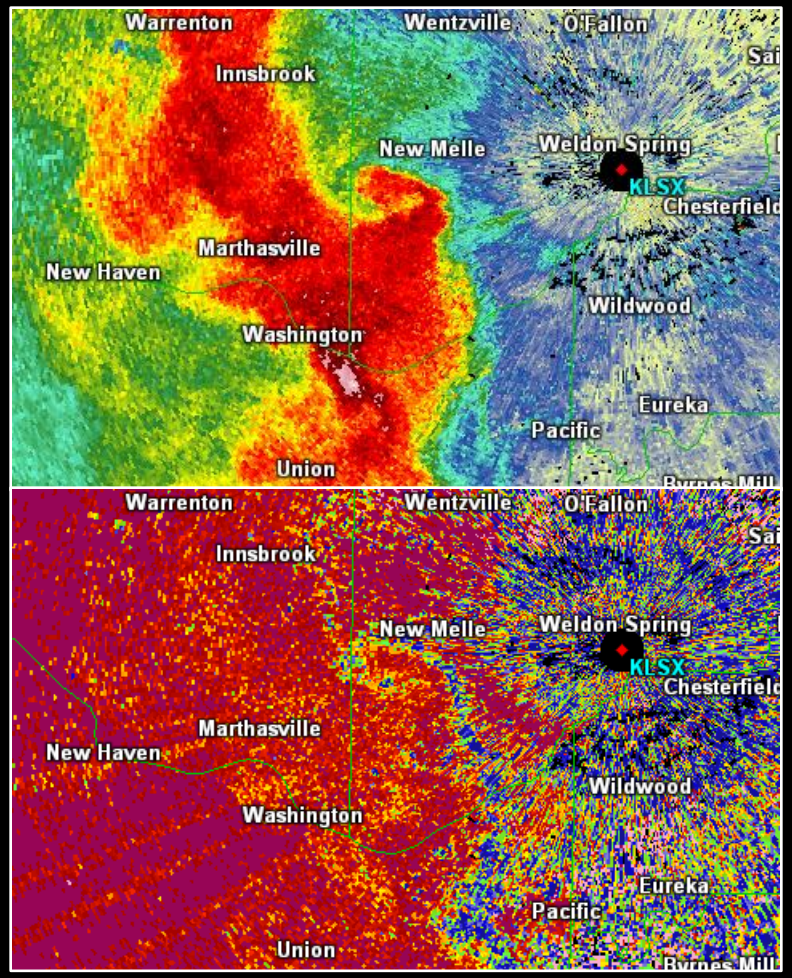
TDS look-alike signatures along the leading edge of QLCSs and implications for warning decisions



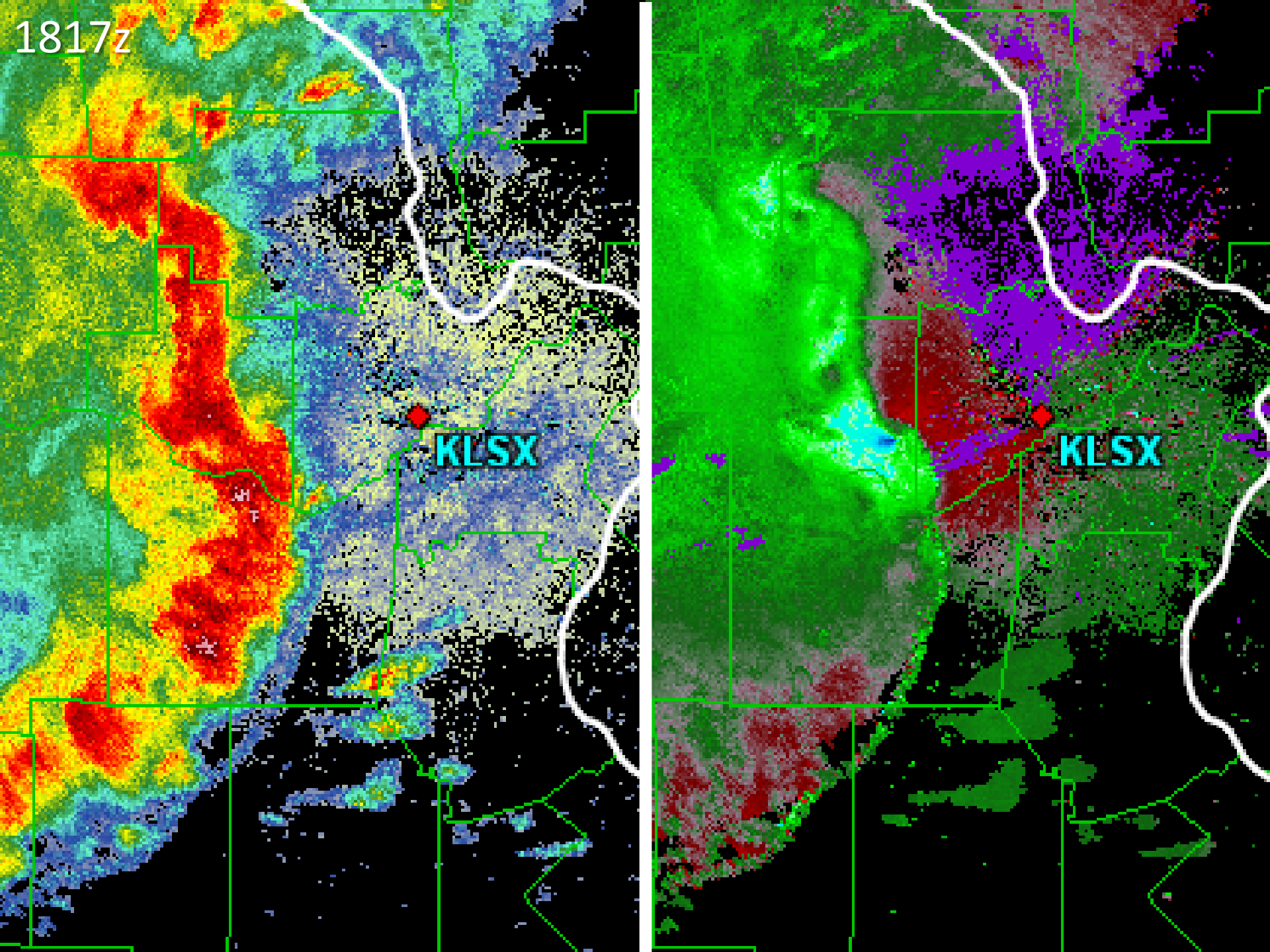
3rd Midwest Bow Echo Workshop

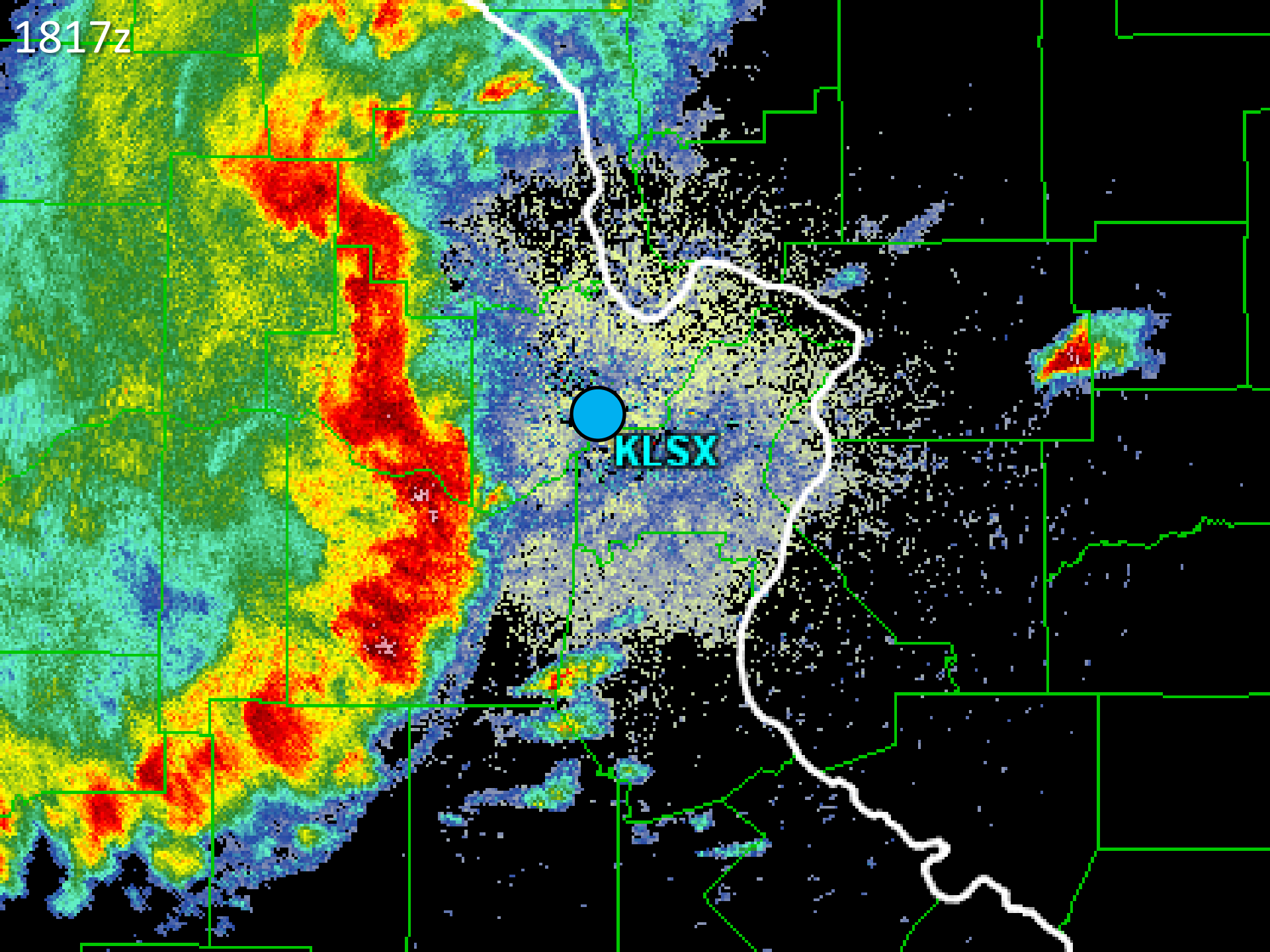
March 2017

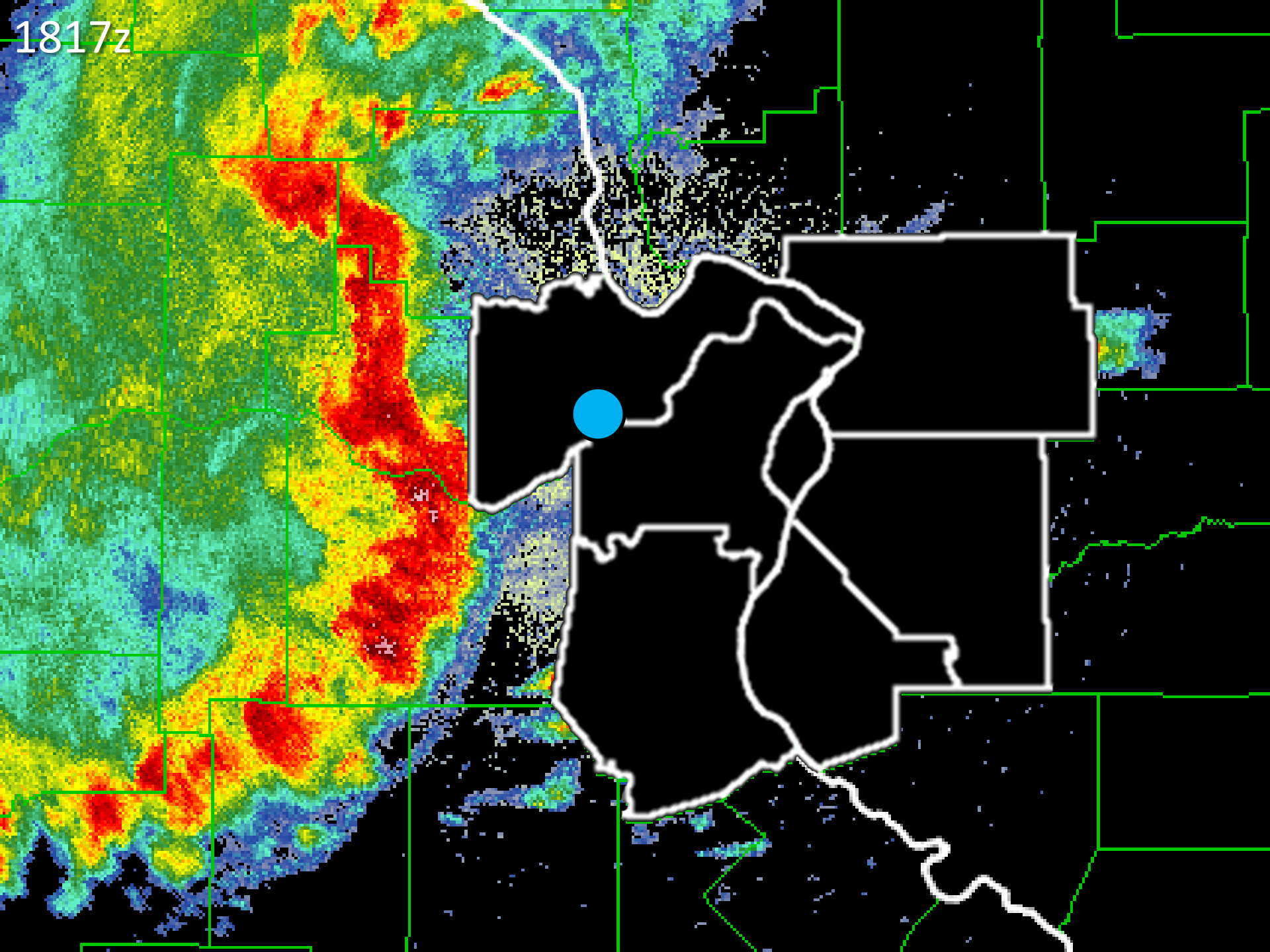
St. Louis, MO

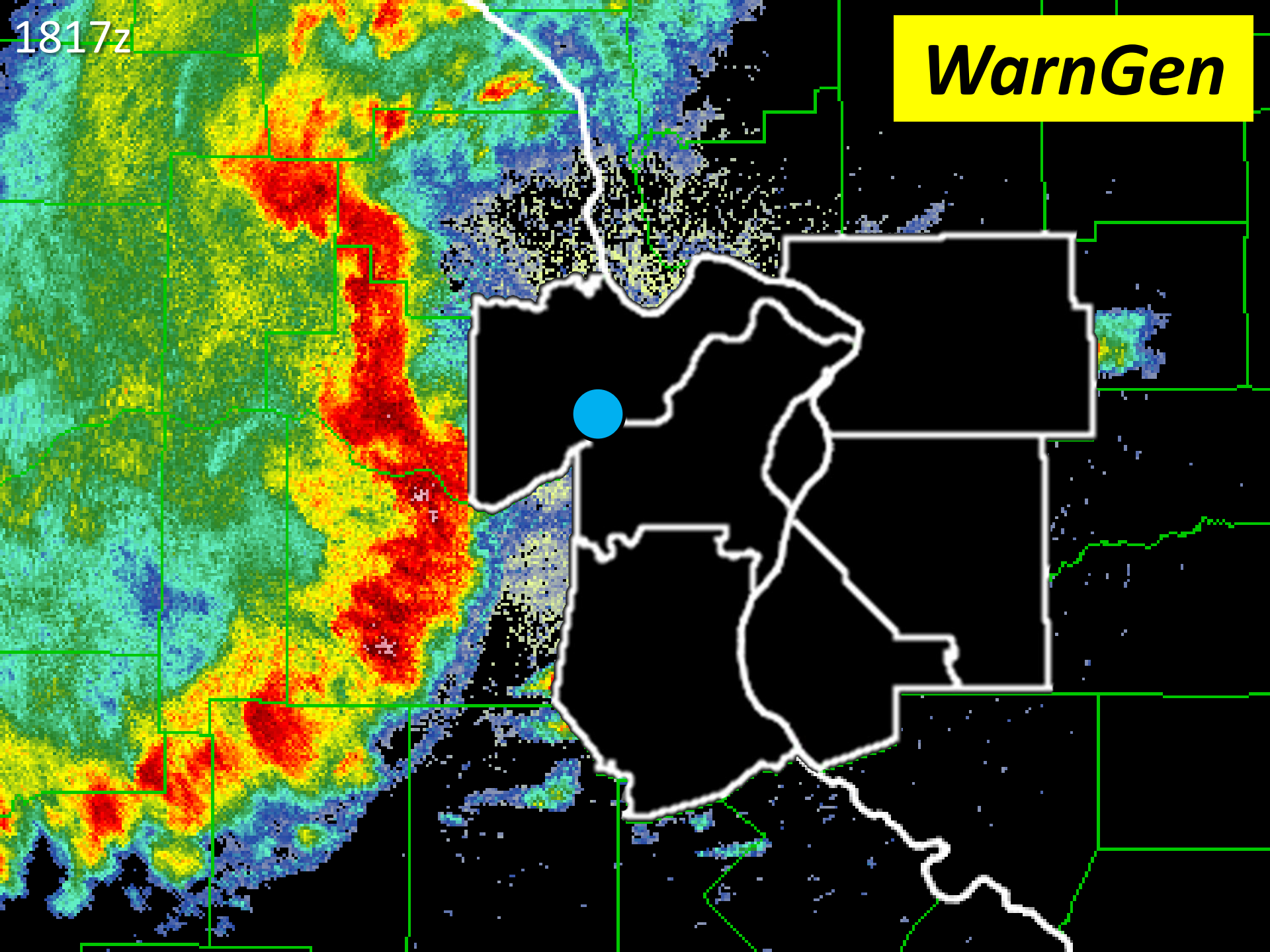
Lewis Kanofsky

NWS St. Louis, MO

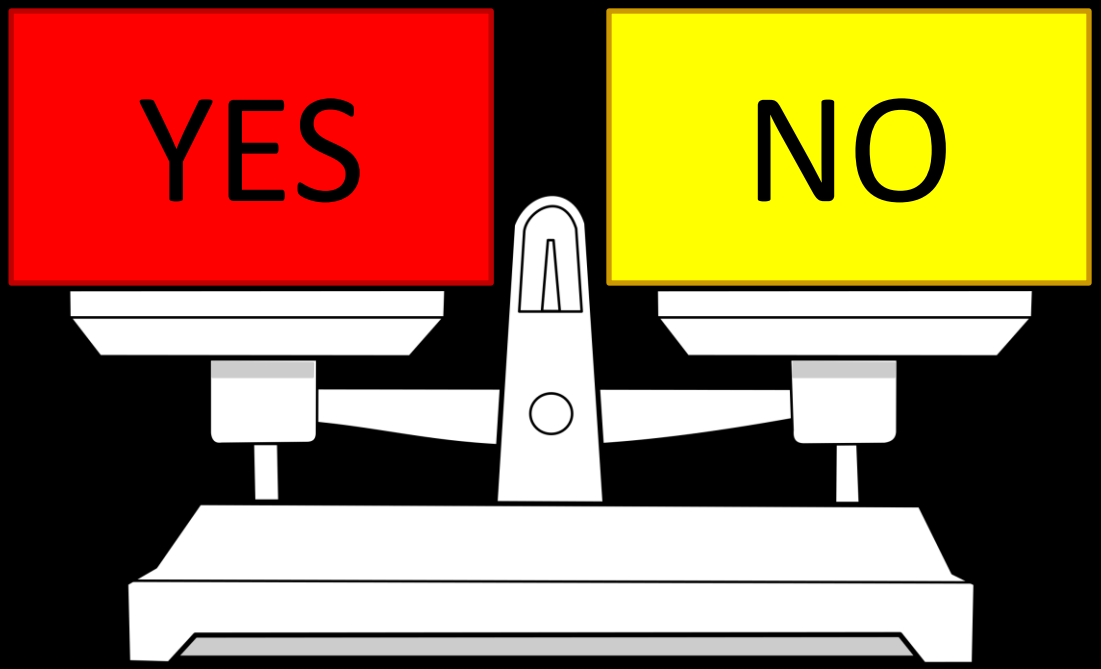

1817z
KLSX
KLSX


1817z
KLSX


1817z


1817z
WarnGen

Issue a tornado warning?

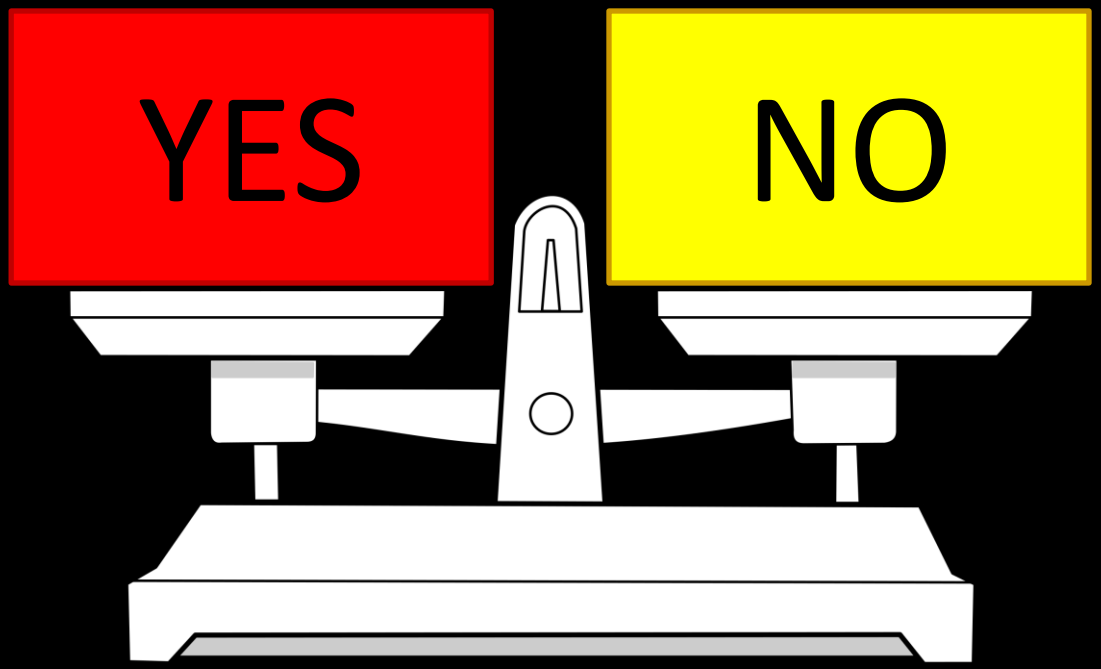


Issue a tornado warning?

