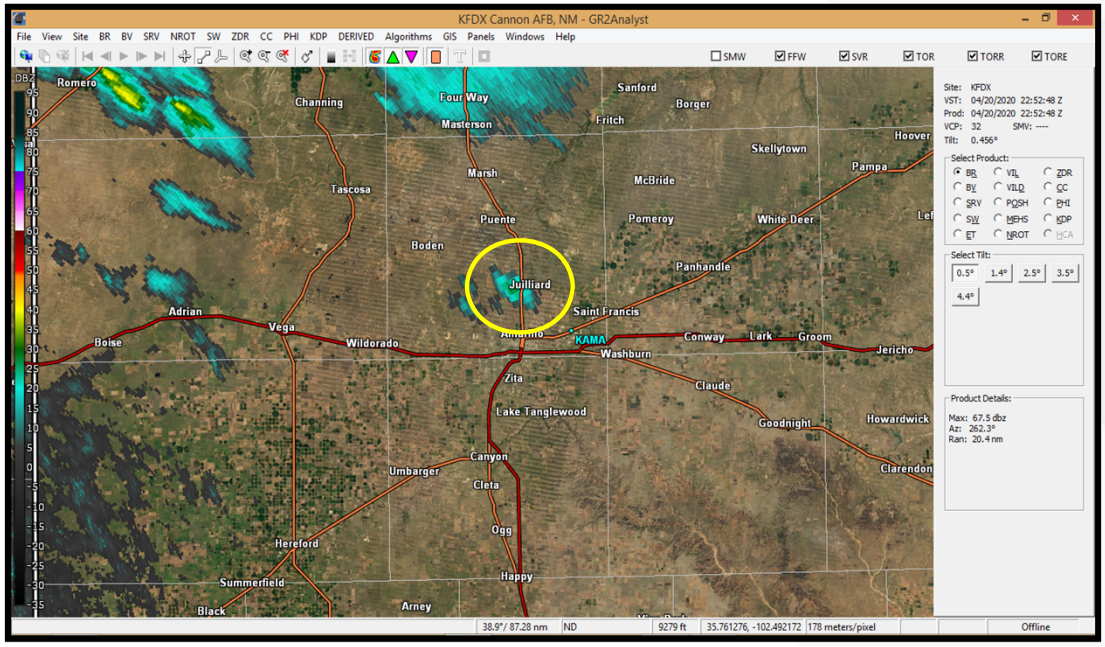
How The Pantex LMA Works



It did! In fact, it was 12 minutes later, a little faster than the 20 minute average, that according to WeatherOps Commander, which utilizes the National Lightning Detection Network (NLDN) that 3 lightning strikes (cloud-to-ground) occurred SW of Kress.

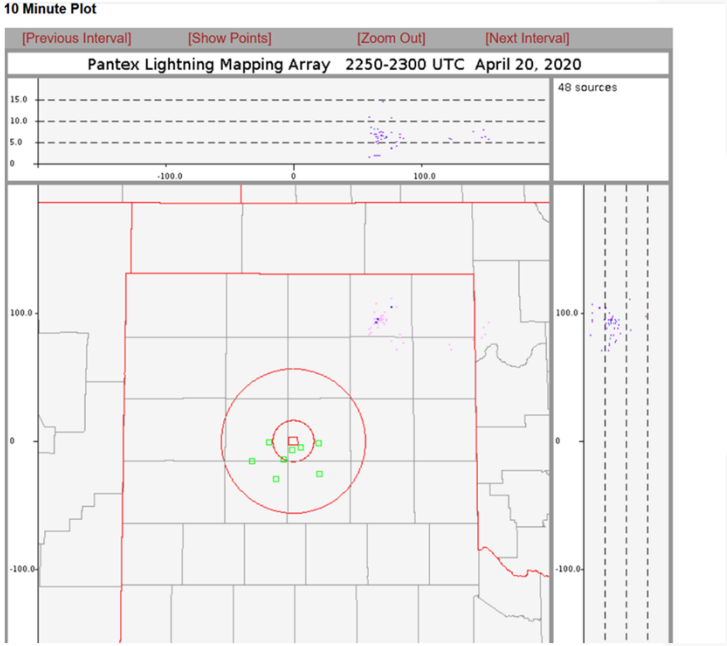
2020 Pantex LMA Research

Around 6pm on April 20, 2020, we had a thunderstorm developing just north of River Road HS. The storm developed in the mid-levels of the atmosphere and was showing up on KFDX and KLBB WSR-88D radars.



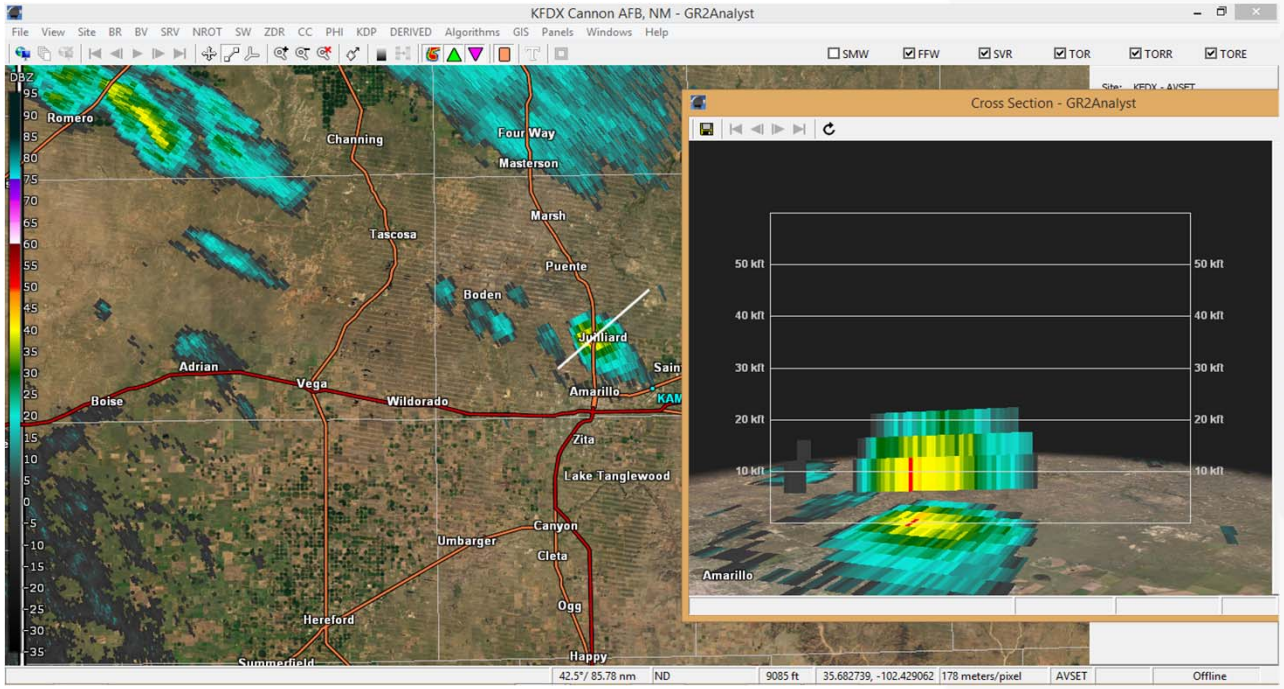
2020 Pantex LMA Research

The Pantex LMA, during this time, was not showing any source densities with the storm north of Amarillo. It did detect some source densities with ongoing thunderstorms south of Perryton, in southern Ochiltree County.



