NWS Weather Radar Use and Limitations

Challenging Case: Lovelady 2014 Tornado

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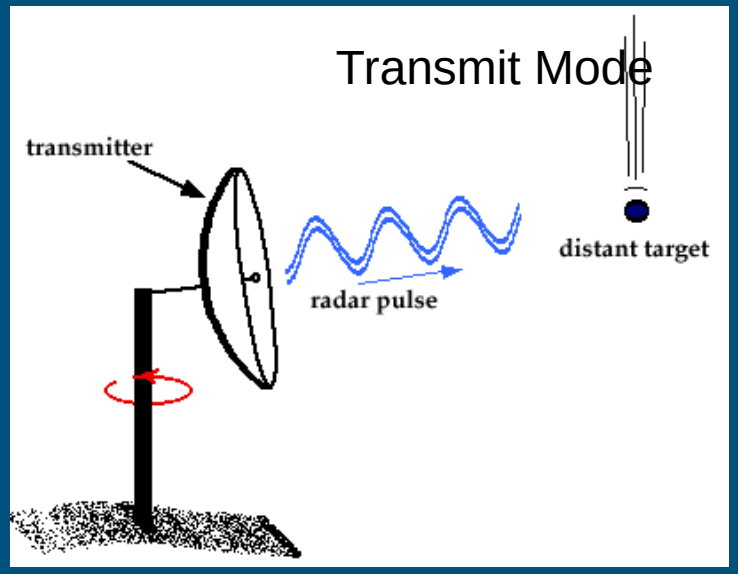
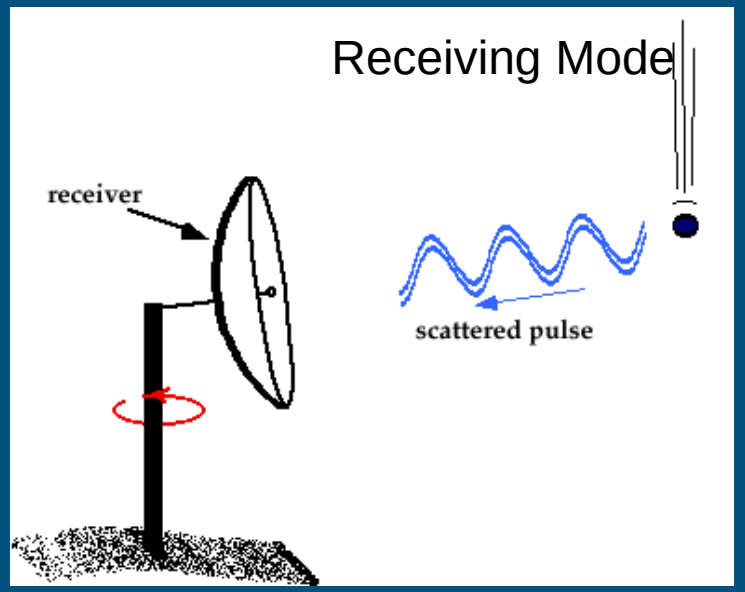
Houston/Galveston

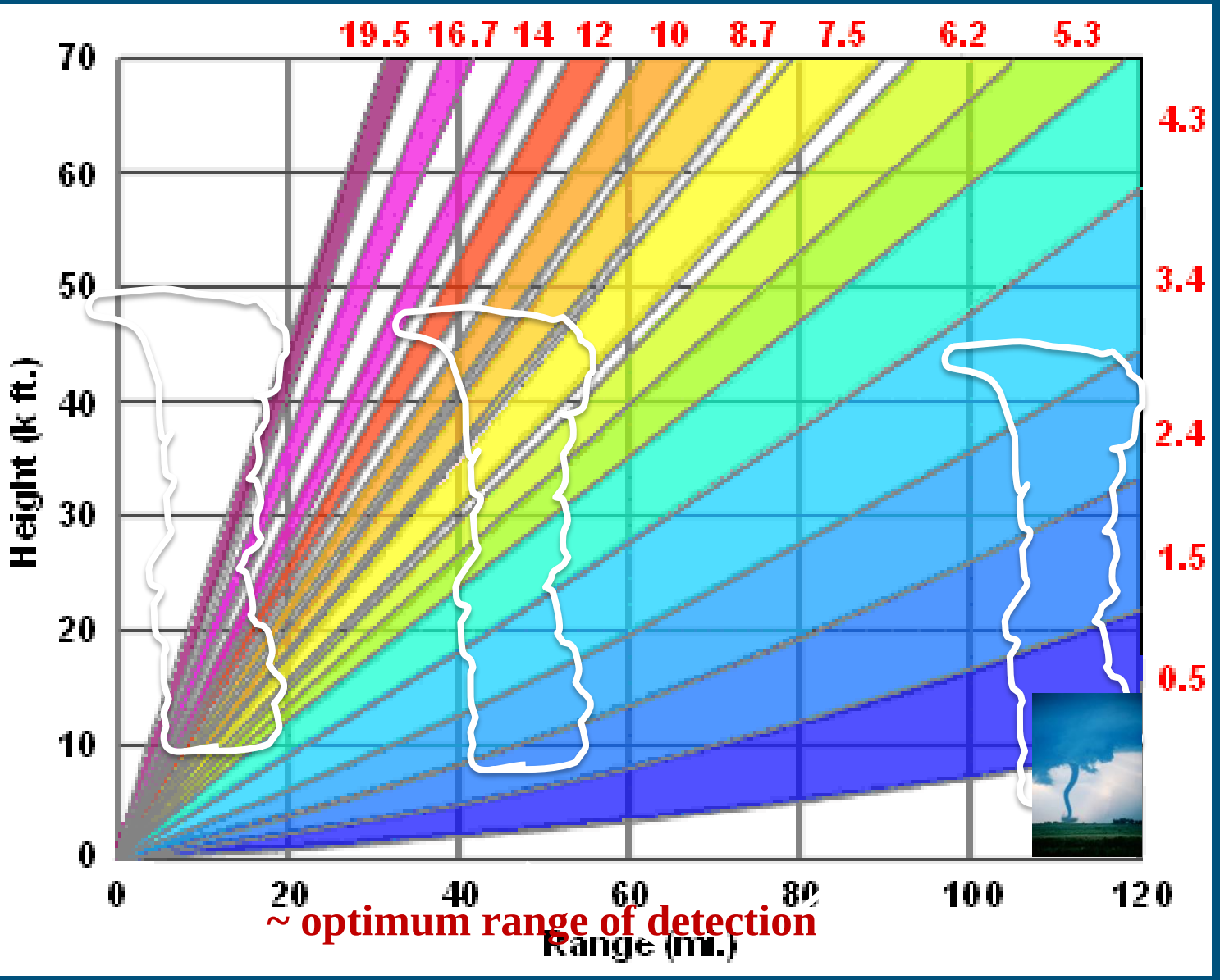
RADAR:RAdio Detection And Ranging





- **Transmitter sends out electromagnetic pulse**
- **"Listens" for pulse to return (the "echo")**
- **Reflectivity = amount of electromagnetic energy of returned pulse**
- **The larger and more dense the raindrops, the higher the energy returned (reflectivity)**
- **Hail also very reflective, produces strong return or "echo"**

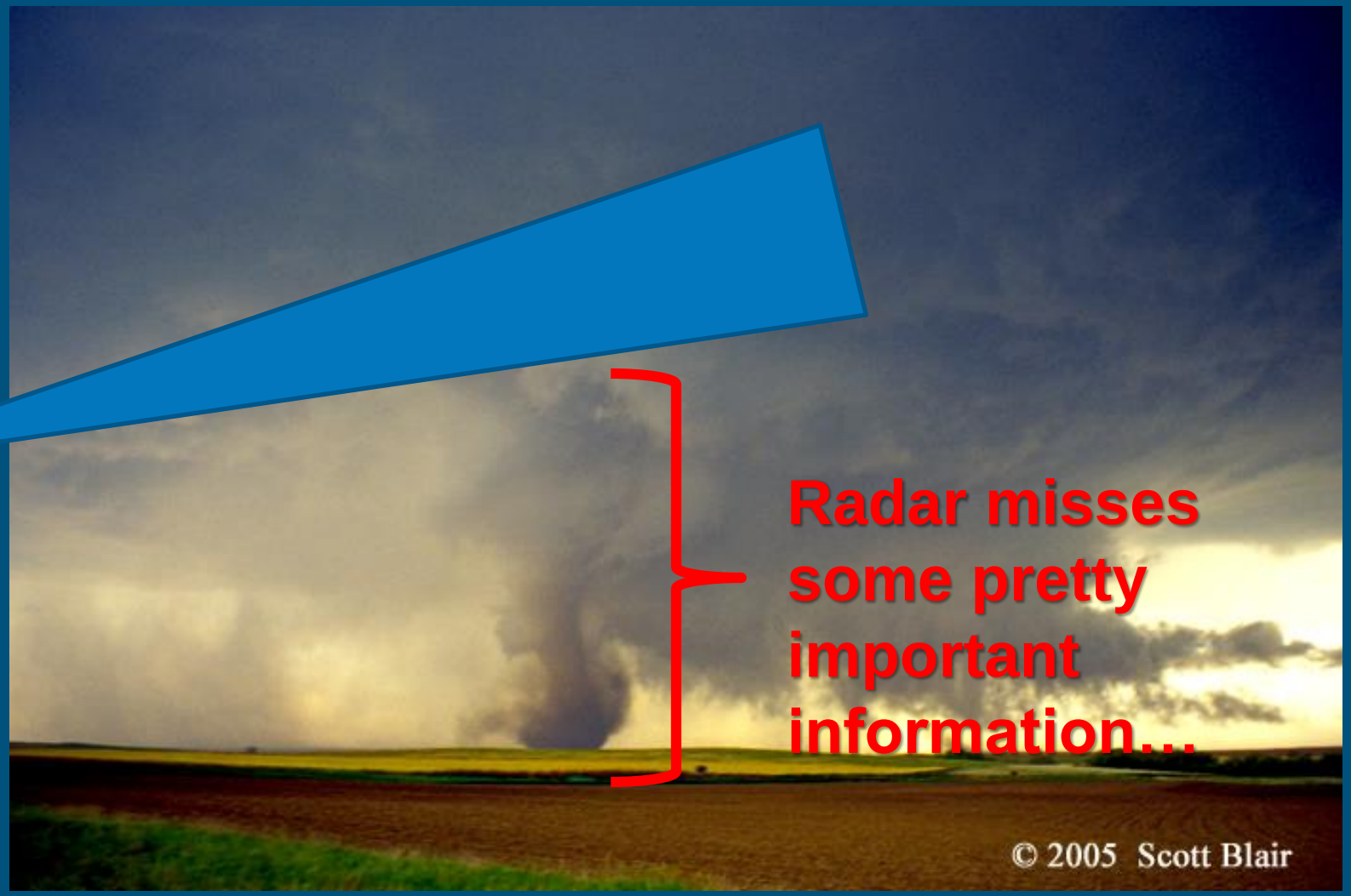
Radar Limitations: Storm May be Too Close or Too Far for Optimal Sampling



Storm within 10 miles of radar, mid or upper parts of the storm might not be sampled. In the "cone of silence" above the highest elevation angle cut.

