WDTD/TWIP WOC Severe Proctor Notes
12 April 2020 Shreveport QLCS WES Case

Yet to Be Accomplished

1. Make sure all hyperlinks point to WDTD website (still awaiting some links on website)
2. Create optional mesoanalysis add-on section
3. Develop optional comms/IDSS add-on section

Training Objectives

After taking this WES case, you will be able to:

1. Assess the mesoscale and near-storm environment using observational and model-based tools to determine the relative risk of tornadoes, hail, and damaging wind gusts.
2. Issue accurate and effective warnings (TOR or SVR) and follow-up statements (SVS), with appropriate type, duration, size, shape, intensity, source, and update frequency.

Prerequisites

1. It is strongly recommended that those who are taking this case as a part of WOC Severe have taken all the modules of WOC Severe before taking the WES case.
2. TWIP modules

Materials Needed

1. WES box
2. PC
3. TWIP QLCS Mesovortex Warning System Reference Sheets
4. CWA maps

Optional Add-Ons

1. Surface/upper air analysis packet
2. COBRAS/PC warning assistant
3. Mesoanalysis
4. Comms/IDSS

Estimated Completion Time

1. Hazard assessment (30 minutes)
2. Warning simulation (2.25 hours w/ option to go 3.5 hours)
3. Debrief (15 minutes)

WES Prep Instructions

1. Log into the WES with the warning forecaster's AWIPS username and password.
    a. If only one screen is available on the WES, use these instructions to resolve the issue:
        i. Under Applications - Select System Tools then Settings
        ii. In the Setting POP Up window click on Devices
        iii. Select Displays
        iv. Make sure "Join Displays" is selected and that the two displays are set in the order 2 on the left and 1 on the right.
        v. Hit Apply
2. Under the "Applications" menu, click on the "WDTD" and then "WES-2 Bridge" options.
3. Once the large GUI opens, go to the "EDEX Instances" section near the bottom. Ensure that EDEX_00 is listed as "Active". If not, right-click on it and "Start EDEX".
4. If "2020Apr12SHV" is loaded, right-click on the case and select "Simulation". If it is not loaded, then do one of the following:
    a. In the EDEX Instance manager, see if a case is in EDEX_01 (you can hover the mouse over the EDEX_01 label). If it is empty, then right-click on "Simulation" to load the case and launch the simulation in one step.
    b. If any EDEX_02, EDEX_03, or EDEX_04 are empty, then ensure one of these is active and then right-click on the case and select "Load Case". Once it finishes loading, then right-click on the case and select "Simulation"
5. Click the box labeled "Remove warnings for the WFO"
6. Click the "Load Macro" button and select "WOC Severe FY21 Simulation" and click "OK".
7. Click "Simulate".
8. After a minute or two, a CAVE session, WESSL window and Simulation Controls should all launch. If not, close everything out and go back to step #2.
9. In the CAVE session, launch the Text Workstation.
10. Click on the "Play" button on the simulation controls and let it play for about 20 seconds. Then "Pause". Two Mozilla windows should have opened (SPC meso data and Outlooks). If you get an error with one of the windows, try and restart the WESSL. Worst case scenario is to restart the case. You need both windows for the hazards assessment portion of the case!
11. To open a second CAVE session, right-click on the EDEX that has the case and then select "Start CAVE". Then drag the CAVE to the right monitor.
12. If the time/date box is not red and matches the time in the other CAVE window, you might want to play the simulation for 15 seconds and then pause, or use the SYNC button.

COBRAS PC/Warning Assistant Instructions (optional)

1. Use the WOC Severe COBRAS Guide to prepare the COBRAS interface.
2. Download the SPC Mesoanalysis and SPC Products zip files. Proceed to follow these instructions to display these data sets on a PC.
3. Launch the following links into separate tabs in Google Chrome
    a. SPC Mesoanalysis data
    b. SPC/WFO products
    c. HREF page
    d. TWIP Mesovortex Warning System Reference Sheets
4. GR2 Settings
    a. Turn off LSR Icons.
    b. Turn off Warnings.

Note: If pausing throughout the simulation, please remember to pause and unpause both the WES box and COBRAS!

Start of WES Case

Part 1 - Hazard Assessment (30 minutes)

1. Begin with the introduction module, which provides an overview of the case.
2. Give the student 15-20 minutes to load and examine the synoptic and mesoscale environment for the SHV CWA. They should focus on the current time through 16 UTC. They can use:
    a. AWIPS procedures and perspectives
    b. Forecast soundings
    c. SPC meso page
    d. CAM output
3. Ask student to provide expectations, hazard assessment (Marginal, Slight, Enhanced, Moderate, High), and reasoning for:
    a. Damaging winds
    b. Hail
    c. Tornadoes
    d. Flooding

Broad longwave trough moving off the Rocky mountains, sharper shortwave trough moving into TX/OK with a 125kt jet maximum rounding the base of the trough broadening into a highly diffluent zone over eastern TX/LA/AR. Lower-level cyclone spinning up centered over northeastern Texas with height gradients leading to 50+ kt 850 mb south southwesterlies. Surface cyclone centered slightly east of the 850 mb low with a warm front stretched eastward over northern LA/southern AR and into central MS. Surface cold front from the low to areas east of Del Rio, TX. Surface dewpoints are in the low to mid 70s across TX and south LA and into the mid 60s across northern LA and northeast TX.

12z soundings show a strong capping inversion around 800mb with rich boundary layer moisture below that. Very steep mid level lapse rates around 8 deg C/km are apparent yielding around 800 J/kg of MLCAPE on the observed sounding. PWAT values are around 1.50" with relatively high humidity apparent through the column. Low level shear is strong as expected with 0-1 km SRH values around 220 m2/s2 with a 0-1 km shear vector of 25 kts, but short term models show the low level height gradient strengthening since the 12z observations (which makes sense given the synoptic situation) and project a 0-3 km shear vector of 50-60 kts from about 210 degrees. That trend can be verified on the KSHV VWP. Deep layer shear is also strong at about 60-70 kts.

A robust convective line is apparent at 13z with local bowing segments, inflow notches, line breaks, and mesovorticies apparent on radar. Moderate to heavy precip is

also apparent along and just south of the warm front. The line is translating along fairly quickly with a modest stratiform region behind it.

The damaging wind potential appears enhanced/moderate, due to the particularly strong low level shear and the robust convective line with local acceleration processes already apparent.

The hail potential appears slight/enhanced, with strong deep layer shear and steep mid level lapse rates, but no clear supercell/discrete cell structures apparent, and a strong capping inversion over the warm sector would presumably keep it that way, with only the strong forcing along the line breaking through the cap.

The tornado potential appears moderate. The 0-3 km shear vector is oriented nearly perpendicular to a few segments of the ongoing line, and rear-inflow jet/inflow notches and mesovorticies are already apparent on radar conditions appear favorable for QLCS tornadoes.

Flooding appears to be a slight threat, mainly along the areas where moderate to heavy rainfall along the warm front is falling now with the convective line, and additional stratiform following precip expected to be an issue.

4. Discuss radar setting strategies going into this event

With more radar scanning strategy options than ever at our disposal, it is critical to employ the best VCP and supplemental scan options. VCP 12 or 212 are obvious choices for severe convection, however there are important subtleties to consider. The fastest VCP is 12, with a full volume collection clocking in at just under four and a half minutes without any supplement scans. A challenge with VCP 12 is range folding interfering with radar interrogation in a random fashion, resulting in reactive changes to PRF or changing to VCP 212. VCP 212 employs the SZ-2 technique to assist in managing the location of range folding. As a result, VCP 212 is slower, but just how much slower depends on use of AVSET, PRF setting and the low level scanning strategy employed. As an example, assuming a full volume collection employing SAILS 2, VCP 12 takes five minutes and five seconds to complete. The same scan in VCP 212 can take as short as five minutes and 25 seconds, or as long as nearly six minutes and 30 seconds.

Supplemental low level scans are a major upgrade to WSR-88D surveillance. Multiple Elevation Scan Option for Supplemental Adaptative Intra-Volume Low-Level Scan, otherwise known as MESO SAILS, and Mid-Level Rescan of Lower Elevations, or MRLE, offer more frequent scans of the lowest elevation slice or the lowest four elevations slices respectively. These are powerful options that require careful consideration. The choice of VCP and low level scanning strategy needs to balance several items that may sometimes be conflicting. What information is needed most? What are the primary hazards? Where are the most dangerous storms located? What information is missing that you need? Are you interrogating a QLCS, supercells, or both?

Does mesoanalysis offer any additional clues – for example LCL heights? There will not always be a clear cut best answer, however situational awareness and frequent conversations with the warning forecaster will facilitate employing the best possible options in the moment.

The image provided below provides a baseline recommendation of low level scanning strategy based on distance from the radar. Farther away from the radar, at and beyond 60nm, use of SAILS 2 or 3 or MRLE 2 is a great place to start. As convection of concern approaches 40nm from the radar, consideration for MRLE 3 or 4 is recommended. And as convection of concern moves within 20nm of the radar, MRLE 4 is recommended.

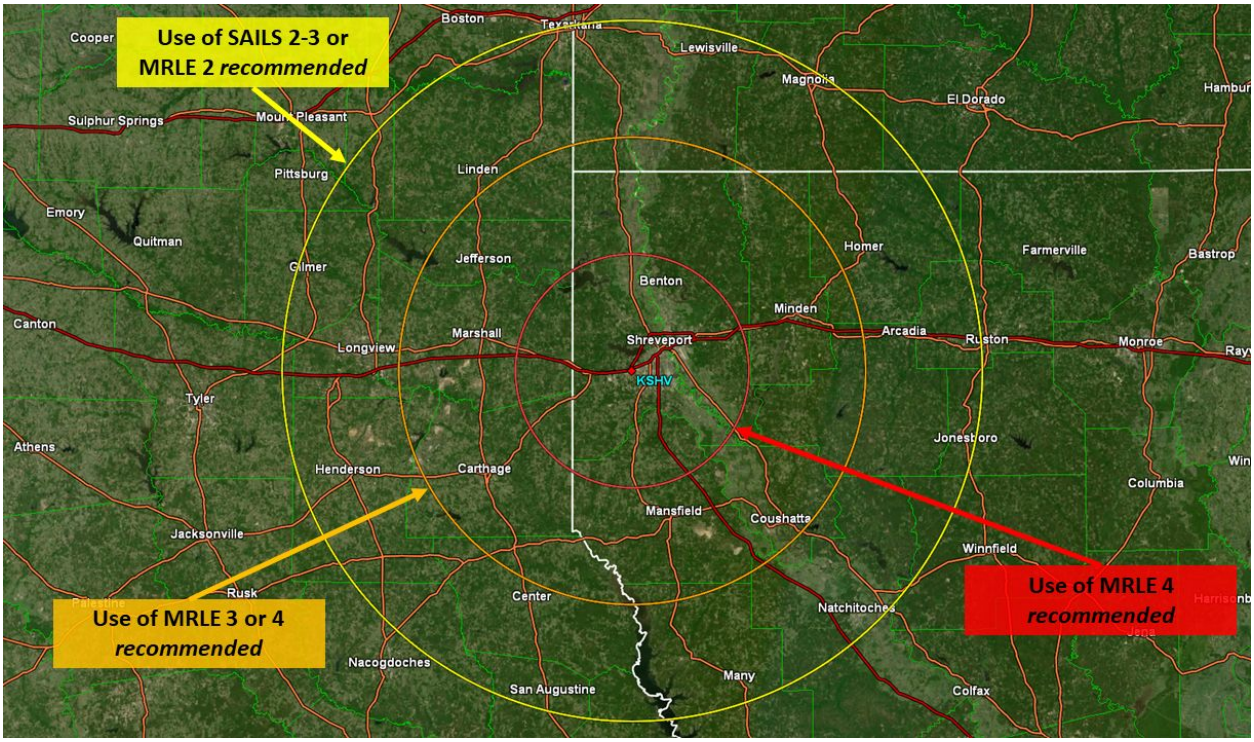

Figure 1: MRLE and SAILS range ring guidance based on 0.5° tilt for KSHV.