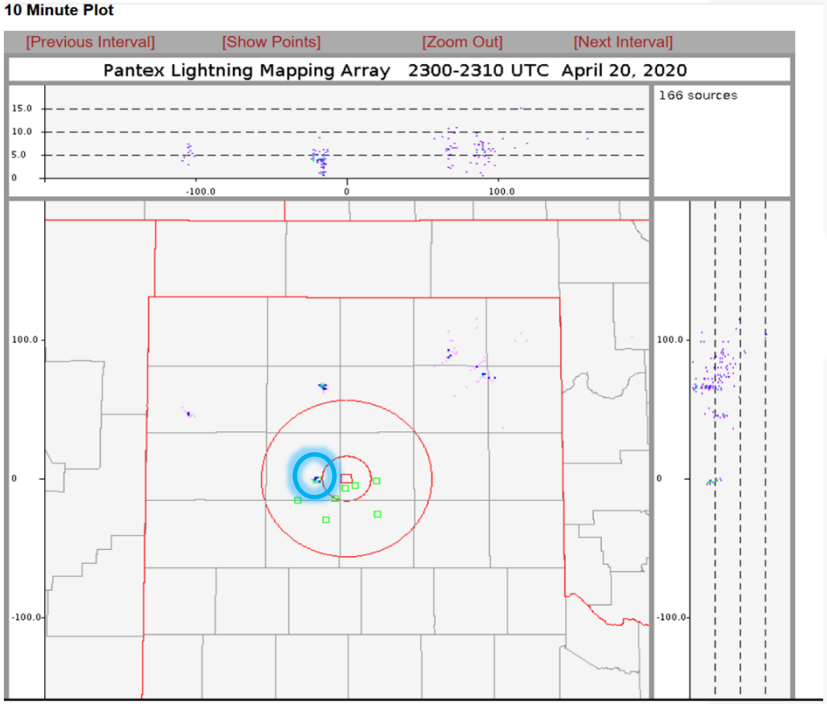
2020 Pantex LMA Research

Just 10 minutes later, around 6:10pm, the storm continues to rapidly develop north of Amarillo. This picture is from the KFDX WSR-88D.



2020 Pantex LMA Research

The Pantex LMA starts detecting “source densities” north of Amarillo at exactly 6:06pm.