Storm beyond 100 miles of radar; due to height of beam and curvature of Earth, radar not sampling lowest parts of storm. At large distances, beam itself broader, less able to resolve smaller circulations, features.

Beam Overshooting



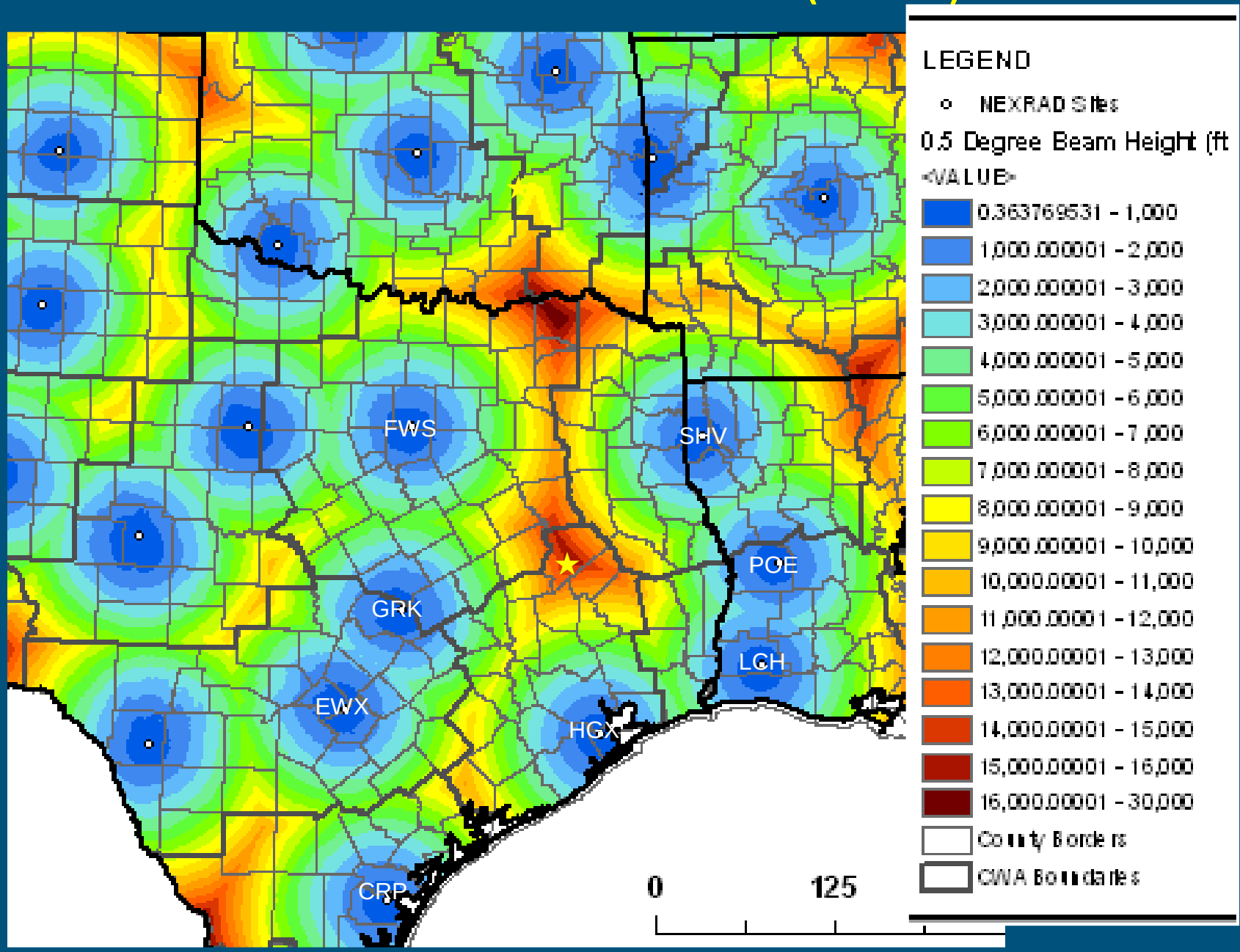
Height of Lowest Beam from Network Radars (2018)

Height of lowest beam from any network radar in feet above ground level.

Location of Lovelady shown by star. Height of lowest beam 13000 feet! No radar information below.

SHV was able to lower the angle of their lowest tilt from 0.5 degrees to 0.3 degrees. This helps some!

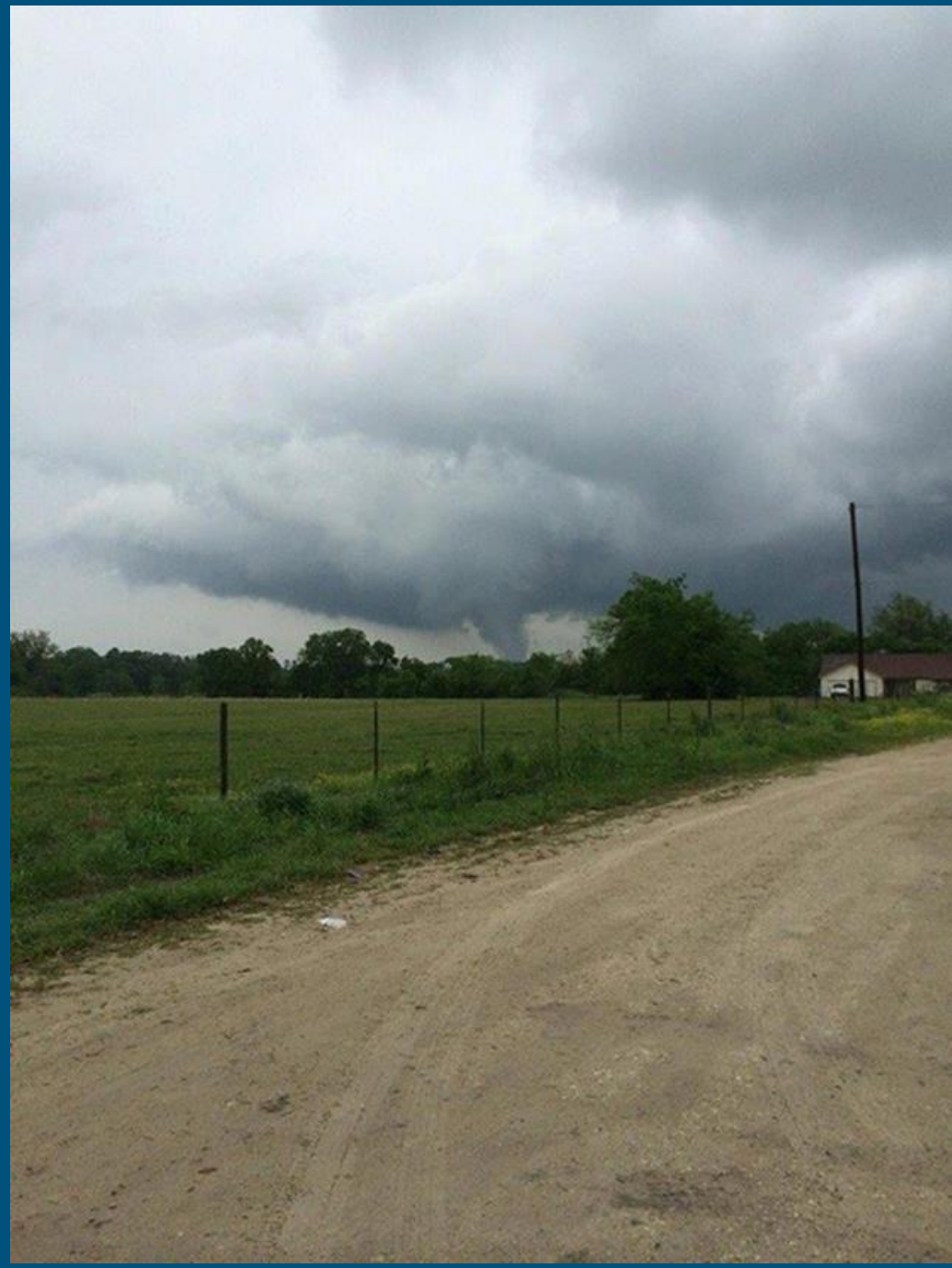
Investigating doing that for other radars.



★ Approximate location of Lovelady 2014 Tornado damage

Lovelady Tornado Timeline

- Based on damage survey and witness interviews, EF-1 tornado touched down in Lovelady between 4:45 and 4:50 pm
  - https://nwschat.weather.gov/p.php?pid=201404151530-KHGX-NOUS44-PNSHGX
- Initial call to first responders 457 pm
- First call to WFO at 540 pm
- There were no watches or warnings in the area



Videos

Damage Photos from Storm Survey

Three mobile homes destroyed.

