Application of the QLCS Mesovortex Warning System
The 14 June 2017 Tornadic QLCS over Northeast Wisconsin

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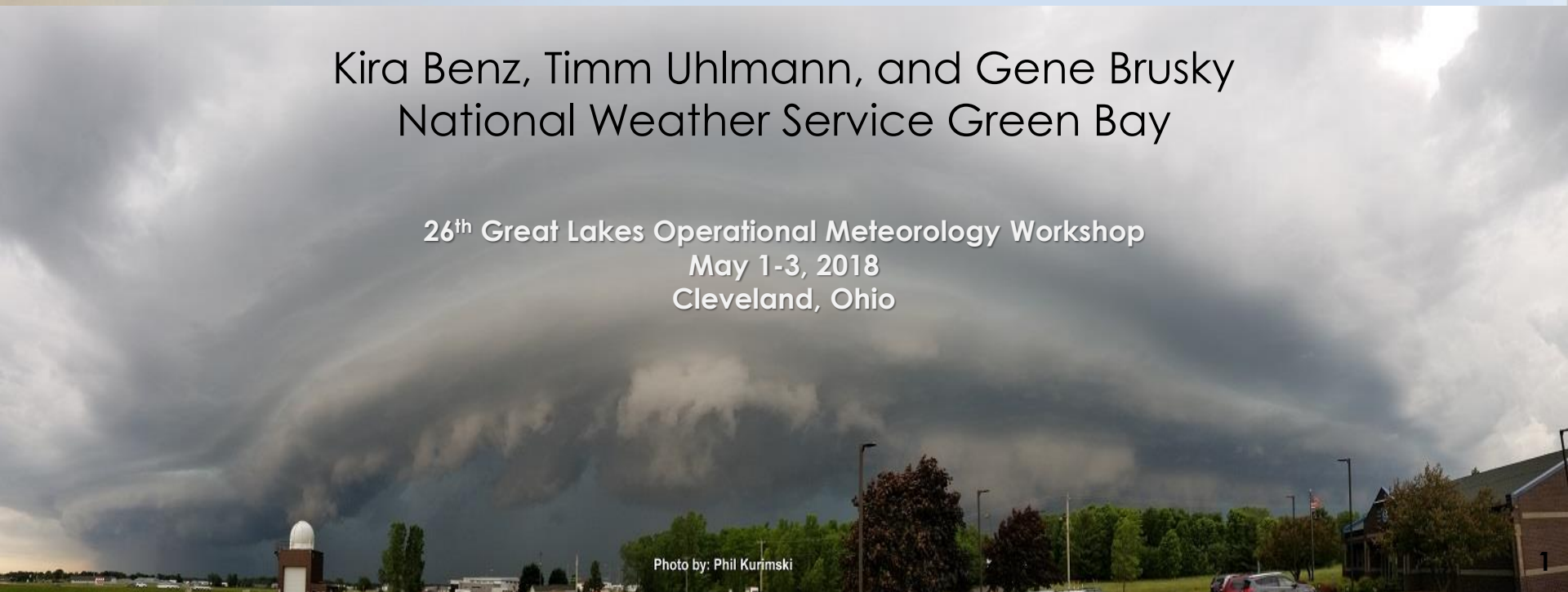


Introduction

- Countless presentations over past several years addressing myriad of challenges associated QLCS events have increased knowledge of QLCS MV genesis and threat communication.

- Significant leap forward in anticipating mesovortex (MV) genesis in 2012 (Schaumann and Pryzybylinski) with **Three Ingredients Method**. Provided operational forecaster a more objective and structured approach.

- NWS Central Region **Tornado Warning Improvement Project (TWIP)** Team formed. One of the goals was to build upon initial work via providing additional structure to help increase forecaster confidence to be more **proactive** in warning for MVs, particularly those that are more likely to become tornadic via applying a 4-step process.

- Our presentation will introduce this methodology by applying components of the 4-step process to a historic QLCS event.

Application of the QLCS Mesovortex Warning System 14 June 2017 Tornadic QLCS over Northeast Wisconsin

Part I: Introduction to the QLCS Mesovortex Warning System and Event Overview

- ❑ Tornado Warning Improvement Project (TWIP)
  - ❖ QLCS Mesovortex Warning System
- ❑ Overview of the 14 June 2017 Tornado QLCS

Part II: Application of the QLCS Mesovortex Warning System

- ❑ Illustrate Operational Application of the TWIP QLCS Warning System to Anticipate Mesovortex Genesis

Takeaways

NWS Central Region Tornado Warning Improvement Project (TWIP) Charter

Vision

Develop and deliver expert-level continuing education for tornado warning decision making

Problem

Significant differences in tornado POD/FAR across CR WFOs primarily due to inconsistent warning decision education and experience

Mission

Provide consistent, scientific approach to tornado warning process focusing on environmental intelligence and probability of impact

TWIP Survey


NWS Central Region
Tornado Warning Improvement Project
Meteorologist Survey Results
December 2017
Photo by Brad Goddard

TWIP Survey Focus

Assess Current State of the CR Tornado Warning Decision Process

Volunteer survey conducted in fall 2016. 325 respondents.