In this case our primary concern is a quasi linear convective system. Our conceptual model indicates the need to monitor the updraft downdraft convergence zone, developing and descending rear-inflow jets, and given 0-3km wind shear profiles, the most common level of mesovortex production which is ~1km AGL. The pictured scanning strategy works well for an event like this. Use of SAILS 2-3 from 60nm on out will provide a good look at the lowest scan or two to monitor signs for any mature mesovorticies, but is fast enough to maintain a good temporal resolution of features higher in the atmosphere, such as the rear inflow jet. As convection moves closer to the radar, the lowest scan focuses lower and lower in the atmosphere, to the point where the lowest scan is below the level for mesovortex genesis and even below the cloud base. As a result, employing MRLE 3 or 4 is best within 40nm as it will maintain a more frequent scan in this key area. In a situation like this, use of SAILS 2 or 3 within 40nm of the radar will provide frequent scans of the lowest elevation, however this is at expense of

surveillance of the mesovortex genesis region which, depending upon VCP, results in new imagery at this level only updating every 5 to 7 minutes. This is a very long time in the world of mesovortex genesis.

5. Discuss warning strategies going into the event
    a. 0-3 km bulk shear vector magnitude and orientation to meet three ingredients method

The RAP13 analysis and short term forecast indicates the following:

- **13 UTC: 0-3 km bulk shear vectors of 35-40 knots towards the northeast**
- **14 UTC: 0-3 km bulk shear vectors of 40-55 knots towards the northeast**
- **15 UTC: 0-3 km bulk shear vectors of 40-55 knots towards the northeast**

The following guidance can then be applied for 0-3km bulk shear vector magnitudes:

- **35 knot magnitude: Vector must be aligned within 30° of line-normal wrt UDCZ**
- **40 knot magnitude: Vector must be aligned within 40° of line-normal wrt UDCZ**
- **45 knot magnitude: Vector must be aligned within 50° of line-normal wrt UDCZ**
- **50 knot magnitude: Vector must be aligned within 53° of line-normal wrt UDCZ**
- **55 knot magnitude: Vector must be aligned within 55° of line-normal wrt UDCZ**

    b. Mesoscale confidence builders and nudgers that are present

A surface warm front is in the vicinity, which is a confidence builder. Low-level CAPE (0-1 km ML parcel lifted to 3 km) is a bit more in question. The 12 UTC KSHV sounding (shown below) indicates no low-level CAPE with the RAP (not shown) also indicating limited amounts. In contrast, the HRRR (not shown) does indicate 50-100 J/kg of low-level CAPE in the 14-15 UTC time frame returning north with the surface warm front. Areas from just north of the front, south into the warm sector may therefore satisfy the 40 J/kg threshold needed to satisfy this tornado warning nudger.

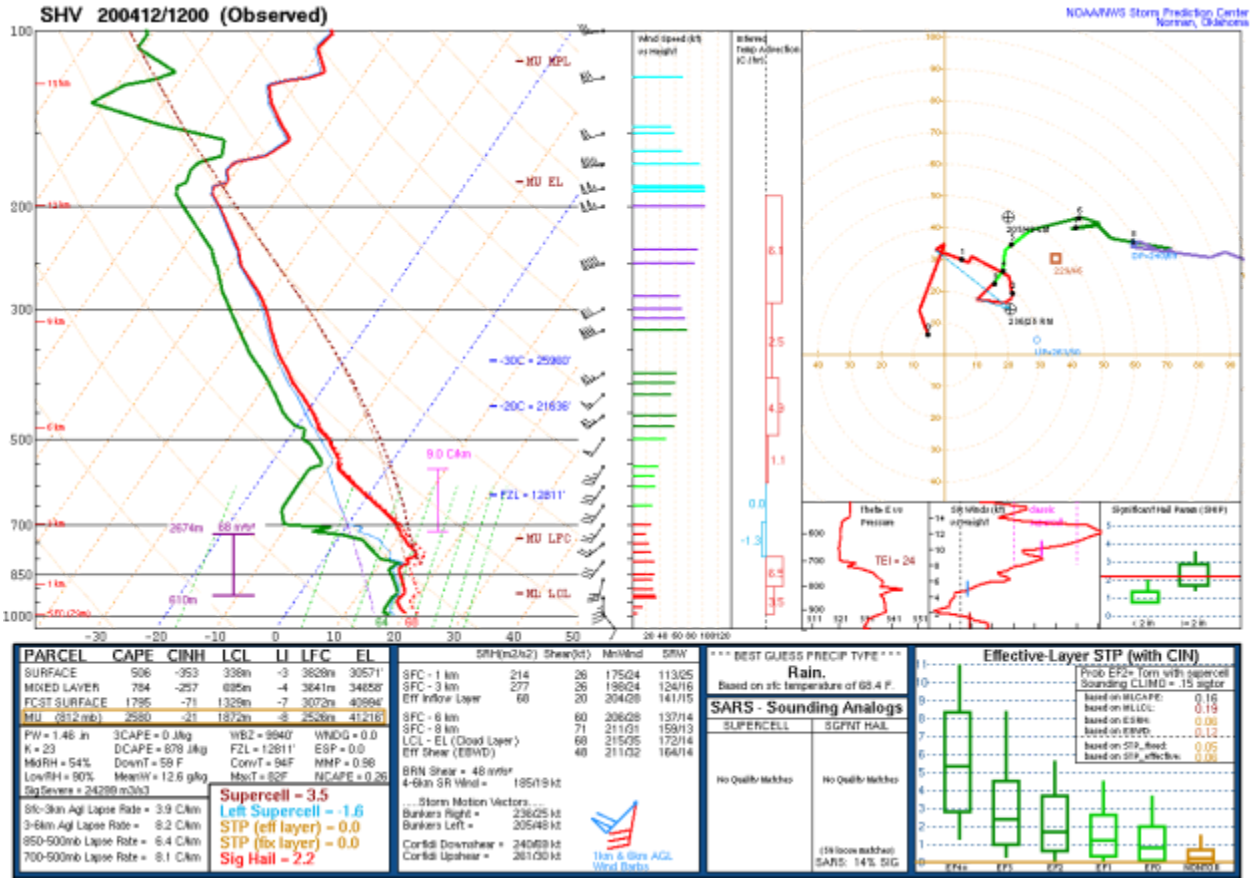

Figure 2: KSHV sounding at 12 UTC on 12 April 2020.

c. Polygon strategies

Given expectations for a fast moving QLCS capable of wind damage and tornadoes, the following polygons strategies are recommended:

- **SVRs (including TOR Possible)**
  - **Suggest warning duration of 45-60 minutes. Stay ahead of the line!**
  - **Use of 70 mph (or higher) wind options may be needed given environment and expectations for a mature QLCS**
  - **Segment lines to group similar intensities and to keep the number of locations/counties manageable**
  - **Polygons should be snapped back to western extent of counties/parishes, when the overlap into the next county is small**
- **TOR**
  - **Embedded in SVRs**
  - **Southern extent should extend just south of bow/surge apices**

- **Northern extent should account for northward migration of mesovortices up the UDCZ. This behavior should be anticipated given the presence of shear dominant regimes!**
- **Polygons should be snapped back to western extent of counties/parishes, when the overlap into the next county is small**

Part 2 - Warning Simulation (2.25 hours w/ option to go 3.25 hours)

1. Warning Forecaster - will be required to issue SVR, SVS, and TOR products. This includes proper usage of tags and IBW options.
2. Optional Warning Assistant - use GR2 and SPC meso data to help perform warning support duties.
3. Start the WES case and optional COBRAS. If using COBRAS, try and start it about 15 seconds after the WES to simulate a slight data lag. Keep in mind that the entire radar volume scan loads simultaneously with GR2 simulations versus data arriving slice by slice in AWIPS.

Pre-Simulation Radar Notes

1300 to 1315 UTC

- Well established QLCS across eastern TX from Longview to Crocket with four embedded bowing structures
- Warm front lifting north through southwestern CWA and appears to intersect the bow echo in Cherokee County
- Three ingredients being met near and north of each bow apex
    - Bows present
    - Balanced near apex and slightly shear-dominant north of apex
    - Line-normal component of 0-3 km bulk shear >= 30 knots
- Entry point present on Cherokee/Rusk County bow given that the UDCZ curls back into the updraft towers (goes from balanced to slightly shear dominant)
- Most bows contain enhancing surges given that they are accelerating and pivoting. Southernmost bow may be a bit too far away to determine enhancing characteristics.
- Descending RIJ/Reflectivity drop in trailing stratiform region on both bows
    - 1305 to 1310 UTC on Gregg/Rusk County bow
    - 1310 and 1315 UTC on Cherokee/Rusk County bow
- Reflectivity tags moving up the line
- A weak mesovortex also develops briefly in northeastern Cherokee County, however it does not reach the 25-kt V_{rot} threshold

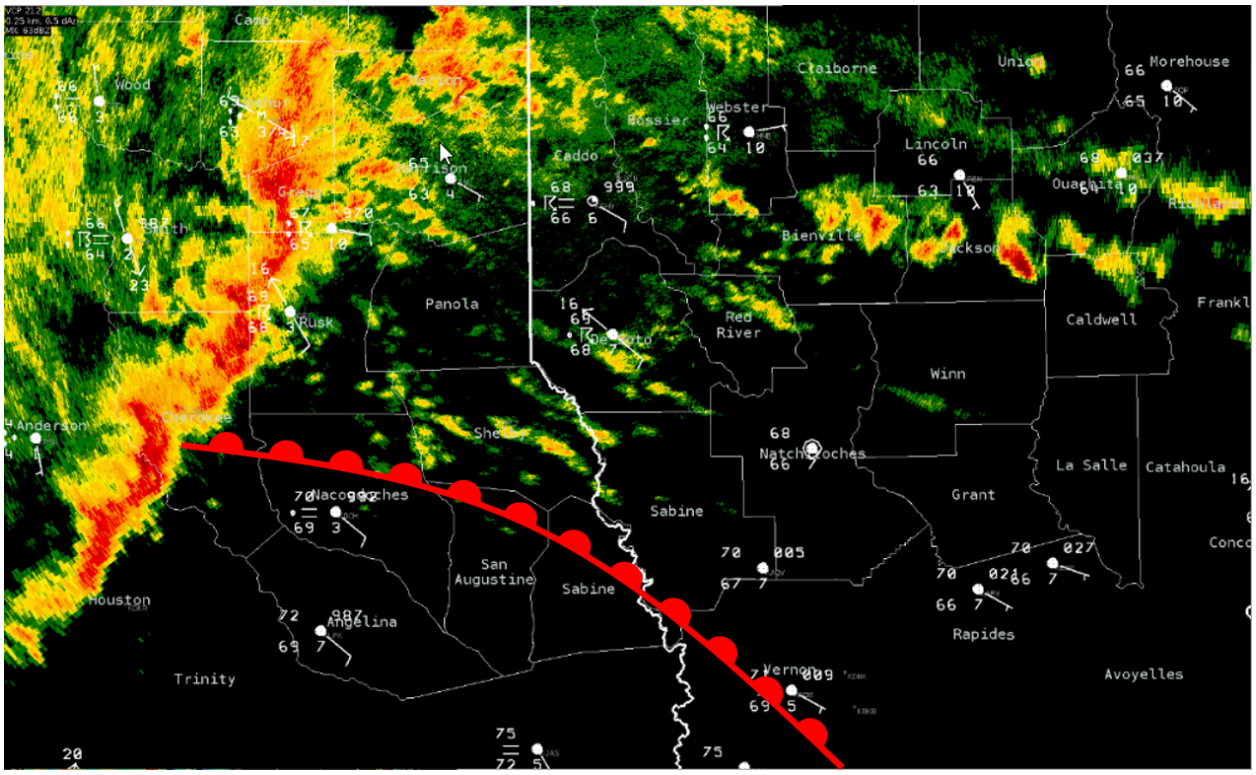

Figure 3: 13 UTC composite radar image with surface observations and approximate warm front overlaid.