Radar

Environment

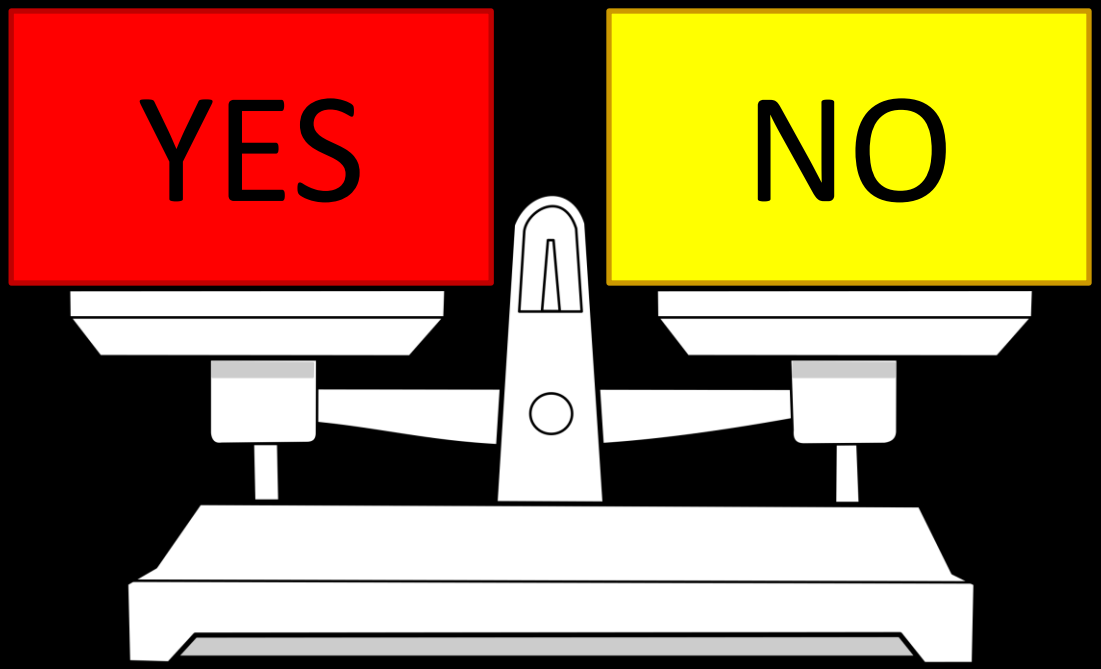
Spotters (no reports)



Issue a tornado warning?

Radar
Environment
Spotters (no reports)

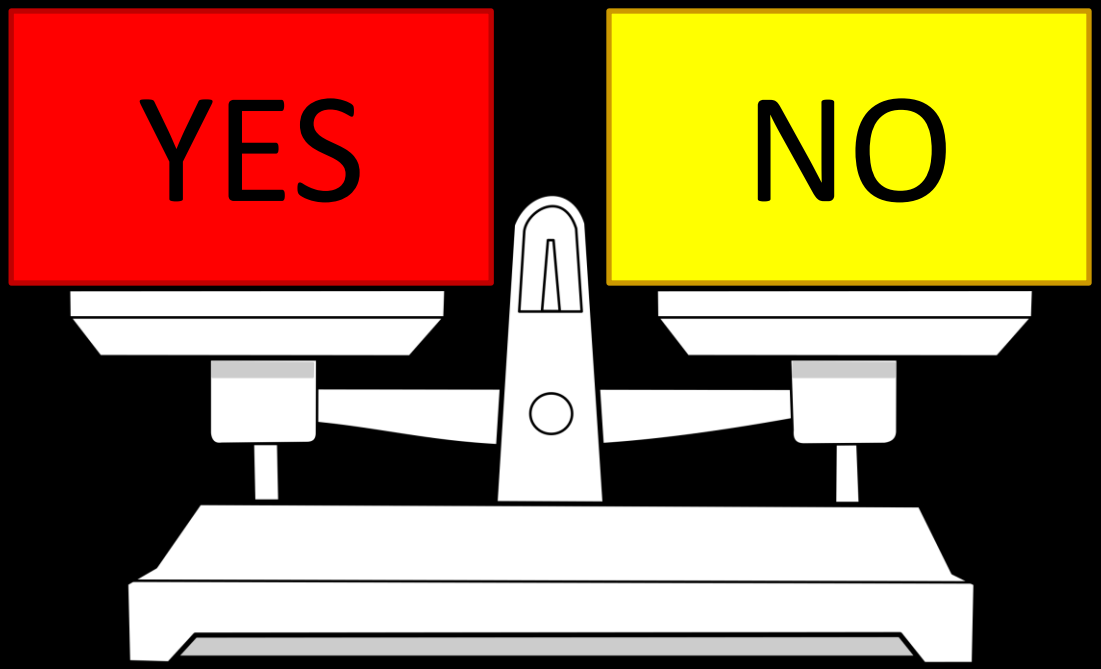
Radar
Environment
Spotters (no reports)

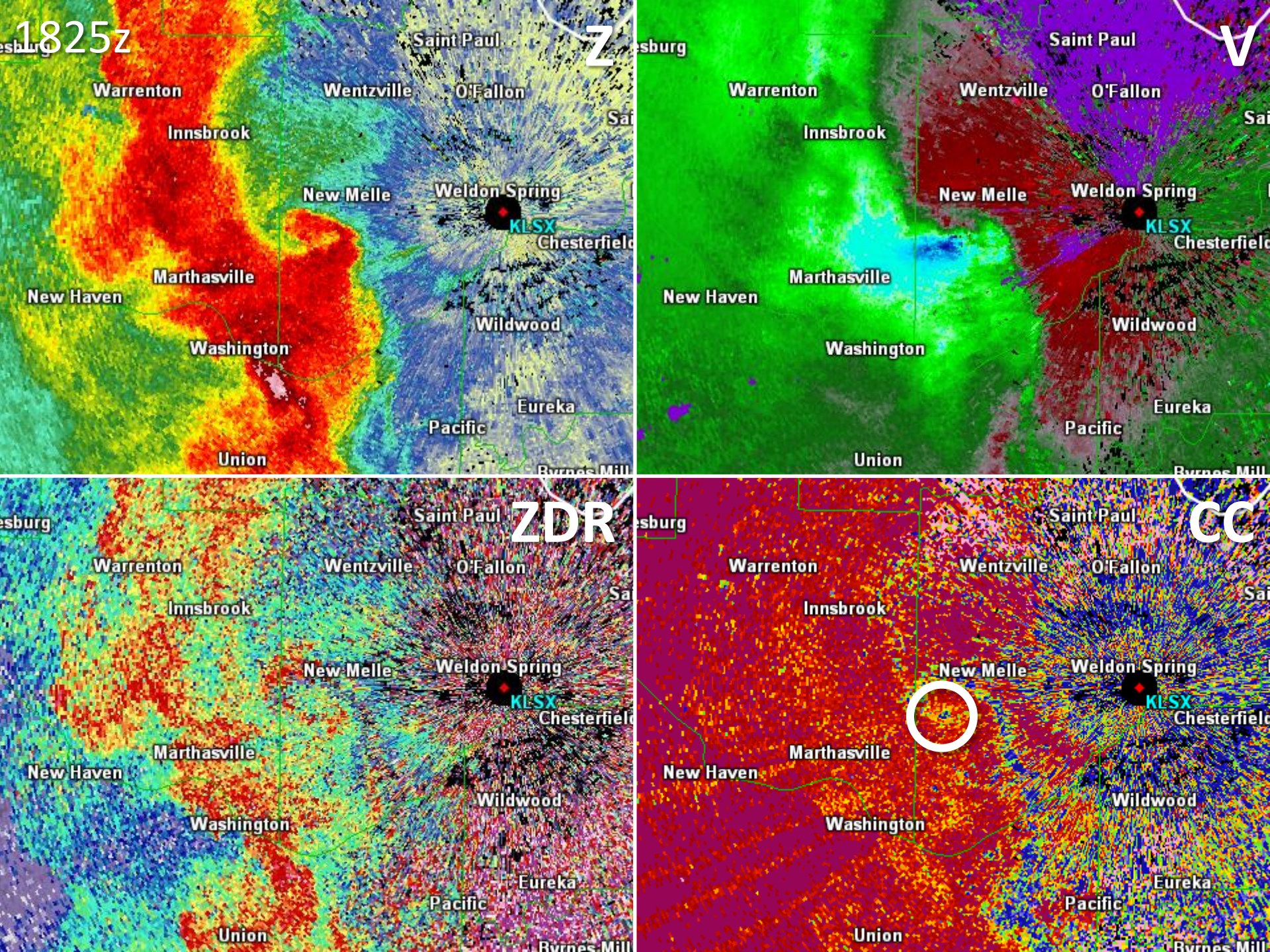


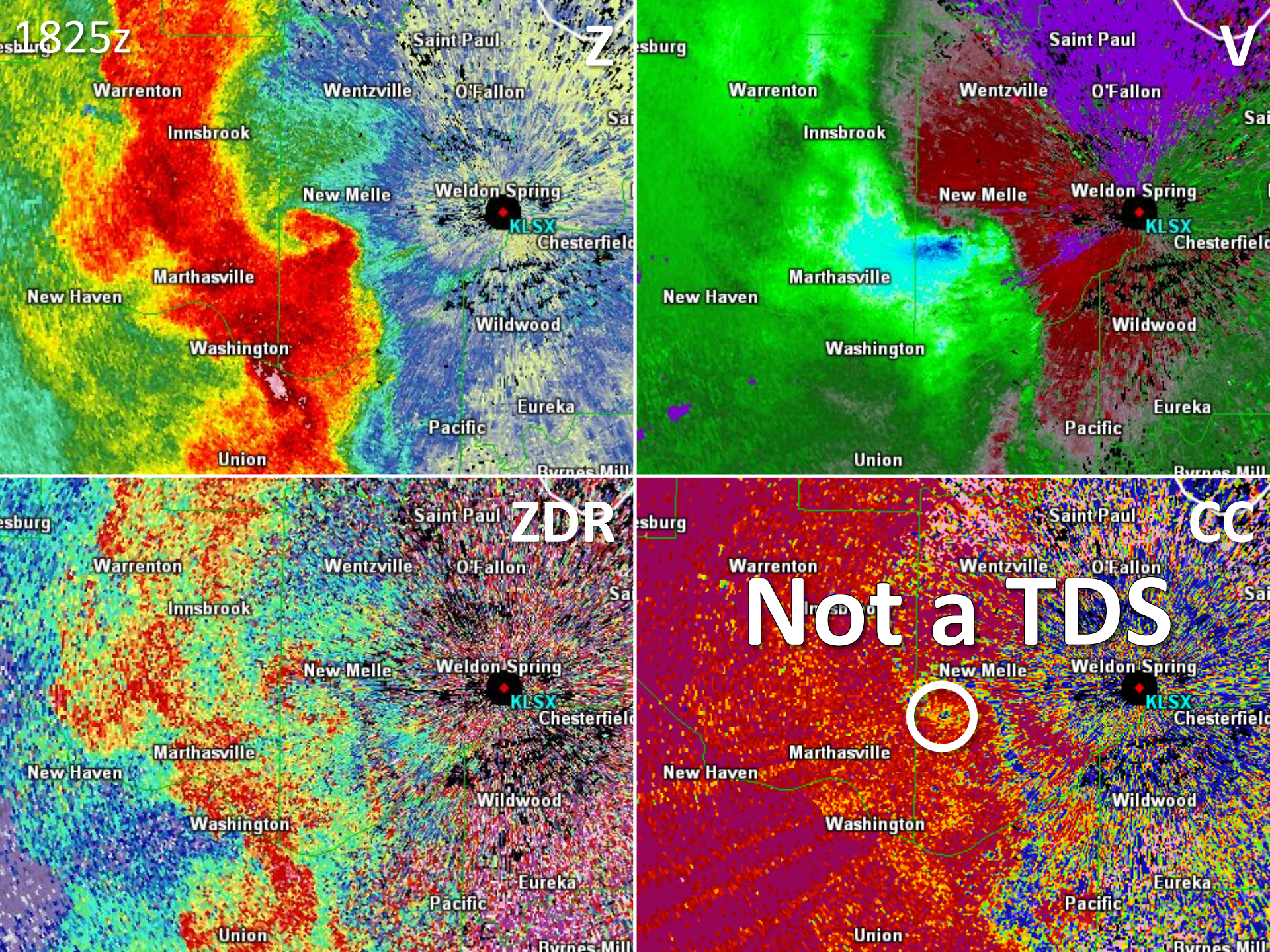
#SafePlaceSelfie

Issue a tornado warning?

Need an extra piece of information to tip the scales




1825z
Z
V
ZDR
CC
Saint Paul
Warrenton
Wentzville
O'Fallon
Innsbrook
New Melle
Weldon Spring
KLSX
Chesterfield
Marthasville
New Haven
Wildwood
Washington
Eureka
Pacific
Union


1825z
Z
V
ZDR
CC
Not a TDS
Saint Paul
Warrenton
Wentzville
O'Fallon
Innsbrook
New Melle
Weldon Spring
KLSX
Chesterfield
Marthasville
New Haven
Wildwood
Washington
Eureka
Pacific
Union


MISSOURI
BL6
488 WC1
JUL
M 3595745
08
MO
SHOW-ME STATE

Tornadic Debris Signature (TDS)

Required
CC reduction*
Appropriate velocity signature
High enough Z**

* CC ≤ 0.70 or 0.80 in some studies

** Z threshold varies by study, typically ≥ 20-30 dBZ

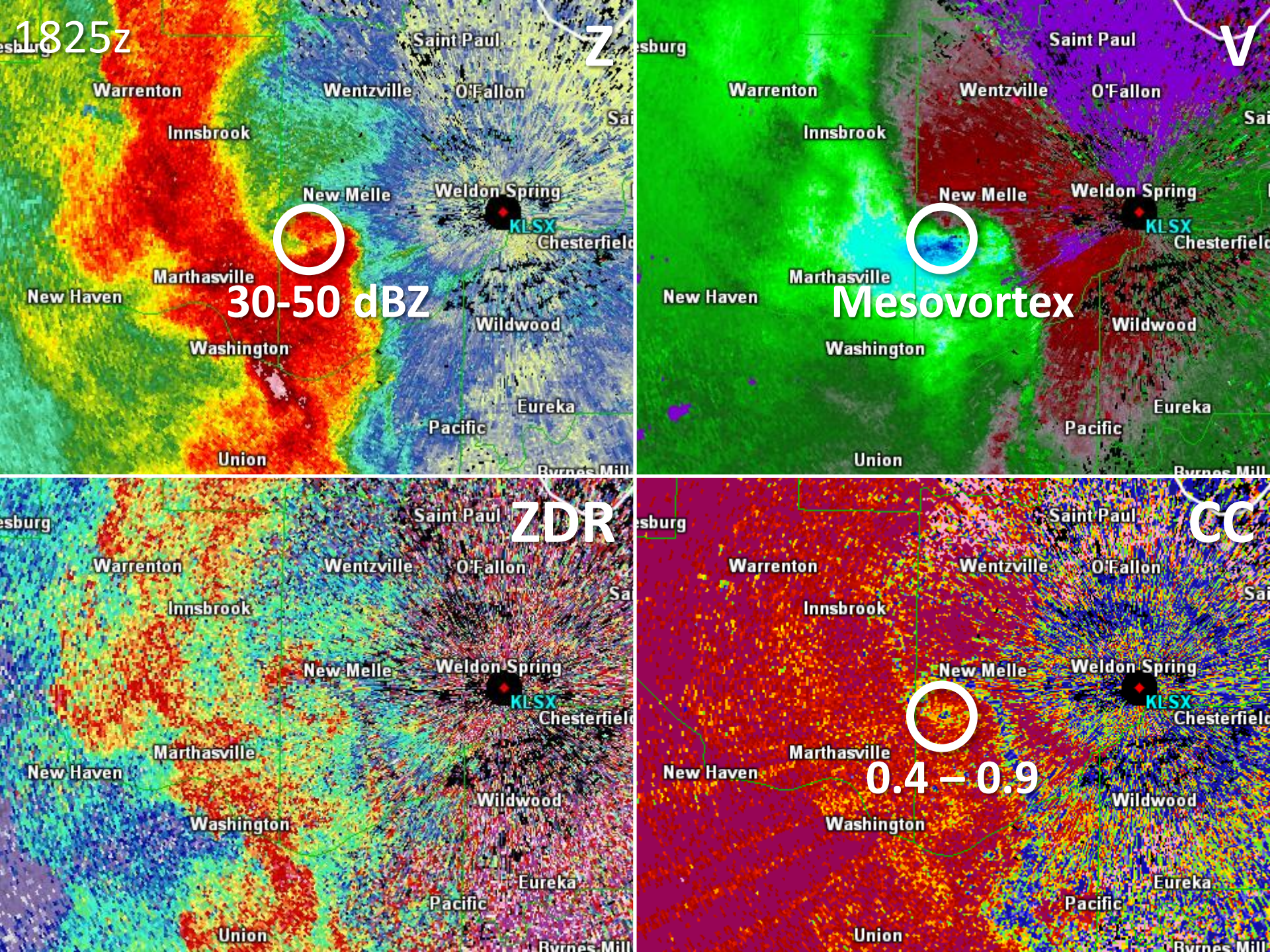
Tornadic Debris Signature (TDS)

Required	Admired (but not required)	May or may not be present
CC reduction*	Spatial and temporal continuity	ZDR near zero***
Appropriate velocity signature		
High enough Z**		

* CC ≤ 0.70 or 0.80 in some studies

** Z threshold varies by study, typically ≥ 20-30 dBZ

*** ZDR ≤ 0.5 in some studies

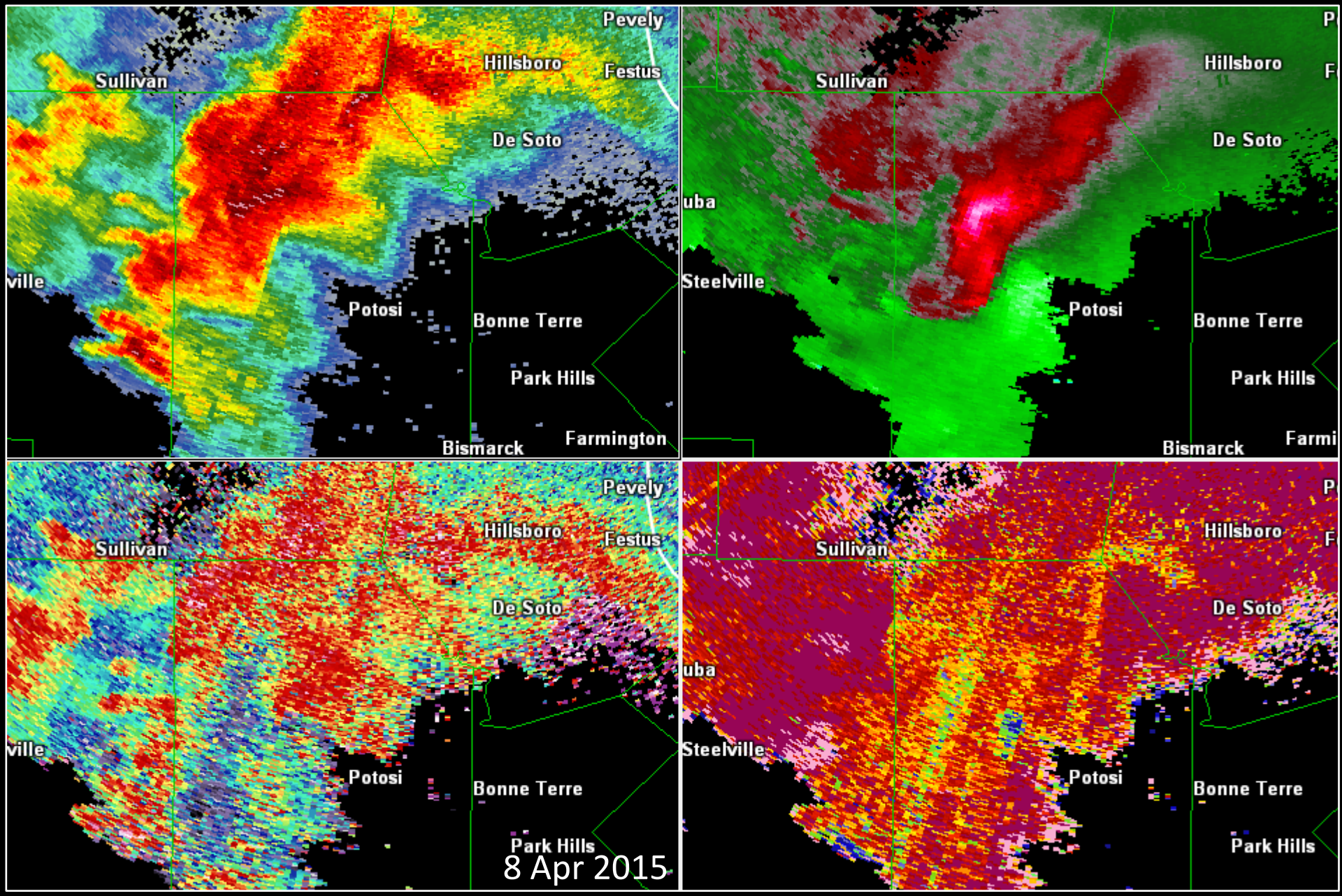

1825z
Z
V
ZDR
CC
Saint Paul
Warrenton
Wentzville
O'Fallon
Innsbrook
New Melle
Weldon Spring
KLSX
Chesterfield
Marthasville
New Haven
Wildwood
Washington
Eureka
Pacific
Union
Byrnes Mill
30-50 dBZ
Mesovortex
0.4 – 0.9