Trailer 1: Rolled off foundation, weakly tied down

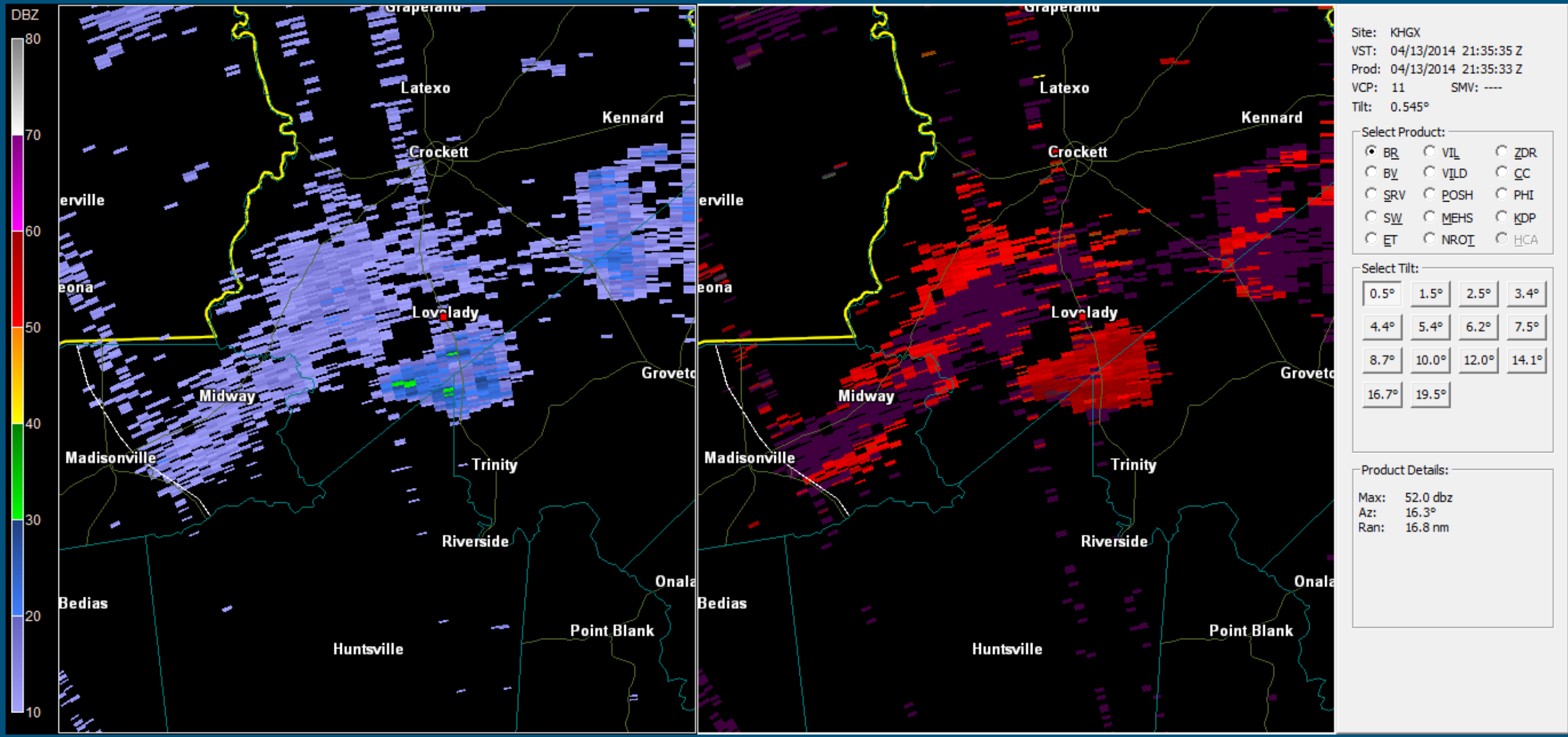
Damage Photos from Storm Survey

Trailer 2: Moved off foundation; three large hardwood trees were uprooted near this single wide, two fell into the mobile home splitting it in two.

There was one minor injury which could have been much more severe as elderly woman had moved from center of trailer just prior to tornado hitting.

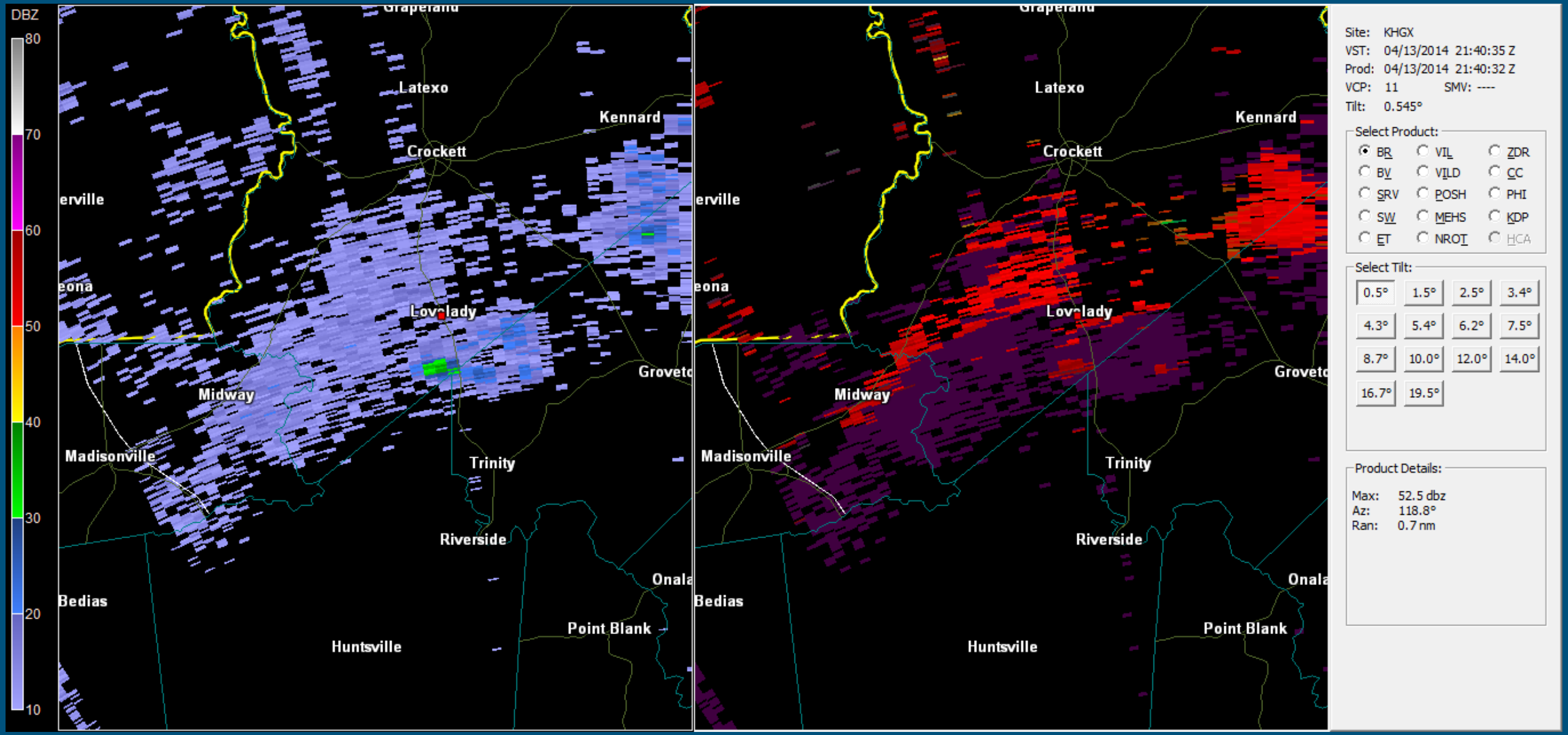
Her daughter, Beverly Cowger Moore said, "She was just a little shaken up, but she was fine. The EMT tried to get her on the gurney and she said, 'No, I can walk.' She walked on a cut on her leg, but she's doing good."