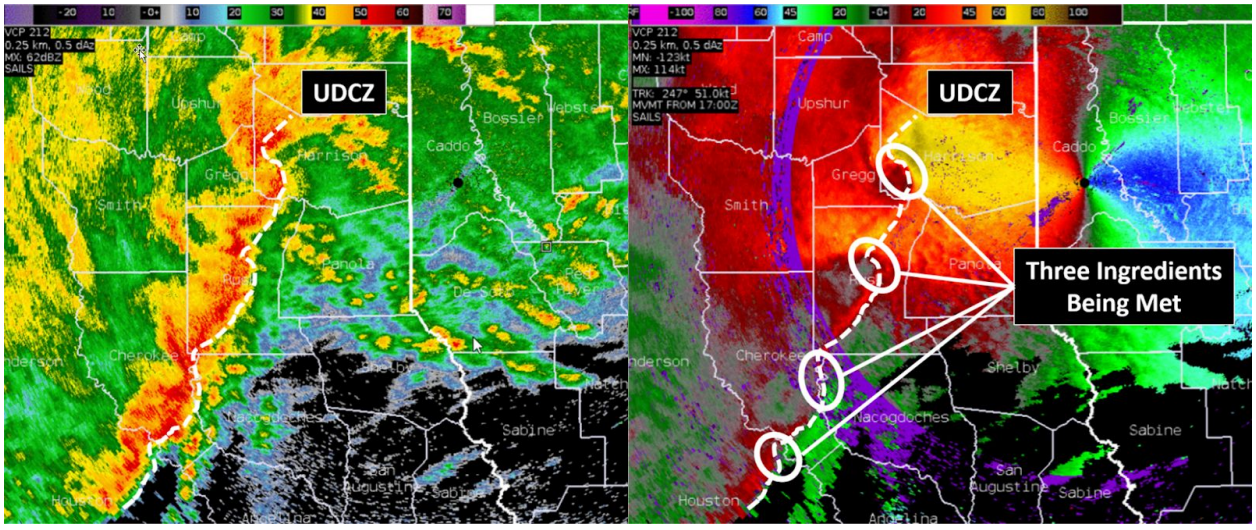

Figure 4: KSHV 0.5° Z/SRM combo at 1314 UTC. The updraft/downdraft convergence zone (UDCZ) is depicted by a white dashed line in both products. White ovals highlight areas where the three ingredients are being met within the SRM product.

1315 to 1330 UTC

- Warm front continues to slowly lift north
- Four bowing structures still present with the three ingredients present for all bows
- A paired front/rear inflow notch appears on the bow near Henderson in Rusk County
- All bows continue to enhance with some acceleration now noted in bow over eastern Houston County
- A weak mesovortex also becomes apparent just north of Henderson

Simulation Radar Notes and Suggested Warning Decisions

1330 to 1345 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1330	SPC	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook
1330	SPC	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso
1331	1"	South Monroe	OUACHITA	LA	32.46	-92.09	(Ouachita Parish, LA) A Monroe resident calls to report quarter size hail falling at their residence in South Monroe.	Hail
1332	1"	3 SSW LAKEPORT	RUSK	TX	32.36	-94.72	(Rusk County, TX) Amateur radio is reporting quarter size hail 2 miles south of the East Texas Regional Airport 3 miles SSW of Lakeport.	Hail
1342	UNK	Price	Rusk	TX	32.13	-94.93	(Rusk County, TX) Local Law Enforcement reports a tree down on State Hwy 42 just north of Farm Road 13 near Price.	Wind

- Warm front continues to slowly lift north through southwestern CWA
- Four bows persist within a north to south line echo wave pattern (LEWP)

Recommended action: Issue large SVRs with TOR possible to initially cover the entire north to south portion of the line coming out of eastern Texas.

- Harrison County Bow
    - Three ingredients are being met

- Descending RIJ/Reflectivity drop punches into southwestern Harrison County
- Enhancing surge given accelerating characteristics
- Entry point becomes apparent around Longview
- Reflectivity tags moving up the line
- Multiple cell mergers occur between 1335 and 1345 UTC. These cells likely developed in partial response to a descending RIJ increasing convergence near and ahead of the UDCZ.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: TOR with radar indicated option given the presence of three ingredients along with three confidence builders and two nudgers.							

- Eastern Rusk/Extreme Western Panola County bow
  - Three ingredients are being met
  - Descending RIJ/Reflectivity drop occurs in western Rusk County
  - Enhancing surge given accelerating and pivoting characteristics
  - Entry point north of Henderson
  - Reflectivity tags moving up the line
  - Multiple cell mergers occur between 1335 and 1345 UTC. Merging cells likely developed in partial response to a descending RIJ increasing convergence near and ahead of the UDCZ.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: TOR with radar indicated option given presence of three ingredients along with three confidence builders and two to three nudgers.							

- Rusk/Nacogdoches County bow
    - Three ingredients are being met
    - Descending RIJ/Reflectivity drop - occurs west of Cushing
    - Entry point becomes apparent closer to 1345 UTC around Cushing
    - Multiple cell mergers occur between 1335 and 1345 UTC. These cells likely developed in partial response to a descending RIJ increasing convergence near and ahead of the UDCZ.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: TOR with radar indicated option is the best option. Could also go SVR w/ TOR possible with a quick upgrade to TOR if more confidence builders/nudgers emerge.							

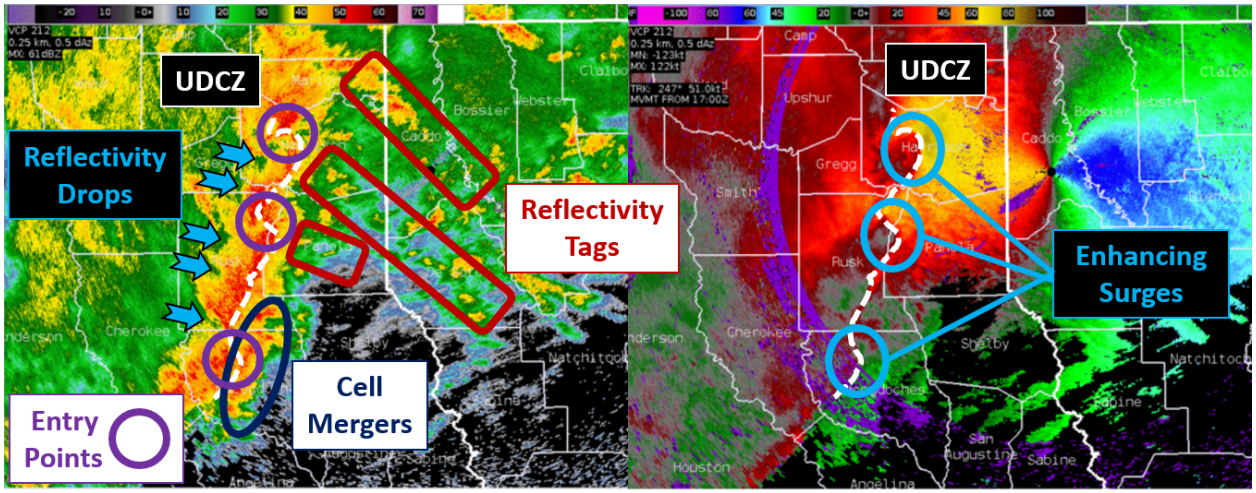

Figure 5: KSHV 0.5° Z/SRM combo at 1344 UTC with the UDCZ depicted by a white dashed line in both products. Multiple tornado warning confidence builders and nudgers are highlighted in the reflectivity product including reflectivity drops (cyan arrows), entry points (purple circles), reflectivity tags (red boxes), and cell mergers (navy blue oval). Enhancing surges are highlighted by cyan ovals in the SRM product.

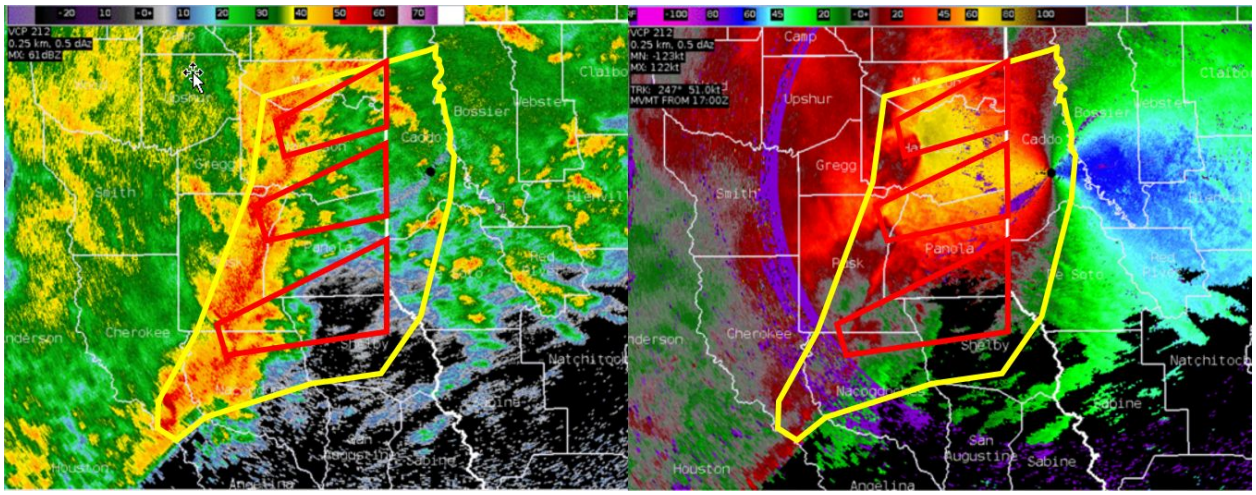

Figure 6: KSHV 0.5° Z/SRM combo at 1344 UTC with proposed a Severe Thunderstorm Warning (yellow polygon) and Tornado Warnings (red polygons). Note how warnings were truncated at state, county, and parish lines when possible.