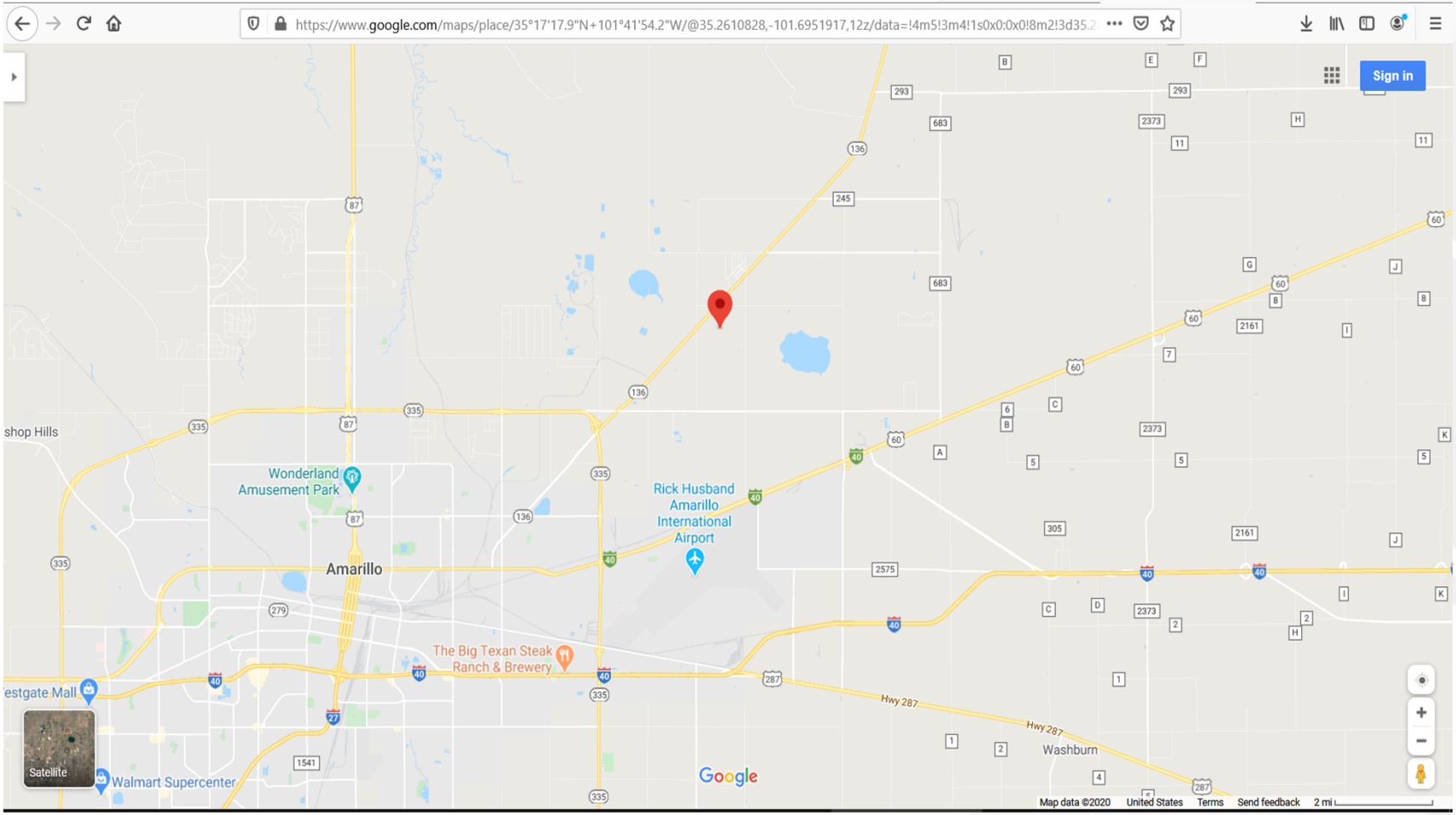


First “Cloud-to-cloud” Lightning Strikes Occur At 6:24pm

Lightning Event List

Date/Time	Latitude	Longitude	Amps	Distance	Bearing (°)
Apr 20, 2020 6:24:45 PM CDT	35.2883	-101.6984	-13653 amps	7.2666 miles	249.9462
Apr 20, 2020 6:24:45 PM CDT	35.2856	-101.6971	-3570 amps	7.2630 miles	248.3934
Apr 20, 2020 6:24:45 PM CDT	35.2863	-101.6961	-6123 amps	7.1934 miles	248.5638