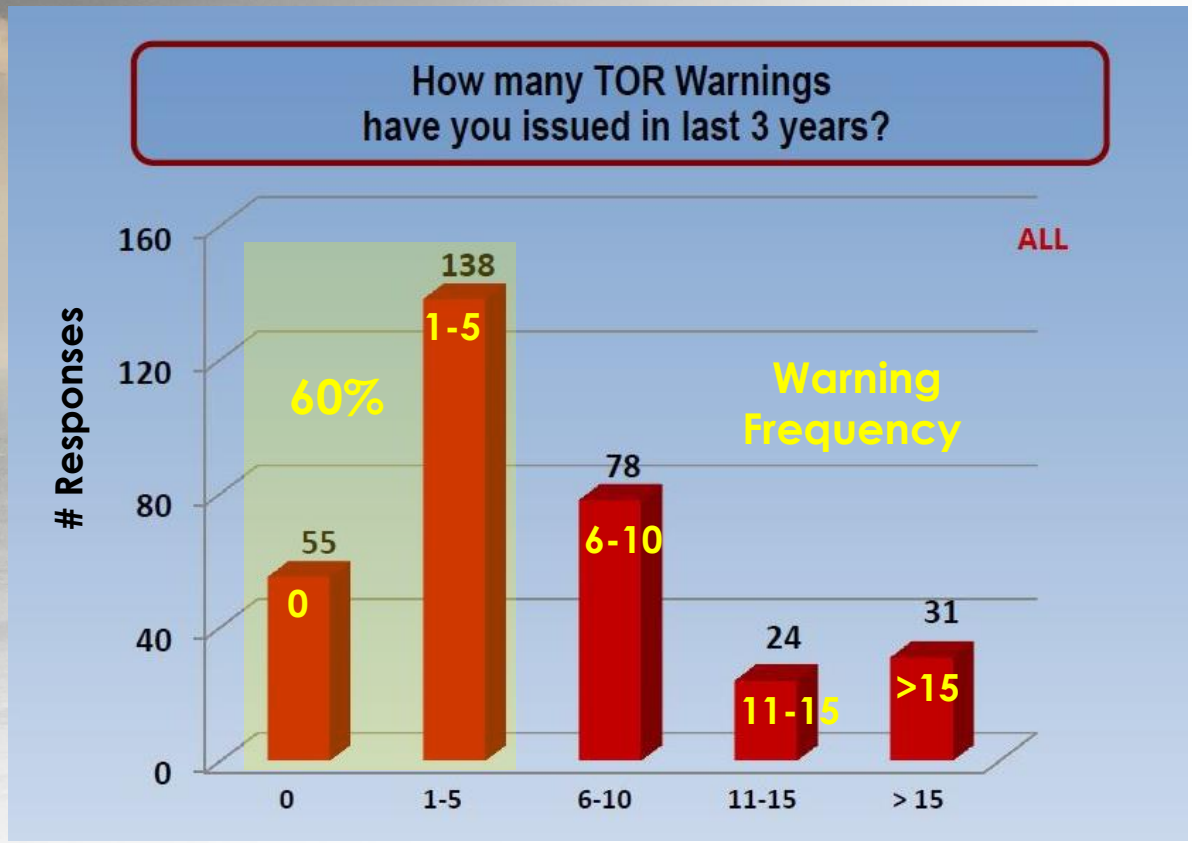
Focus areas included:

- ❑ Experience
- ❑ Office Culture
- ❑ Radar-based Factors
- ❑ Human-based Factors
- ❑ Risk Communication & Messaging
- ❑ Training Needs

TWIP training recommendations based on survey results.