1345 to 1400 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1357	SPC	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso
1358	SPC	SPC	SPC	SPC	SPC	SPC	If you have a separate mesoanalyst for this event, you may let them know it is ok to open the 14Z SPC Mesoanalysis now	SPC

- The warm front continues to lift north and appears to be intersecting the bow entering western Shelby County
- Three distinct bows persist within a north to south line echo wave pattern (LEWP).
- Harrison County bow
    - Three ingredients are being met
    - Descending RIJ/Reflectivity drop west of Marshall in Harrison County
    - Enhancing surge continues given that the UDCZ is accelerating forward with slight cyclonic pivots
    - Entry point still present given that the UDCZ converts from balanced to slightly shear dominant north of bow apex
    - Reflectivity tags moving up the line
    - Multiple cell mergers continue

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Continue TOR with radar indicated option.							

- Eastern Rusk/Panola County bow
    - Three ingredients are being met
    - Descending RIJ/Reflectivity drop west of Henderson in Rusk County
    - Enhancing surge continues given that the UDCZ is accelerating forward with slight cyclonic pivots
    - Entry point still present given that the UDCZ converts from balanced to slightly shear dominant north of bow apex
    - Reflectivity tags moving up the line
    - Multiple cell mergers continue

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Continue TOR with radar indicated option.							

- Rusk/Nacogdoches/western Shelby County bow
    - Three ingredients are being met
    - Descending RIJ/Reflectivity drop near Mount Enterprise in southern Rusk County
    - Enhancing surge becomes apparent given that the UDCZ is accelerating forward with slight cyclonic pivots
    - Entry point still present given that the UDCZ converts from balanced to slightly shear dominant north of bow apex

- A weak mesovortex becomes apparent in extreme southeastern Rusk County, but does not meet the 25 knot Vrot threshold to qualify as a confidence builder
- Multiple cell mergers occur between 1335 and 1345 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Continue TOR (or upgrade to TOR if you previously had a SVR out). Use a radar indicated tornado option.							

1400 to 1420 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1401	UNK	Church Hill	Rusk	TX	32.19	-94.67	(Rusk County, TX) The Rusk County Emergency Manager reports a tree down across Farm to Market Road 1251 3 mi east of state hwy 43 near Church Hill.	Wind
1406	UNK	1 SE TIMPSON	SHELBY	TX	31.89	-94.38	(Shelby County, TX) A storm chaser calls to report a tornado 1 mile southeast of Timpson.	Tornado
1410	UNK	7 S SCOTTSVILLE	HARRISON	TX	32.43	-94.23	(Harrison County, TX) You see a live video stream of a tornado 7 miles south of Scottsville on your SA display.	Tornado
1410	UNK	3.4 NW Elysians Fields	HARRISON	TX	32.4	-94.23	(Harrison County, TX) Law Enforcement reports a tree down on Woodly Rd. 3.4 miles northwest of Elysian Fields.	Wind
1412	UNK	7 SSE SCOTTSVILLE	HARRISON	TX	32.44	-94.22	(Harrison County, TX) A storm chaser calls to report a tornado 7 miles south-southeast of Scottsville.	Tornado
1414	UNK	8 WSW WASKOM	HARRISON	TX	32.42	-94.19	(Harrison County, TX) Amateur radio reports large tree limbs broken 8 miles	Wind

							west-southwest of Waskom.	
1417	UNK	5 WNW WASKOM	HARRISON	TX	32.49	-94.14	(Harrison County, TX) A storm chaser calls to report a tornado is now 5 miles west-northwest of Scottsville.	Tornado
1418	UNK	4 miles NNE Elysian Fields	HARRISON	TX	32.42	-94.16	(Harrison County, TX) An NWS employee calls to report a tree downed onto a power line on Strickland Springs Road South, 4 miles north-northeast of Elysian Fields.	Wind

- Warm front continues to lift north and appears to be interesting the bow moving into western Shelby County
- LEWP persists with three distinct bows

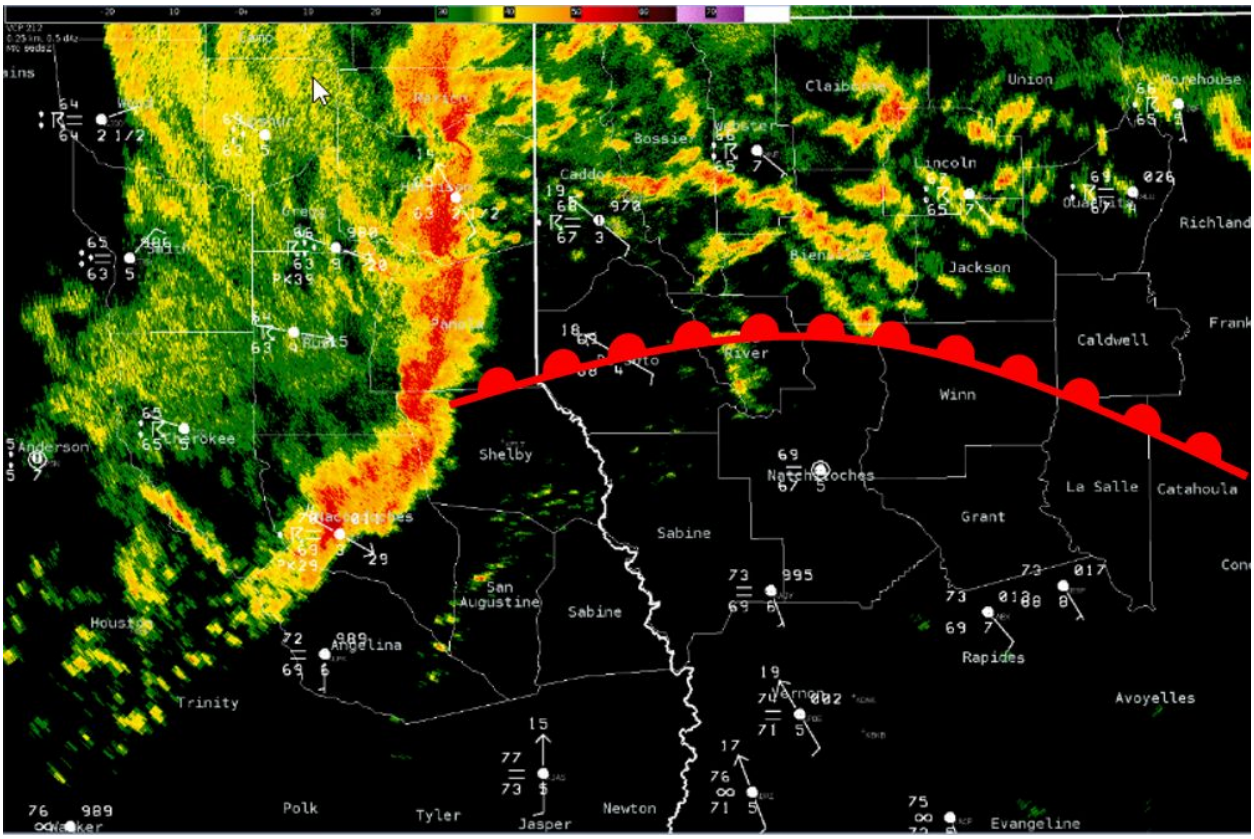

Figure 7: 14 UTC composite radar image with surface observations and approximate warm front overlaid.

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of original SVRs.

- Southeast Marion/Harrison County bow
    - Three ingredients still present
    - Slight reflectivity drop around 1400 UTC
    - The bow becomes less concave. This is most notable in velocity products.
    - UDCZ resets itself to the front of the updraft towers eliminating the entry point
    - A few small cell mergers take place

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point		Confirmed tornado/TDS			
Recommended warning decision: Would maintain TOR with radar indicated option for now. However, a downgrade to a SVR with TOR possible can be considered if the bow ceases to persist and/or no more confidence builders/nudgers emerge.							

- Southern Harrison/Northern Panola County Bow
    - Three ingredients present
    - Another reflectivity drop over central Panola County
    - Bow continues to increase in size (enhance)
    - Entry point persists
    - Rapid mesovortex genesis takes place over southern Harrison County between 1408 and 1413 UTC with a Vrot of around 30 knots present by 1413 UTC. This is another confidence builder.
    - A TDS appears on the 1415 UTC scan associated with the mesovortex in southern Harrison County. This is yet another confidence builder.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Continue TOR and use radar confirmed option.							

- Western Shelby County Bow
    - Three ingredients present
    - Slight pivot continues
    - Another descending RIJ/Reflectivity drop occurs over northwestern Shelby County
    - Reflectivity tags continue to migrate up the line
    - Mesovortex strengthens with a Vrot around 30 knots. This is another confidence builder.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Continue TOR given that the three ingredients are still being met along with the presence of several recent confidence builders and nudgers.							

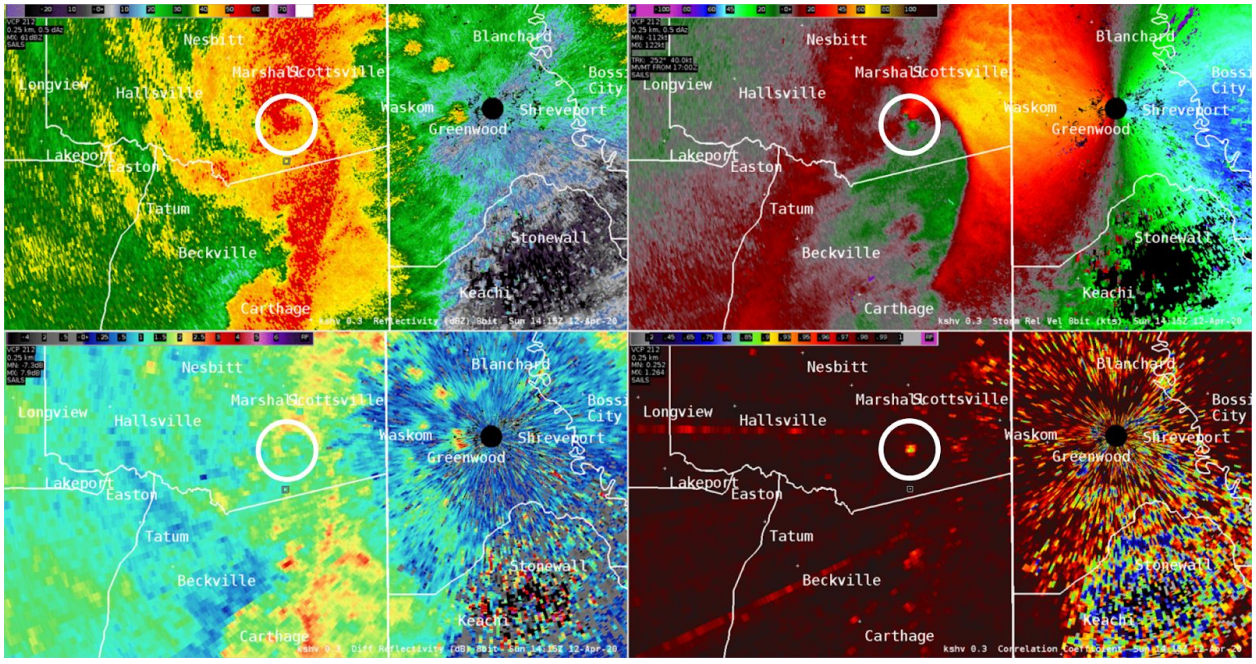

Figure 8: KSHV 0.5° Z/SRM/CC/ZDR combo at 1415 UTC. A TDS is present within the white circled region in southeastern Harrison County, TX. A CC drop (values ≤ 0.9) is co-located with a mesovortex and areas of sufficient reflectivity (≥ 30 dbZ). A minima of ZDR (near 0 dB) is not yet present.