First “Cloud-to-cloud” Lightning Strikes Occur At 6:24pm

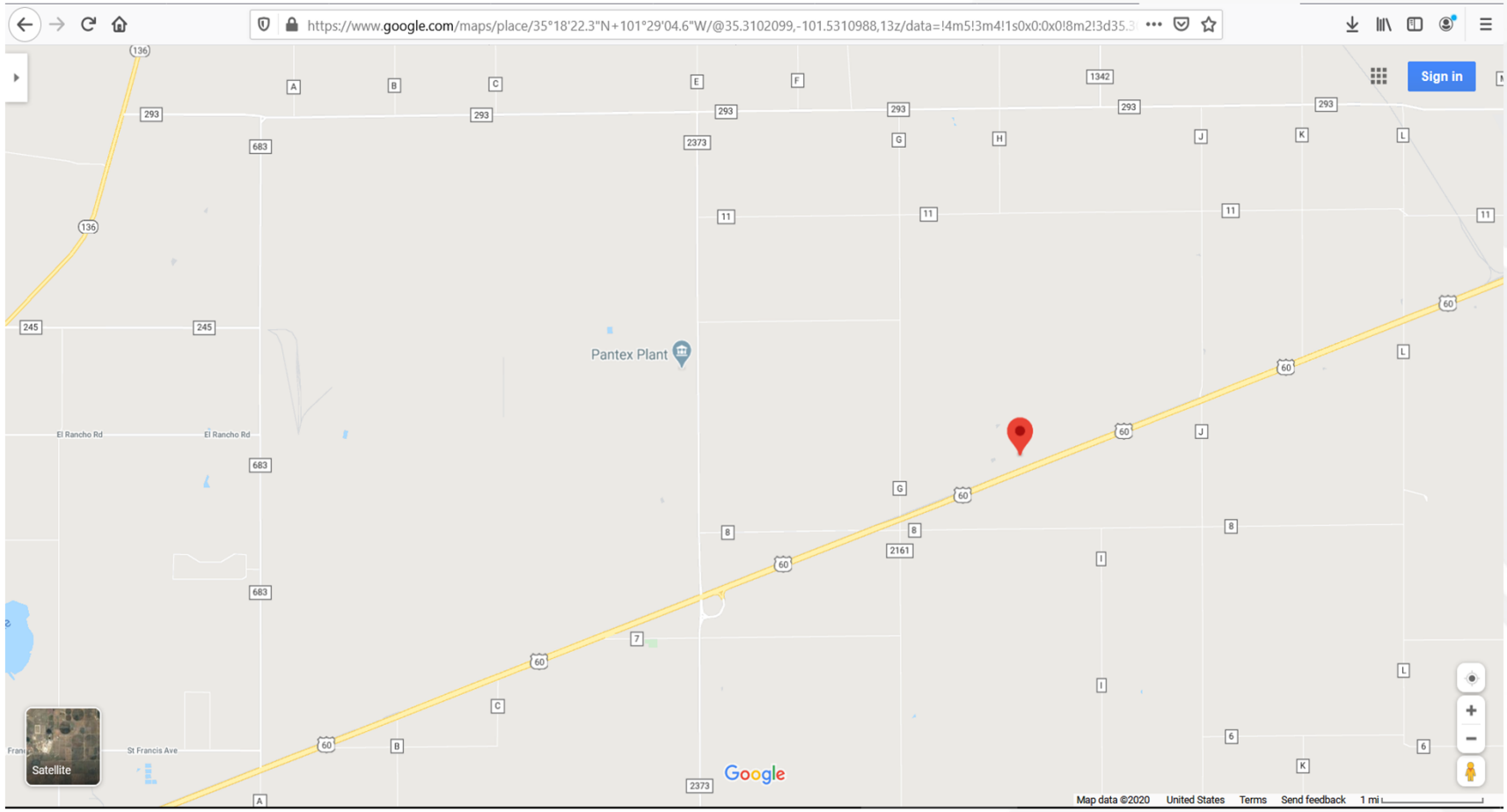


First “Cloud-to-Ground” Lightning Strike Occurs At 7:01pm

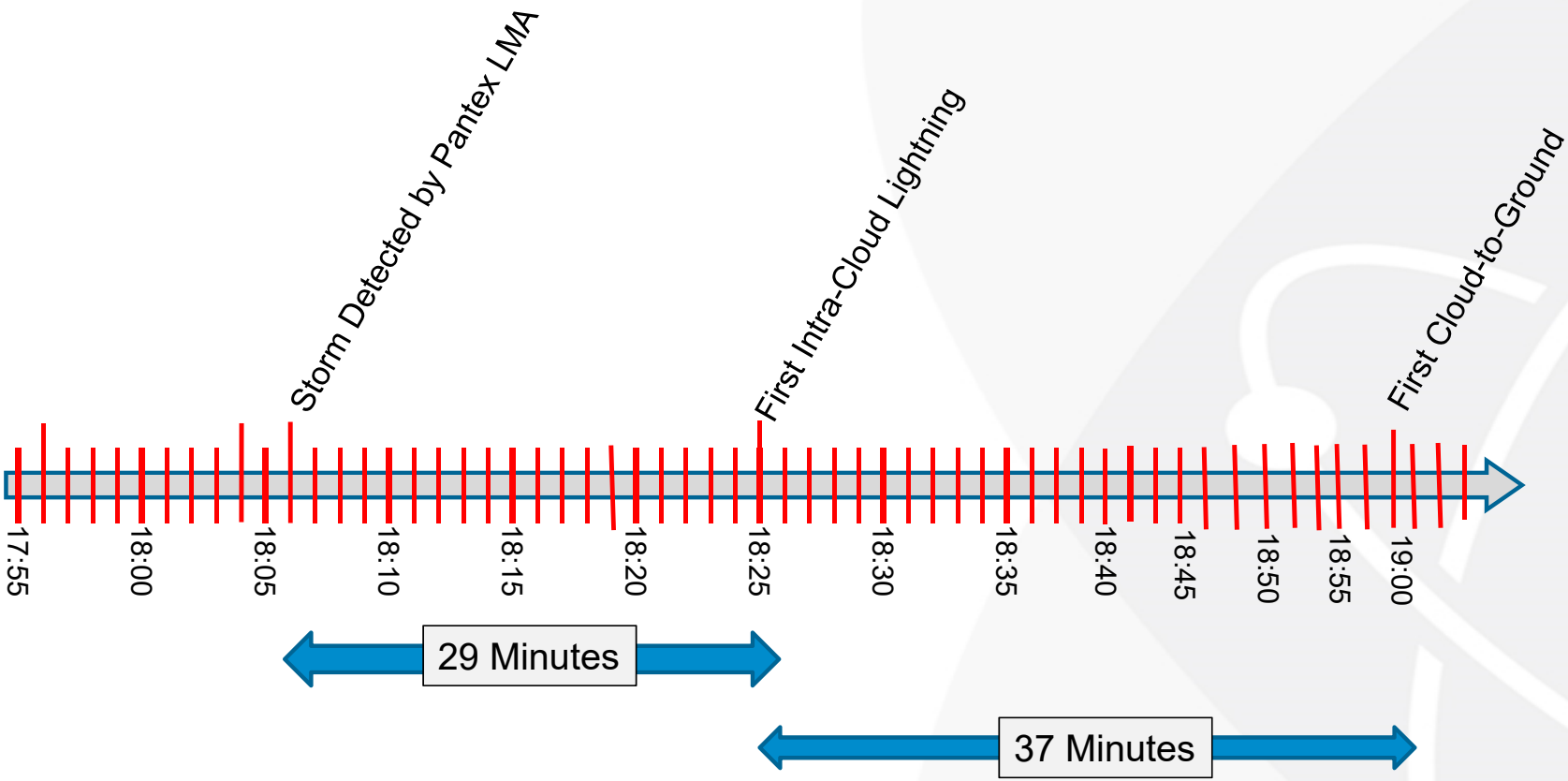
Lightning Event List

Date/Time	Latitude	Longitude	Amps	Distance	Bearing (°)
Apr 20, 2020 7:01:50 PM CDT	35.3062	-101.4846	-17464 amps	5.3790 miles	103.4711

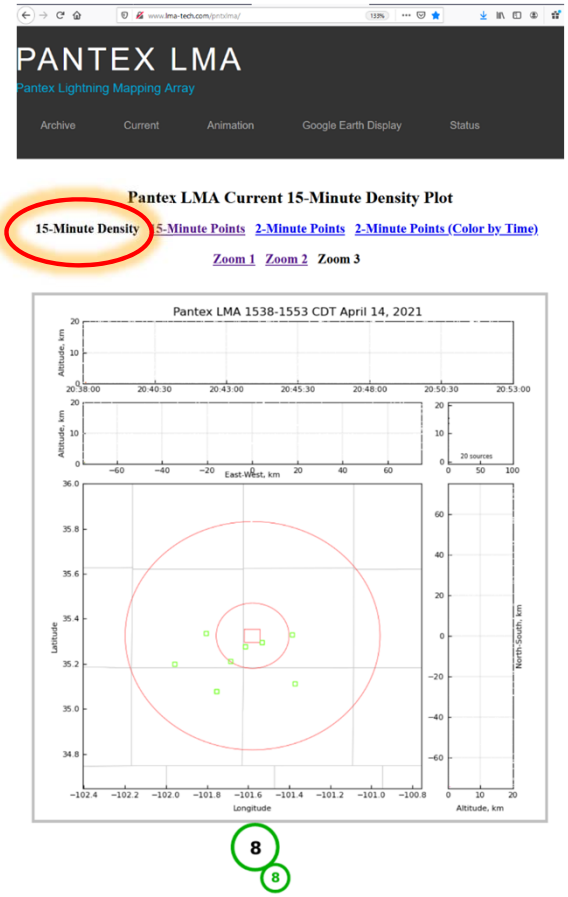
First “Cloud-to-Ground” Lightning Strike Occurs At 7:01pm



Timeline for April 20, 2020 Storm Event



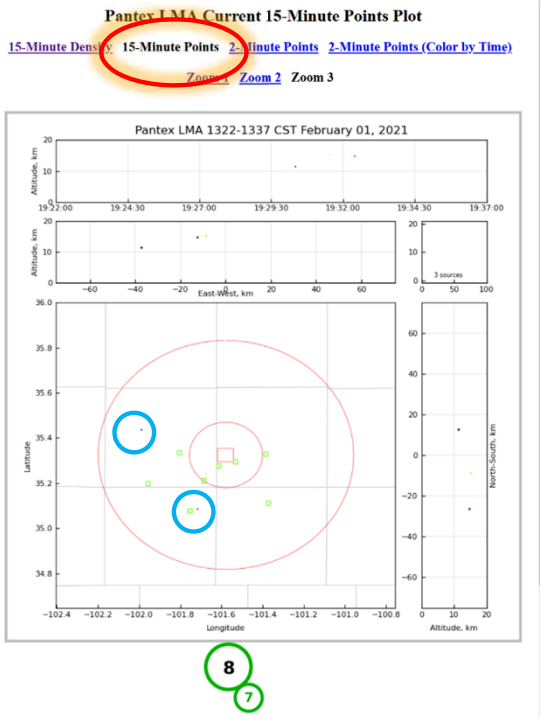
The Pantex LMA Website Features/Settings



http://www.lma-tech.com/pntxlma

When the LMA map loads up for the first time, it will default to the “15-Minute Density” setting. This is what it should be kept on to detect the “source densities” of developing storms.