Other processes can mimic a TDS

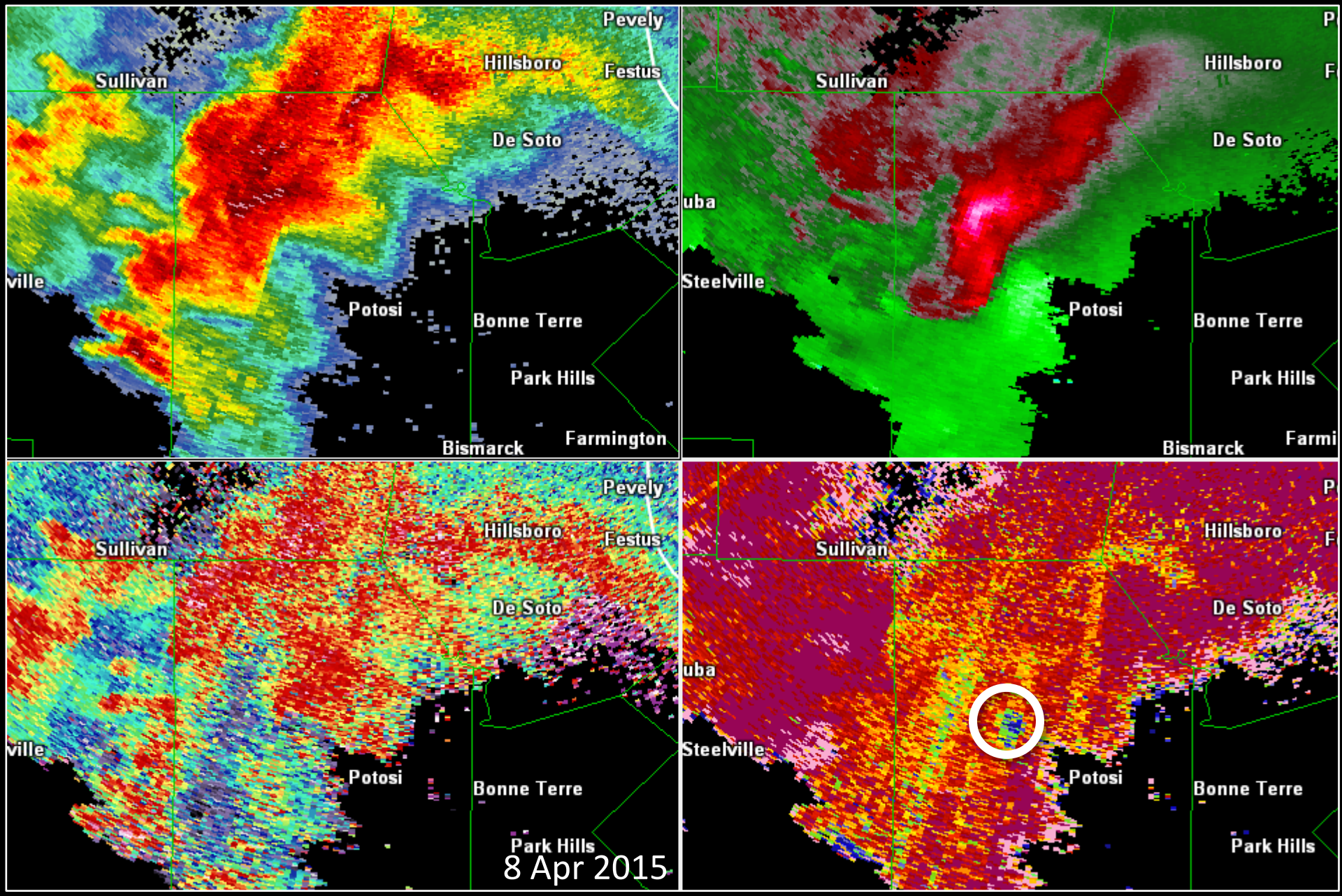
Other processes can mimic a TDS

Required	Admired (but not required)	May or may not be present
✓ CC reduction	✓ Spatial and temporal continuity (sometimes)	? ZDR near zero
✓ Appropriate velocity signature		
✓ High enough Z (sometimes)		