Survey results made available in December 2017

TWIP Motivation
Focus Area - *Experience*



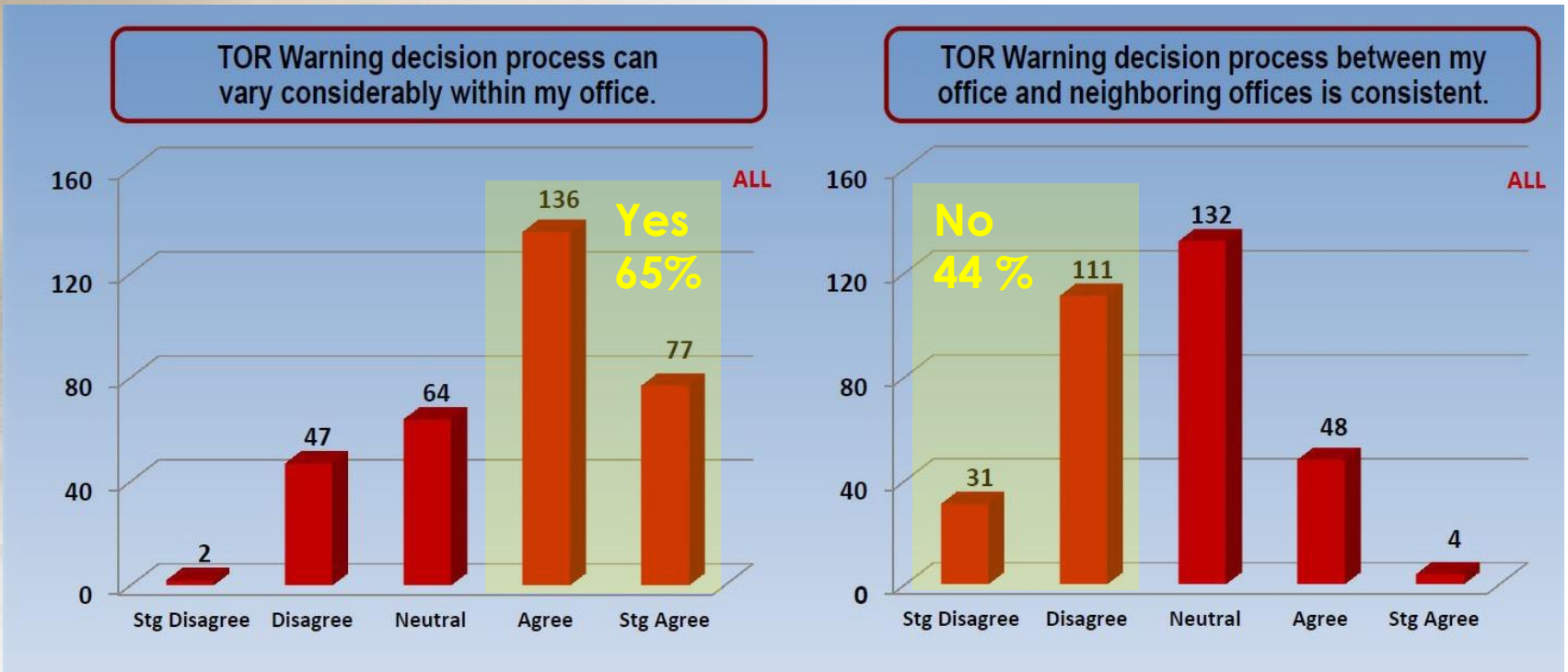
Difficult to be proficient & confident with few real-time warning opportunities

TWIP Motivation Focus Area

WDM Process

Varying service levels

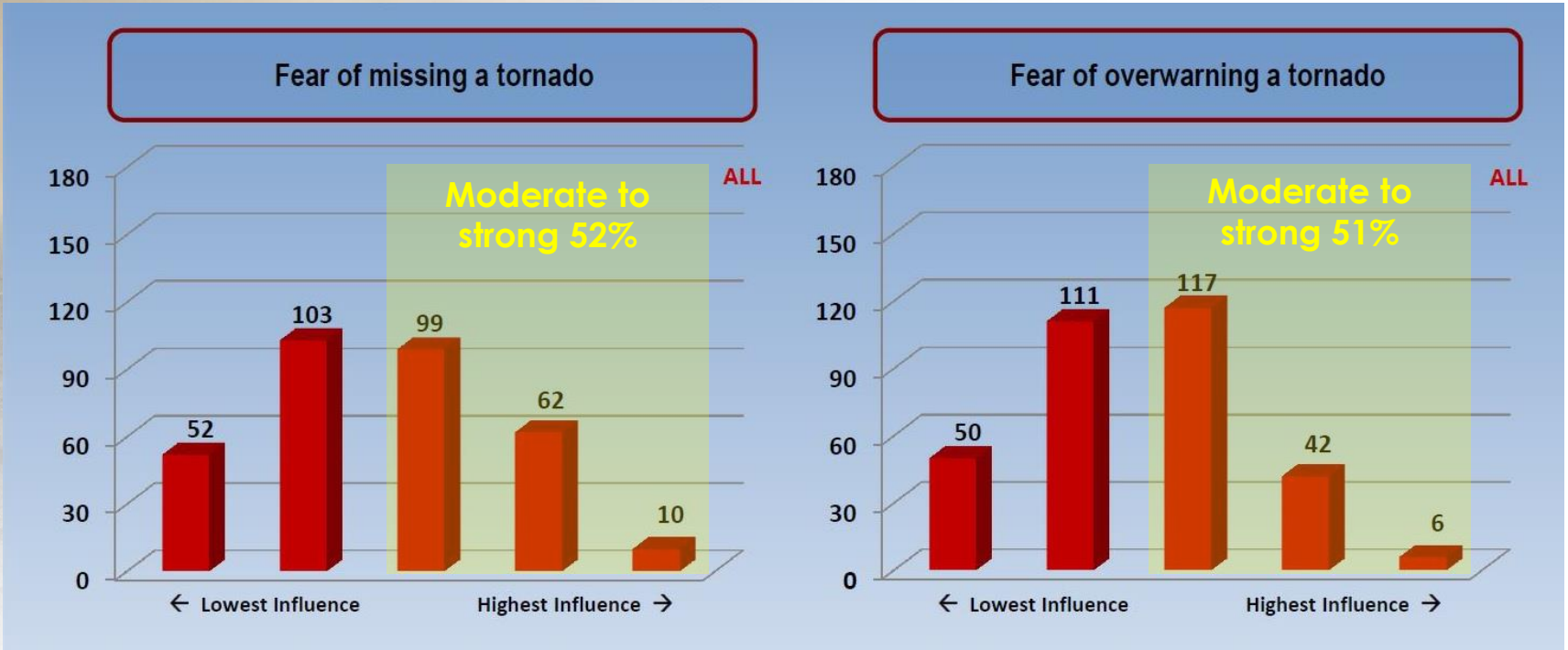
Need more consistent, objective and scientific warning process



TWIP Motivation Focus Area
Culture

Fear of missing a tornado (or fear of over warning for a tornado) can facilitate an increase in FAR (decrease in POD).