1420 to 1440 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1430	SPC MD	SPC MD	SPC MD	SPC MD	SPC MD	SPC MD	SPC MD	SPC MD
1437	UNK	2 SE MARSHALL	HARRISON	TX	32.51	-94.32	(Harrison County, TX) The Harrison County Emergency Manager tells you there has been damage reported 2 miles southeast of Marshall. She reports large trees are down with some broken or snapped.	Tornado

- Two distinct bows persists with the original northernmost bow losing definition
- Warm front continues to lift north and is beginning to approach the I-20 corridor

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of original SVRs.

- Southeast Marion/Harrison County moving into Caddo Parish
  - No longer meeting three ingredients given lack of bow/surge
  - Mergers continue
  - Reflectivity tag coming up the line, but no bow or surge.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop		Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	
Surge or bow		Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point		Confirmed tornado/TDS			
Recommended warning decision: Drop TOR and go SVR with TOR possible (which should already be out with larger SVRs).							

- Bow moving from Harrison County into Caddo Parish
  - Three ingredients present
  - New instance of DRIJ/Reflectivity drop punches northeast into Caddo Parish
  - Mesovortex loses some definition initially but begins to tighten again by 1439 UTC

        - Note that the mesovortex is well back into the precipitation region near the tip of a “reflectivity candy cane”. This may be the start of a bookend vortex.
    - TDS appears to dissipate on 0.5 degree tilt by 1430 UTC
    - Reflectivity tag moving up the line and crosses the bow near the KSHV RDA around 1435 UTC
    - Several small mergers continue

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Continue TOR with radar confirmed option.							

- Bow moving from Panola/Shelby County line into DeSoto Parish
    - Three ingredients present
    - Impressive descending RIJ/reflectivity drop signature from southeastern Panola County into western DeSoto Parish
    - Bow appears to pivot (enhance)
    - Classic coupled inflow notch signature (a confidence builder) develops by 1434 UTC
    - Entry point persists
    - Mesovortex strengthens especially on 0.9 tilt. Vrot of around 55 knots at 1426 UTC.
    - New mesovortex begins to develop closer to the bow apex (south of Grand Cane) by 1439 UTC
    - TDS becomes apparent in western DeSoto Parish by 1435 UTC and appears to dissipate by 1439 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN	Y	Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Maintain TOR and use radar confirmed option.							

1440 to 1500 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1441	UNK	7 SSE STONEWALL	DE SOTO	LA	32.18	-93.75	(De Soto Parish, LA) Local media is showing video of an ongoing tornado 7 miles south-southeast of Stonewall.	Tornado
1442	UNK	4 SW WASKOM	HARRISON	TX	32.44	-94.12	(Harrison County, TX) Harrison County Emergency Management reports trees down near Stricklin Springs.	Wind
1443	UNK	7 SSE STONEWALL	DE SOTO	LA	32.18	-93.75	(De Soto Parish, LA) A trained spotter reports a tornado 7 miles south-southeast of Stonewall.	Tornado
1451	UNK	8 SE STONEWALL	DE SOTO	LA	32.18	-93.71	(De Soto Parish, LA) Local Law Enforcement reports a mobile home completely destroyed on Hwy 5 in Kingston.	Tornado
1451	UNK	BENTON	BOSSIER	LA	32.7	-93.74	(Bossier Parish, LA) A local resident calls to report a tornado moving through Benton.	Tornado
1452	UNK	1 SSW BARKSDALE AIR FOR	BOSSIER	LA	32.5	-93.68	(Bossier Parish, LA) A local resident reports a large tree on their home in the Shady Grove neigborhood 1 mile south-southwest of Barksdale Air Force Base.	Wind
1452	UNK	3 E SHREVEPORT	CADDO	LA	32.47	-93.75	(Caddo Parish, LA) The following report is received via MPING from 3 miles east of Shreveport: 1 inch tree limbs	Wind

							broken; shingles blown off. (SHV)	
1457	UNK	13 W HALL SUMMIT	DE SOTO	LA	32.17	-93.53	(De Soto Parish, LA) Local media is showing live footage of a tornado 13 miles west of Hall Summit.	Tornado
1500	SPC	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso

- Line across northwestern Louisiana starts to take on a large bowing appearance with multiple smaller embedded bows
- The warm front continues to lift north and is now likely near the I-20 corridor

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

- Miller and Lafeyette Counties into northern Caddo and Bossier Parishes
  - UDCZ remains rather flat with three ingredients not met
  - Reflectivity tags continue to move up the line, but no bow or surge present
  - Several mergers take place

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop		Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	
Surge or bow		Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point		Confirmed tornado/TDS			
Recommended warning decision: Maintain SVR and drop the TOR possible. Odds of mesovortex genesis (let alone a tornado) are very low without a bow.							

- Caddo into western Bossier Parish
  - Three ingredients present
  - Bow/surge seems to be accelerating northeast and growing (enhancing)
  - UDCZ entry point persists
  - Could make the case that the bookend vortex contracts
  - Mesovortex genesis takes place southwest of Benton. Maximum Vrot of around 30 knots. Given the contracting nature of the bookend vortex, this satisfies another confidence builder.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop		Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt	Y	Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	Y
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Maintain TOR. Could drop back to radar indicated since the TDS appears to dissipate at 1430 UTC.							

- Northern DeSoto Parish
    - Three ingredients present
    - Reflectivity drop punches through Kingston
    - Enhancing surge near and south of Kingston
    - Paired FIN/RIN region
    - Mesovortex strengthens north of Grand Cane and continues to strengthen as it moves through the Kingston area. Reaches peak Vrot of 71 knots around 1449 UTC.
    - TDS becomes apparent starting around 1442 UTC and increases in size through 1451 UTC. Debris then begins to fan out starting at 1456 UTC.
    - Reflectivity tags moving up through surge region
    - Multiple small mergers

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Continue TOR with radar confirmed option. Upgrade to a <u>Considerable Damage Tag</u> given the Vrot of 71 knots and a tornado in progress.							

- Central DeSoto Parish
    - Three ingredients present
    - Reflectivity drop punches in towards Carmel and Naborton by 1456 UTC
    - Surge enhances (accelerates and pivots) near and south of Mansfield

- Three ingredients present
- Entry point develops as UDCZ shifts back into the updraft towers near Naborton
- A reflectivity core spike (another nudger) takes place just east of Mansfield
- Broad rotation develops near Mansfield

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Given that the three ingredients are present along with four confidence builders and at least one nudger, a TOR is recommended. It is possible that you included this area within the TOR covering the Kingston area. If so, special attention should be made to differentiate the meosovortices within warnings, statements, and messaging.							

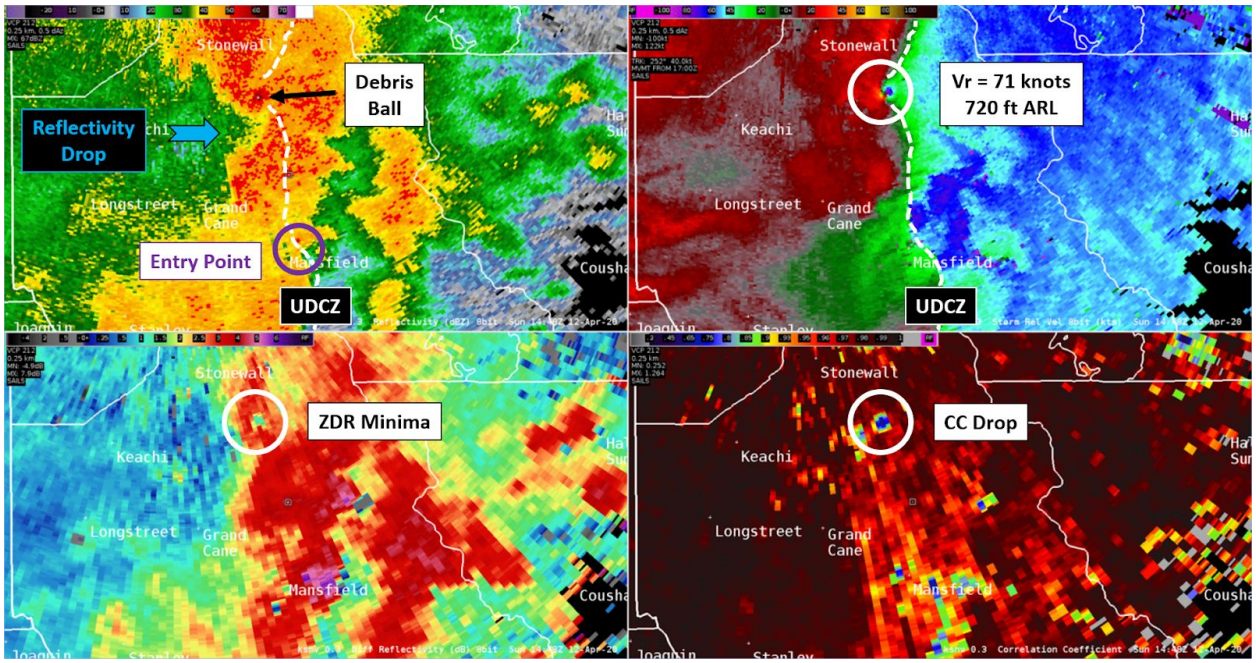

Figure 9: KSHV 0.5° Z/SRM/CC/ZDR combo at 1448 UTC. A TDS is present within the white circled region southeast of Stonewall, LA. A CC drop (values ≤ 0.9) is co-located with a strong mesovortex (Vr = 71 knots) and a ZDR minima at approximately 720 feet ARL. A debris ball also appears to be present in the reflectivity product. The UDCZ is depicted by the white dotted lines in the Z/SRM products. Reflectivity drop and entry point regions are also highlighted.