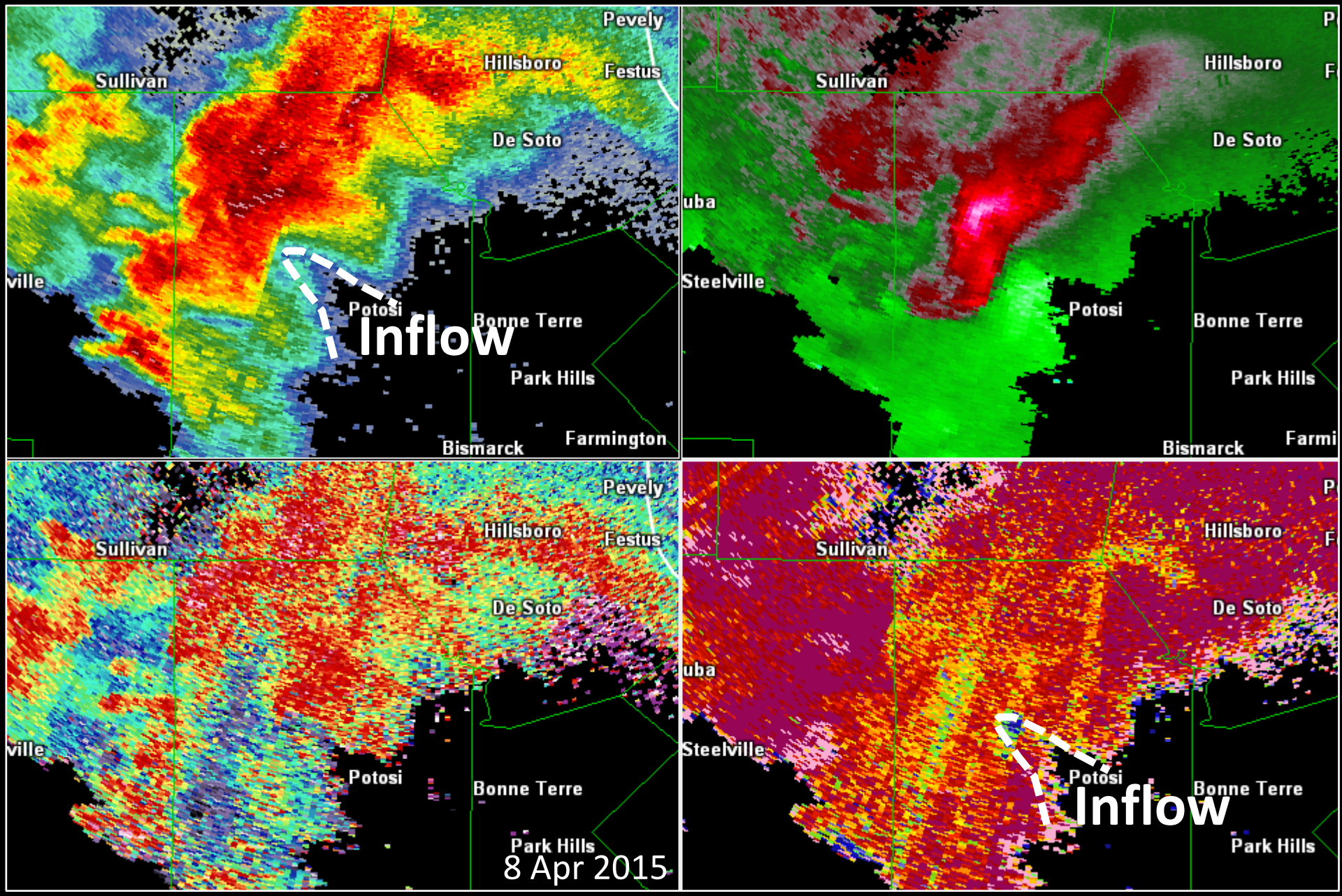
Other processes can mimic a TDS



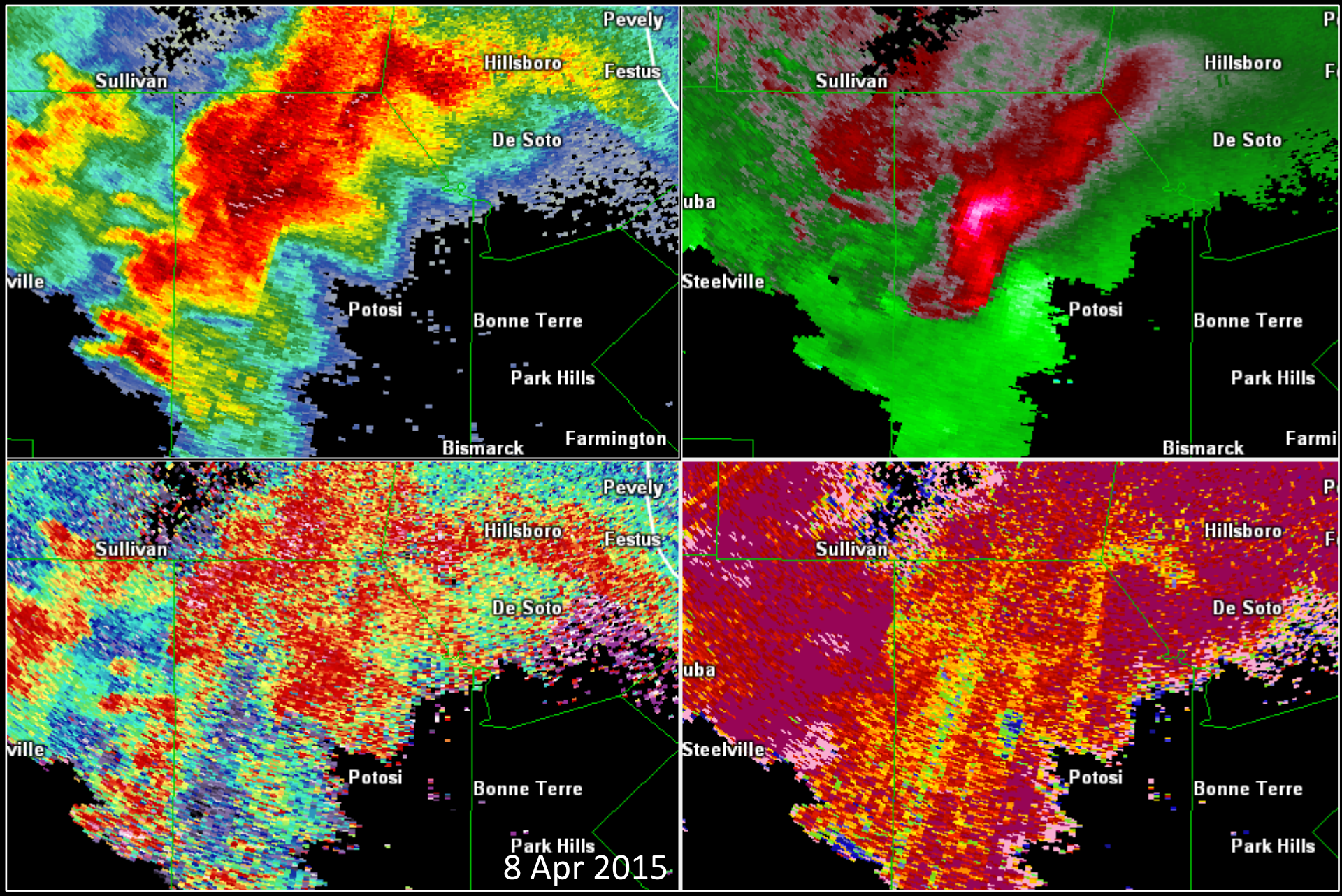
Other processes can mimic a TDS



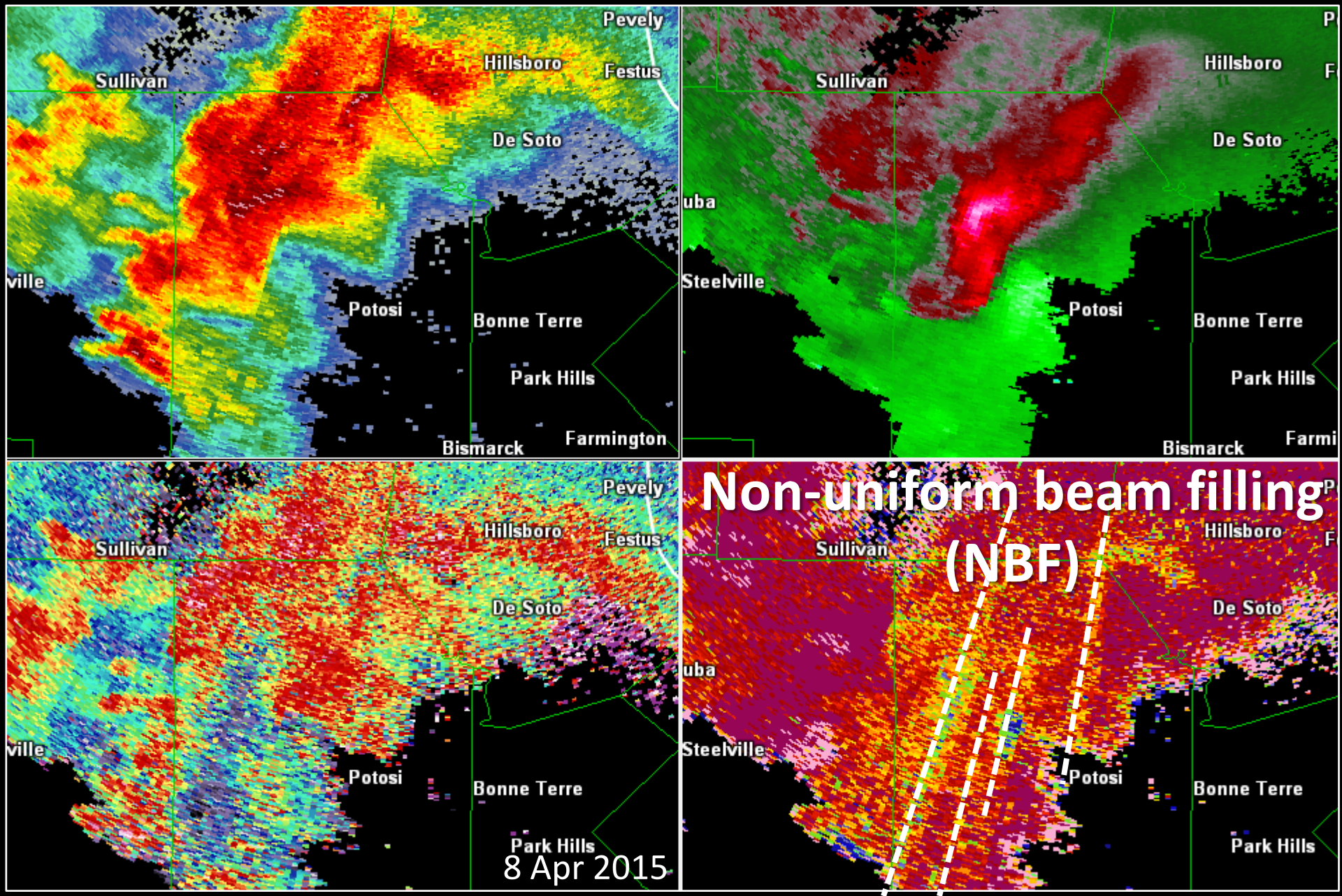
Other processes can mimic a TDS



Other processes can mimic a TDS

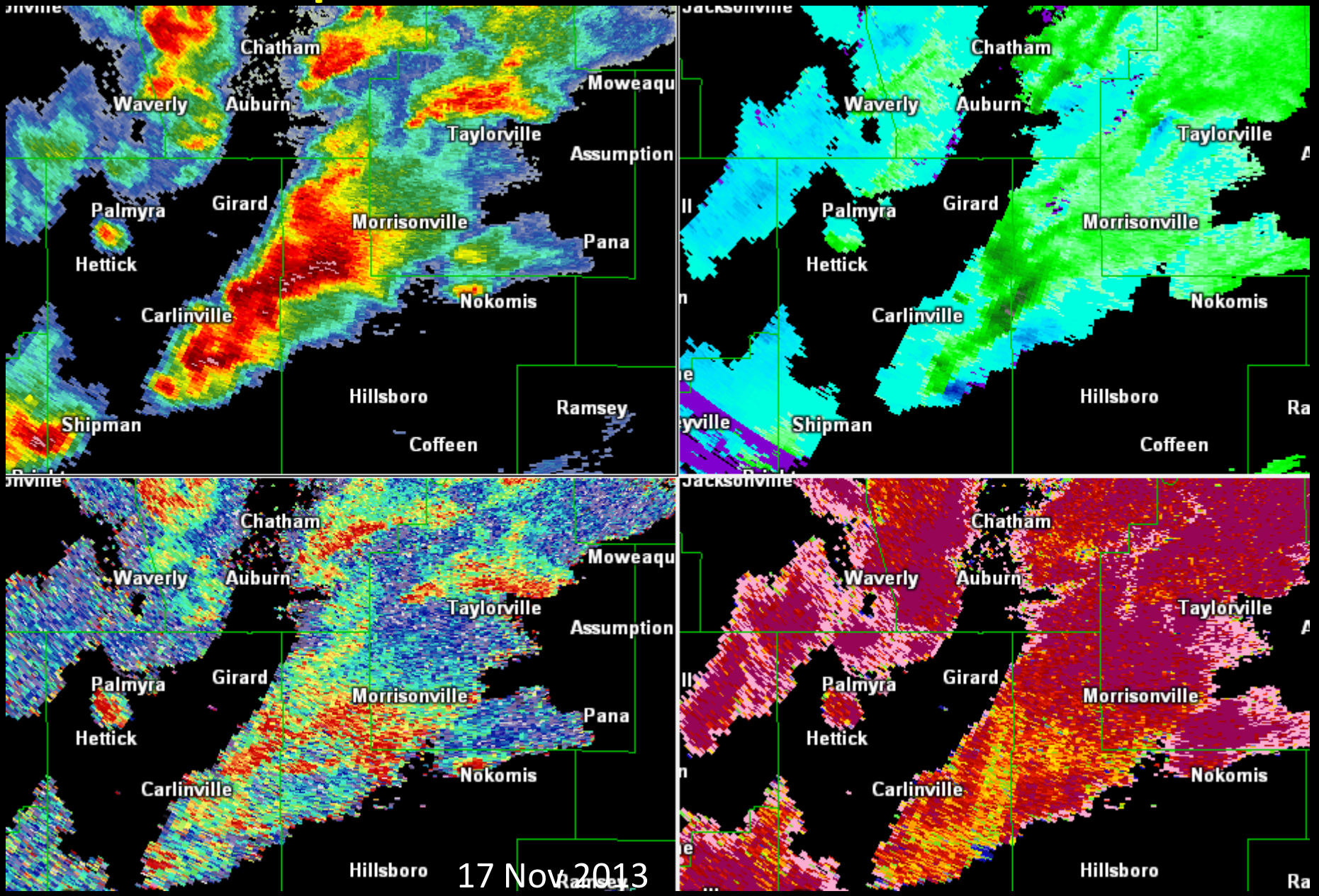


Other processes can mimic a TDS



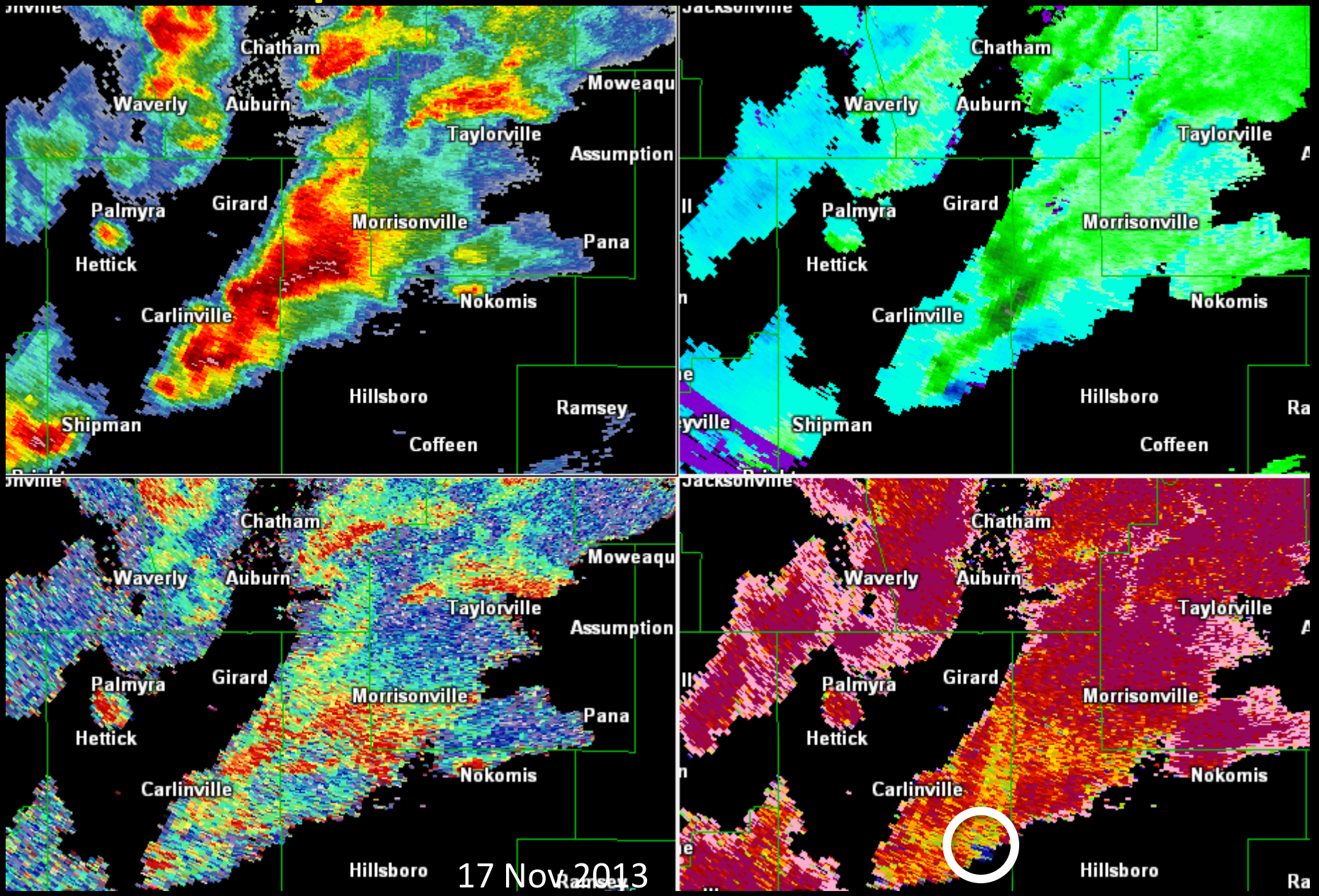
Other processes can mimic a TDS

Other processes can mimic a TDS

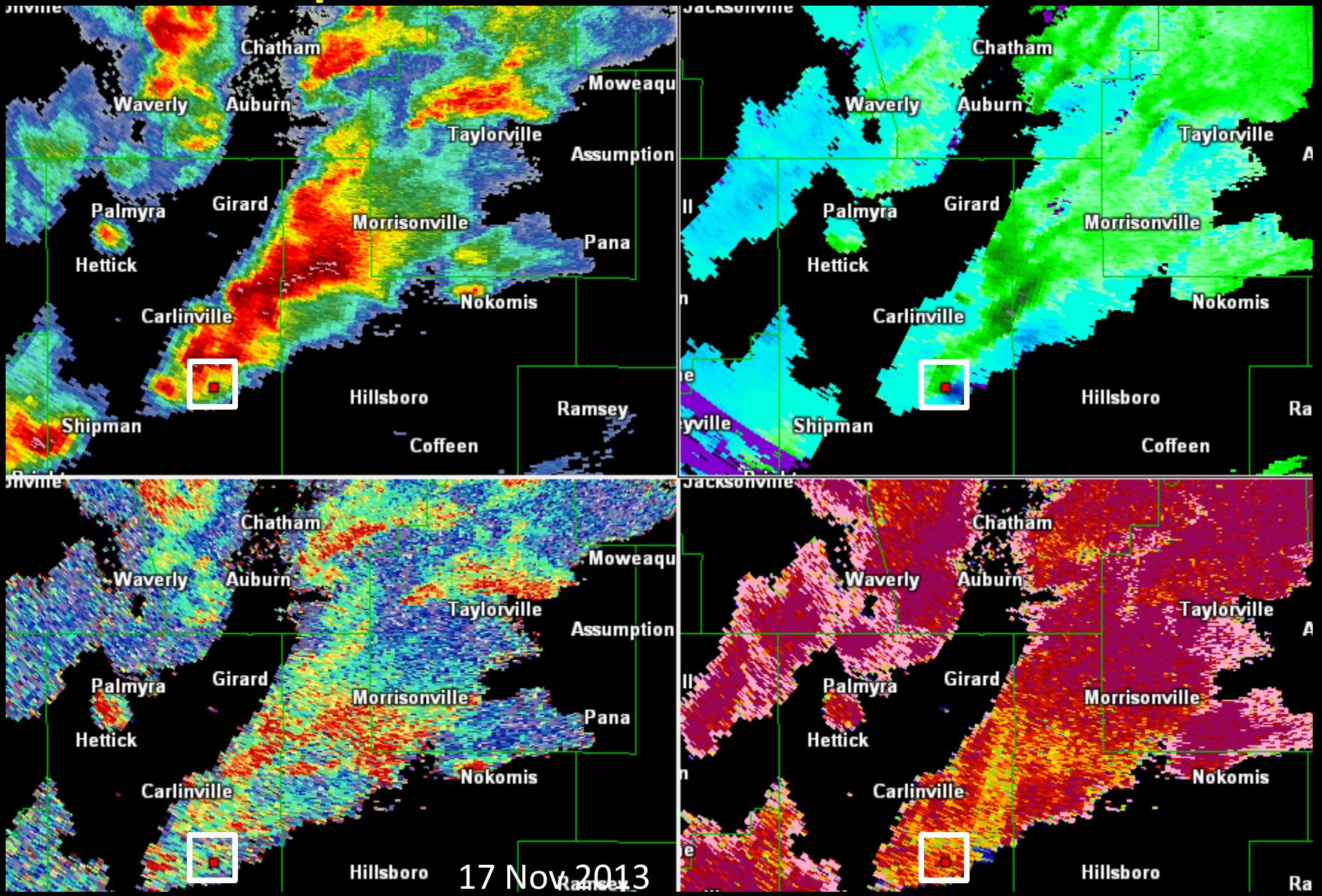


17 Nov 2013

Other processes can mimic a TDS

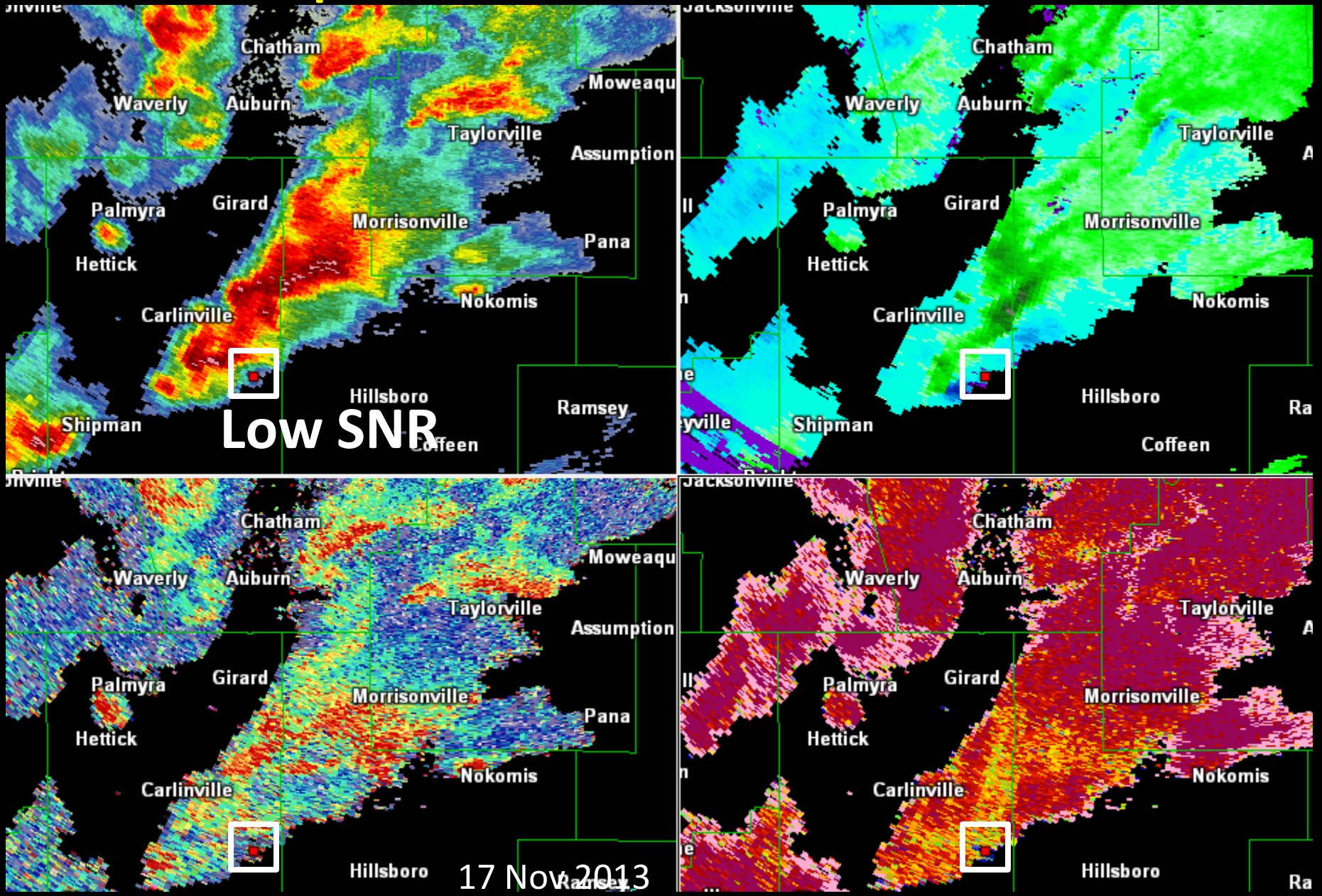