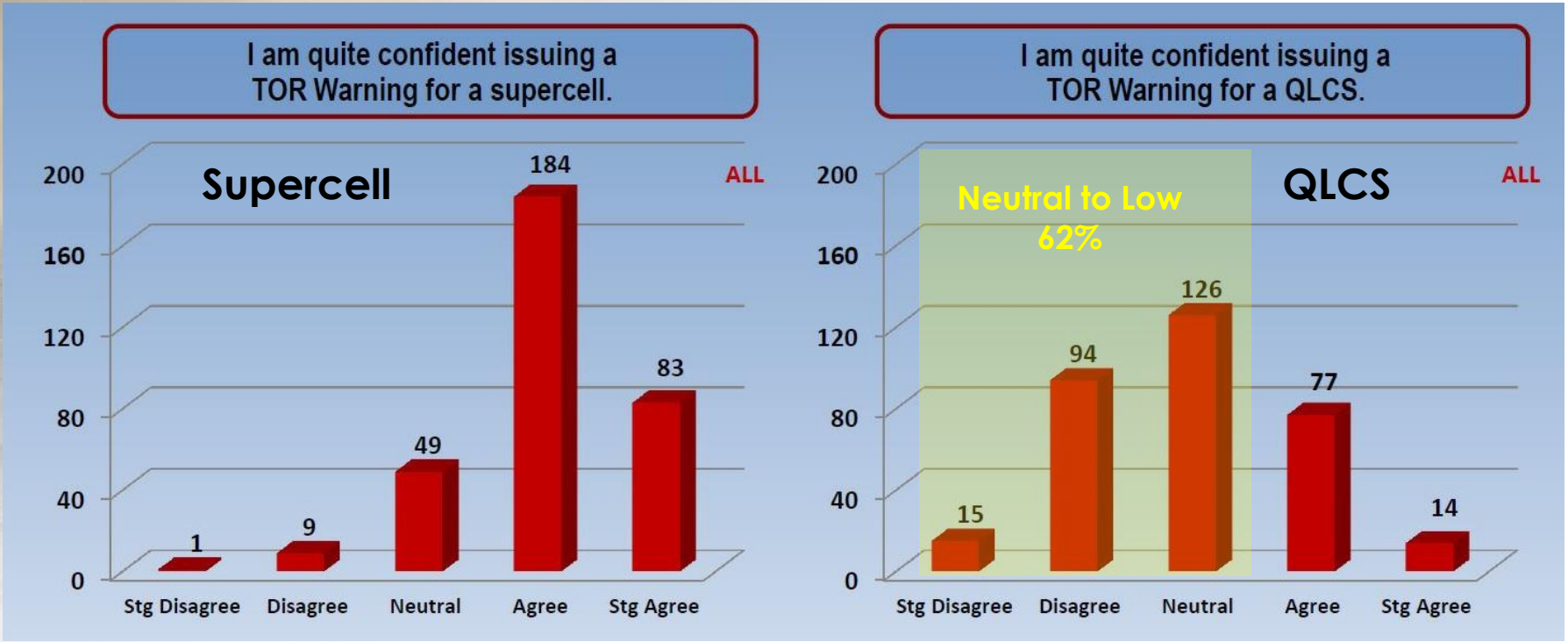
Focus on science-based warning decisions



TWIP Motivation Focus Area
Confidence

Shaky forecaster confidence for QLCS tornado warnings.