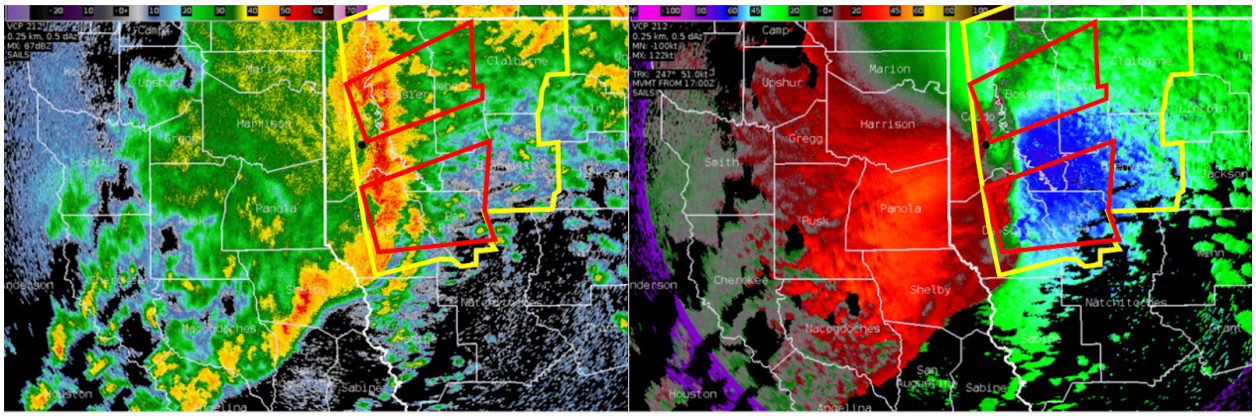

Figure 10: KSHV 0.5° Z/SRM combo at 1448 UTC with proposed a Severe Thunderstorm Warning (yellow polygon) and Tornado Warnings (red polygons). Given the close proximity of mesovortices in northern and central DeSoto Parish, the southernmost Tornado Warning polygon was drawn larger to encompass both threat areas. Note that the northern extent of the Severe Thunderstorm Warning continues into southern Arkansas.

1500 to 1520 UTC

Time	Size Speed	City	County	State	Lat	Lon	Report	Type
1501	SPC	SPC	SPC	SPC	SPC	SPC	If you have a separate mesoanalyst for this event, you may let them know it is ok to open the 15Z SPC Mesoanalysis now	SPC
1502	E80	11 WNW RINGGOLD	BOSSIER	LA	32.36	-93.47	(Bossier Parish, LA) A trained storm spotter calls to report two hardwood trees were uprooted and blown to the east-northeast at her location 11 miles west-northwest of Ringgold. She estimates the winds to be around 80mph.	Wind
1505	UNK	9 S DOYLINE	BOSSIER	LA	32.39	-93.44	(Bossier Parish, LA) A local resident reports multiple trees blown over around Spring Branch and Teague Roads about 9 miles south of Doyline.	Wind
1509	UNK	2.8 SSW Lake Bistineau	WEBSTER	LA	32.39	-93.4	(Webster Parish) An NWS Employee reports numerous trees snapped along Plum Orchard Road about 3 miles south-southwest of Lake Bistineau North.	Wind

1510	UNK	7 SSE DOYLINE	WEBSTER	LA	32.43	-93.38	(Webster Parish, LA) A storm chaser calls to report a tornado west of Gorton Road and north of Hwy 163, 7 miles south-southeast of Doyline.	Tornado
1519	UNK	HEFLIN	WEBSTER	LA	32.46	-93.26	(Webster Parish, LA) The Webster Parish EM reports a tree on a home on North Main Street in Heflin.	Wind

- Large bowing line with multiple small embedded bows continues to move east across northern Louisiana and far southern Arkansas
- The warm front has now made it to the I-20 corridor.

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

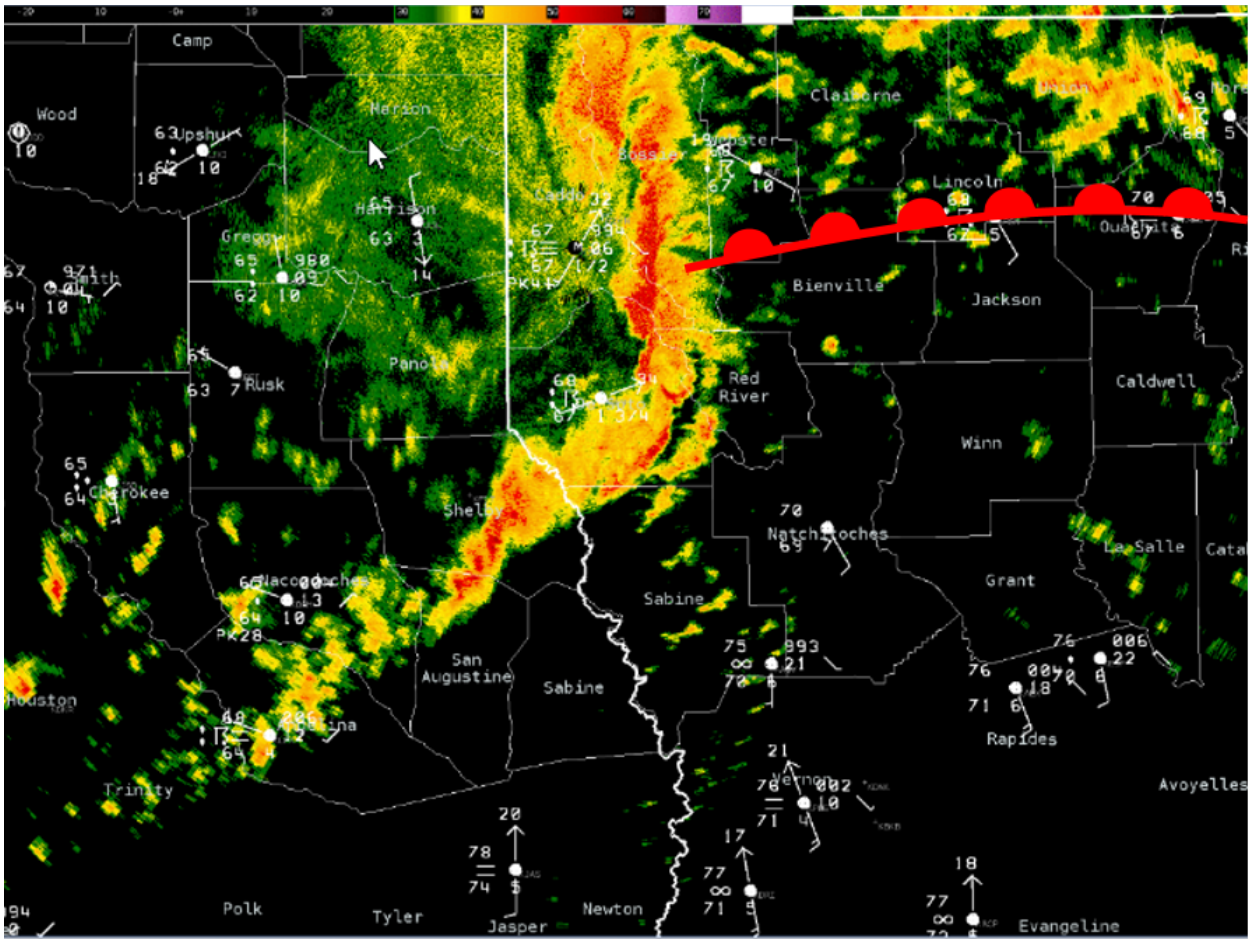

Figure 11: 15 UTC composite radar image with surface observations and approximate warm front overlaid.

- Northern Bossier and northern Webster Parish
    - UDCZ starts fairly flat but reflectivity does reveal a surge beginning to develop near the state line from 1512 to 1520 UTC
    - Three ingredients are present with the development of that surge
        - Bow or surge present
        - Balanced near apex and slightly-shear dominant north of apex
        - Line-normal component of 0-3 km bulk shear >= 30 knots
    - Reflectivity drop signature around 1519 UTC just south of Springhill
    - The surge is enhancing as it is accelerating with a slight pivot
    - Entry point develops given that there is a transition from a balanced to slightly shear dominant regime north of the surge
    - Reflectivity tags moving up the line

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: An upgrade to TOR with radar indicated option is the best option. Could also go SVR w/ TOR possible with a quick upgrade to TOR if more confidence builders/nudgers emerge.							

- Southeastern Bossier Parish into western Bienville and Southern Webster Parish
    - Three ingredients present
    - Reflectivity drop southwest of Heflin
    - Surge enhances (accelerating and pivoting)
    - Entry point develops south of Heflin
    - Rapid mesovortex genesis in southern Webster Parrish from 1510 to 1515 UTC. Mesovortex quickly migrates from the leading edge of reflectivity gradient to the rearward reflectivity gradient. Max Vrot of around 40 knots at 1517 UTC.
    - TDS becomes evident between 1512 and 1515 UTC and persists through 1520 UTC (and beyond)

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point		Confirmed tornado/TDS	Y		
Recommended warning decision: TOR with radar confirmed option.							

- Extreme northeastern DeSoto/extreme northwestern Red River/western Bienville Parish
    - Three ingredients present
    - Small enhancing surge develops
    - Could make a case for a line break (another confidence builder) given the interruption to stronger reflectivity cores near Westdale
    - UDCZ entry point present as UDCZ cuts into updraft tower region in western Red River Parish
    - Mesovortex develops and rapidly strengthens, reaching a peak Vrot of 55 knots around 1503 UTC. Mesovortex then broadens and weakens.
    - TDS becomes evident around 1503 UTC and quick fans out
    - Multiple mergers take place

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: TOR with radar confirmed option.							

- Eastern DeSoto into Red River Parish
    - Three ingredients present
    - Subtle reflectivity drop between 1510 and 1515 UTC north of Harmon in Red River Parish
    - Enhancing surge completes pivot and becomes status quo
    - Entry point remains

- Cell merger occurs between 1500 and 1510 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	Y
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Continue with a TOR given that three ingredients are being met with at least three confidence builders and at least two nudgers (second nudger is a history of tornadoes).							

1520 to 1540 UTC

Time	Size/ Speed	City	County	State	Lat	Lon	Report	Type
1530	UNK	1 WNW ASHLAND	BIENVILLE	LA	32.15	-93.12	(Bienville Parish, LA) A trained spotter calls to report a tornado 1 mile west-northwest of Ashland	Tornado
1539	UNK	1 NW ARCADIA	BIENVILLE	LA	32.56	-92.95	(Bienville Parish, LA) A local resident calls to report a tornado just west of Arcadia along Hwy 9 and south of I-20.	Tornado

- Large bowing line with multiple small embedded bows continues to move east across northern Louisiana and far southern Arkansas
- Warm front is near the I-20 corridor

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

- Columbia County, AR through most of Claiborne Parish, LA
  - A surge/mini-bow continues to track northeast between 1530 and 1540 UTC
  - Three ingredients are still being met
  - Reflectivity drop signature across eastern Webster Parish
  - The surge is enhancing as it is accelerating with a slight pivot
  - Subtle line break develops west of Emerson around 1531 UTC
  - Entry point remains present

- A mesovortex develops east of Taylor but does not reach the 25 knot Vrot threshold
- Reflectivity tags moving up the line

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion		0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Maintain TOR with radar indicated option.							

- Extreme southern Webster and northern Bienville Parish
  - Three ingredients present
  - Reflectivity drop punches in towards Arcadia between 1530 and 1540 UTC
  - New enhancing surge which pivots and accelerates across northern Bienville Parish (most noticeable between 1520 and 1530 UTC in SRM plot)
  - Entry point remains
  - Mesovortex near Heflin rapidly decreases
  - TDS that passes near Heflin fans out but remains discernible all of the way through 1536 UTC
  - Reflectivity tags continue to migrate north along the line
  - Mesovortex genesis takes place southwest of Arcadia with a Vrot of around 32 knots by 1539 UTC. The mesovortex is somewhat broad.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Maintain TOR. Could continue with radar observed tag given recent TDS near Heflin, however the radar indicated option may be best once you get closer to 1540 UTC.							