Radar Sequence from HGX radar: Location of Damage Indicated by Red Dot



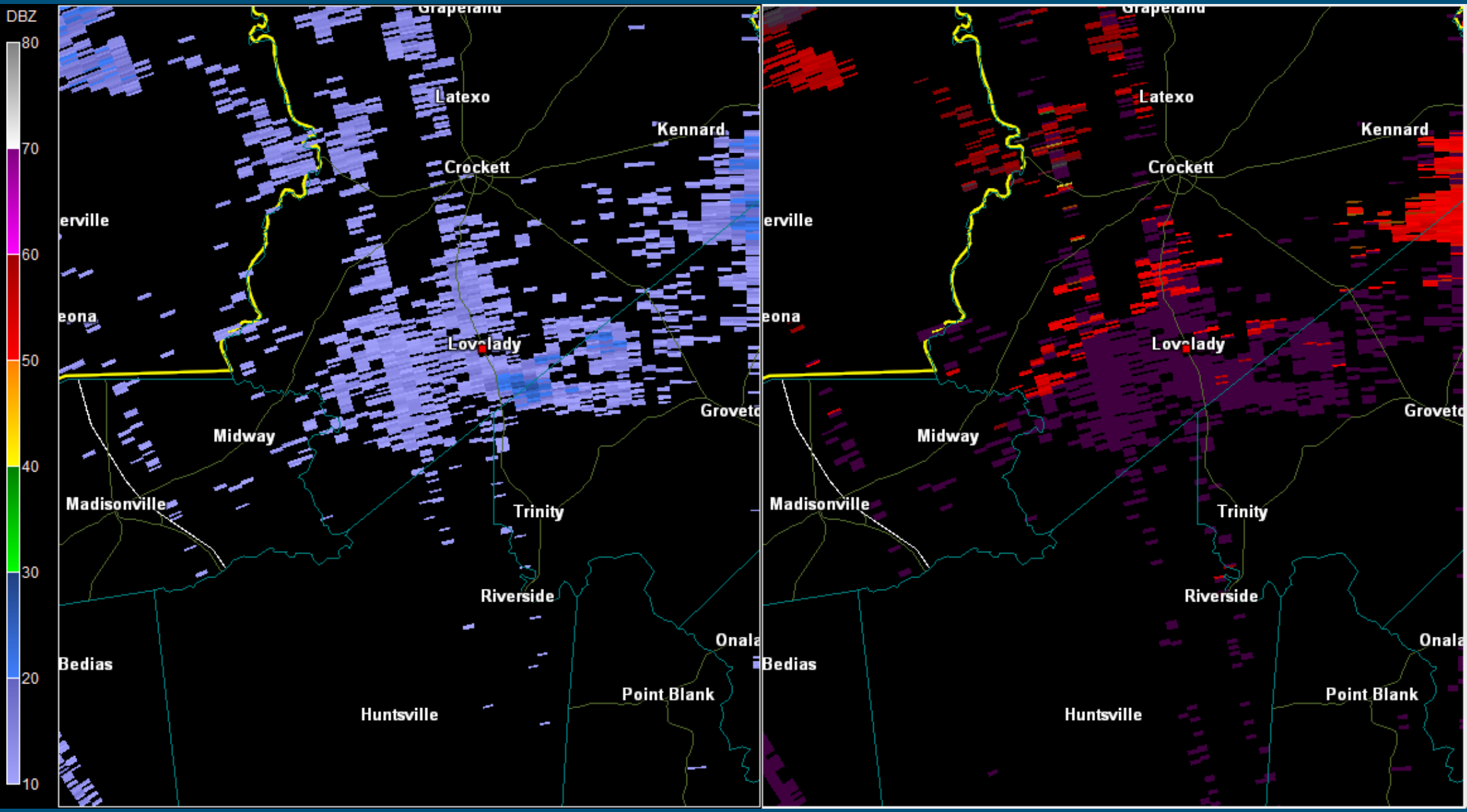
Reflectivity (left) and Base Velocity from HGX radar at 4:36 PM CDT

Radar Sequence from HGX radar: Location of Damage Indicated by Red Dot



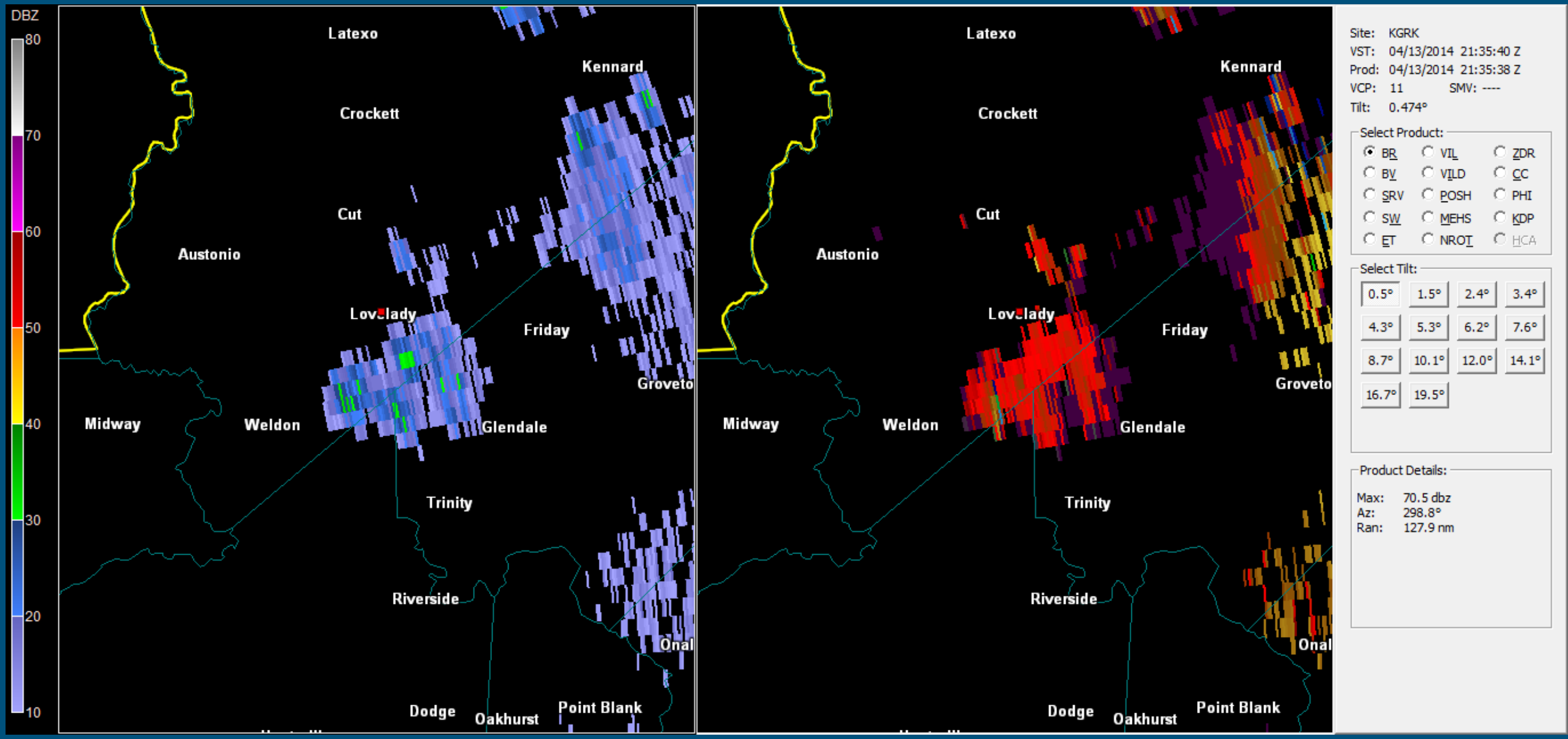
Reflectivity (left) and Base Velocity from HGX radar at 4:41 PM CDT

Radar Sequence from HGX radar: Location of Damage Indicated by Red Dot



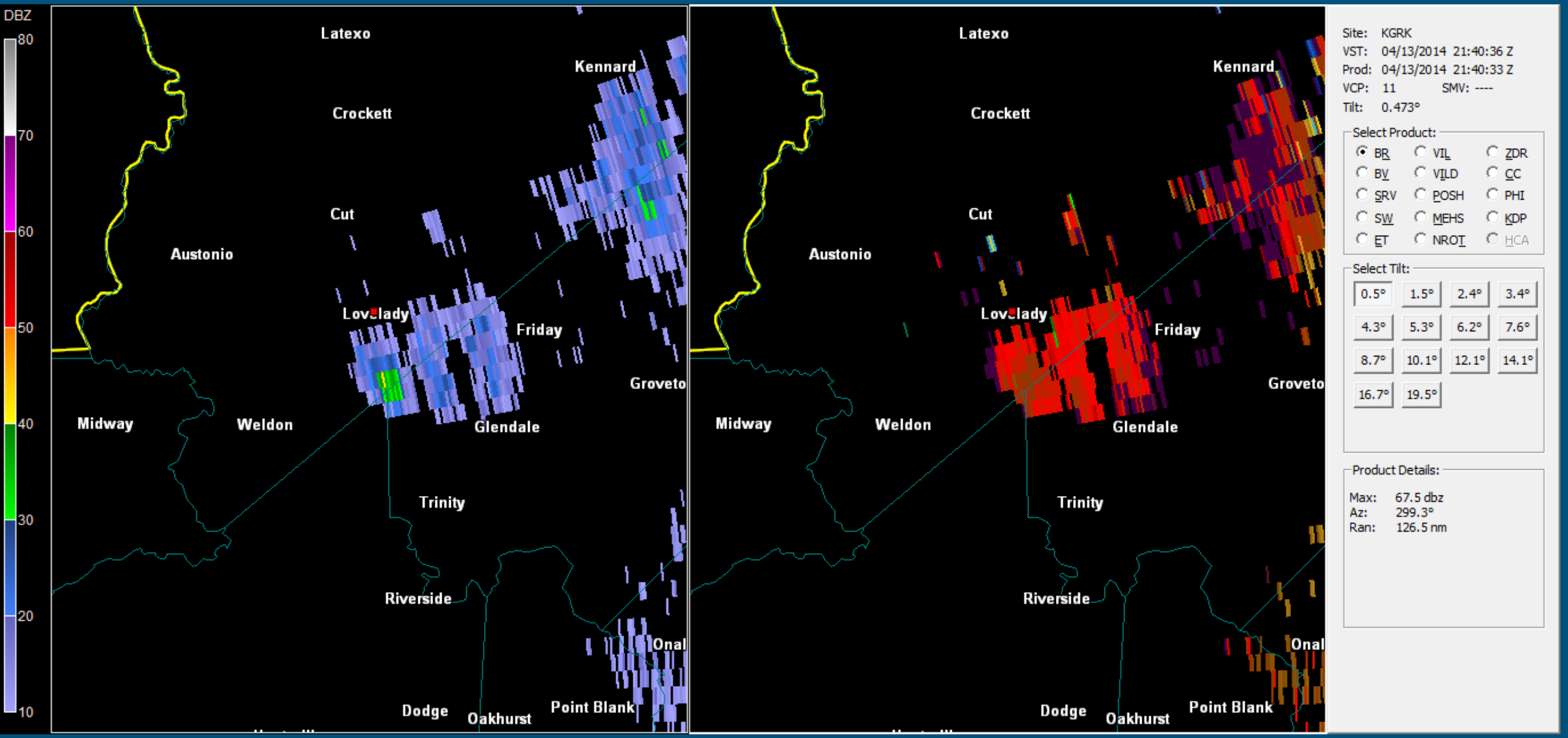
Reflectivity (left) and Base Velocity from HGX radar at 4:46 PM CDT