Strong need for QLCS conceptual model and tornadogenesis training

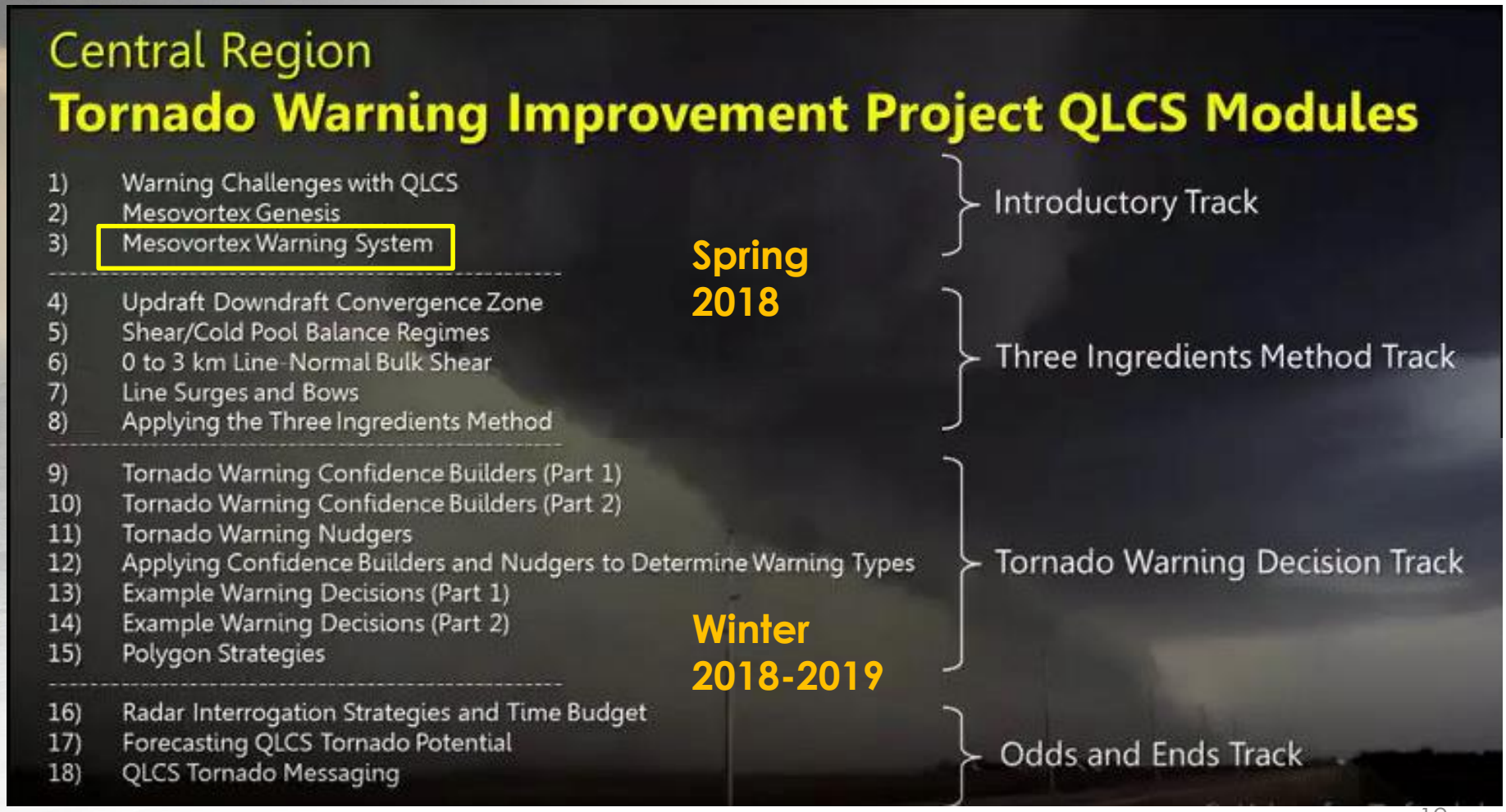


NWS Central Region Tornado Warning Improvement Project (TWIP)

Training Philosophy

- ✓ Address need for consistency between forecasters and offices for tornado warnings.
- ✓ Focus on scientific process to promote more consistent, more accurate and timely tornado warnings.
- ✓ **Initial TWIP training focus on QLCS warnings**

NWS Central Region Tornado Warning Improvement Project (TWIP)



QLCS Mesovortex Warning System

General Goals

- ✓ Issue tornado warnings for portions of a QLCS where tornadoes are most likely (regardless of possible tornado strength)
- ✓ Issue severe thunderstorms warnings (may include Tornado Possible Tag) where confidence in tornadoes is lower
- ✓ More accurate and timely warnings require identification of key radar features ideally before mesovortices even form
- ✓ Employ polygon strategies to ensure favored mesovortex genesis regions are captured