- Southern Bienville/Eastern Red River/Extreme northern Natchitoches Parishes
    - Three ingredients present for both surges
    - Small reflectivity drop between 1524 and 1529 UTC near DeSoto and Red River Parish line
    - Pair of small surges track northeast into southern Bienville Parish. The southern surge is most pronounced and shows enhancing characteristics.
    - Both surges contain entry points
    - Line break signature persists through about 1530 UTC but becomes less discernible after this time
    - Reflectivity tag moves up the line and causes a core spike from 1524 to 1538 UTC near Natchitoches/Bienville Parish line
    - Mesovortex genesis takes place north of the apex of the southern surge near Ashland with a Vrot of 40 knots at 1529 UTC
    - TDS becomes apparent at 1531 UTC and persists through about 1536 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Continue TOR with radar confirmed option. Polygons may be tricky given that the northern surge was a former tornado producer with the southern surge becoming the most concerning surge between 1520 and 1540 UTC. Could elect to go with a larger polygon to cover both surges or two smaller polygons. A lot would depend on previous polygon configurations.							

1540 to 1600 UTC

- Large bowing line with multiple small embedded bows continues to move east across northern Louisiana and far southern Arkansas
- Warm front is likely located near or slightly north of the I-20 corridor

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

- Eastern Columbia and western Union Counties, AR into Eastern Claiborne and Union Parishes, LA
    - Small bow tracks northeast into eastern Columbia and western Union Counties
    - Three ingredients still met

- Bow still enhancing given pivoting nature
- Line break develops over northwestern Union County as descending RIJ/reflectivity drop signature persists (RIJ likely punches through the updraft towers)
- Entry point persist just north of bow apex
- Two reflectivity tags cross the bow between 1540 and 1550 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt		History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Maintain TOR with radar indicated option.							

- Small bow moving through Northern Bienville into Lincoln Parish
  - Three ingredients persist
  - DRIJ/reflectivity drop signature punches completely through updraft towers (forming a line break) in Lincoln Parish
  - Small pivot and acceleration to the bow
  - Line break signature develops and tracks between Arcadia and Vienna
  - UDCZ connecting to the southern tip of a reflectivity pendant behind the line break
  - Entry point remains
  - Mesovortex present on southern tip of reflectivity pendant with a Vrot of around 27 knots
  - Likely TDS becomes evident at 1543 UTC and intermittently persists until 1600 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Maintain TOR and use radar confirmed option.							

- Bow moving from southeastern Bienville into western Jackson Parish
  - Three ingredients persist
  - Two reflectivity drops
    - First occurs in eastern Bienville Parish around town of Lucky from 1546 to 1550 UTC
    - Second occurs from 1555 to 1600 UTC in western Jackson Parish
  - Bow shows enhancing characteristics with slight acceleration and pivot
  - Entry point present
  - Subtle paired front/rear inflow notch signature from 1548 to 1555 UTC near Bienville/Jackson Parish line
  - Mesovortex genesis from 1553 to 1558 UTC with a Vrot of 43 knots at 1558 UTC. This includes a gate-to-gate Vrot of 41 knots.
  - Reflectivity core spike from 1543 to 1548 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break		Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN	Y	Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Continue TOR. Could start with radar confirmed given recent TDS in southern Bienville Parish and then drop back to radar indicated by around 1550 UTC.							

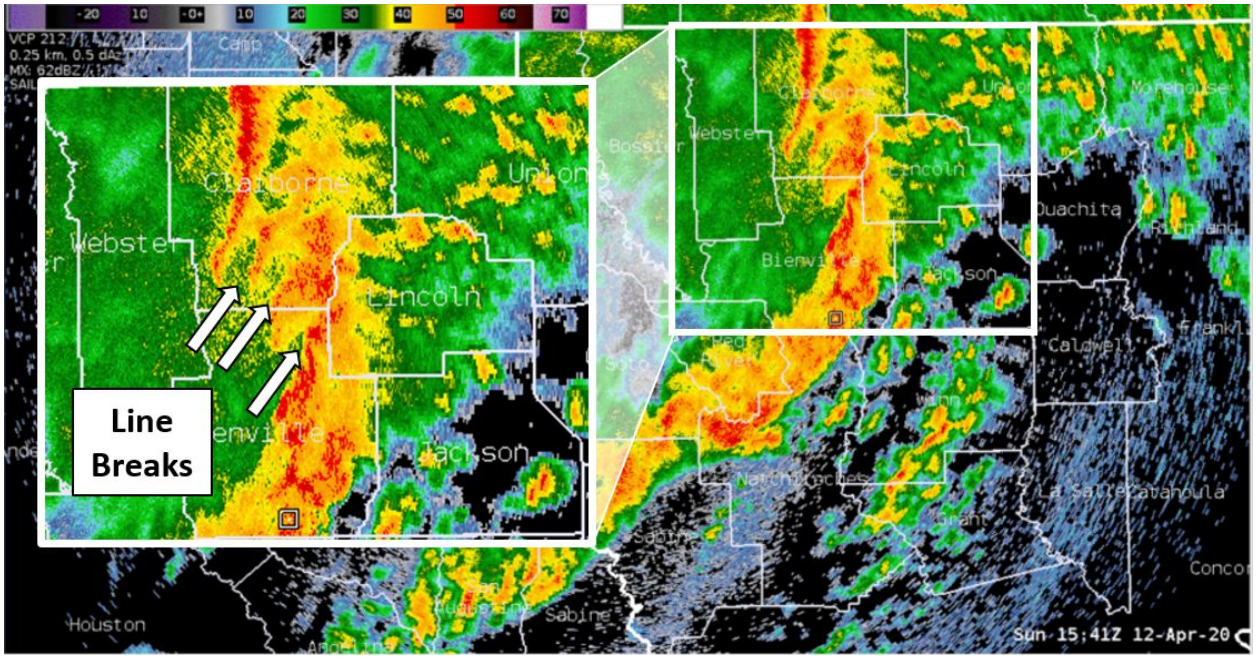

Figure 12: KSHV 0.5° reflectivity product at 1541 UTC. The zoomed region features three line break signatures.

1600 to 1625 UTC

Time	Size/Speed	City	County	State	Lat	Lon	Report	Type
1600	SPC	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook
1600	SPC	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso	SPC Meso
1605	UNK	EL DORADO	UNION	AR	33.22	-92.66	(Union County, AR) A trained spotter reports large trees and a large sign down as well as a small metal building destroyed in El Dorado.	Wind
1607	UNK	4 NE CHOUDRANT	LINCOLN	LA	32.58	-92.47	(Lincoln Parish, LA) The Lincoln Parish EM reports trees down near the intersection of Highways 145 and 821 4 miles northeast of Choudrant.	Wind

- Large bowing line with multiple small embedded bows continues to move east across northern Louisiana and far southern Arkansas
- Warm front remains near or slightly north of the I-20 corridor
- Half degree radar beam now in the 3.5 to 7 kft agl range. Thus, you are now overshooting the region where mesovortex genesis is most resolvable.

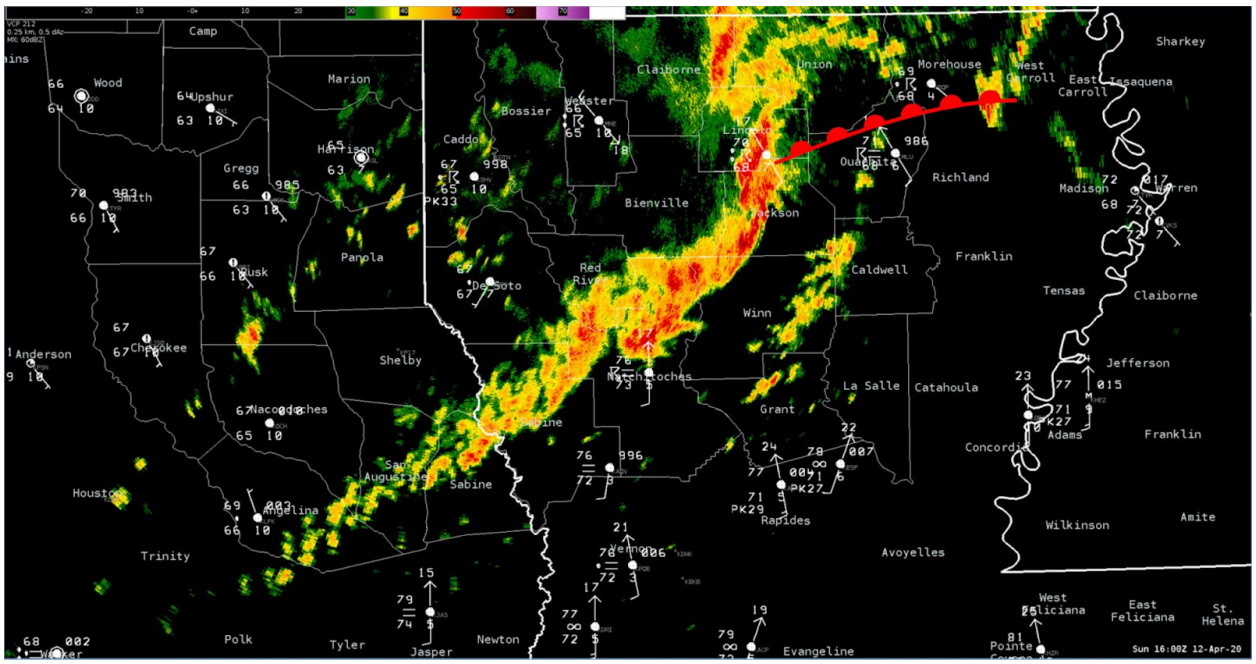

Figure 13: 16 UTC composite radar image with surface observations and approximate warm front overlaid.

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

- Union County, AR into eastern Claiborne and northern Union Parishes, LA
  - Multiple mini bows present with the most pronounced bow going through El Dorado, AR. The bows do not appear to be enhancing.
  - Three ingredients present for all mini bows
  - Three line break signatures
    - One exits northern Union County by 1625 UTC
    - One developed near the state line but fills in by 1625 UTC
    - Another tracks through central Union Parish
  - Descending RIJ/reflectivity drop with line break that tracks out of northern Union County. Multiple reflectivity drops also occur within line break that track through Union Parish between 1600 and 1625 UTC.
  - Entry points present for each line break
  - Reflectivity tags moving up the line

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	?	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Maintain TOR with radar indicated option until line break clears northern Union County into LZK CWA. If there is not a TOR out for the reflectivity pendant tracking northeast across Union Parish (behind the line break), have a TOR polygon drawn up and ready to send if more confidence builders/nudgers show up.							

- Lincoln into southern Union Parish
  - Three ingredients are present
  - Enhancing surge starts around Ruston and tracks towards Downsville
  - Entry point present
  - Reflectivity tags continue to move up the line
  - Pair of mesovortices develop
    - First mesovortex forms just north of Ruston with a Vrot around 30 knots at 1605 UTC
    - Second mesovortex develops southwest of Downsville from 1610 to 1612 UTC. Max Vrot is around 29 knots at 1612 UTC.
  - A TDS (or remnants of a TDS) are visible early on over northwestern Lincoln Parish. This seemed to be associated with the southern pendant of the old line break signature. The line break became largely absent by 1600 UTC.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop		Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Maintain TOR. Could start with radar confirmed given recent TDS, however dropping back to radar indicated would be ideal by 1610 UTC.							