Other processes can mimic a TDS

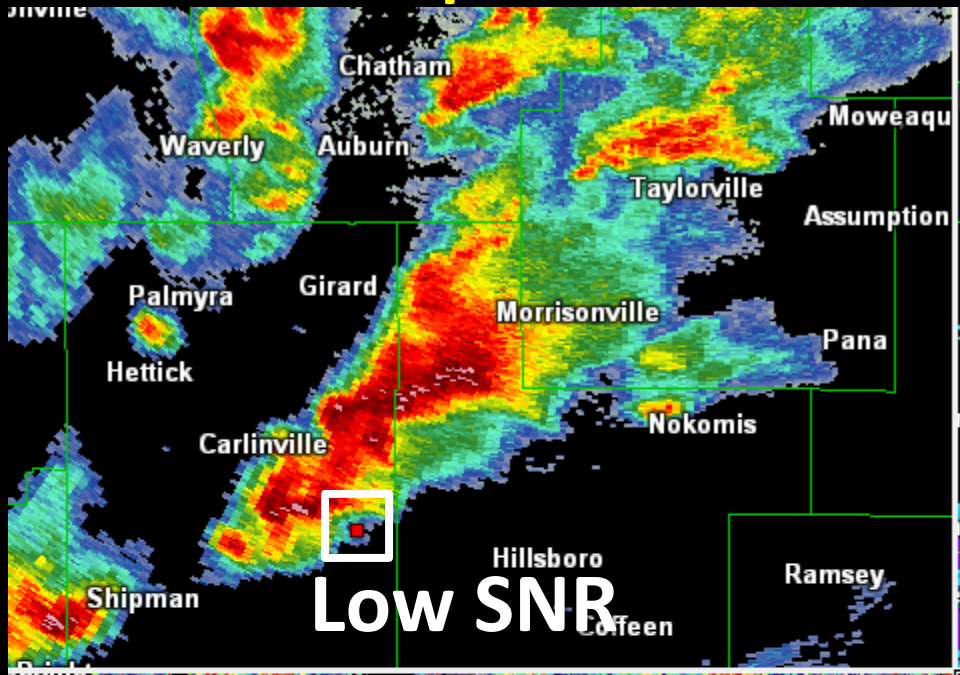


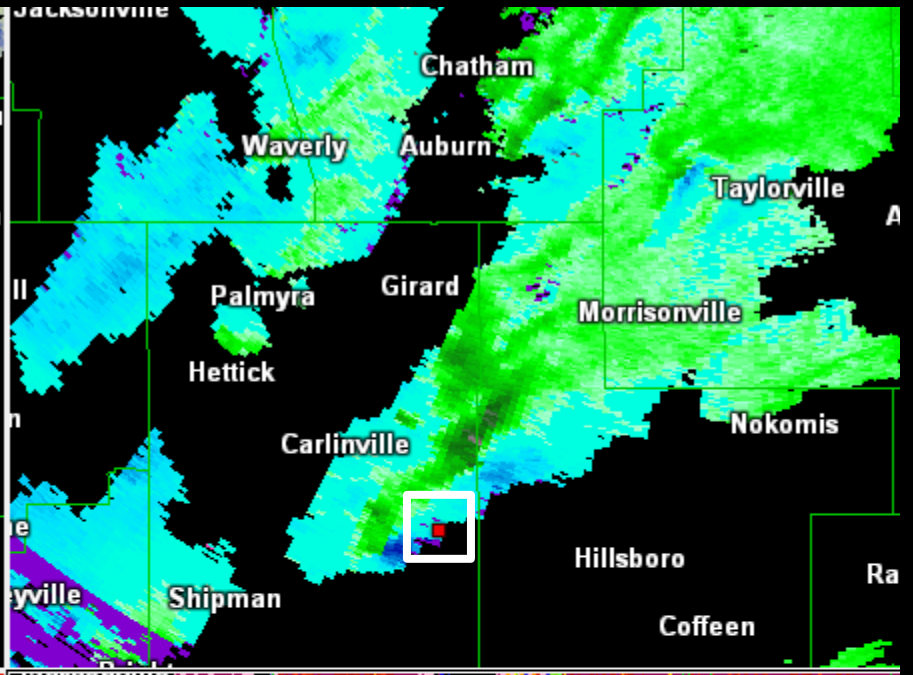
17 Nov 2013

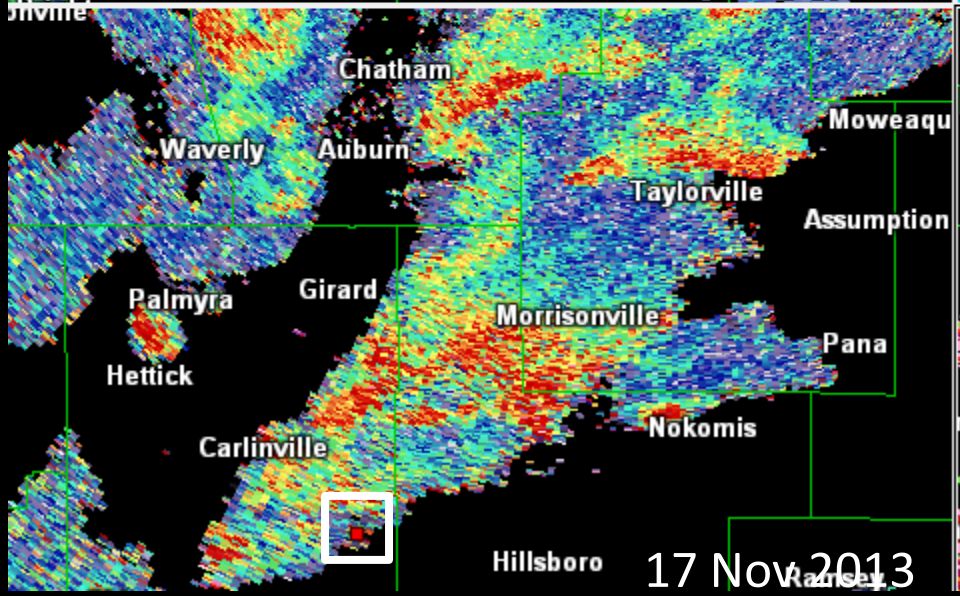
Other processes can mimic a TDS

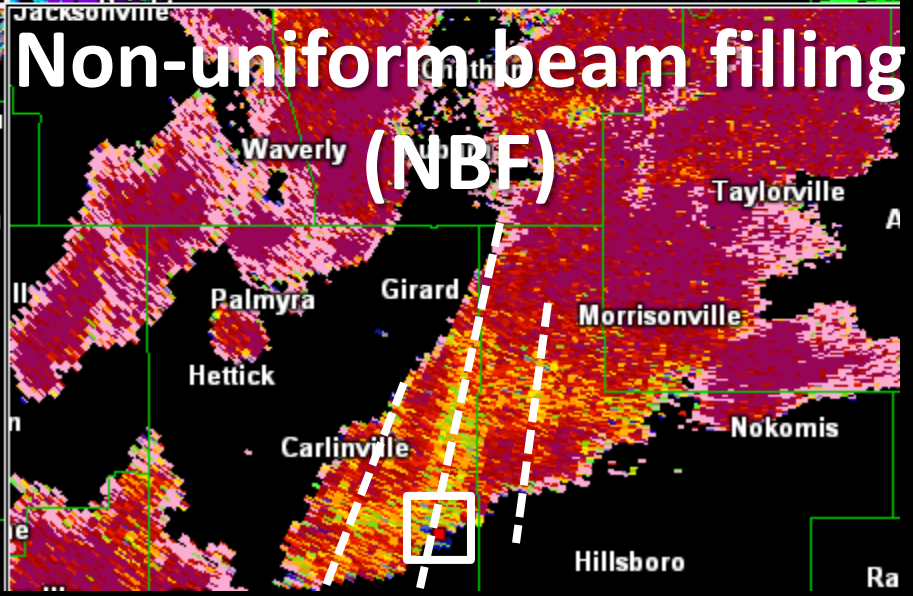


Other processes can mimic a TDS







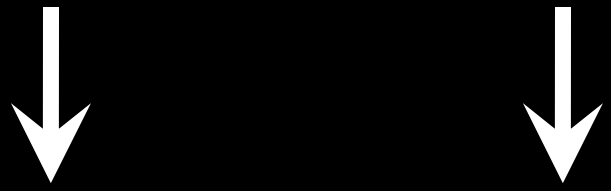


17 Nov 2013

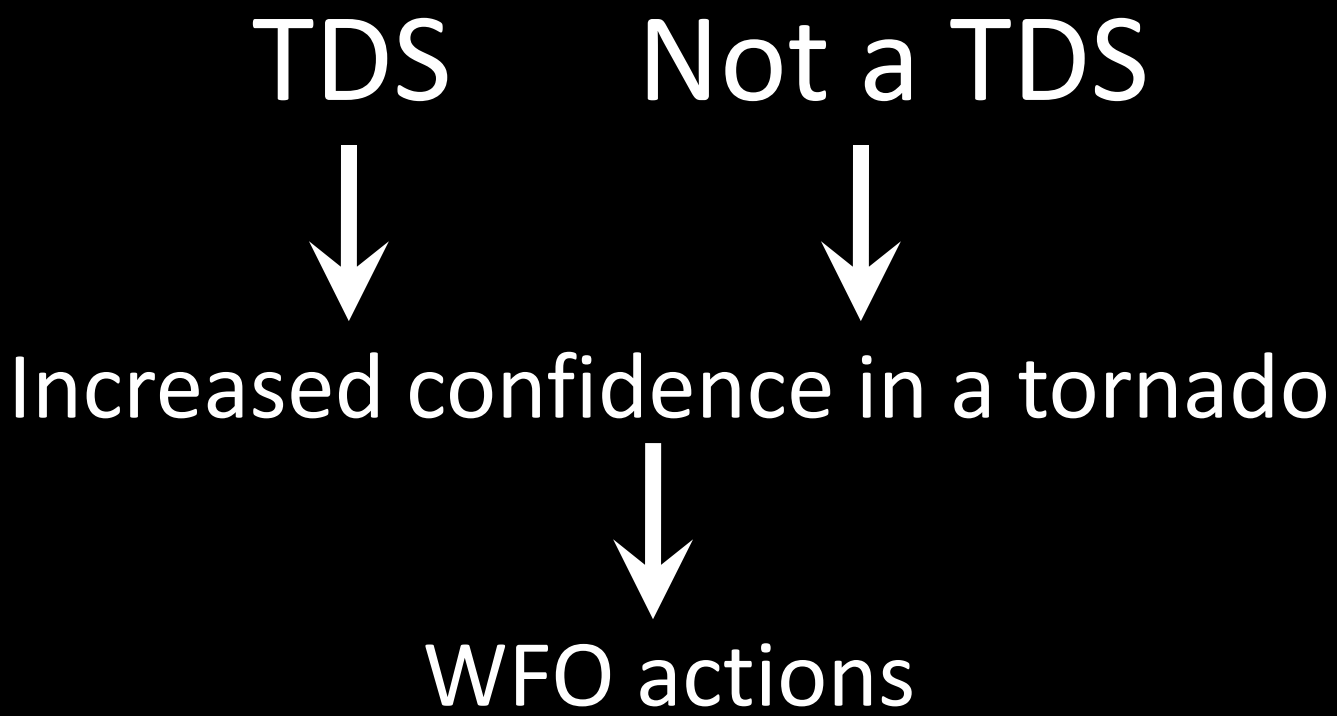
Not a TDS

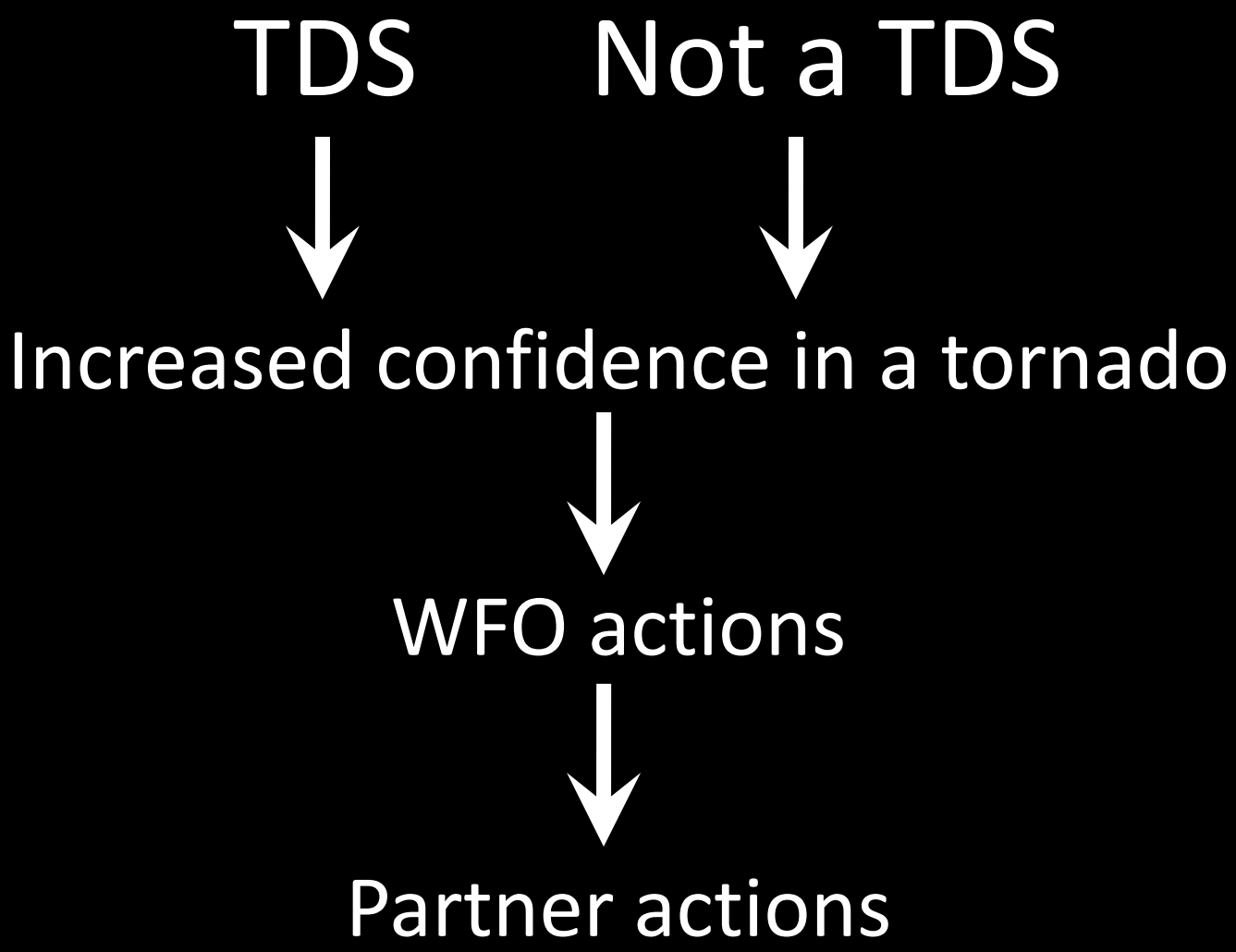
1. Inflow region of a supercell
2. Non-uniform beam filling
3. Hail spikes downstream
4. Side lobe contamination (vertical or horizontal)