Radar Sequence from GRX radar: Location of Damage Indicated by Red Dot



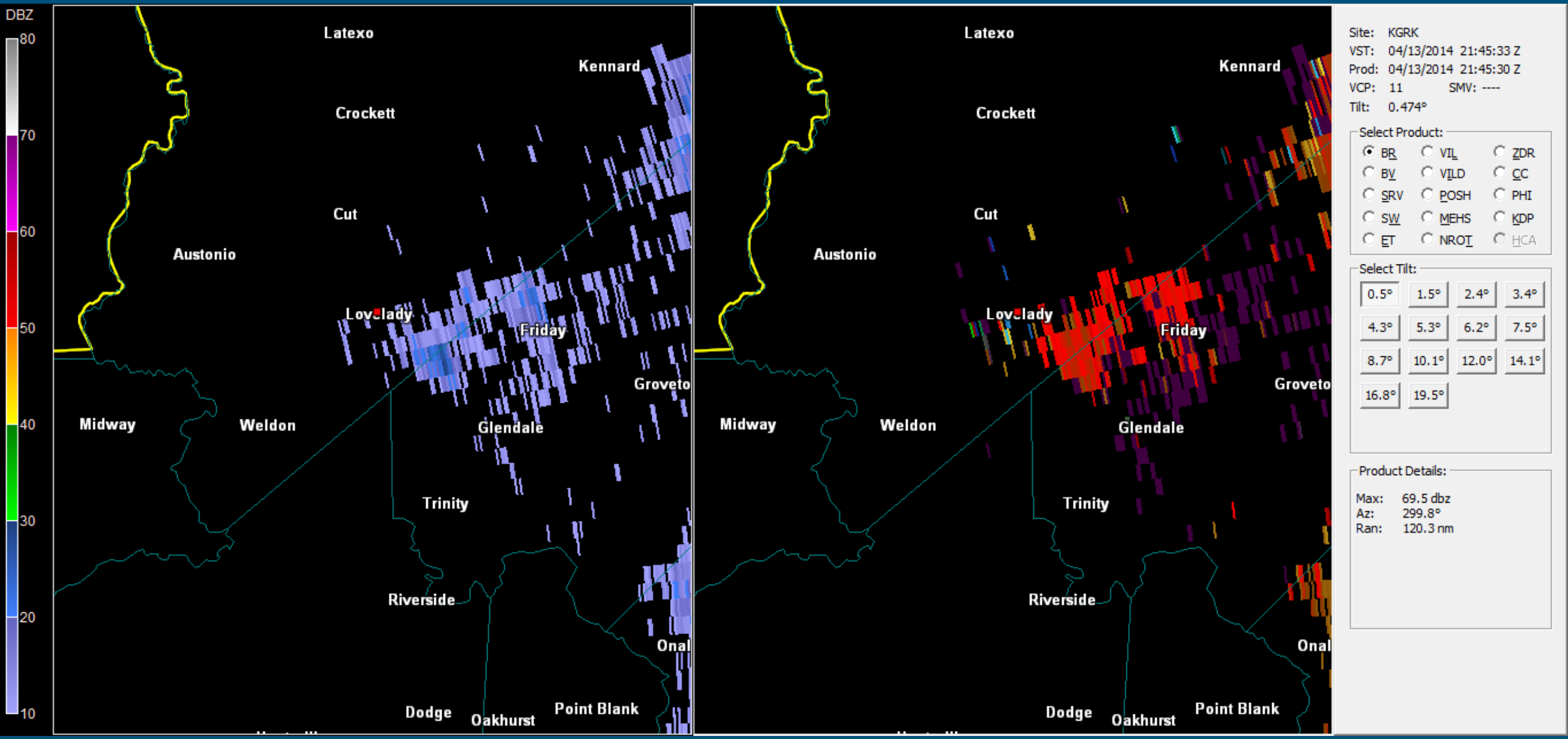
Reflectivity (left) and Base Velocity from GRK radar at 4:36 PM CDT

Radar Sequence from GRX radar: Location of Damage Indicated by Red Dot



Reflectivity (left) and Base Velocity from GRK radar at 4:41 PM CDT

Radar Sequence from GRX radar: Location of Damage Indicated by Red Dot



Reflectivity (left) and Base Velocity from GRK radar at 4:46 PM CDT

Photos/Videos/Media Coverage

KTRE

http://www.ktre.com/story/25236273/3-homes-destroyed-woman-injured-in-possible-tornado-in-lovelady

Weather Channel

http://www.weather.com/news/tornado-central/east-texas-lovelady-tornado-radar-hole-20140416

Weather Channel piece includes quotes from one of our forecasters about radar gaps; CASA radar program also mentioned by reporter.

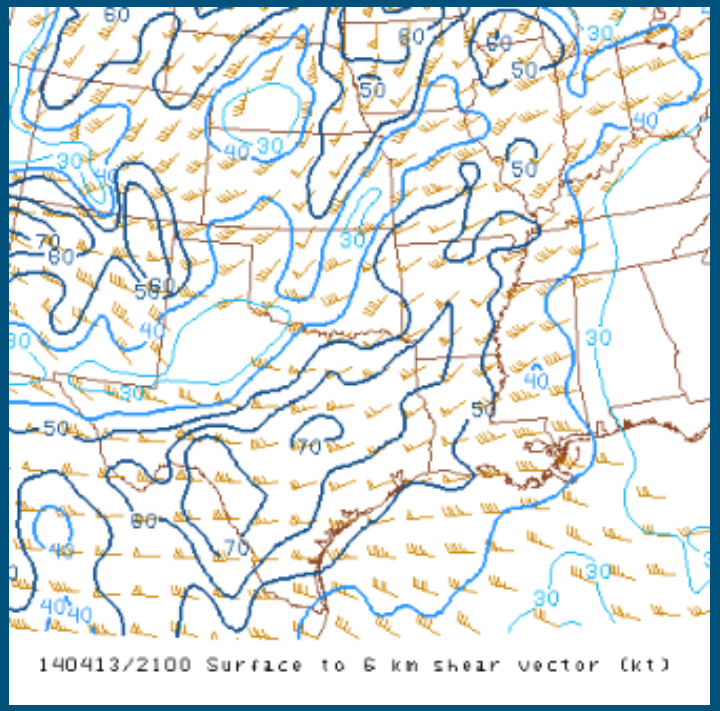
https://www.facebook.com/KTREnews/photos/pb.151420812993.-2207520000.1397441794./10152409004562994/?type=3&theater

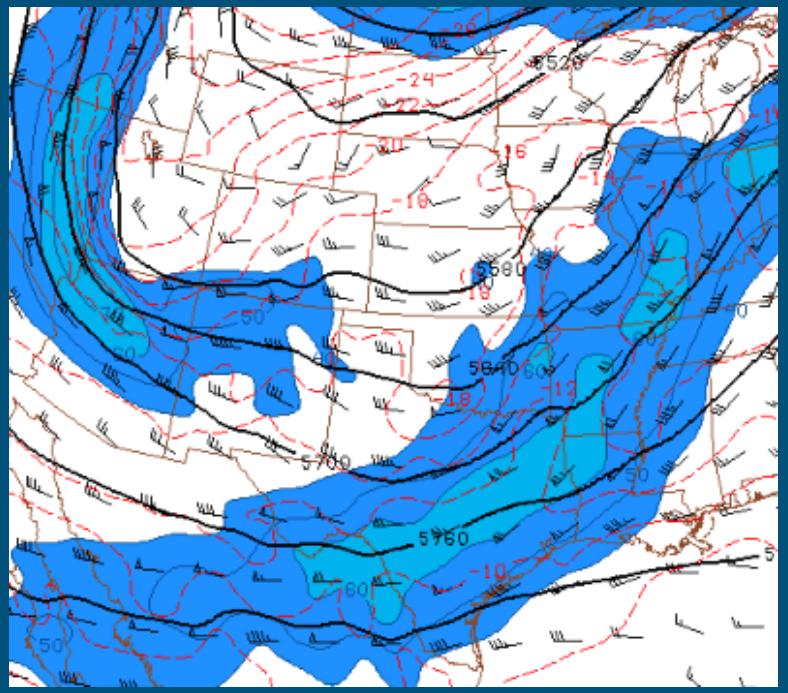
Video

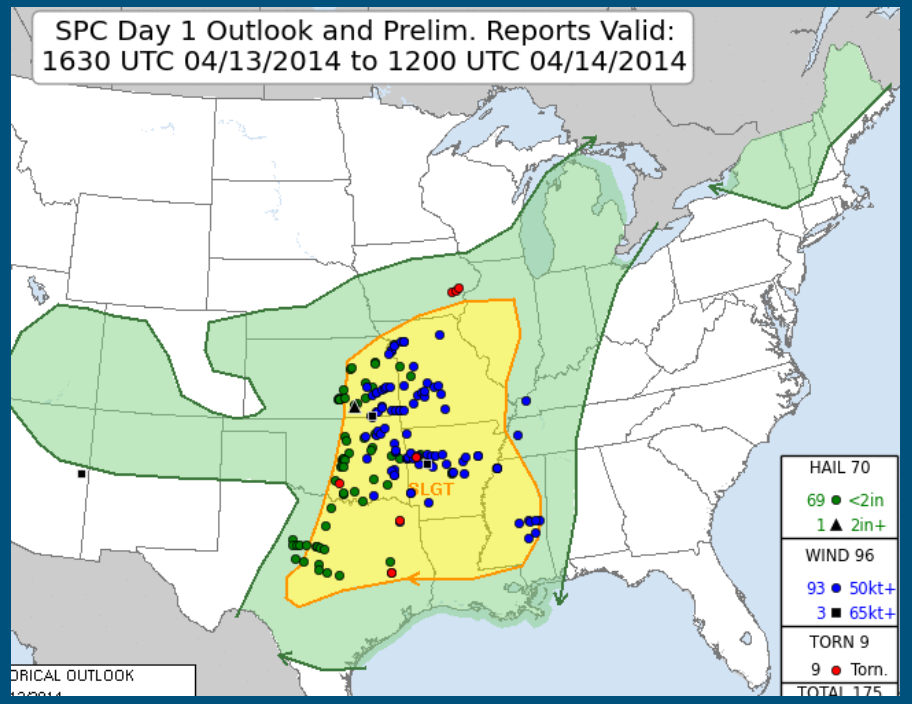
https://www.facebook.com/photo.php?v=794677480544760&set=vb.286917484654098&type=2&theater