Put odds in favor of WDM to proactively warn for QLCS tornadoes

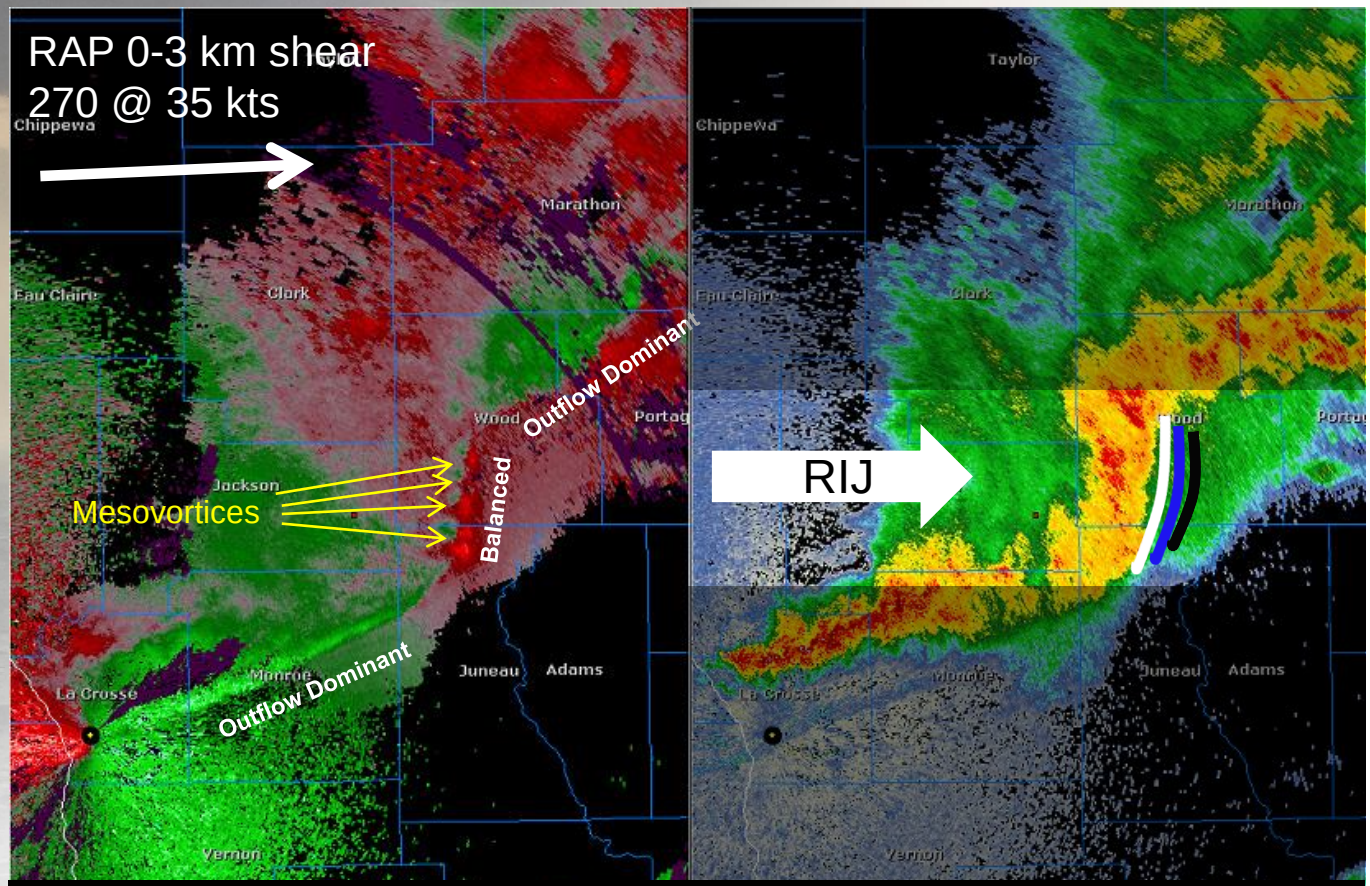
QLCS Mesovortex Warning System

Four Step Process

1. **Apply Three Ingredients Method** *(Schaumann and Przybylinski, 2012)*
   - ✓ Used to anticipate mesovortex genesis over next 30-45 minutes
2. **Identify presence of confidence builders and nudgers**
   - ✓ Indication for increased likelihood for tornadic mesovortices
3. **Determine number and quality** of confidence builders/nudgers
   - ✓ Dictates warning type
4. **Construct a "smart" polygon**
   - ✓ Capture anticipated mesovortex genesis region

QLCS Mesovortex Warning System

Step 1: Three Ingredients Method



Mesovortex genesis and intensification favored where the three criteria are co-located within a QLCS

System cold pool and ambient low-level shear are balanced or slightly shear dominant. Identify UDCZ.

0 to 3 km line-normal bulk shear magnitude ≥ 30 kts

Rear-inflow jet (RIJ) or enhanced outflow causes a surge or bow in the UDCZ

Effectively eliminates large areas of QLCSs where mesovortices are not favored

QLCS Mesovortex Warning System

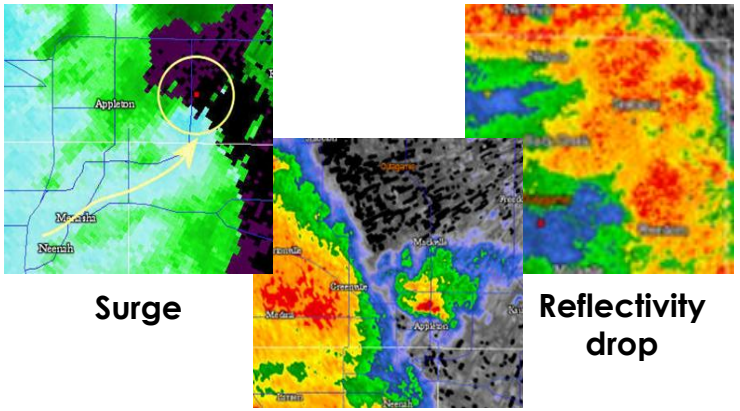
Step 2: Identify Confidence Builders & Nudgers

Confidence Builders

3 Ingredients Met in Most Situations
Descending RIJ/Reflectivity Drop
Enhanced Surge
Line Break
UDCZ entry/inflection point
Paired front/rear inflow notch
Boundary ingestion
Front reflectivity nub
Contracting bookend vortex with $V_r \geq 25$ kt *
Tight/strong mesovortex with $V_r \geq 25$ kt
Confirmed tornado/Tornadic debris signature (TDS)

Nudgers

3 Ingredients Met in Most Situations
Reflectivity tag intersecting a surge
0 to 3 km MLCAPE $\geq$ 40 J/kg
Cell merger / Reflectivity spike near surge