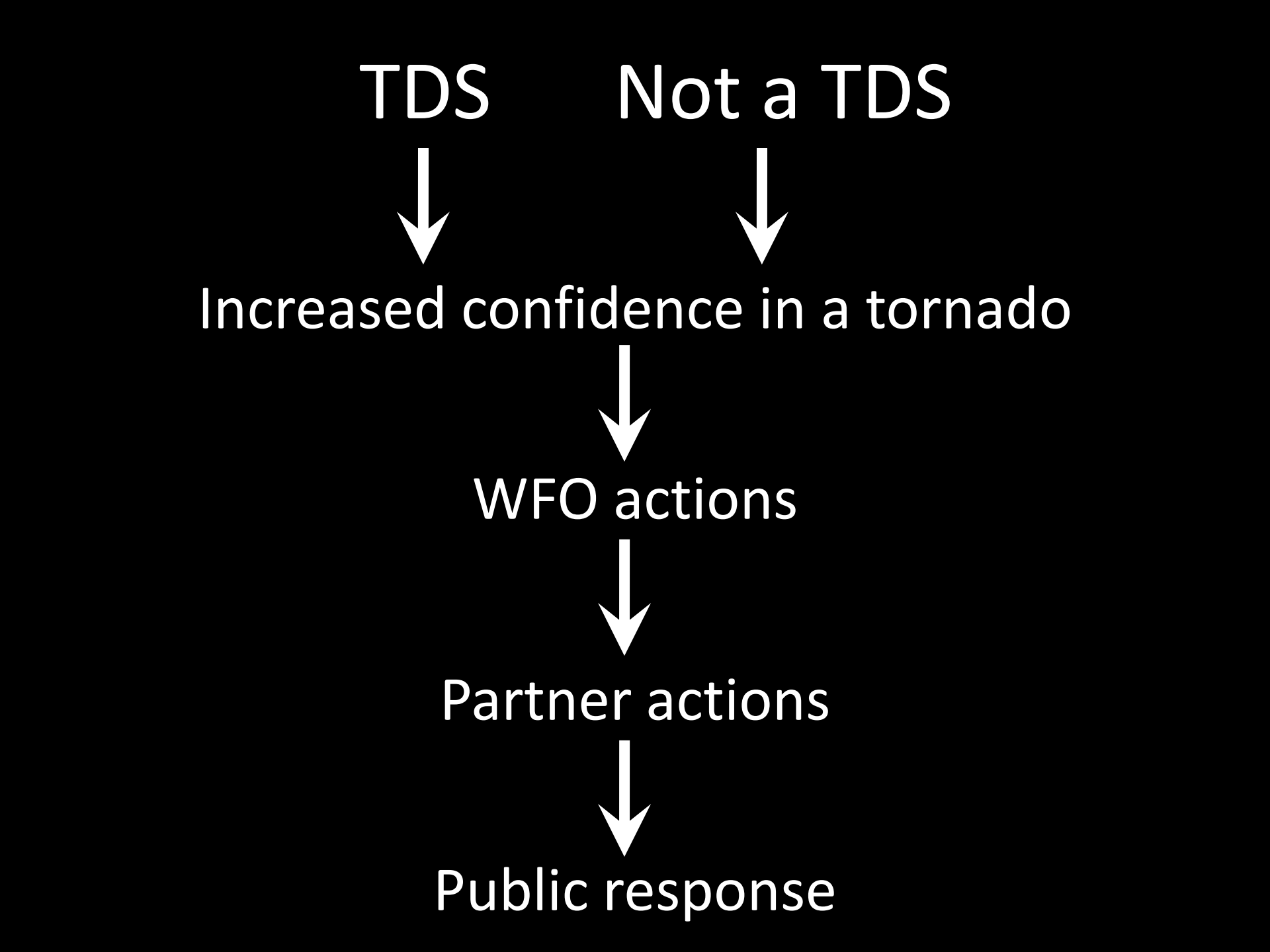
TDS Not a TDS



Increased confidence in a tornado


TDS
Not a TDS
Increased confidence in a tornado
WFO actions


TDS
Not a TDS
Increased confidence in a tornado
WFO actions
Partner actions


TDS
Not a TDS
Increased confidence in a tornado
WFO actions
Partner actions
Public response

TDS

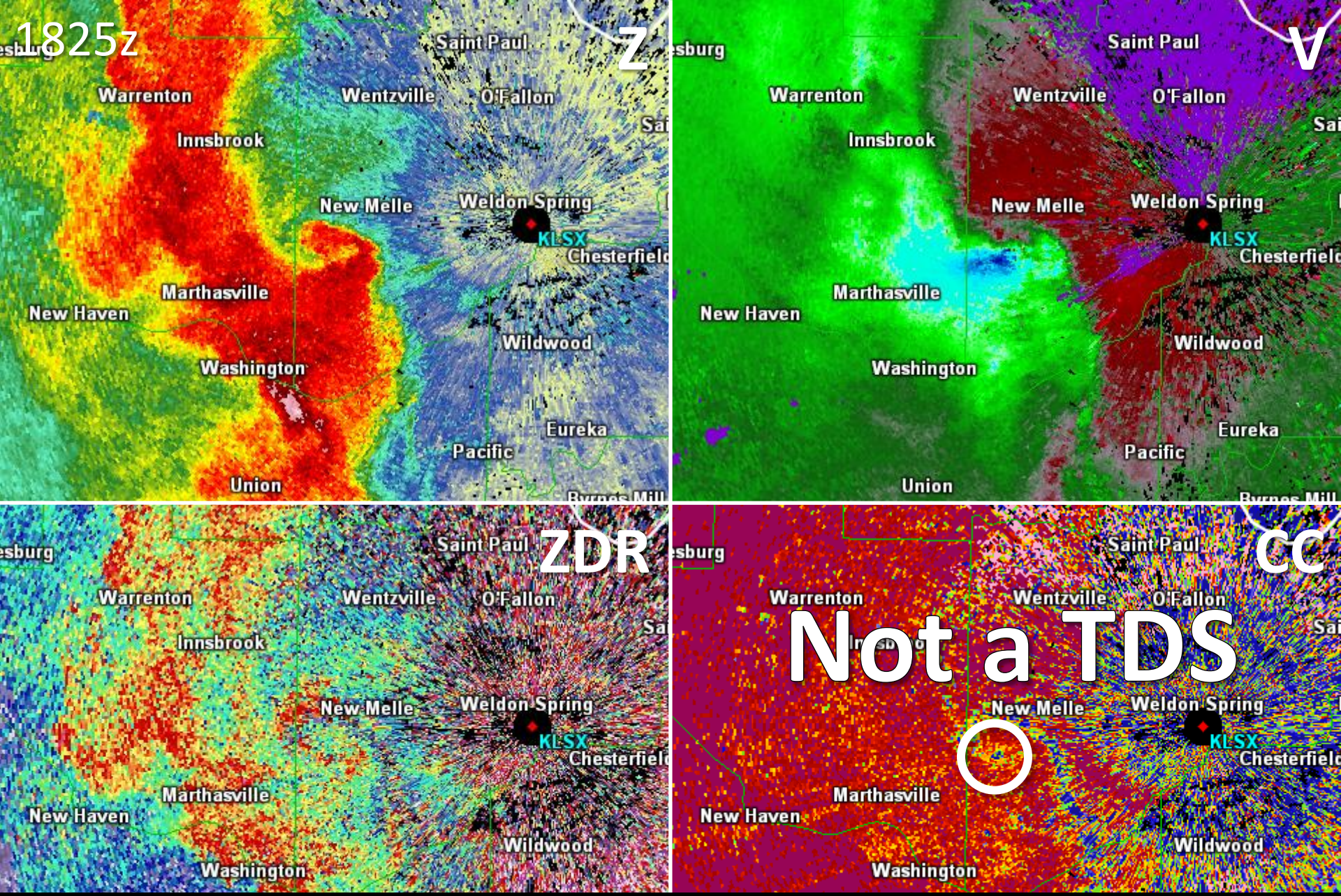
Not a TDS

Increased confidence in a tornado

WFO actions

Partner actions

Public response



This static image alone isn’t enough

Watching multiple mesos?

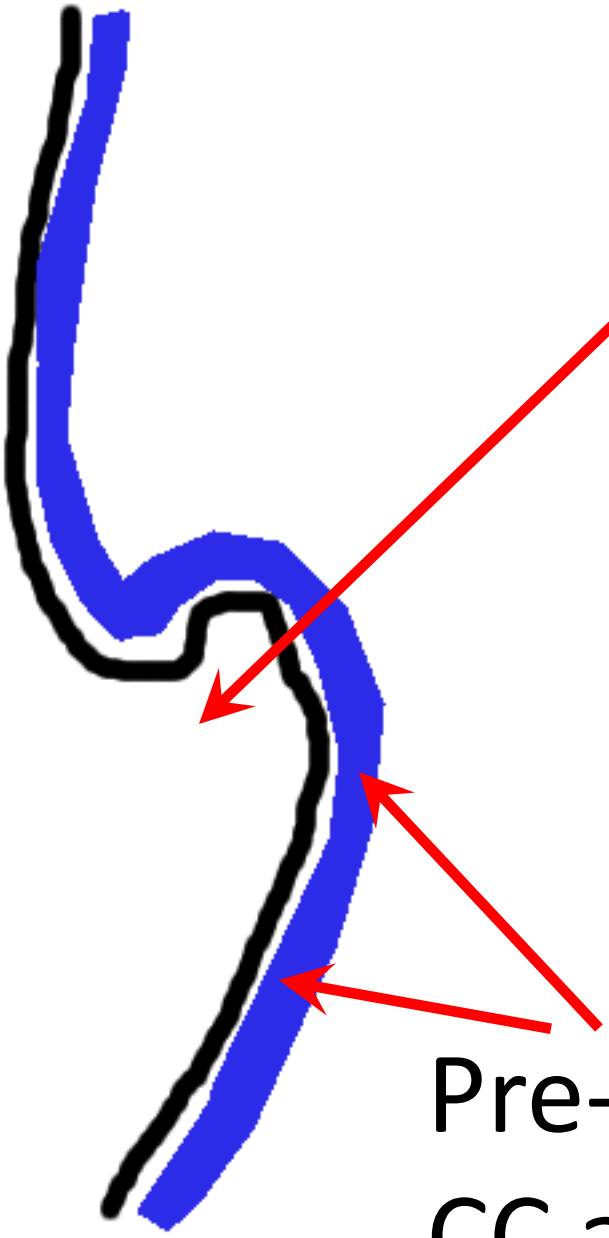
Easy to be startled when a new slice comes in (especially with MESO-SAILS)

Watching multiple mesos?

Easy to be startled when a new slice comes in (especially with MESO-SAILS)

Key question: how did the imagery evolve?

Why it’s not a TDS

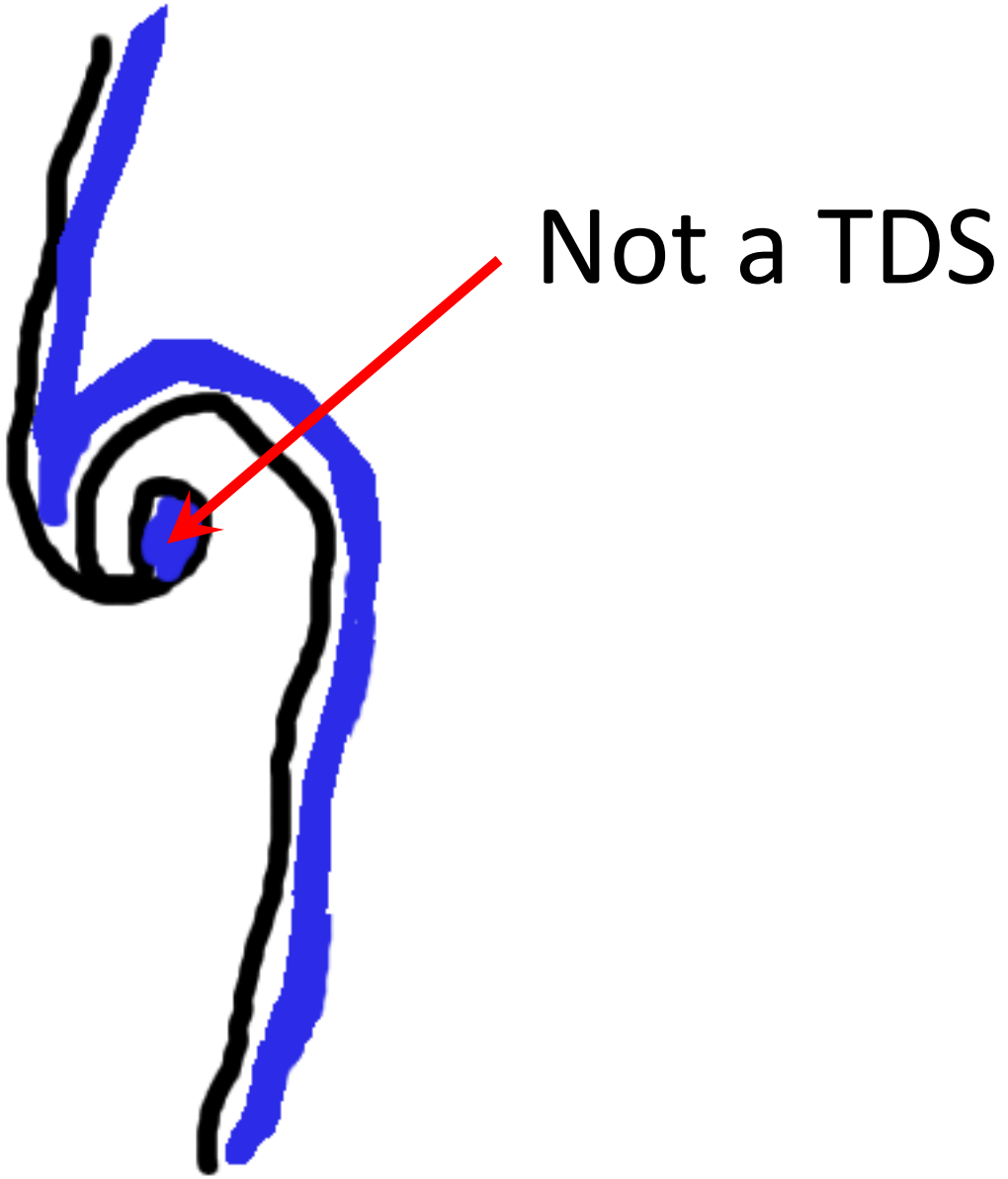


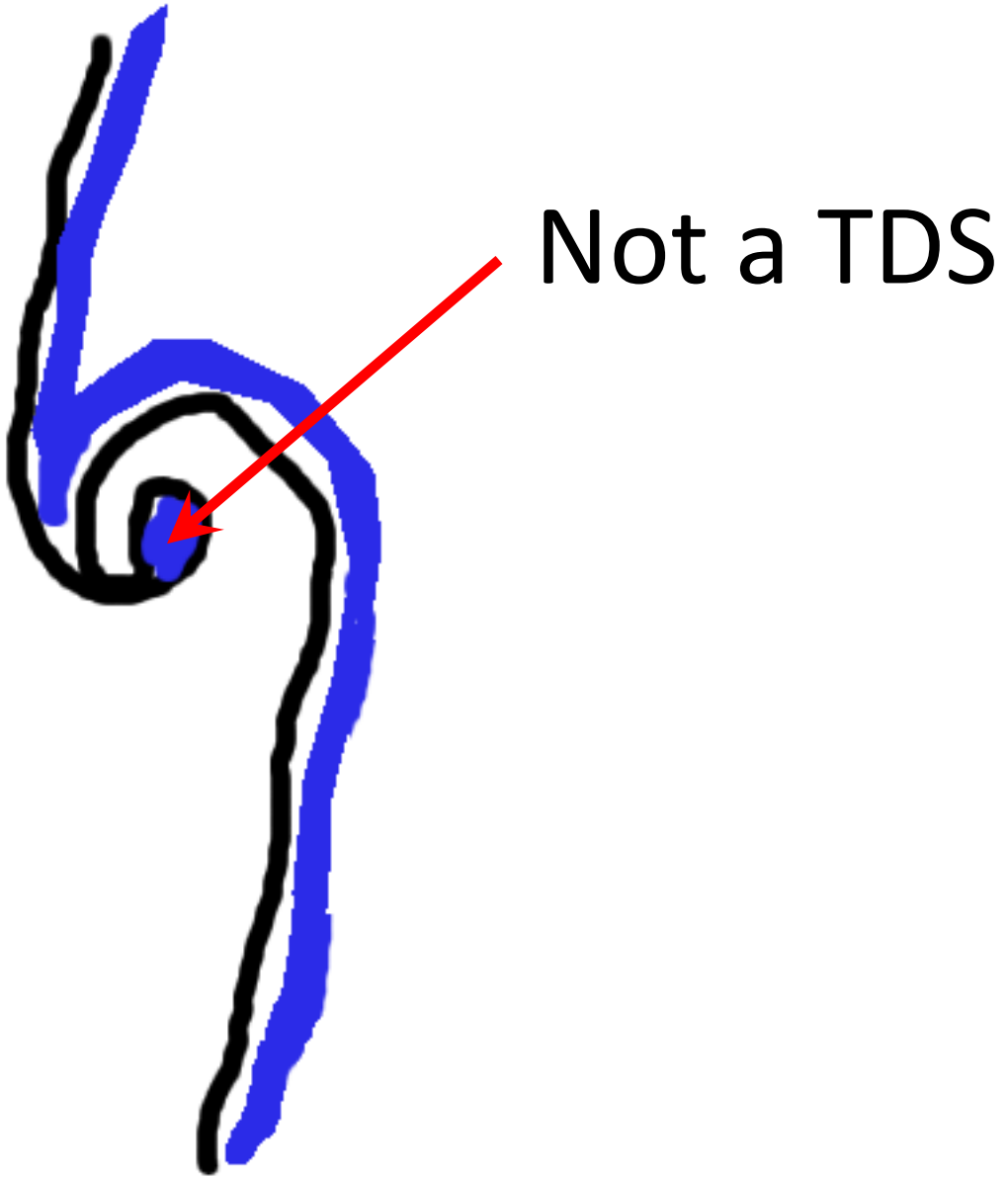
Notch, nub, or hook

Pre-existing ribbon of low CC along the leading edge

Ribbon of low CC wraps back into the meso

Area of low CC becomes closed off

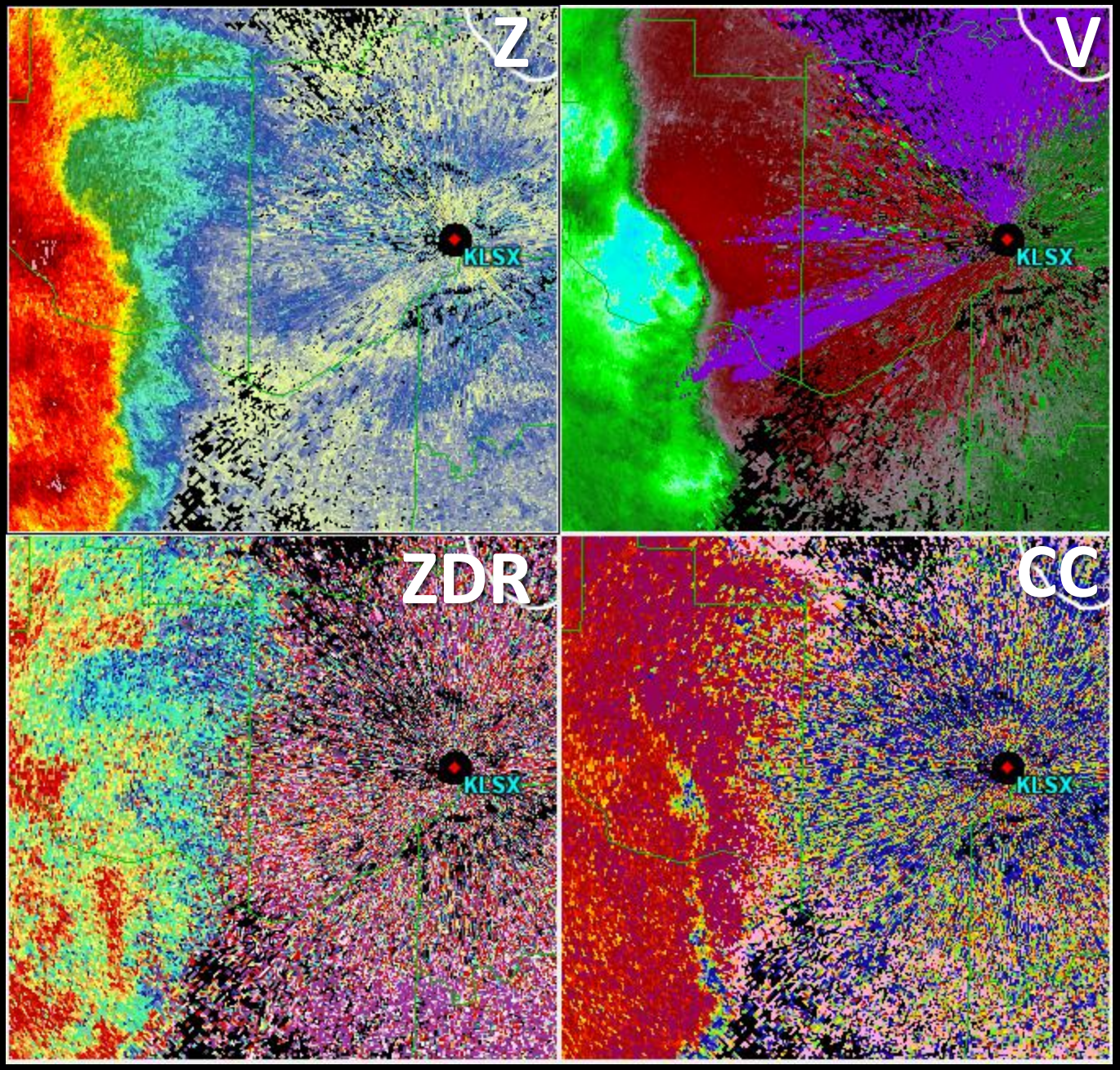

Not a TDS



CC isn’t low because of debris.