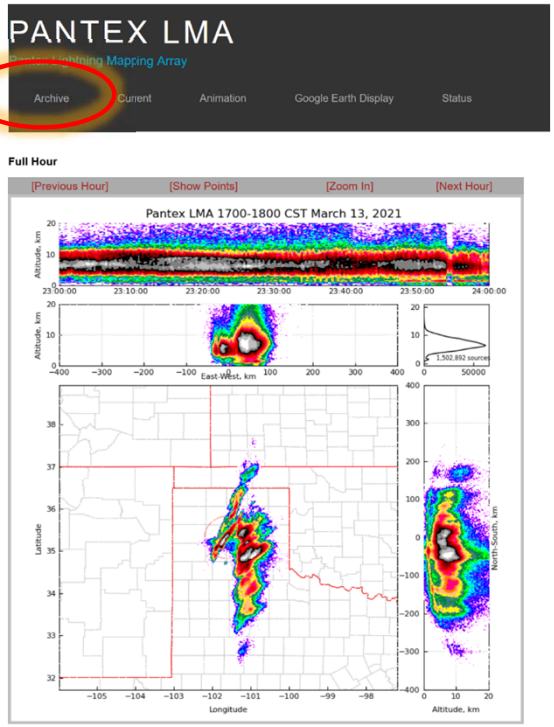
The Pantex LMA Website Features/Settings



http://www.lma-tech.com/pntxlma

If you click on the “15-Minute Points” setting, the map will then be set to detect ANY random, static discharge that the LMA picked up. These could be from any static producing source, not just developing thunderstorms! This feature is really used for diagnostic purposes only.

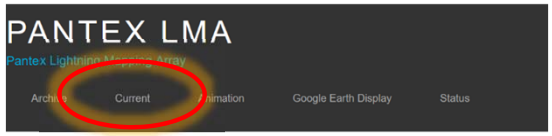
The Pantex LMA Website Features/Settings

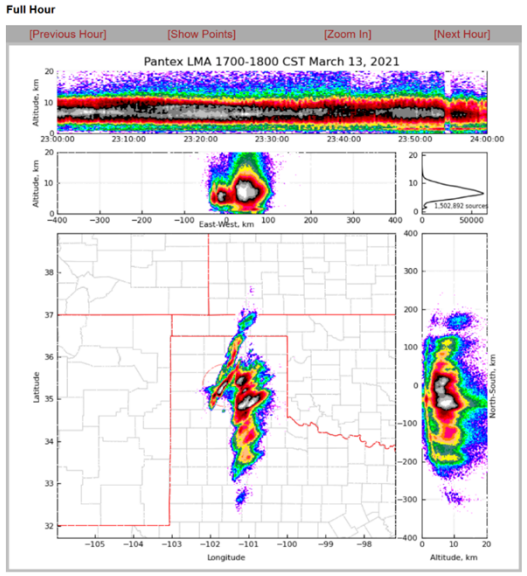


http://www.lma-tech.com/pntxlma

If you would like to “go back in time” and see what previous storm events looked like on our LMA, you can easily do that by clicking on the “Archive” button, on the upper-left of the menu. This picture is from March 13, 2021, in which we had several tornado producing thunderstorms over the southern and southeastern Texas Panhandle.

The Pantex LMA Website Features/Settings

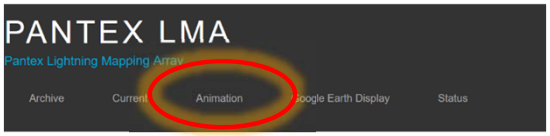


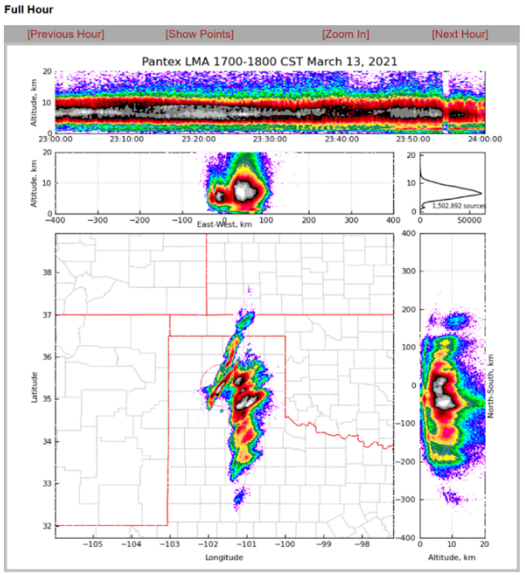


http://www.lma-tech.com/pntxlma

The “Current” button gets you back to the real-time display where you can see what is going on right now.

The Pantex LMA Website Features/Settings

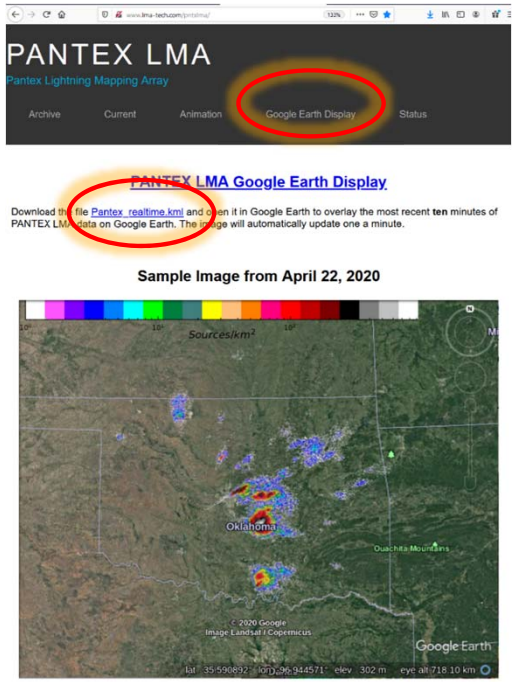




http://www.lma-tech.com/pntxlma

The “Animate” button allows the source density information to be animated, so you can easily see the motion of the static producing showers and thunderstorms.

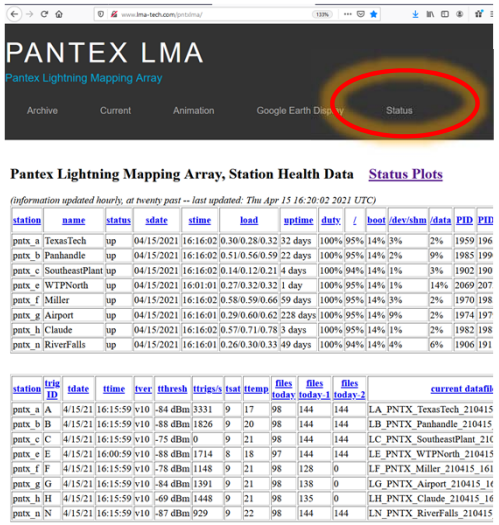
The Pantex LMA Website Features/Settings



http://www.lma-tech.com/pntxlma

The “Google Earth Display” button takes you to this page. On it, you can download the Pantex LMA data in realtime KML files, so that it can be displayed on Google Earth maps!