QLCS Mesovortex Warning System

Step 3: Determine number & quality of confidence builders & nudgers

3 Ingredients Met in Most Situations
✓ Descending RIJ/Reflectivity Drop
✓ Enhanced Surge
Line Break
UDCZ entry/inflection point
✓ Paired front/rear inflow notch
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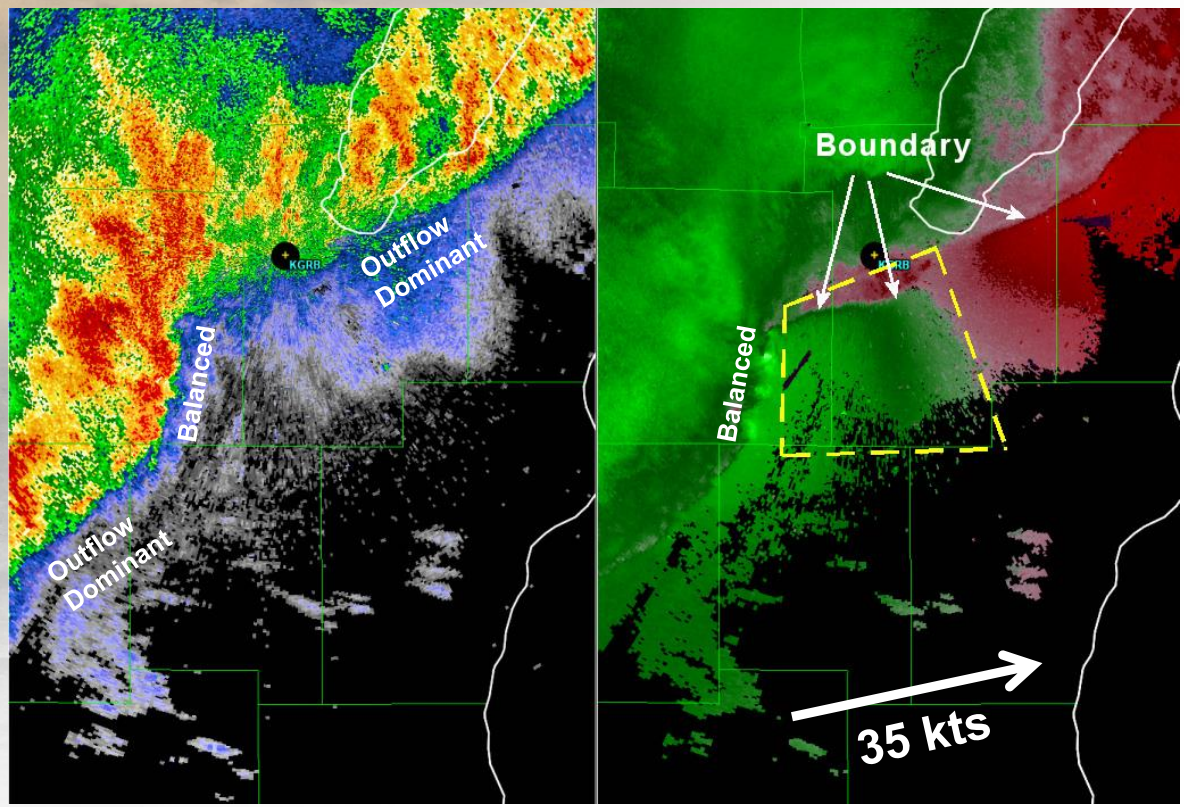
3 Ingredients Met in Most Situations
Reflectivity tag intersecting a surge
✓ 0 to 3 km MLCAPE ≥ 40 J/kg
✓ Cell merger / Reflectivity spike near surge

1-3: Severe with tornado possible tag recommended
4 or more: Tornado Warning recommended

- ✓ **Assess quality/persistence**
- ✓ **No magic numbers or magic combinations!**

QLCS Mesovortex Warning System

Step 4: Generate smart polygon



Factors

Balanced/Shear Dominant Regions

Confidence Builders & Nudgers

MV migration

Challenging as you are aiming to issue warnings before MVs even develop!

Central Region Tornado Warning Improvement Project

References and Training

HOME PAGE | CASE REPOSITORY | CONTACT INFORMATION | MESOANALYST AND RADAR TOOLS | RADAR FEATURE CATALOGS | SURVEY RESULTS | TRAINING RESOURCES

TWIP RELEASES

Home Page

https://sites.google.com/a/noaa.gov/nws-cr-tornado-warning-improvement-project/

A mirrored version of the TWIP Google Site is also available on VLab. Also be sure to check out the TWIP YouTube channel!

TWIP Project Charter

Vision - Develop and deliver an expert-level, continuing education curriculum for tornado warning decision making.

Basis/Statement of the Problem - There are significant differences in the probability of detection and false alarm rates for tornado warnings across WFOs in CR. This is largely due to inconsistent warning decision education/experience after the quality initial standardized NWS-wide training (DLOC). There may also be a lingering culture that values the viewpoint that it is better to have a false alarm than to miss any tornado.

Mission - This task force will provide a consistent, scientific approach to the tornado warning process, focusing on both environmental intelligence and probability of impact. CR SOOs will deliver this curriculum to forecasters with warning decision making responsibilities within each of their respective offices.