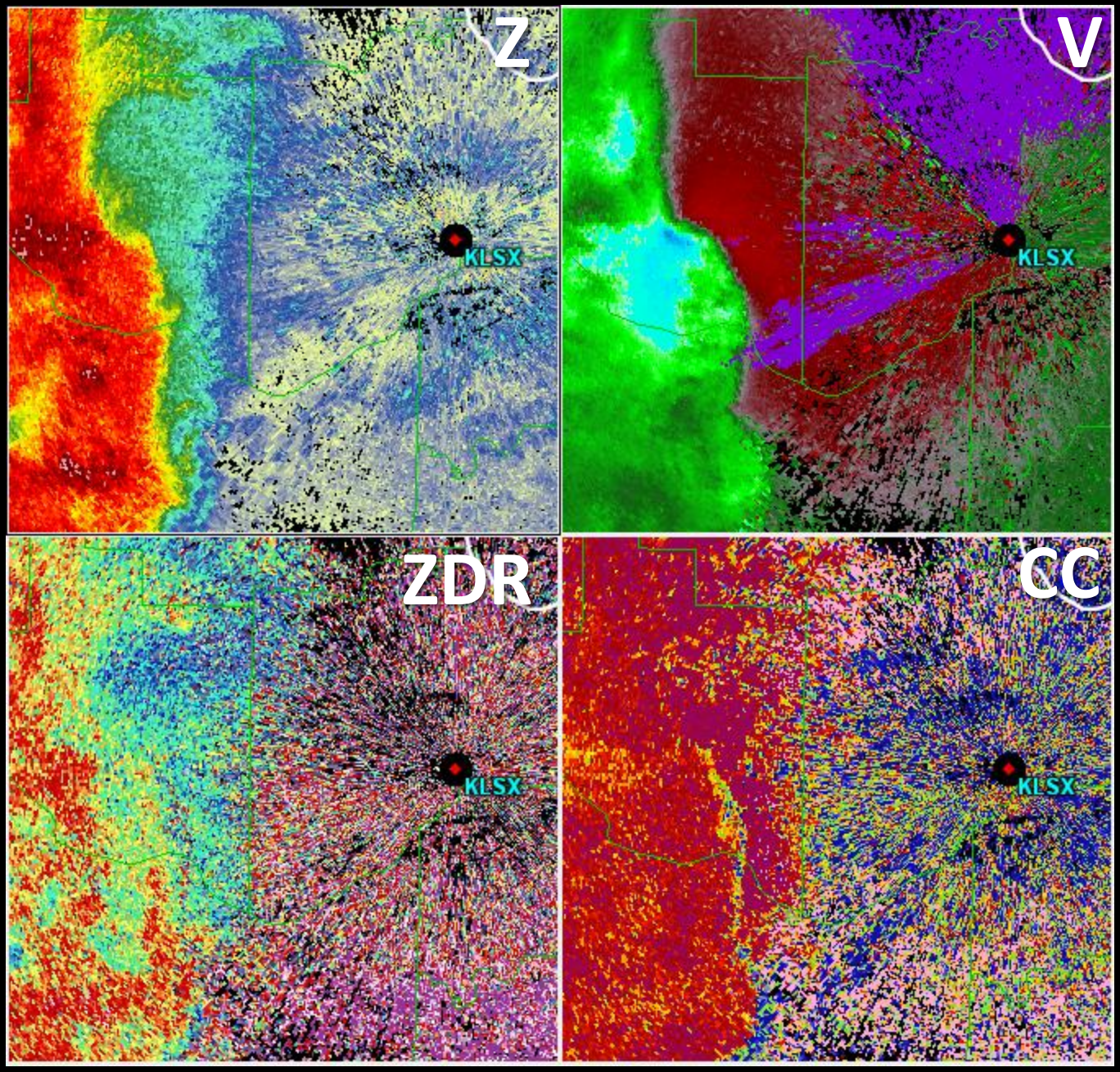
26 Apr 2016
1804z

0.5°



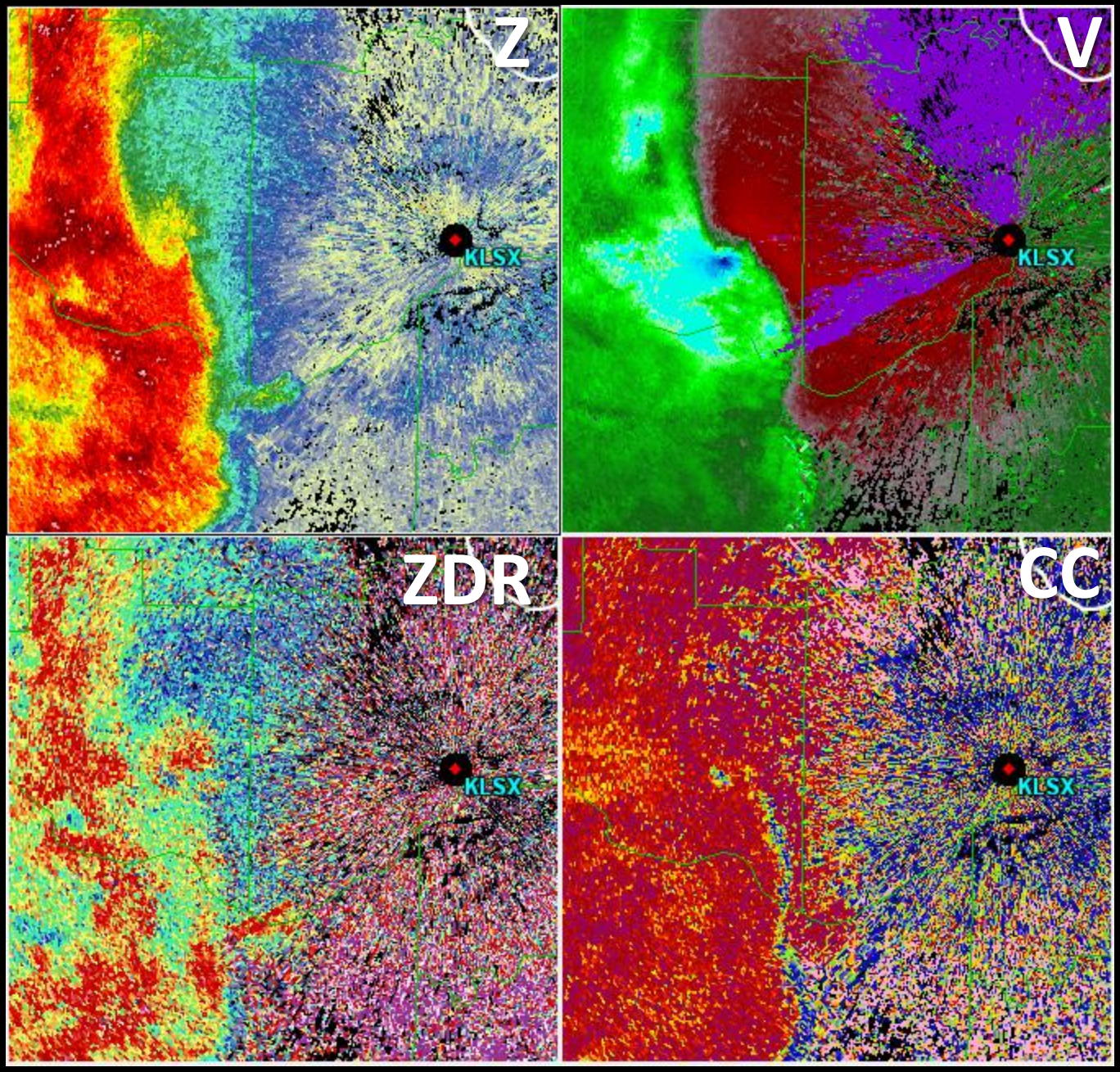
26 Apr 2016
1809z

0.5°



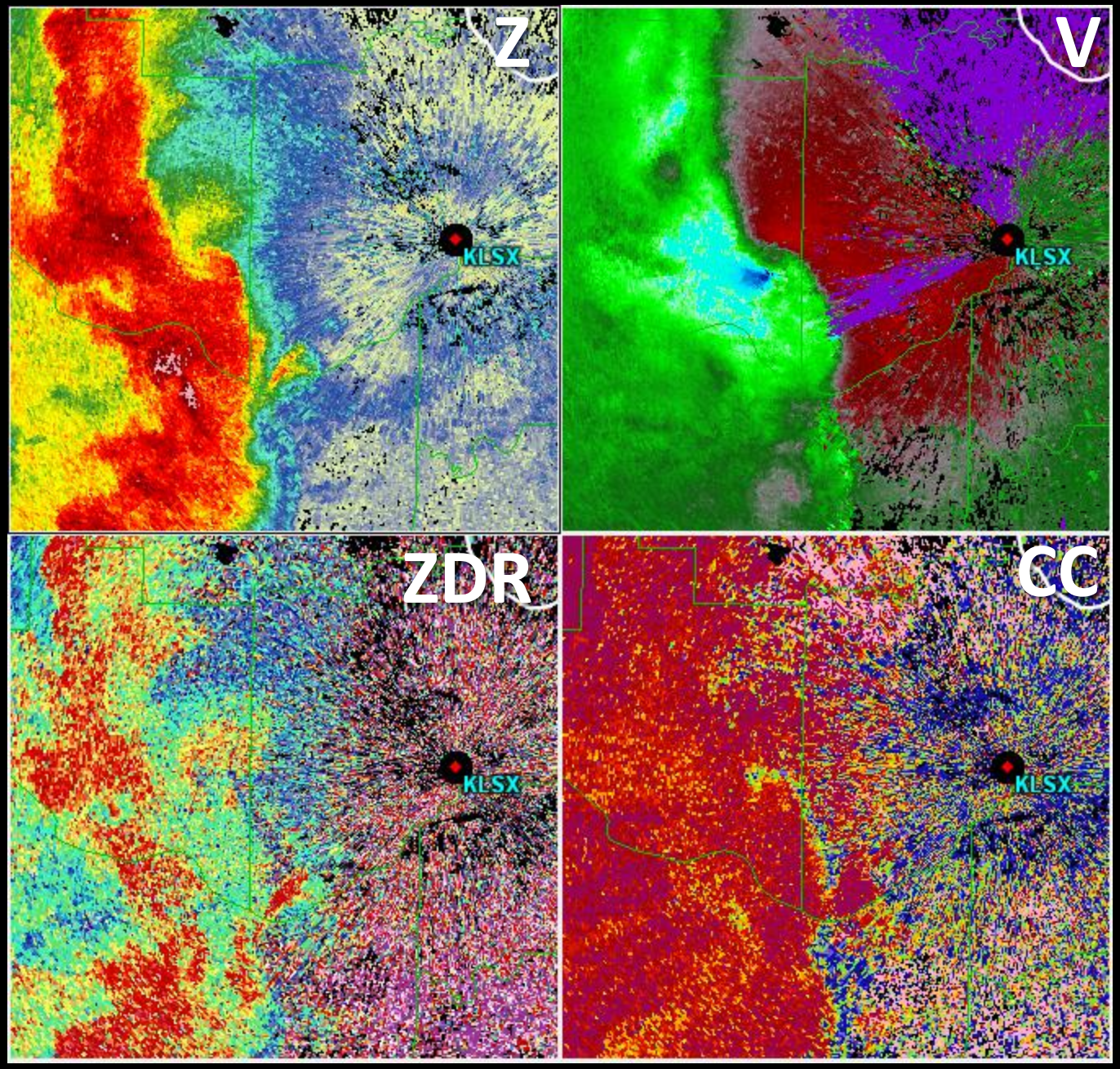
26 Apr 2016
1813z

0.5°



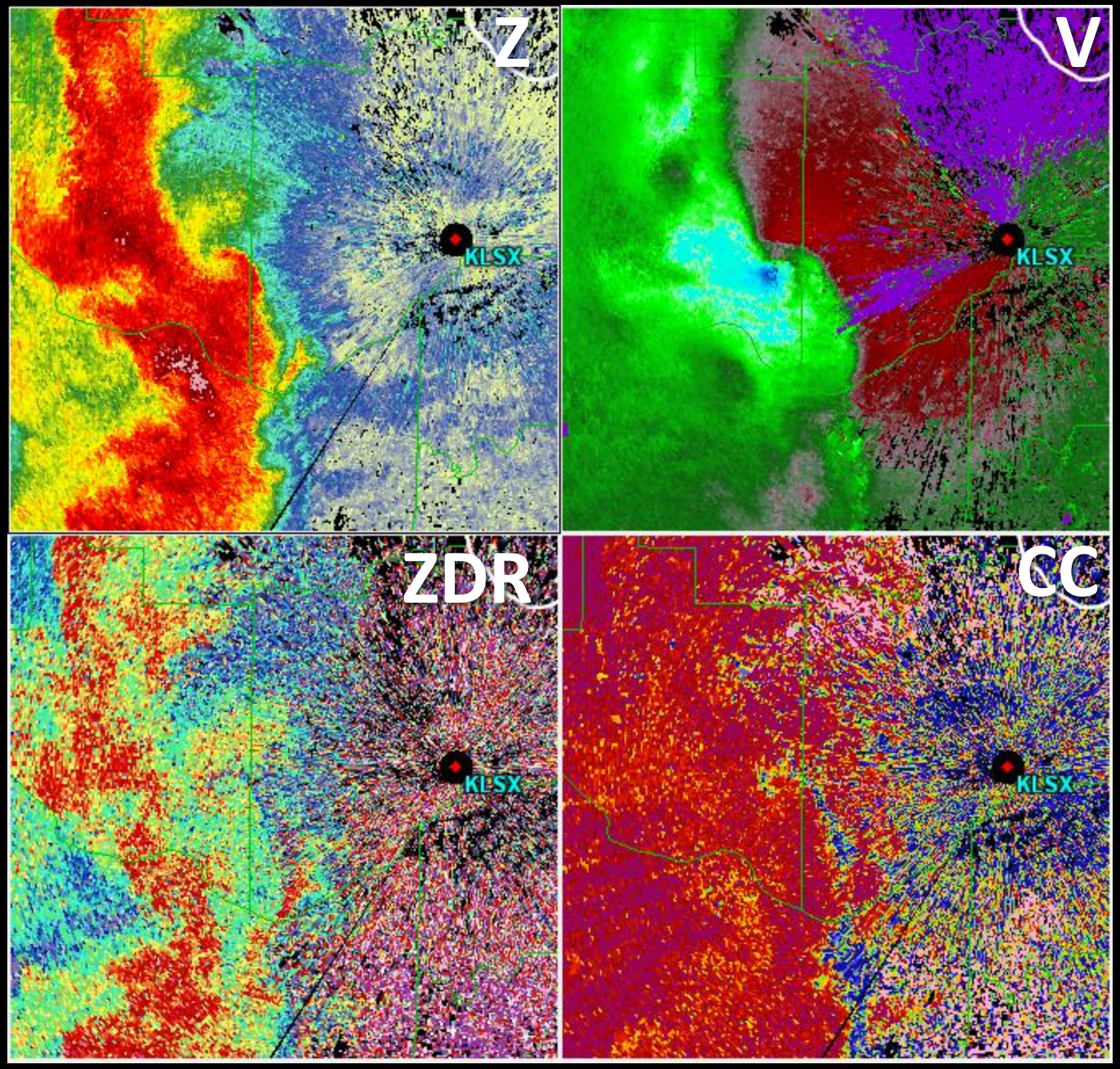
26 Apr 2016
1817z

0.5°



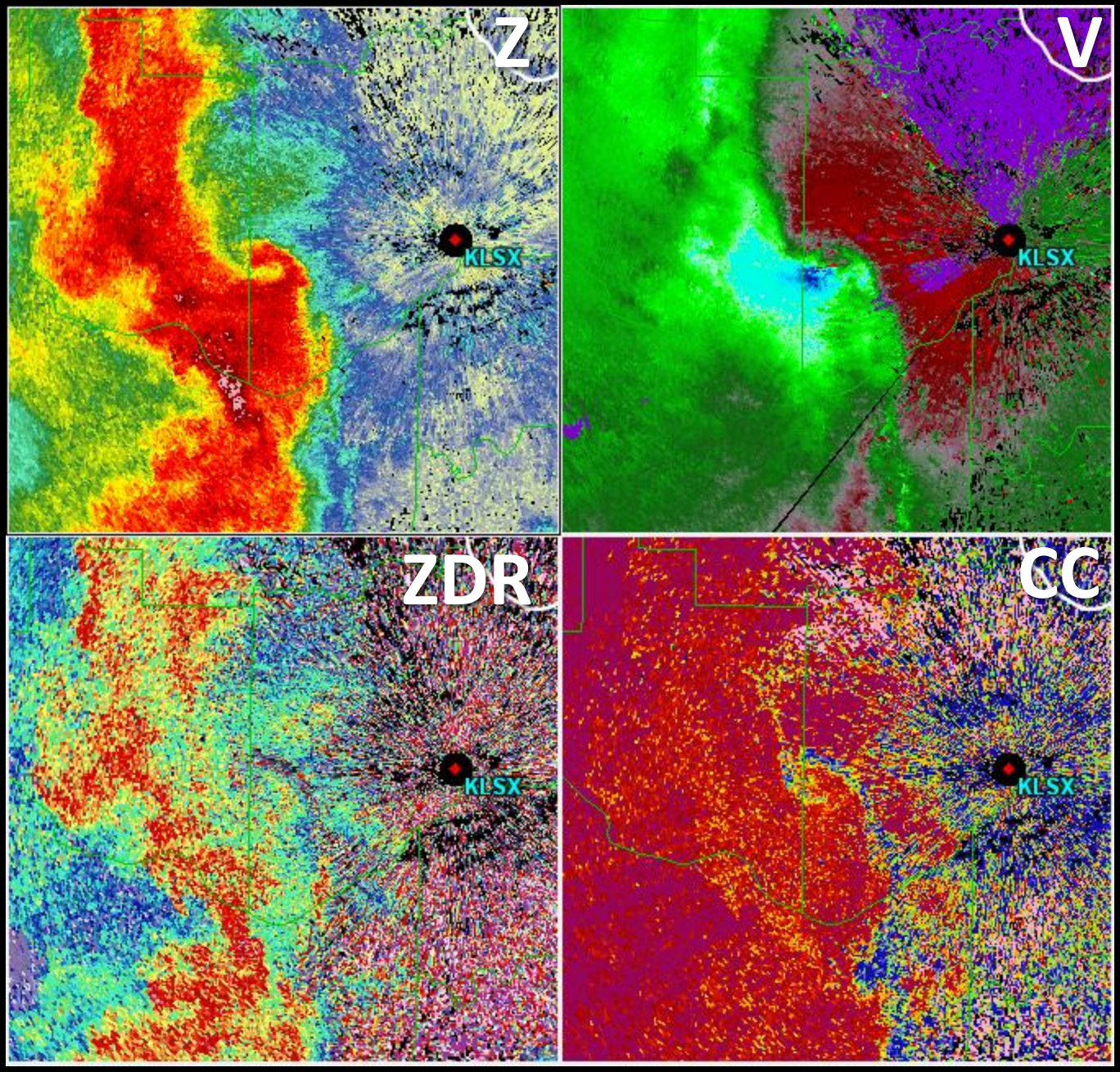
26 Apr 2016
1819z

0.5°



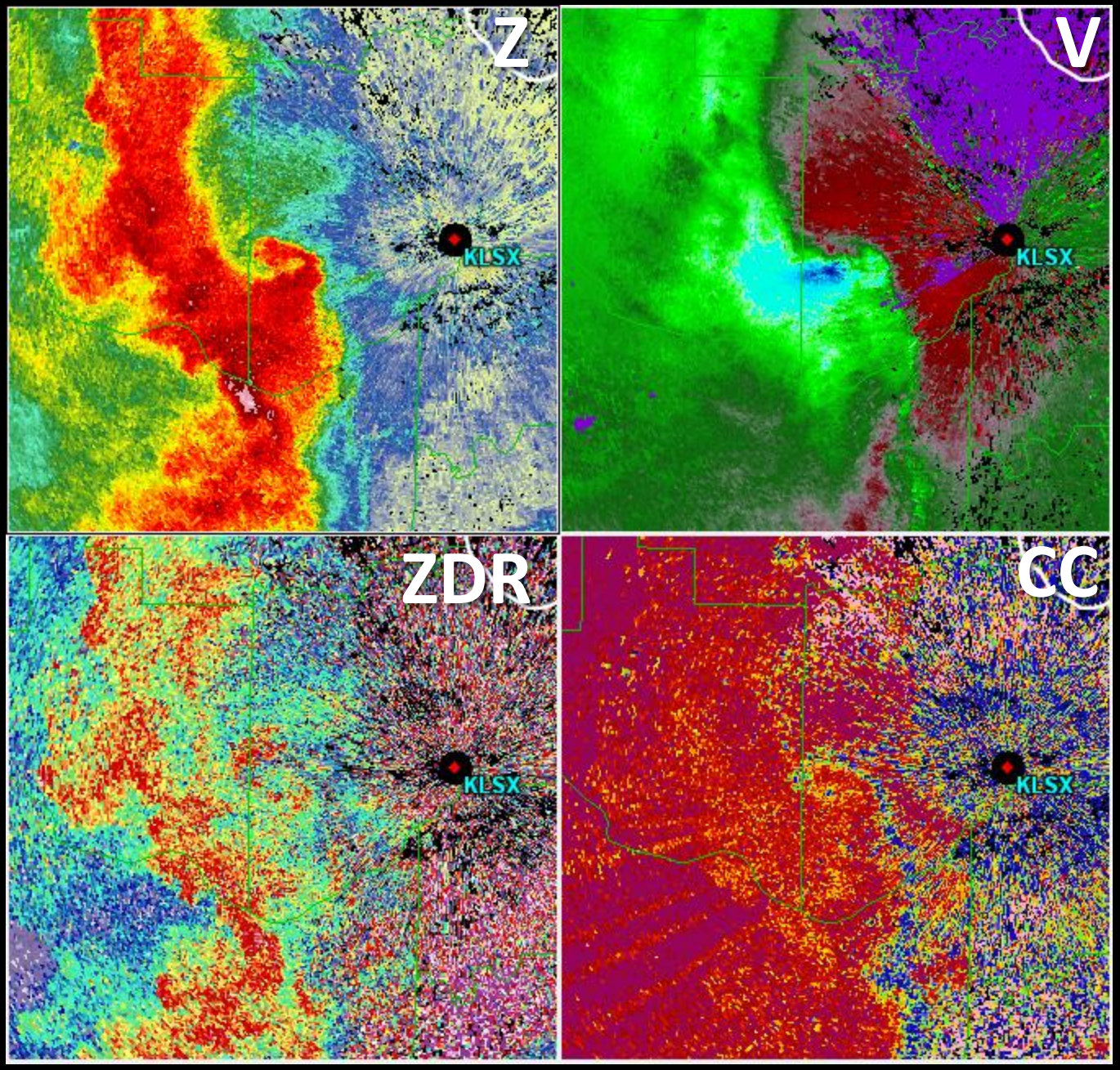
26 Apr 2016
1823z

0.5°



26 Apr 2016
1825z

0.5°



Damage survey results

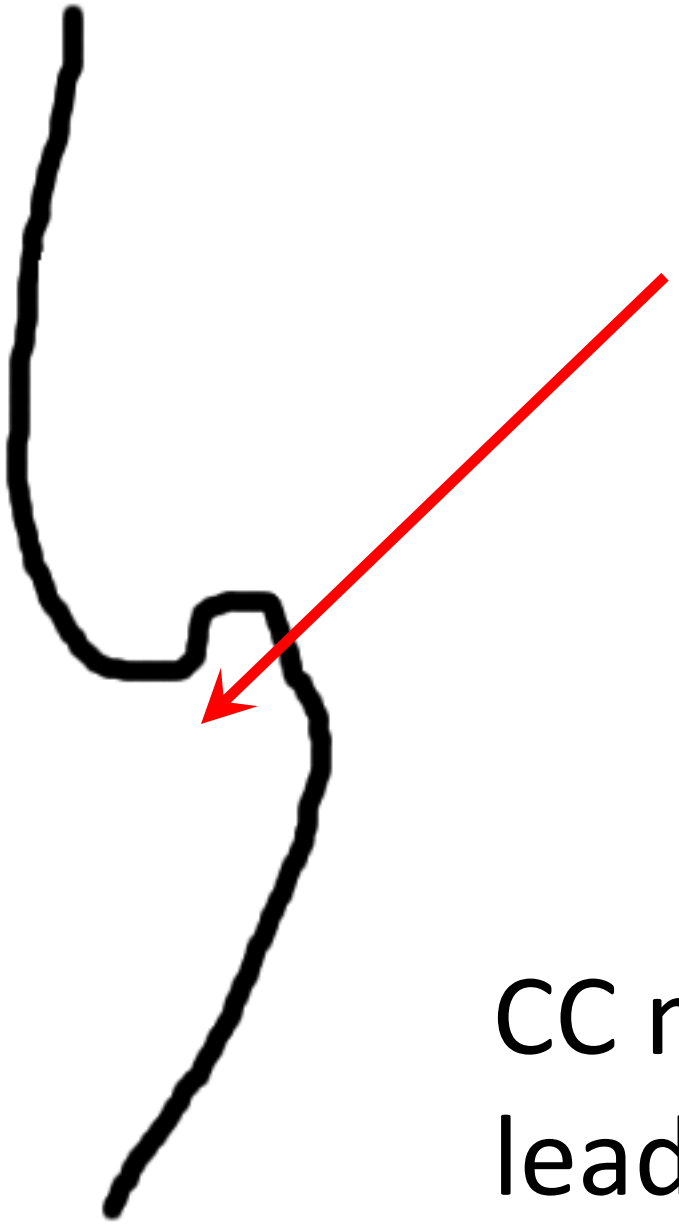
Extensive damage survey

Widespread 80 mph wind damage

2 weak tornadoes

No tornadoes associated with this CC feature

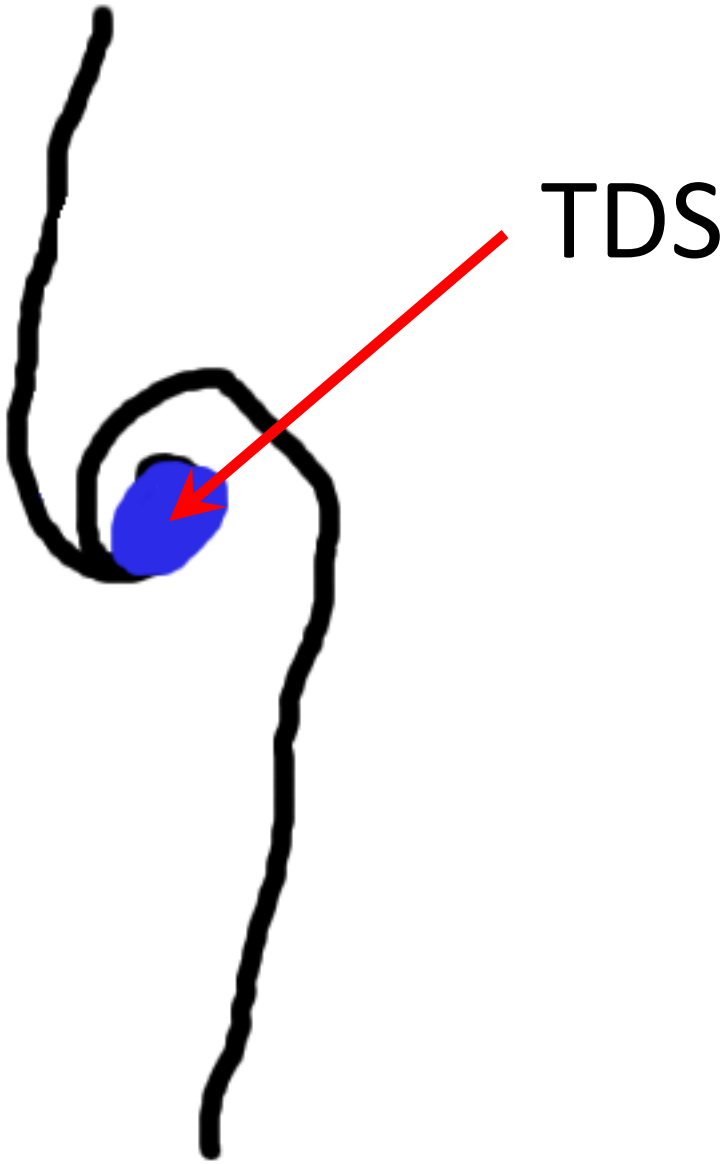
Comparison with a real TDS



Notch, nub, or hook

CC may be noisy along the leading edge, but it’s not a clear ribbon

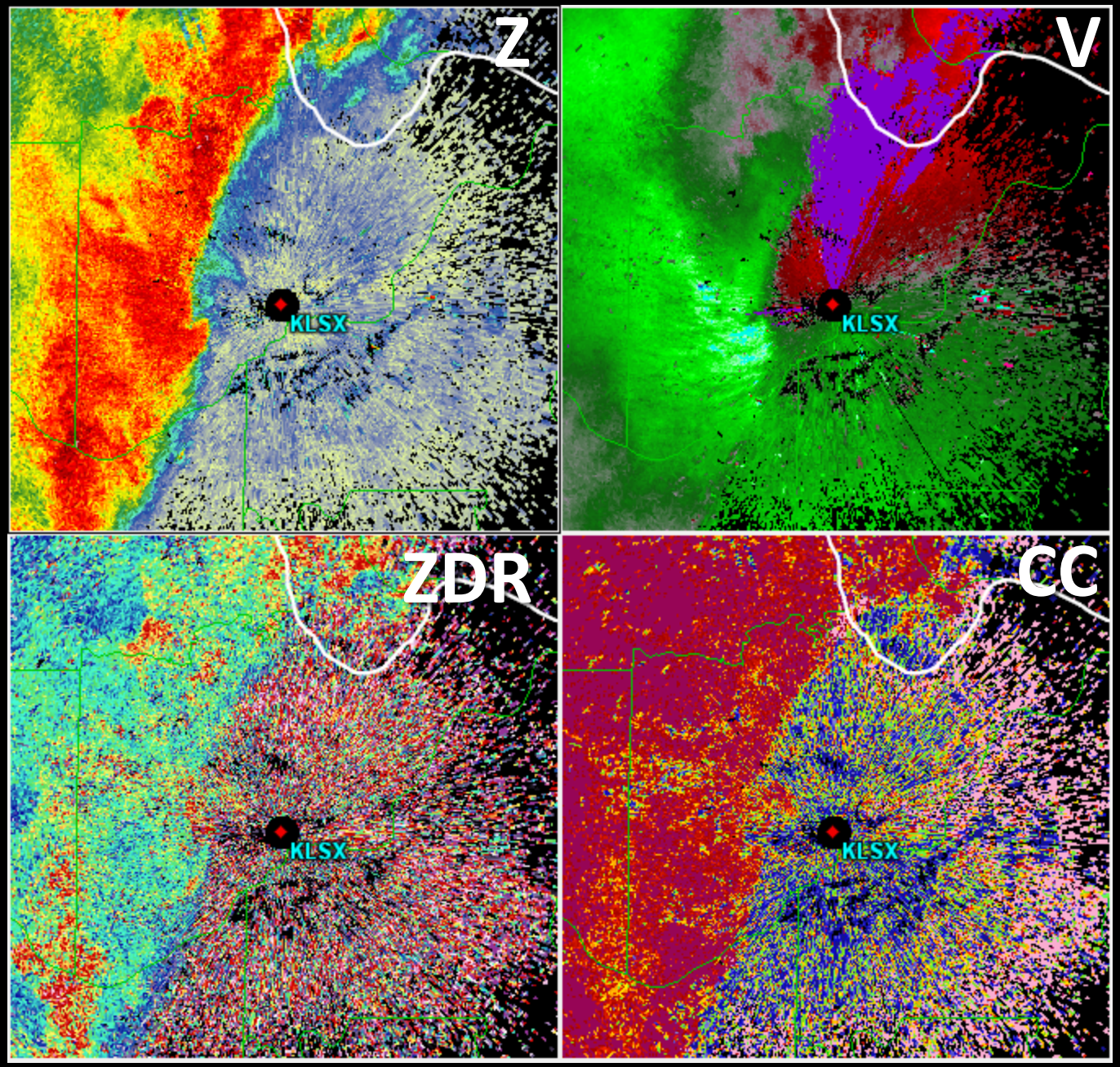
Area of low CC appears suddenly



CC <u>is</u> low because of debris.