The Pantex LMA Website Features/Settings



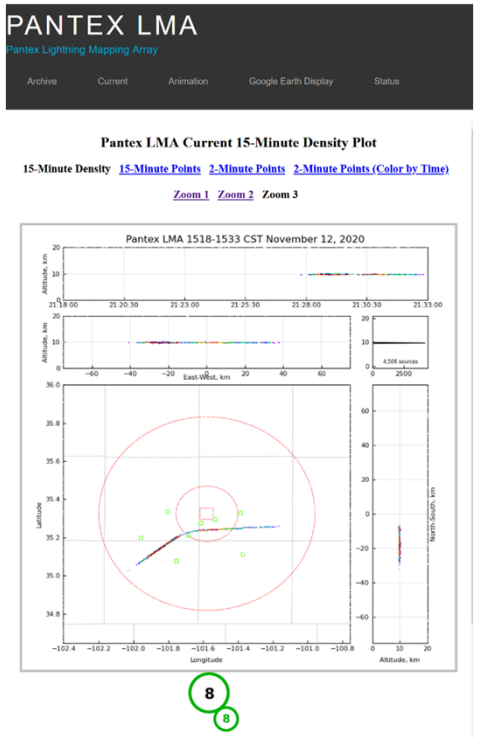
station	name	status	sdate	stime	load	uptime	duty	/	boot	/dev/shm	/data	PID	PID
pntx_a	TexasTech	up	04/15/2021	16:16:02	0.30/0.28/0.32	32 days	100%	95%	14%	3%	2%	1959	196
pntx_b	Panhandle	up	04/15/2021	16:16:02	0.51/0.56/0.59	22 days	100%	95%	14%	2%	9%	1985	199
pntx_c	SoutheastPlant	up	04/15/2021	16:16:02	0.14/0.12/0.21	4 days	100%	94%	14%	1%	3%	1902	190
pntx_e	WTPNorth	up	04/15/2021	16:01:01	0.27/0.32/0.32	1 day	100%	95%	14%	1%	14%	2069	207
pntx_f	Miller	up	04/15/2021	16:16:02	0.58/0.59/0.66	59 days	100%	95%	14%	3%	2%	1970	198
pntx_g	Airport	up	04/15/2021	16:16:01	0.29/0.60/0.62	228 days	100%	95%	14%	9%	2%	1974	197
pntx_h	Claude	up	04/15/2021	16:16:02	0.57/0.71/0.78	3 days	100%	95%	14%	1%	2%	1982	198
pntx_n	RiverFalls	up	04/15/2021	16:16:01	0.26/0.30/0.33	49 days	100%	94%	14%	4%	6%	1906	191

station	trig ID	tdate	ttime	tver	tthresh	ttrigs/s	tsat	ttemp	files today	files today_1	files today_2	current datafil
pntx_a	A	4/15/21	16:15:59	v10	-84 dBm	3331	9	17	98	144	144	LA_PNTX_TexasTech_210415
pntx_b	B	4/15/21	16:15:59	v10	-88 dBm	1826	9	20	98	144	144	LB_PNTX_Panhandle_210415
pntx_c	C	4/15/21	16:15:59	v10	-75 dBm	0	9	21	98	144	144	LC_PNTX_SoutheastPlant_210
pntx_e	E	4/15/21	16:00:59	v10	-88 dBm	1714	8	18	97	144	144	LE_PNTX_WTPNorth_210415
pntx_f	F	4/15/21	16:15:59	v10	-78 dBm	1148	9	21	98	128	0	LF_PNTX_Miller_210415_161
pntx_g	G	4/15/21	16:15:59	v10	-84 dBm	1391	9	21	98	138	0	LG_PNTX_Airport_210415_16
pntx_h	H	4/15/21	16:15:59	v10	-69 dBm	1448	9	21	98	135	0	LH_PNTX_Claude_210415_16
pntx_n	N	4/15/21	16:15:59	v10	-87 dBm	929	9	22	98	144	144	LN_PNTX_RiverFalls_210415

http://www.lma-tech.com/pntxlma

The “Status” button is strictly for diagnostic use and allows our engineers and technicians to see how well the network is operating.

Man-Made “Static Discharges” On The Pantex LMA

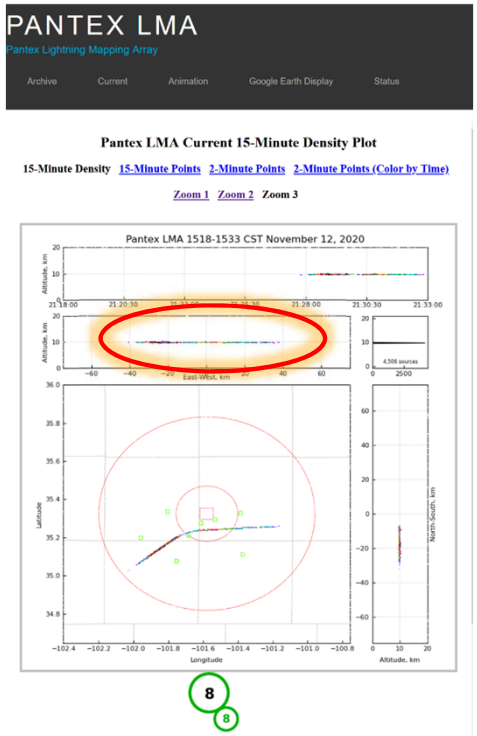


http://www.lma-tech.com/pntxlma

When airplanes are flying overhead and fly into cirrus clouds, their wings come into contact with the ice crystals of the clouds and produce static discharges. Our LMA is so sensitive that it can detect these very small discharges.

There are a few things that give away the fact that what we are detecting isn’t a developing thunderstorm.

Man-Made “Static Discharges” On The Pantex LMA



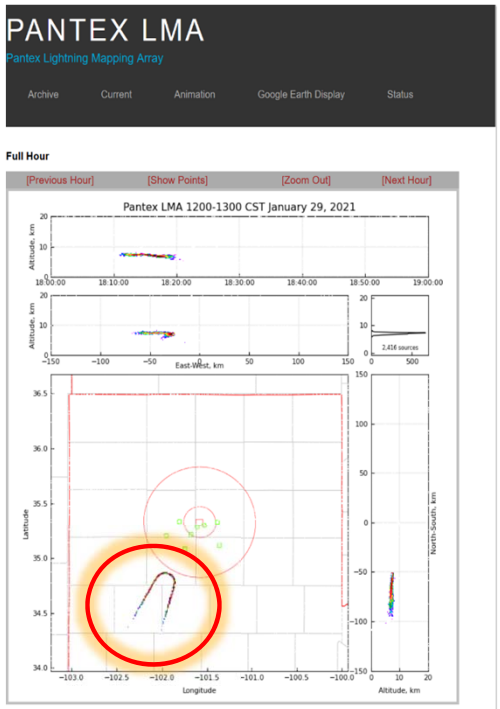
http://www.lma-tech.com/pntxlma

First off, the altitude is staying at a constant level. For this particular aircraft, it was flying at a level altitude of 10km, which is around 32,000 feet.