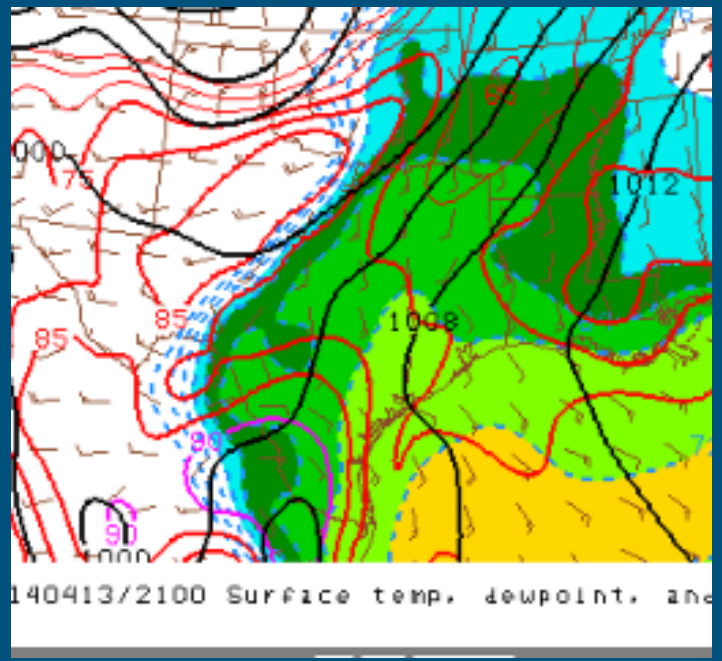
Factors/Considerations

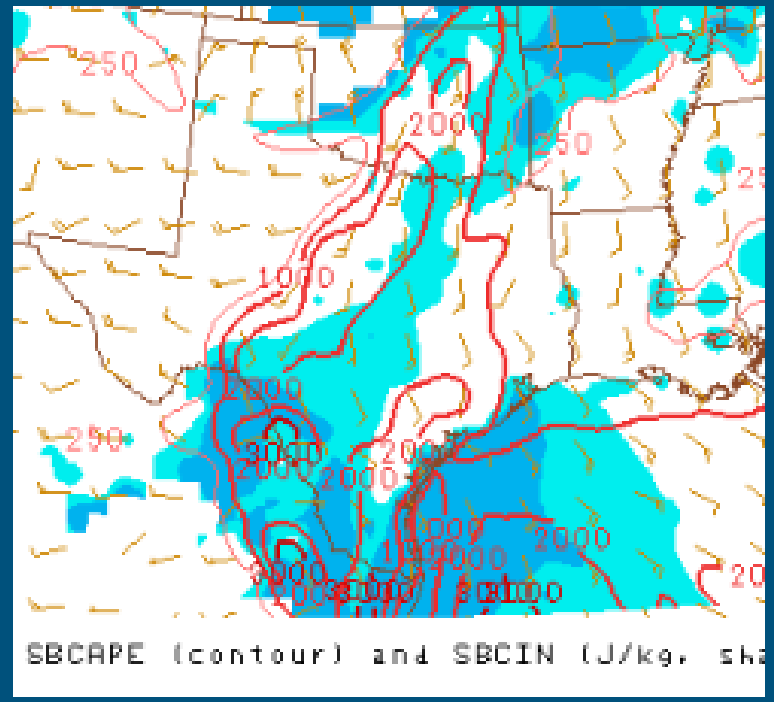
- Storm occurred in an area with poor radar coverage (height of lowest beam from nearest radar around 13,000 feet)
- Storm was apparently low-topped with peak reflectivity values for one volume scan around 30 dbZ on the lowest scan and no reflectivity max on the second cut (1.5 degrees around 23000 ft)
- No indication of a radar couplet at that distance (and barely even a precipitation echo!)

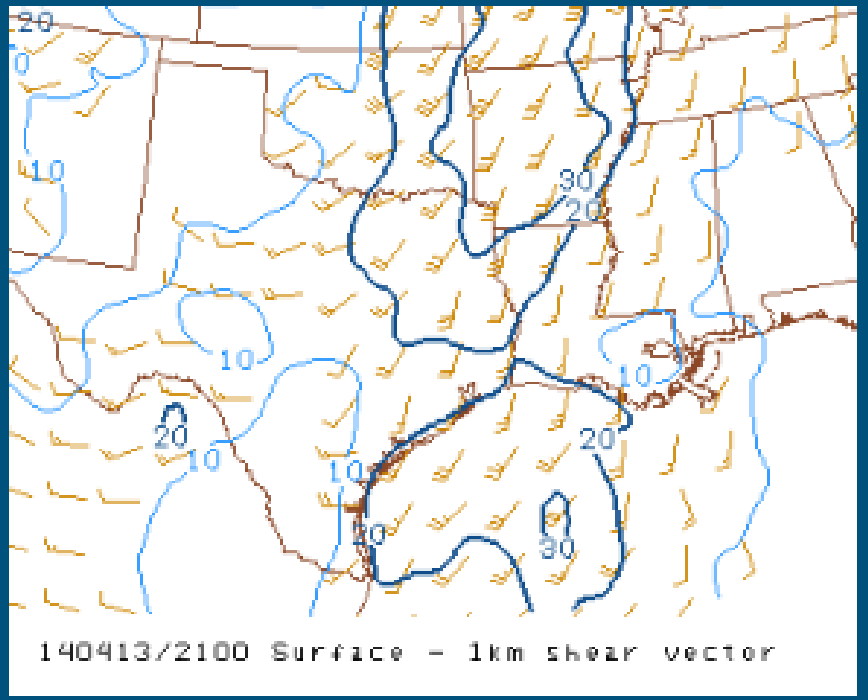

140413/2100 Surface to 6 km shear vector (kt)



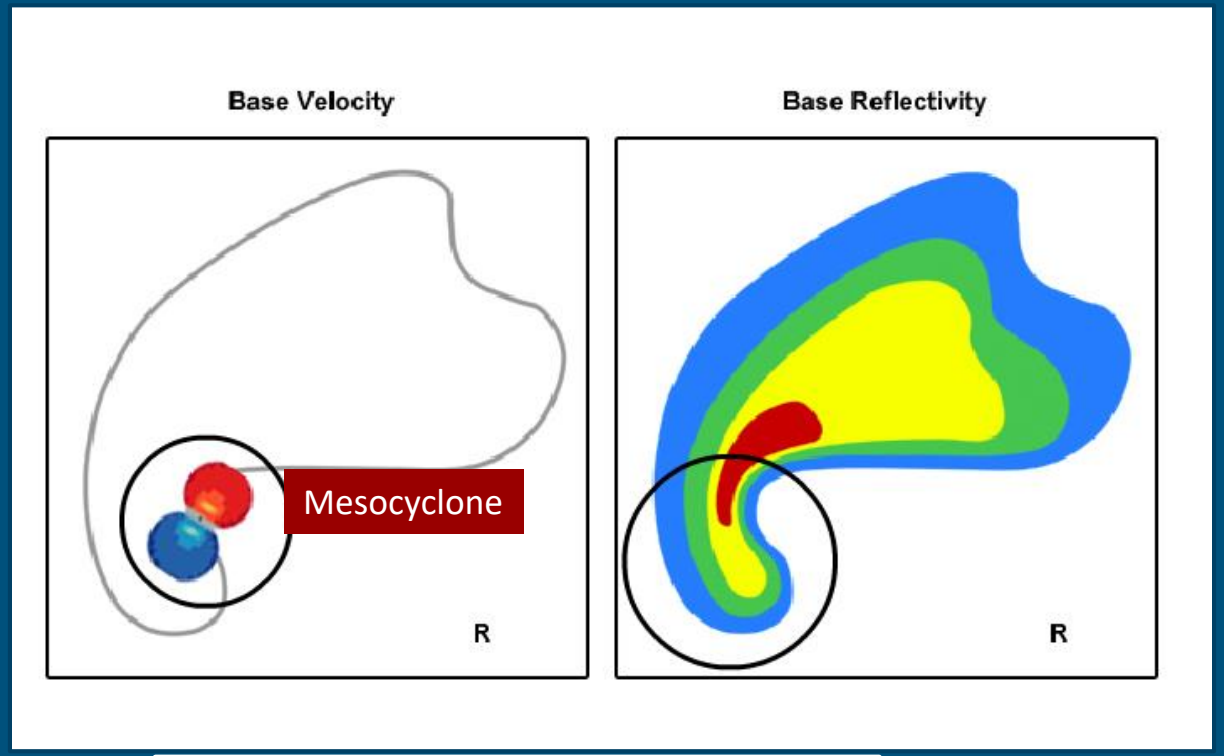

SPC Day 1 Outlook and Prelim. Reports Valid:
1630 UTC 04/13/2014 to 1200 UTC 04/14/2014
HAIL 70
69 ● <2in
1 ▲ 2in+
WIND 96
93 ● 50kt+
3 ■ 65kt+
TORN 9
9 ● Torn.
SLGT