- Jackson into Ouachita Parish
    - Aggressive bow with enhancing characteristics moves northeast from near Jonesboro to Eros
    - Three ingredients are present
    - Descending RIJ/reflectivity drop signature leads to pronounce rear inflow notch
    - Line break signature development from 1614 to 1620 UTC
    - Entry point present as UDCZ curls back into updraft towers
    - Mesovortex remains apparent for the entire period but is broader than previous scans just prior to 1600 UTC. Radar is likely overshooting the genesis region.
    - Reflectivity core spikes up to the west of Monroe from 1616 to 1624 UTC

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	Y
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	Y
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: Maintain TOR with radar indicated option (no recent TDSs).							

1625 to 1655 UTC

Time	Size/Speed	City	County	State	Lat	Lon	Report	Type
1630	SPC	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook	SPC Outlook
1636	UNK	1 SSW BROWNSVILLE -BAWCO	OUACHITA	LA	32.47	-92.17	(Ouachita Parish, LA) A storm chaser reports a tornado 1 mile south-southwest of Bronwsville-Bawcomville.	Tornado
1639	UNK	5 SSW STERLINGTON	OUACHITA	LA	32.62	-92.1	(Ouachita Parish, LA) Amateur radio relays a report of a tornado 5 miles south-southwest of Sterlington.	Tornado
1642	UNK	1 SSE MONROE	OUACHITA	LA	32.5	-92.08	(Ouachita Parish, LA) Local media reports 2 semi trucks were blown over on I-20 at the Hwy 165 overpass 1 mile south-southeast of	Tornado

							Monroe.	
1642	UNK	1 NE MONROE	OUACHITA	LA	32.52	-92.08	(Ouachita Parish, LA) Monroe Emergency Management reports 20 homes damaged in the Sunflower Subdivision of Monroe.	Tornado
1643	UNK	2 SE MONROE	OUACHITA	LA	32.49	-92.06	(Ouachita Parish, LA) Local media reports that many power lines and power poles are down along Millhaven Rd near the Mall in Monroe along I-20. The road is closed.	Tornado
1644	UNK	3 E MONROE	OUACHITA	LA	32.51	-92.04	(Ouachita Parish, LA) A member of the public calls to report multiple planes and hangers damaged at Monroe Regional Airport.	Tornado
1646	M69	3 E MONROE	OUACHITA	LA	32.52	-92.03	(Ouachita Parish, LA) The ASOS station KMLU in Monroe shows a 69 mph wind gust.	Wind
1646	UNK	4 SSE STERLINGTON	OUACHITA	LA	32.65	-92.04	(Ouachita Parish, LA) A storm chaser calls to report a tornado in Fairbanks.	Tornado
1647	E80	SWARTZ	OUACHITA	LA	32.57	-91.99	(Ouachita Parish, LA) A trained spotter reports large tree limbs down as well as roof and structural damage. He estimates that wind gusts were greater than 80 mph.	Wind
1648	Unk	Monroe	OUACHITA	LA	32.5	-92.04	(Ouachita Parish, LA) Local media is reporting overturned vehicles on I-20 at U.S. Hwy 165.	Tornado
1652	Unk	Fairbanks	OUACHITA	LA	32.64	-92.04	(Ouachita Parish, LA) A trained spotter calls to report trees down and debris over the road at Brook Orchard Blvd in Fairbanks.	Wind

- Large bowing line with multiple small embedded bows continues to move east across northern Louisiana and far southern Arkansas
- Warm front remains near or slightly north of the I-20 corridor
- Half degree radar beam now in the 6 to 9 kft agl range. Thus, you are now overshooting the region where mesovortex genesis is most resolvable.

Recommended Action: Large downstream SVRs with TOR possible should be considered if nearing the end of previous SVRs.

- Eastern Union County, AR into northeastern Union Parish, LA
  - Slight bowing noted to UDCZ starting around 1636 UTC
  - Three ingredients met
    - Bow or surge present
    - Balanced near apex and slightly-shear dominant north of apex
    - Line-normal component of 0-3 km bulk shear >= 30 knots
  - Descending RIJ/reflectivity drop from 1640 to 1650 UTC (further enhancing line break)
  - Although at an increased distance from the radar, an entry point can be inferred as the UDCZ connects to the southern tip of the reflectivity pendant behind the line break.
  - A mesovortex develops with a Vrot of around 21 knots. This is below the 25 knot Vrot threshold required to make this a confidence builder, however the radar beam is shooting well above the mesovortex genesis region.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow		Boundary ingestion	?	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	?	History of tornadoes (includes prior TDSs)	Y
		UDCZ entry point	Y	Confirmed tornado/TDS			
Recommended warning decision: TOR with radar indicated option is the best option given three confidence builders and one nudger. It is quite possible that a fourth confidence builder is present in that a stronger mesovortex meeting the 25 knot Vr threshold is being overshot by the lowest radar tilt. The mesovortex at 1636 UTC near the town of Strong, AR does come close to meeting the threshold and it is located around 8 kft ARL.							

- Southeastern Union Parish
  - Small bow persist and continues to move northeast
  - Three ingredients met
  - Reflectivity starts west of Sterlington around 1633 UTC and punches northeast
  - Small bow enhances between 1625 and 1631 UTC
  - Entry point remains
  - Reflectivity tag intersects bow from around 1625 to 1631 UTC
  - Mesovortex persists early on with a gate-to-gate Vrot of 32 knots

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	Y
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN		Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		
Recommended warning decision: Maintain radar indicated TOR given presence of several confidence builders (including tight mesovortex) and at least one nudger.							

- Ouachita Parish
    - Pivoting and accelerating bow moves northeast
    - Three ingredients met
    - Descending RIJ/reflectivity drop from 1631 to 1638 UTC near and southwest of Monroe
    - Occasional line break signatures
    - Subtle paired FIN/RIN signature present at 1631 UTC south of Monroe
    - UDCZ entry points associated with line breaks
    - Mesovortex genesis takes place in two locations
        - From 1624 to 1629 UTC just southwest of Monroe in the southern tip of the reflectivity pendant behind the line break. Mesovortex contains Vrot of 41 knots at 1629 UTC and then 55 knots as it is moving into Monroe.
        - North of the bow apex from 1631 to 1636 UTC southwest of Fairbanks. Mesovortex contains a Vrot of 58 knots at 1641 UTC.
    - Two TDSs become apparent
        - Monroe starting at 1638 UTC and persists through 1655 UTC. Max depth exceeds 15 kft by 1655 UTC.
        - Fairbanks starting at 1641 UTC and persists through 1650 UTC. Max depth of around 19 kft at 1646 UTC.

3 Ingredients Method		TOR Confidence Builders				TOR Nudgers	
Balanced or slightly shear dominant	Y	Descending RIJ/ reflect drop	Y	Front reflect nub		Reflect tag intersecting surge or/bow	
0-3 km line-normal bulk shear ≥ 30 kt	Y	Enhancing surge or bow	Y	Boundary ingestion	Y	0-3 km MLCAPE ≥ 40 J/kg	?
Surge or bow	Y	Line break	Y	Contracting bookend vortex w/ Vr ≥ 25 kt		Cell merger or reflect spike near surge/bow	
		Paired FIN/RIN	Y	Mesovortex w/ Vr ≥ 25 kt	Y	History of tornadoes (includes prior TDSs)	Y
		UDCZ entry point	Y	Confirmed tornado/TDS	Y		

Recommended warning decision: TORs with radar confirmed options (once TDSs are observed). Could use one larger polygon and describe the location of both mesovortices/TDSs or go with two smaller ones.

- **<u>Considerable tag</u> should be used given highly likelihood of strong tornadoes**
  - **Vr over 50 knots for both mesovortices**
  - **TDS heights over 15 kft**
- **Could consider <u>Tornado Emergency</u>, especially for Monroe given that it is a larger city with a greater likelihood of a direct hit. If going with the Tornado Emergency, two separate polygons would be preferred.**

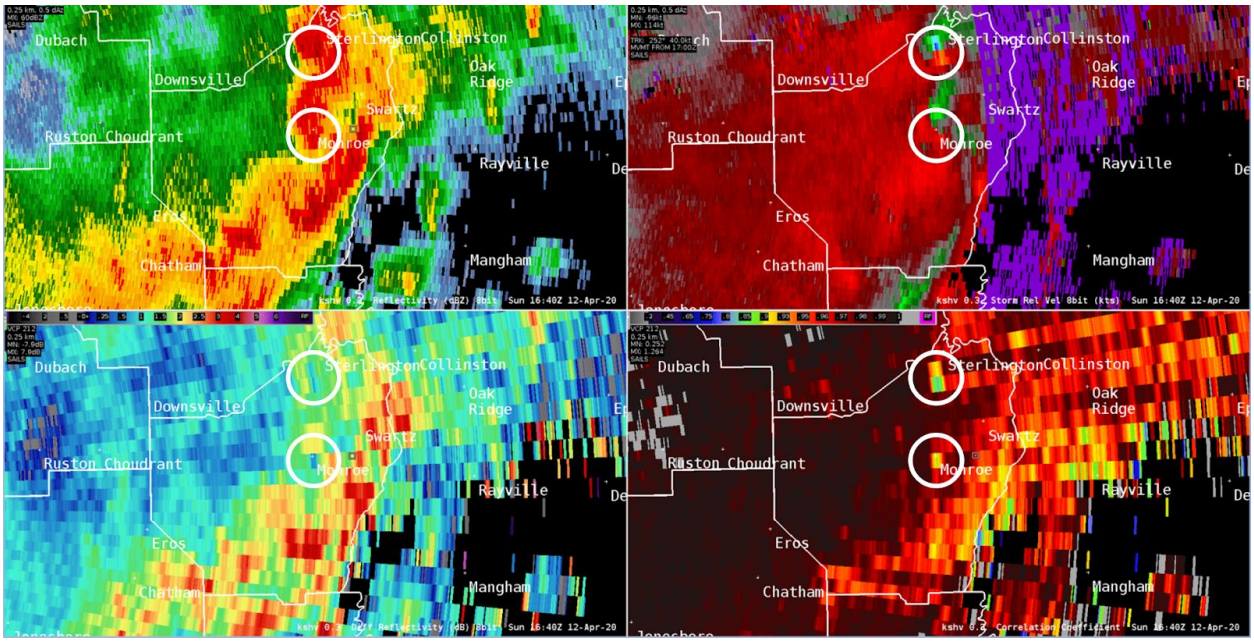

Figure 14: KSHV 0.5° Z/SRM/CC/ZDR combo at 1640 UTC. Two TDSs are present within the white circled regions near and north of Monroe, LA. CC drops (values ≤ 0.9) are co-located with mesovortices and areas of sufficient reflectivity (≥ 30 dbZ). Minimas of ZDR are also present. Note that both TDSs (and associated tornadoes) are well back into the line.

Part 3 - Debrief (15 minutes)

1. Have student view the provided debriefing video and take the quiz in module for course completion credit (mandatory for those in WOC Severe)
2. If proctored, go over the case with the radar team focusing on how they did regarding the objectives. Students can also conduct self-assessment if non-proctored.
    a. Where they did well
    b. Areas to improve
    c. Best practices
    d. Lessons learned