Another giveaway that what we are looking at is an airplane is the “turn” that it took as it approached Rick Husband International Airport in Amarillo.

The last giveaway that this is an airplane is the very small and narrow nature of the static discharges. The developing thunderstorms have a “blob-like” appearance, airplanes don’t.

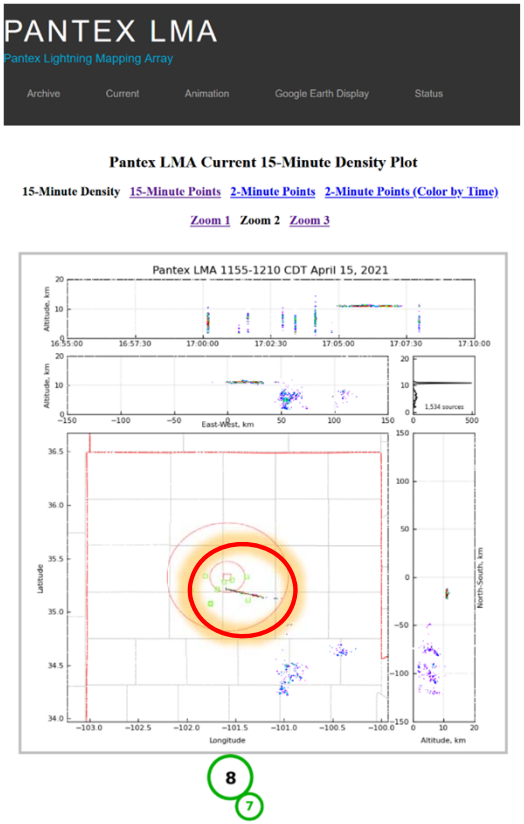
Man-Made “Static Discharges” On The Pantex LMA



http://www.lma-tech.com/pntxlma

We have also detected military aircraft from Cannon AFB, NM, that have been flying overhead. This particular plane did a U-Turn over the SW TX Panhandle and returned back to Cannon AFB, just west of Clovis, NM.

“Plane Tracks” & Storms Simultaneously

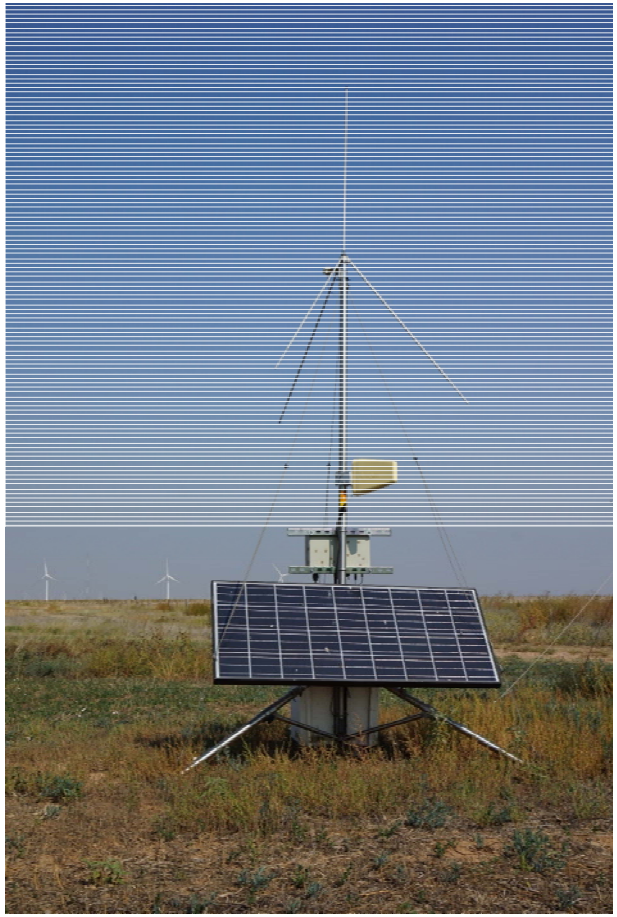


http://www.lma-tech.com/pntxlma

Oftentimes, when we have ongoing thunderstorms in the area, we will have the “blowoff” cirrus clouds from those storms. As planes fly through the cirrus clouds, static discharges result.

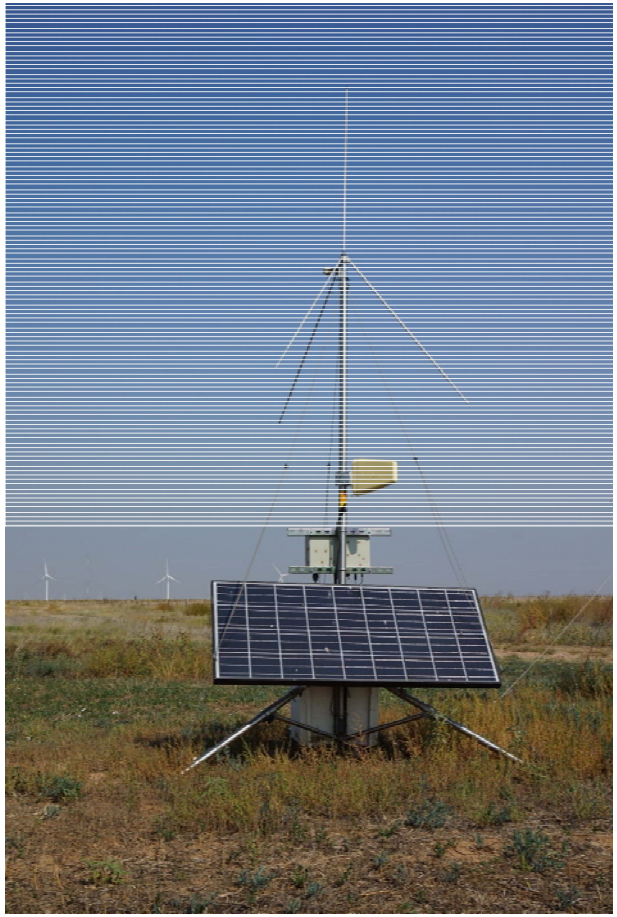
So, as was the case with this LMA picture from April 15, 2021, we had ongoing thunderstorms in the SE TX Panhandle and a “plane track” from an aircraft from Claude to Amarillo at the same time.