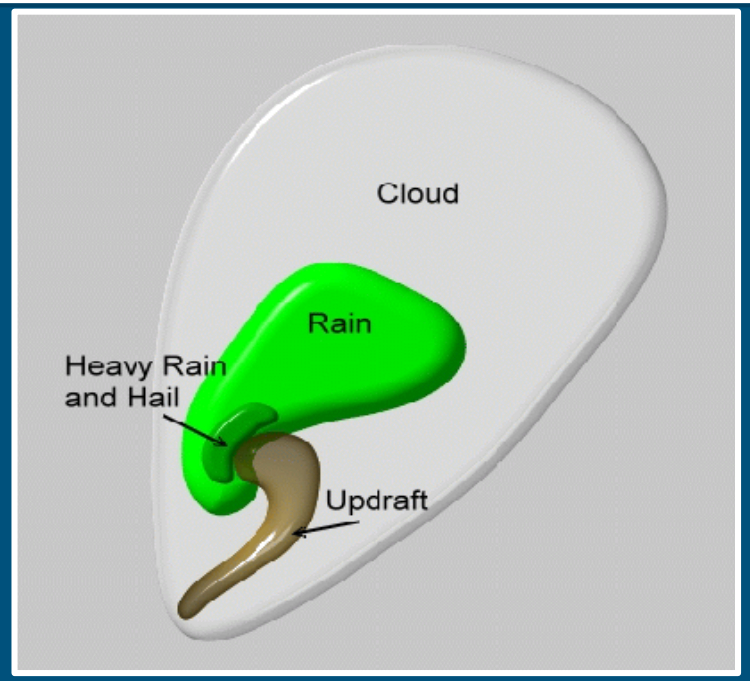

140413/2100 Surface temp, dewpoint, and

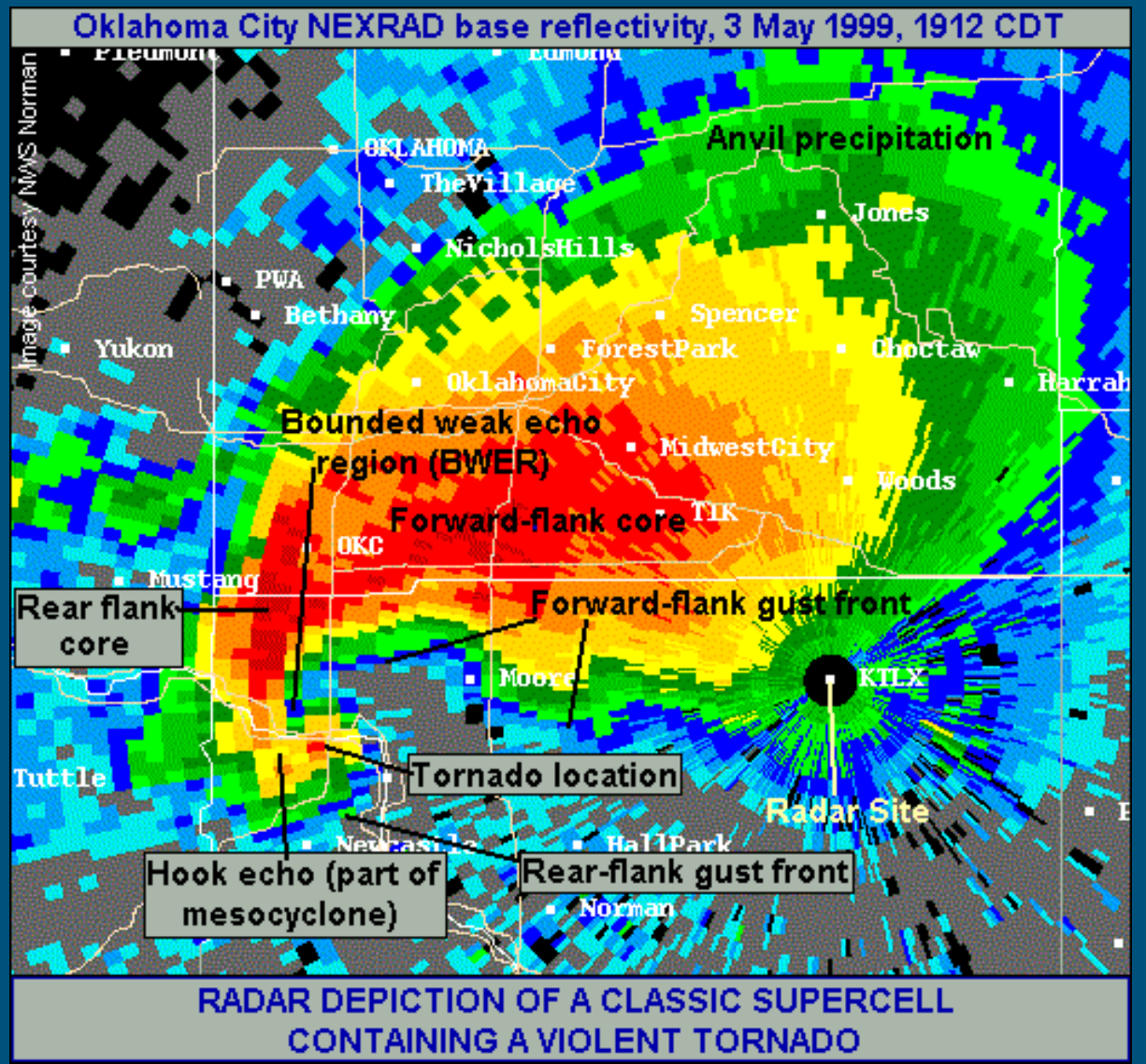

SBCAPE (contour) and SBCIN (J/kg, sha


140413/2100 Surface - 1km shear vector

What a supercell typically looks like on Doppler Radar: Wont see this at large distances