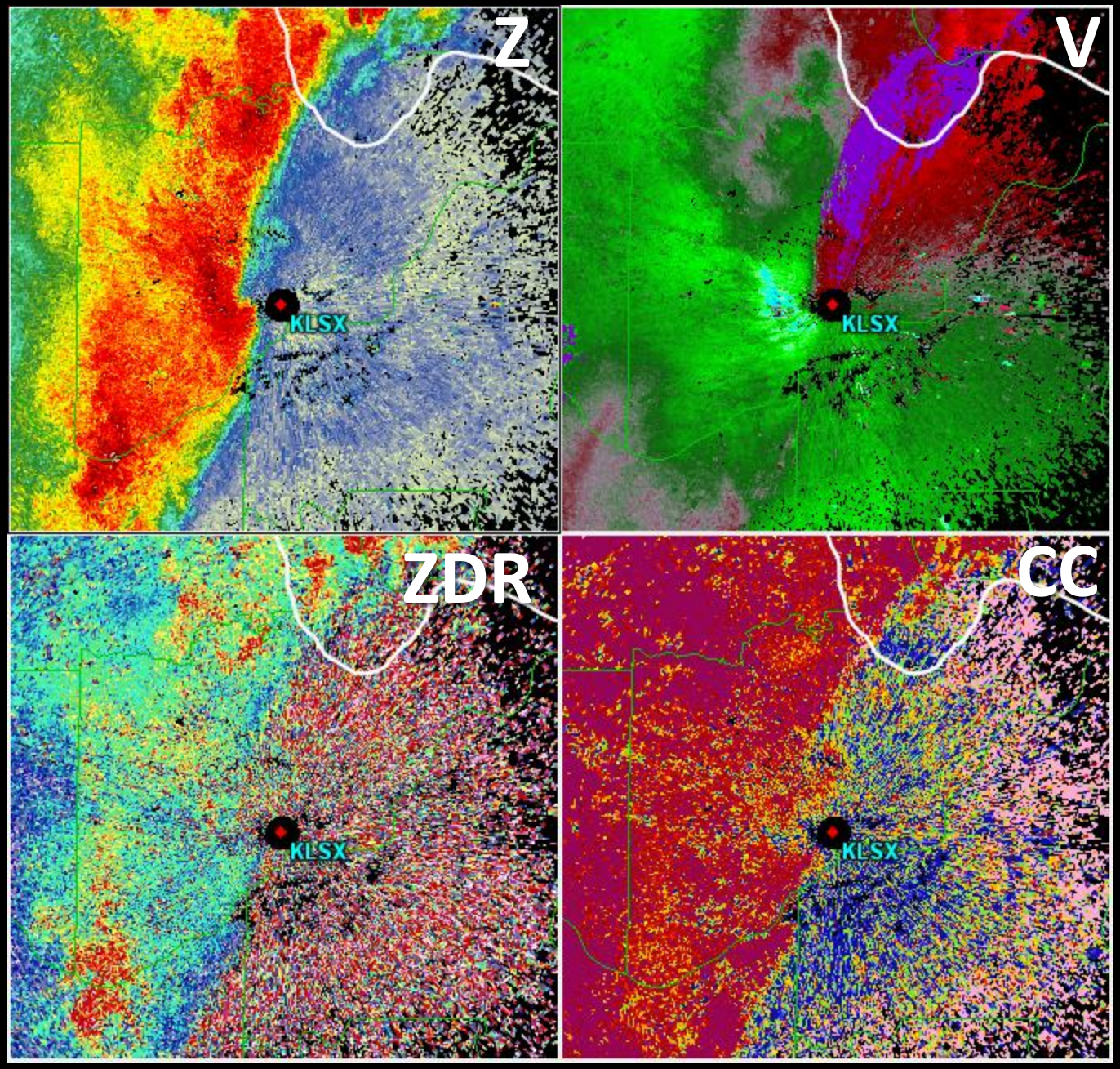
01 Jun 2013
0048z

0.5°



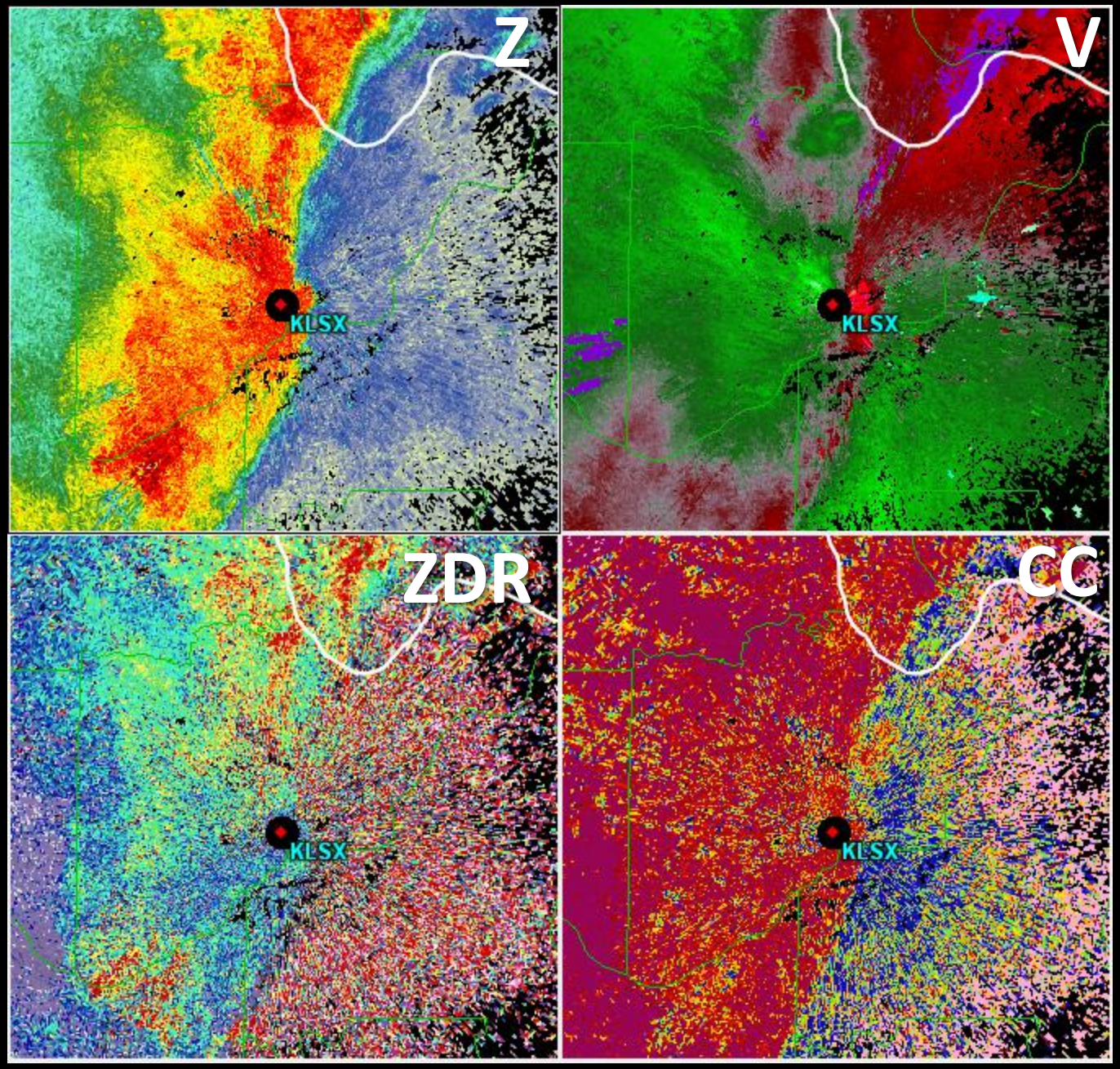
01 Jun 2013
0053z

0.5°



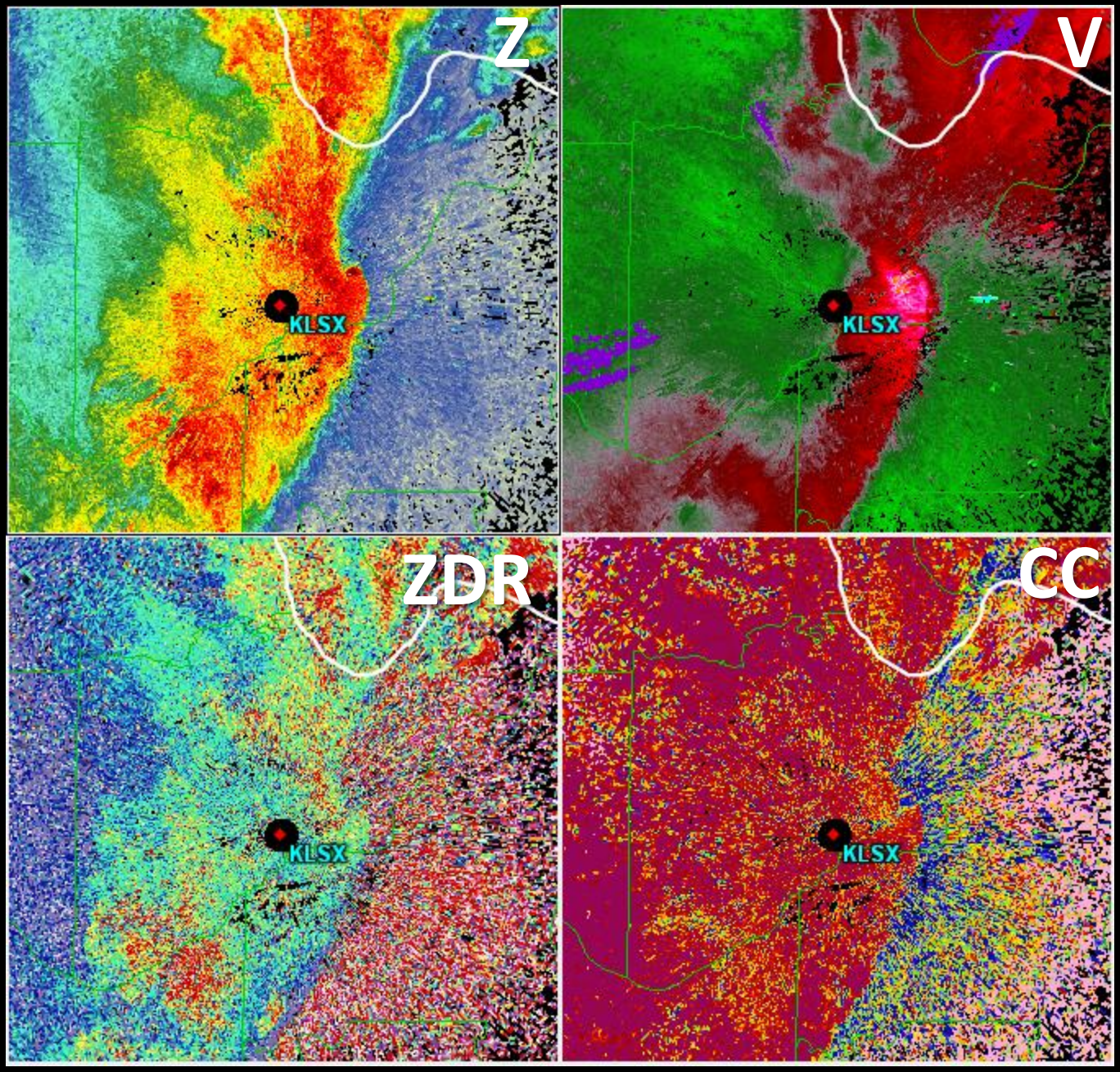
01 Jun 2013
0057z

0.5°



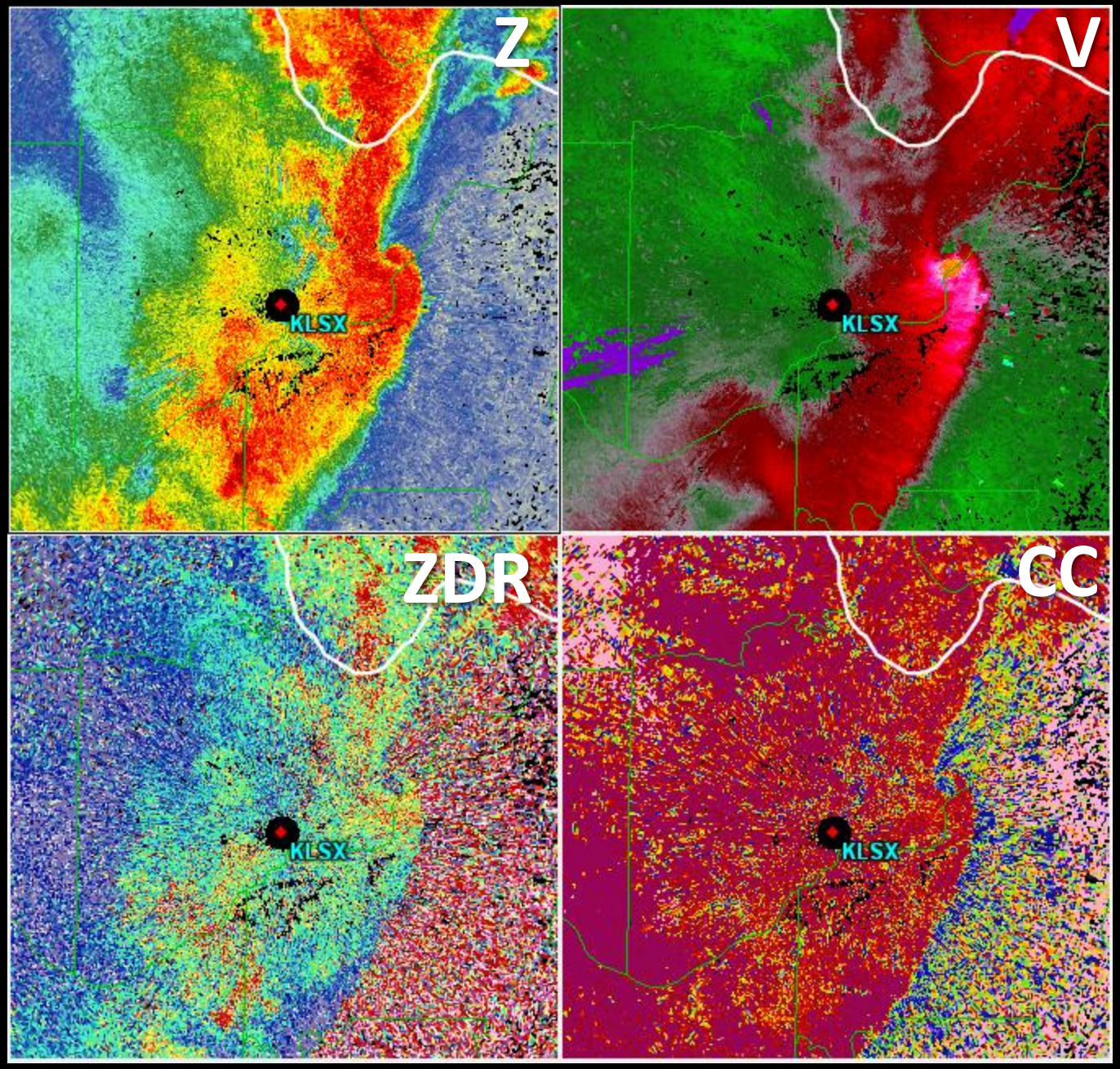
01 Jun 2013
0101z

0.5°



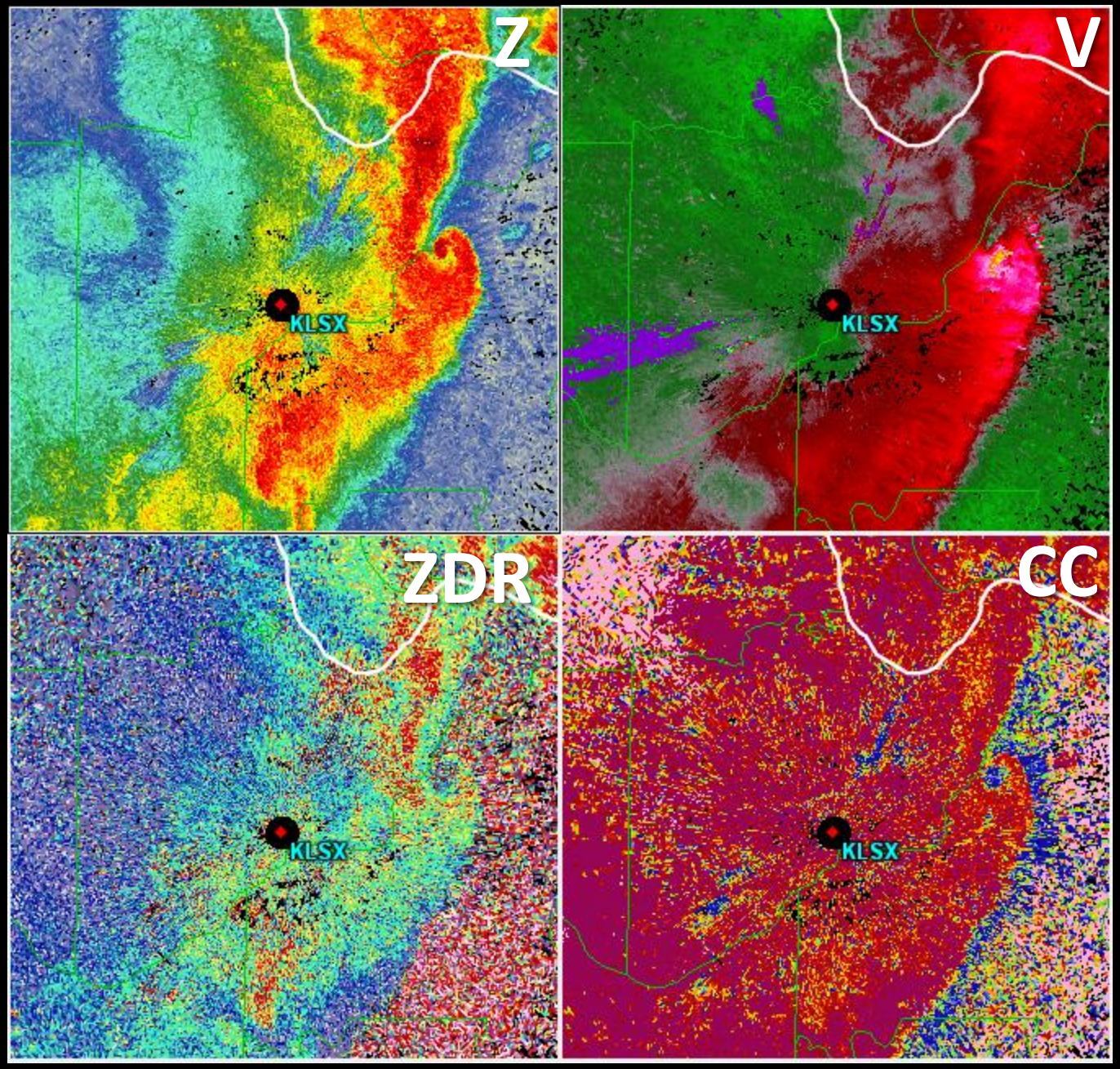
01 Jun 2013
0106z

0.5°



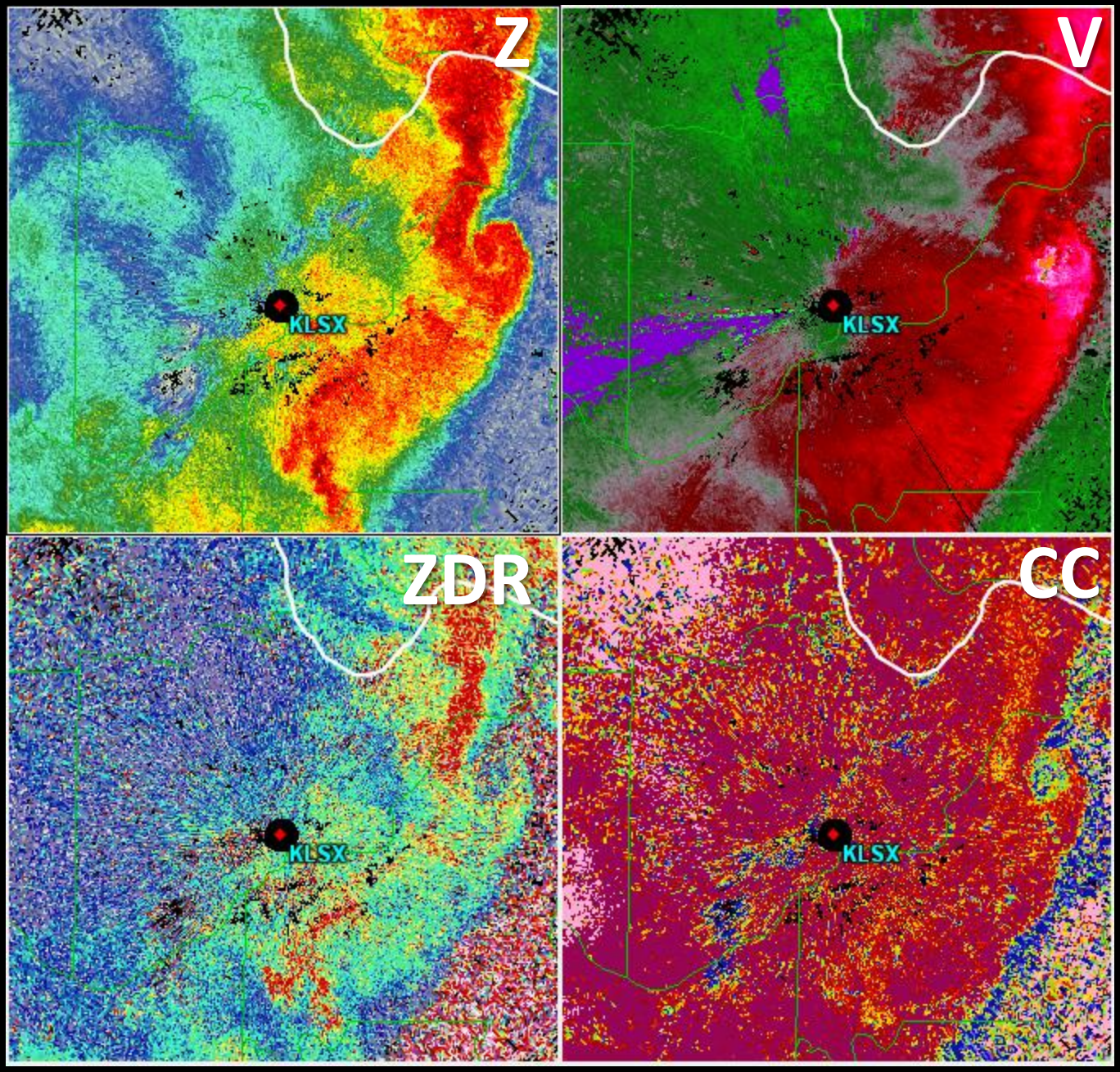
01 Jun 2013
0110z

0.5°



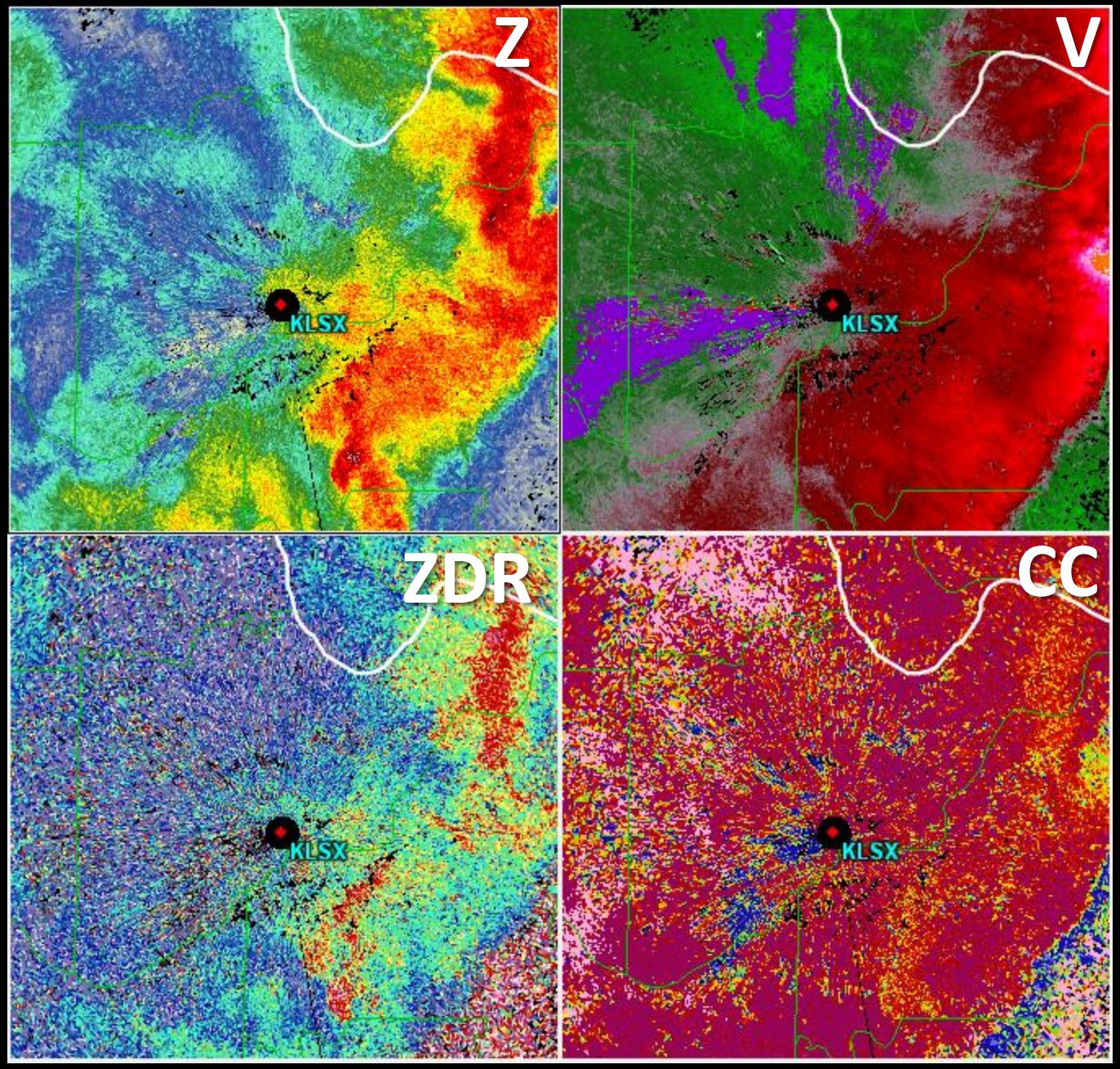
01 Jun 2013
0114z

0.5°



01 Jun 2013
0119z

0.5°



Damage survey results

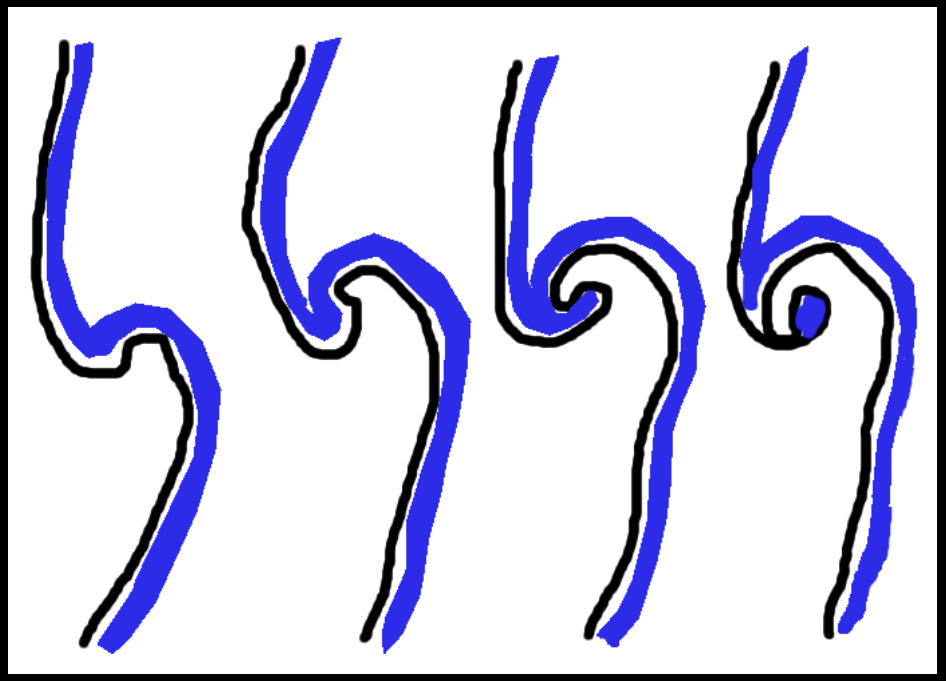
EF-3

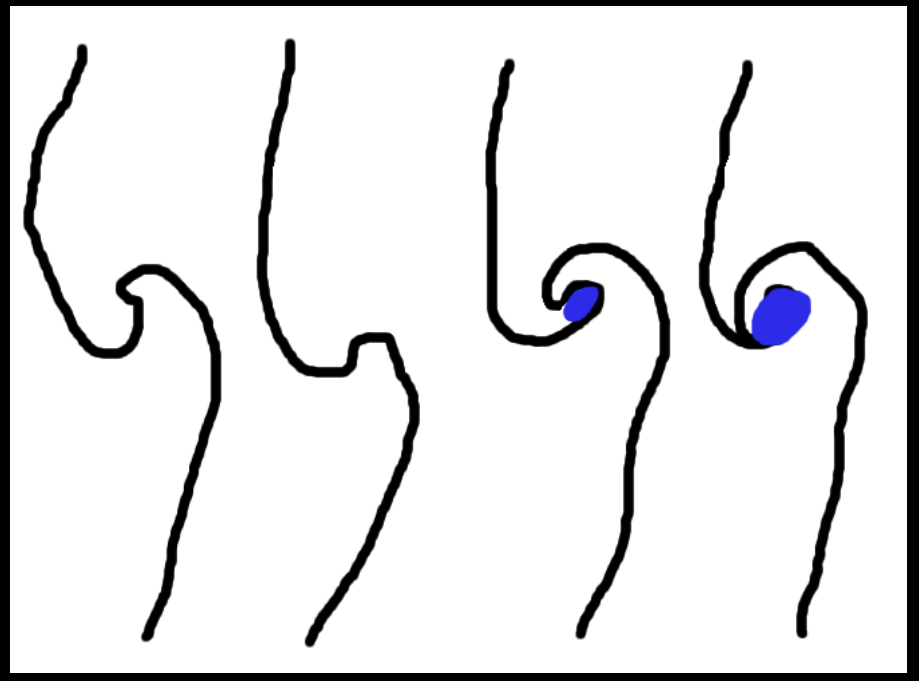
Track passed within 1 mile of WFO St. Louis

Implications for warning decisions

Spot a potential TDS?

Take a few seconds to step back and forth.





Ask: how did the radar imagery get to this point?

Unresolved questions

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Physically, what causes the ribbon of low CC?

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Why some QLCSs but not others?

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Why doesn’t the return signal from the rain dominate the pulse volume after the ribbon of low CC has wrapped back into the meso?

Unresolved questions

Physically, what causes the ribbon of low CC?

Why some QLCSs but not others?

Why doesn’t the return signal from the rain dominate the pulse volume after the ribbon of low CC has wrapped back into the meso?

Why does this zone retain an independent identity? (Why doesn’t it mix?)

Unresolved questions

Is this feature unique to QLCSs or does it also occur with supercells?

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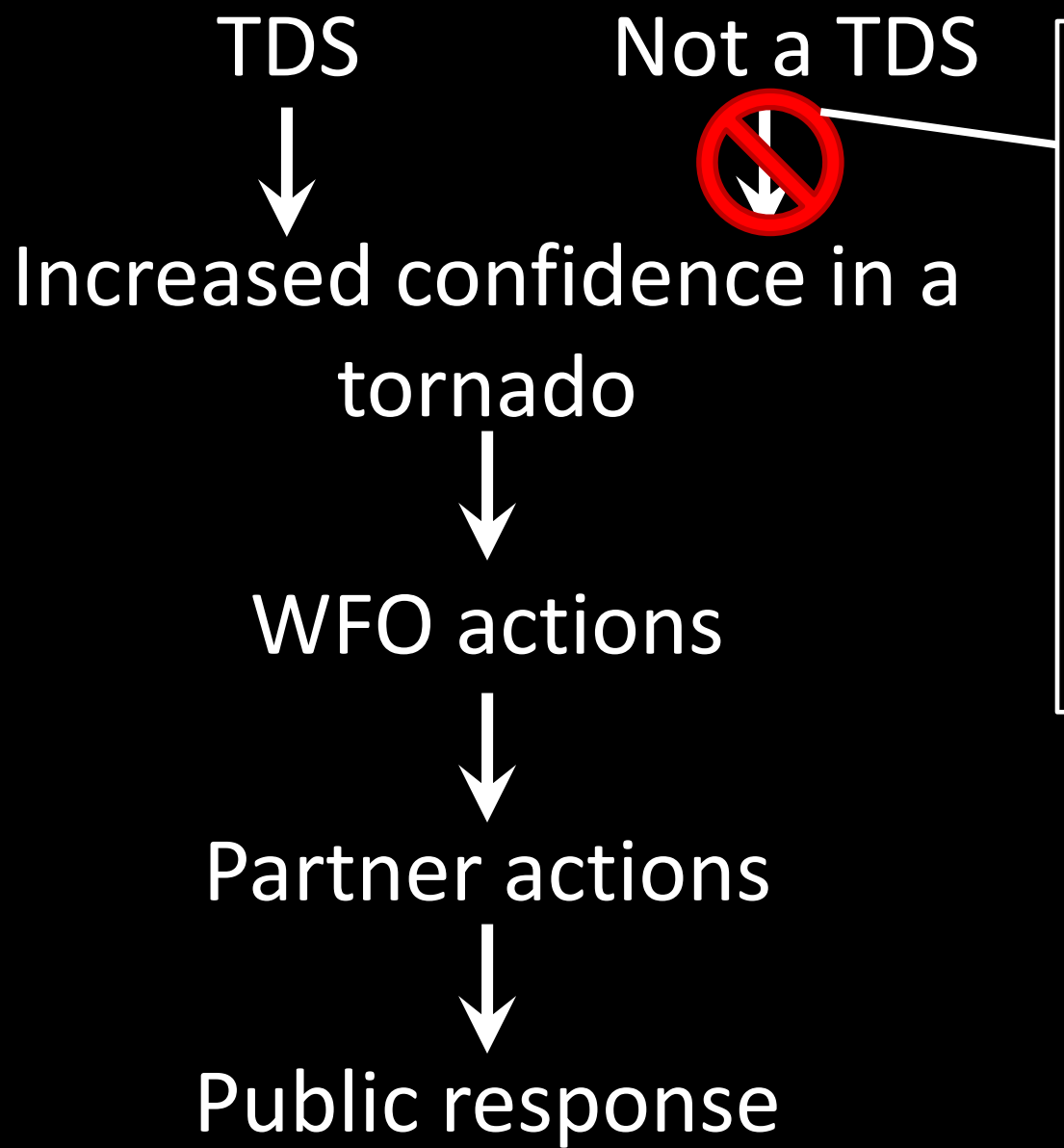
Is this feature unique to QLCSs or does it also occur with supercells?

If a tornado occurs in the closed-off area and lofts debris, would CC decrease further, or is it a blind spot for radar operators (unable to detect tornadoes because CC is already low)?

Take-home messages



Spot a potential TDS?

Ask: how did the radar imagery evolve?