In Conclusion



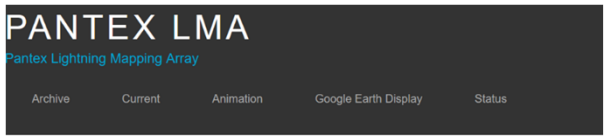
The Pantex LMA is an extremely helpful meteorological tool that can detect developing thunderstorms before they even produce their first cloud-to-cloud or cloud-to-ground lightning strike.

In Conclusion

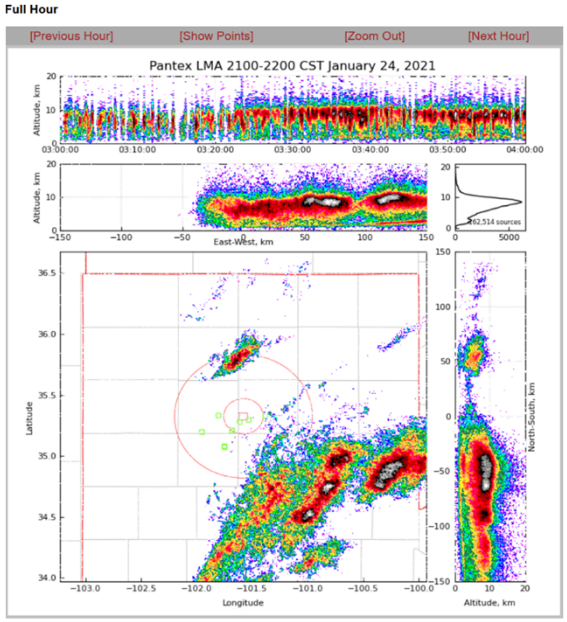


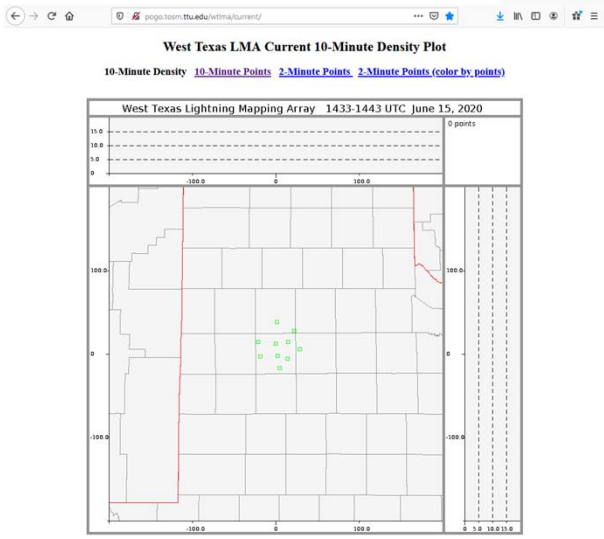
The Pantex LMA will continue to grow and expand and provide even better resolution of data, higher accuracy and redundancy.

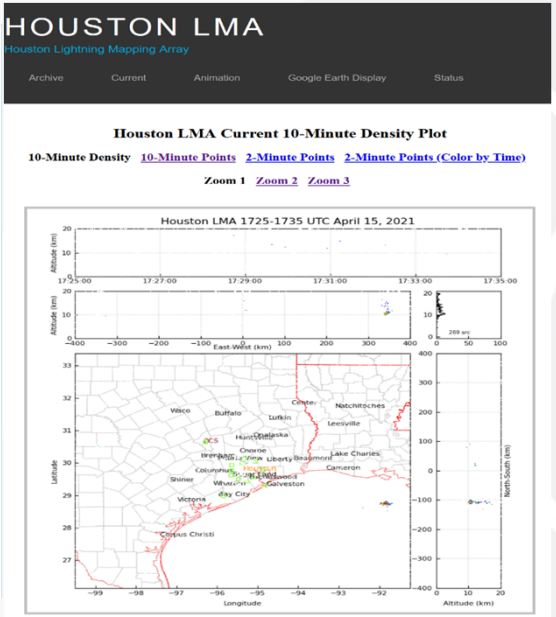
In Conclusion



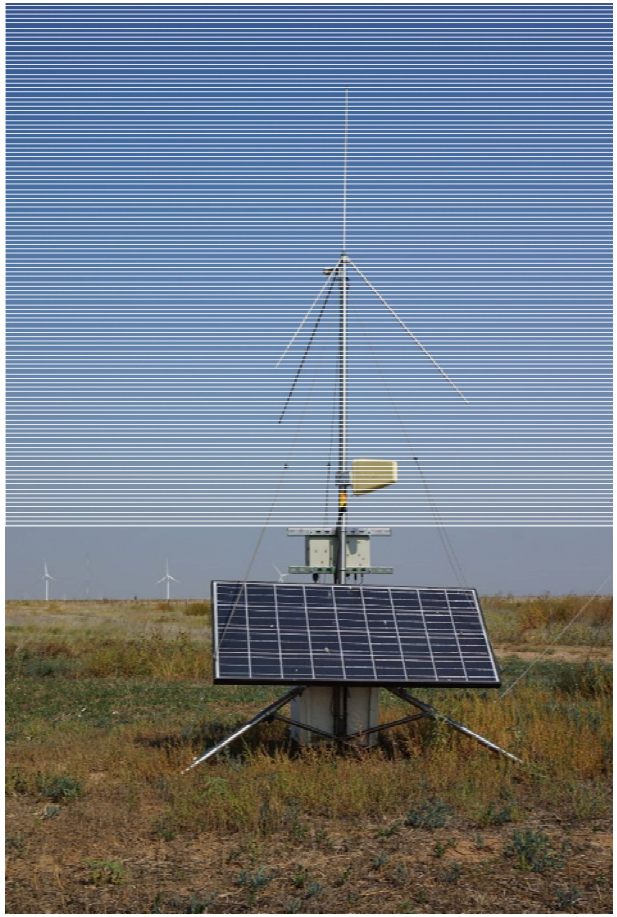
Pantex is proud to be one of only 3 existing LMA networks in the State of Texas (Texas Tech & Houston/Texas A&M)







In Conclusion



Pantex will continue to support research into lightning and lightning safety with the goal of keeping not just Pantexans safe, but all who live in the Texas Panhandle as well.

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