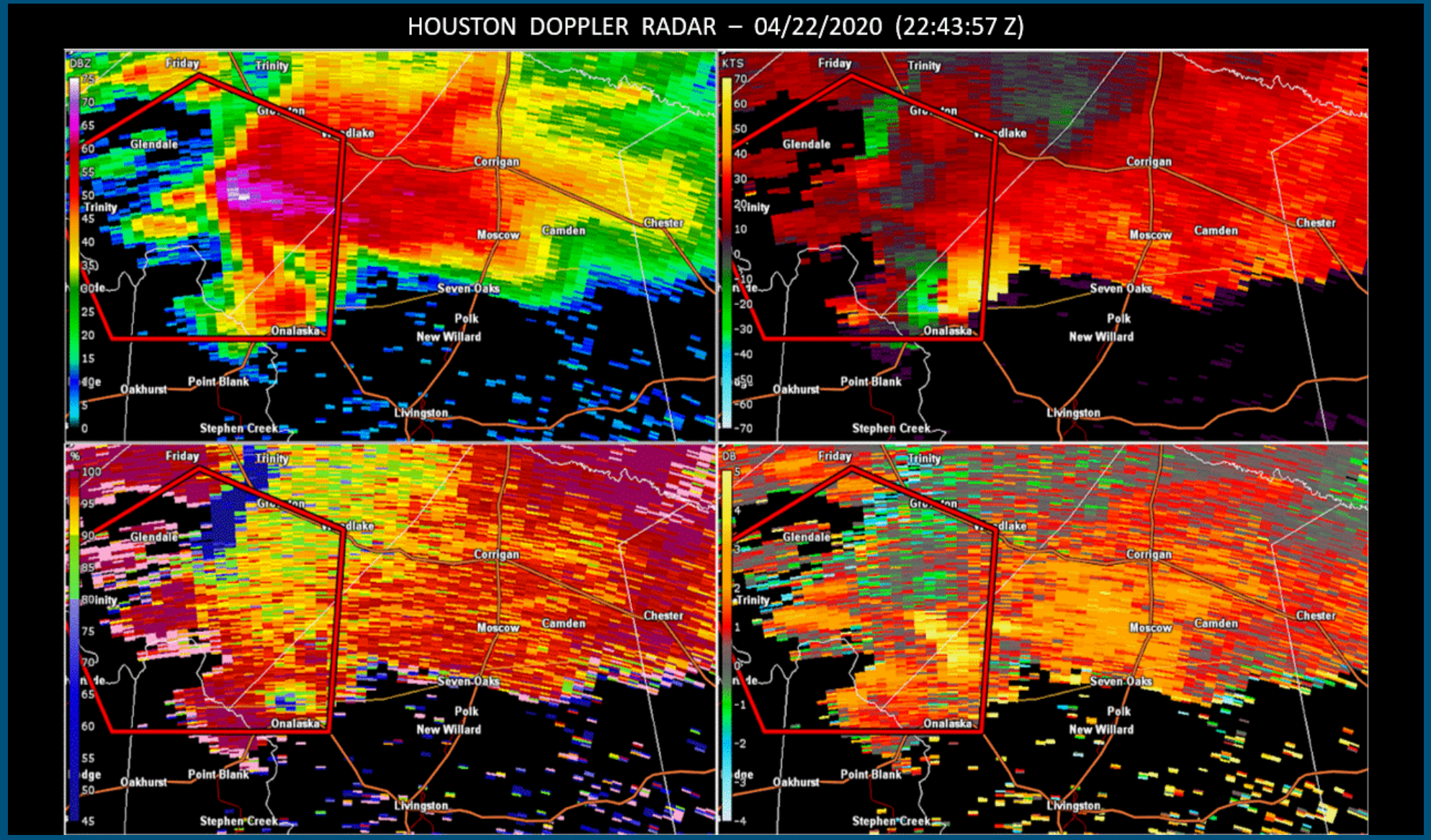




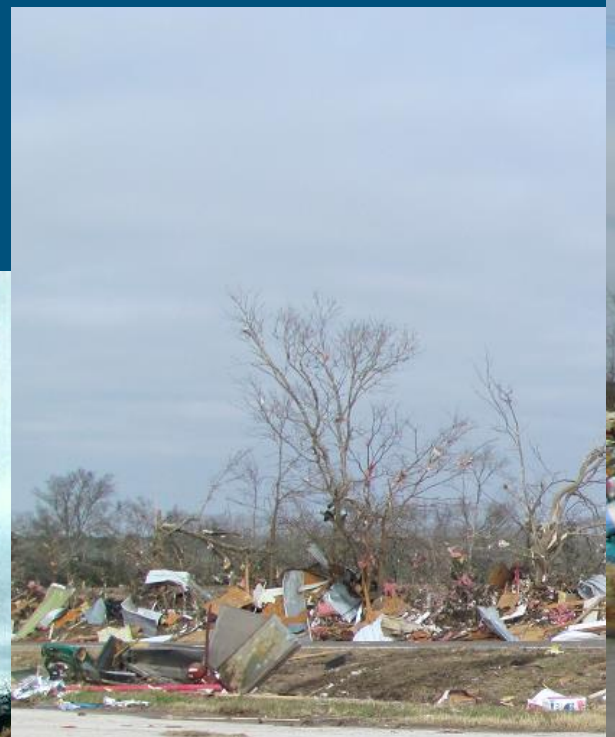


Onalaska/Polk County EF3 Tornado April 22nd, 2020

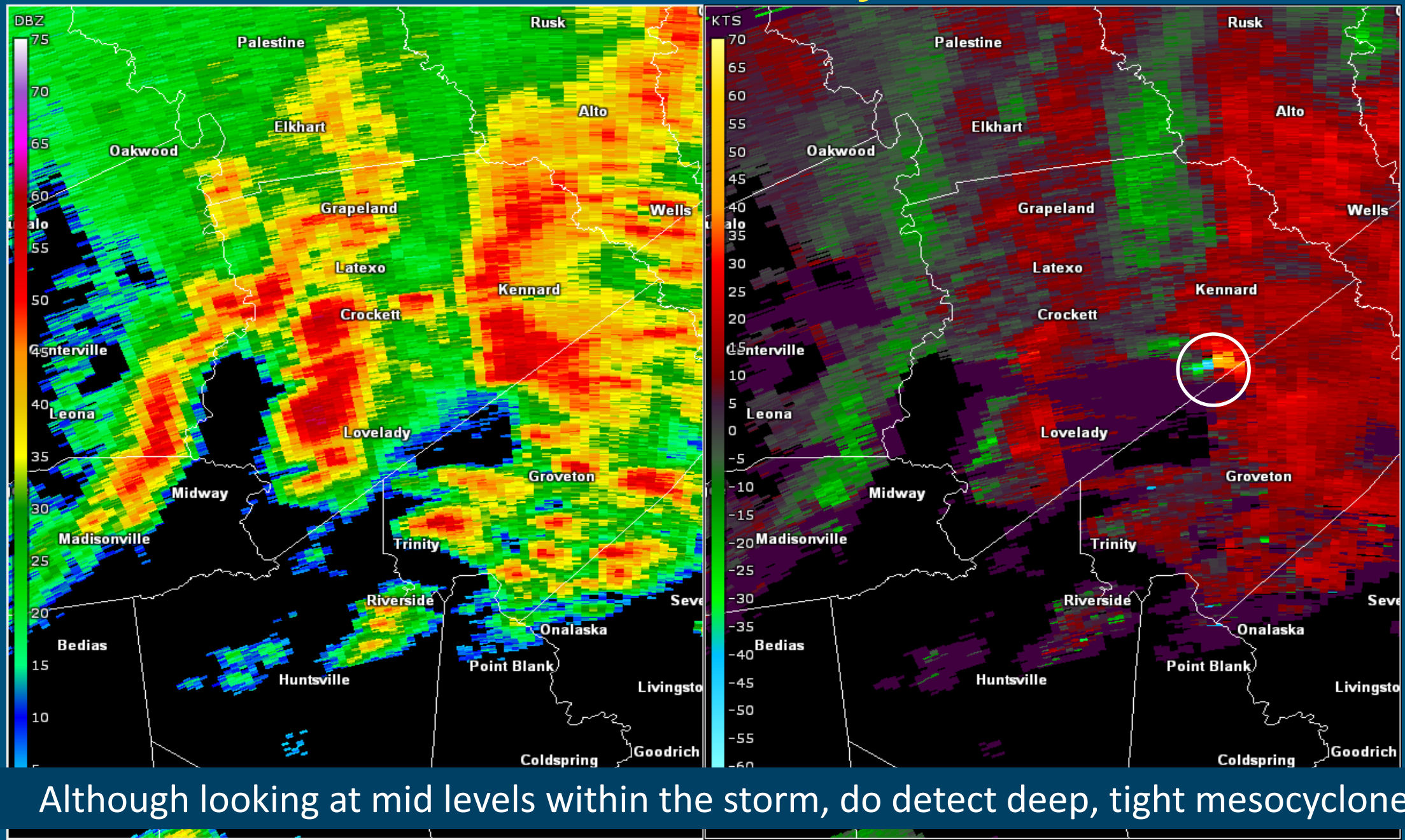
Can track these features as the tornadic supercell moves across Polk County



Pennington EF3
Dec 25th 2012



Find the Mesocyclone!



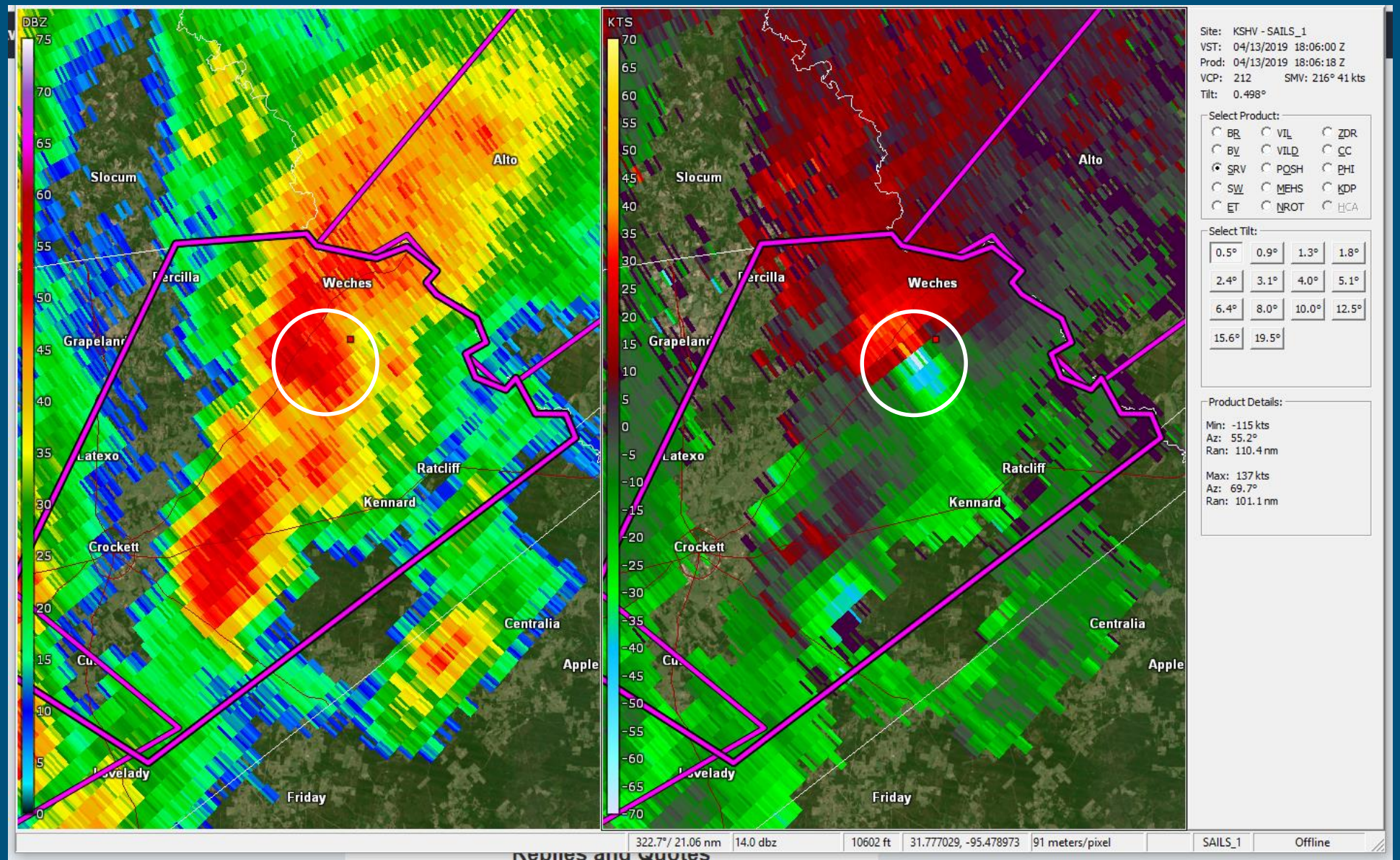
Although looking at mid levels within the storm, do detect deep, tight mesocyclone

April 13th, 2019 EF3 Tornado

West of Lovelady; Mobile home destroyed, man not home at the time

Photos Nikki Hathaway, Scott Overpeck, Dan Reilly

View from SHV Radar. Beam Height around 13000 feet AGL so hook echo not visible. Very strong meso aloft!



Summary

- Radar has significant limitations especially very close and far from the radar.
- Some measures to alleviate the coverage gap would be additional radars and/or lower elevation angle scans on existing ones. Has been a test program for cheaper radars on cell towers to fill gaps (CASA program, http://www.casa.umass.edu/, @casaradar .
- SHV has gotten permission and enabled a 0.3 degree scan. Currently seeing if similar action may be feasible for others.
- Lovelady 2014 was an extreme case with an EF1 tornado resulting from a low topped storm with no lightning and very little rain! Would be hard to detect that type of tornado with even a nearby radar.
- Weather spotters, communications from law enforcement to NWS forecast office become even more important in these situations. Those real time reports of funnel cloud/tornado vital!