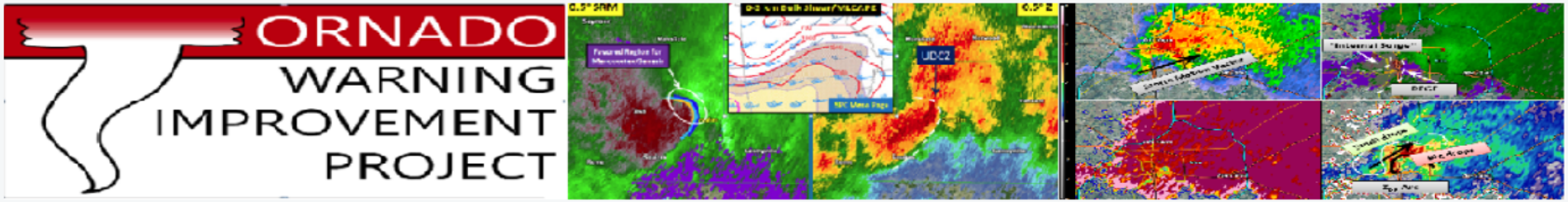
TWIP Philosophies

Effective Training - The TWIP approach on training is multi-faceted. Everyone has a different learning styles that are effective for them. Some people like hands-on training while others prefer literature or modules. Additionally, the TWIP is not interested in "check the box" type training. In general, the training will come in five phases:

Phase 1 – Background materials (setting the foundation)
Phase 2 – Hands on and interactive training (practice how you play)
Phase 3 – Supporting references and tools
Phase 4 – Refresher training (sharpen the saw)
Phase 5 – Expert level

Focus on Process - The TWIP charter as well as results from the TWIP survey reveal the need for much more consistency between forecasters and offices when it comes to tornado warning issuance. TWIP training and

https://vlab.ncep.noaa.gov/group/cr-soo/twip



NWS CENTRAL REGION - TORNADO WARNING IMPROVEMENT PROJECT (TWIP)

BUILDING A FRAMEWORK FOR WARNING METEOROLOGISTS

A mirrored version of the TWIP VLab Site also is available on Google. Click here to visit the TWIP Google site!

TWIP Project Charter

- **Vision** - Develop and deliver an expert-level, continuing education curriculum for tornado warning decision making.
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  - *Phase 5 – Expert level*

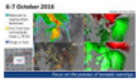
TWIP PAGES

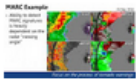
- Case Repository
- Mesoanalyst and Radar Tools
- Radar Feature Catalog
- Survey Results
- Team Members and Contact Information
- Training Resources
- TWIP Releases
- TWIP Video Channel

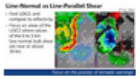
YouTube

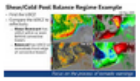
Search

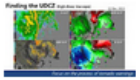
SciShare Videos Playlists

7 
TWIP QLCS Curriculum - 8 Three Ingredients Application
by Aaron Johnson - NOAA Federal

8 
TWIP QLCS Curriculum - 7 Surges and Bows
by Aaron Johnson - NOAA Federal

9 
TWIP QLCS Curriculum - 6 0-3 km Line Normal Bulk Shear
by Aaron Johnson - NOAA Federal

10 
TWIP QLCS Curriculum - 5 Shear Cold Pool Balance Regimes
by Aaron Johnson - NOAA Federal

11 
TWIP QLCS Curriculum - 4 Updraft Downdraft Convergence Zone
by Aaron Johnson - NOAA Federal

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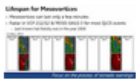
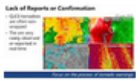
TWIP QLCS Curriculum - 3 QLCS Mesovortex Warning System
by Aaron Johnson - NOAA Federal

13 
TWIP QLCS Curriculum - 2 Mesovortex Genesis
by Aaron Johnson - NOAA Federal

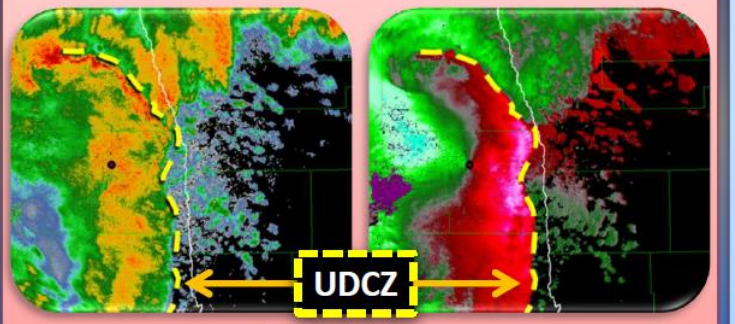
14 
TWIP QLCS Curriculum - 1 Warning Challenges
by Aaron Johnson - NOAA Federal

Operational Quick References

Three Ingredients Method for Mesovortex Genesis and Intensification Within a QLCS

A – Find Balanced or Slightly Shear Dominant Regimes of the QLCS

1. Define the Updraft Downdraft Convergence Zone (UDCZ)
   - Convergence zone coincident with gust front
2. Along UDCZ, look for:
   - Deep nearly vertical updraft
   - Tight reflectivity gradient
   - Trailing stratiform, also possibly thin leading stratiform
   - Entry/Inflection points



NOTE: Examine 0.5° Z/SRM or Z/V plots to identify regimes.

C – Look for Surges or Bows in the Line

- A descending rear inflow jet or enhanced outflow are likely candidates to cause a surge or bowing

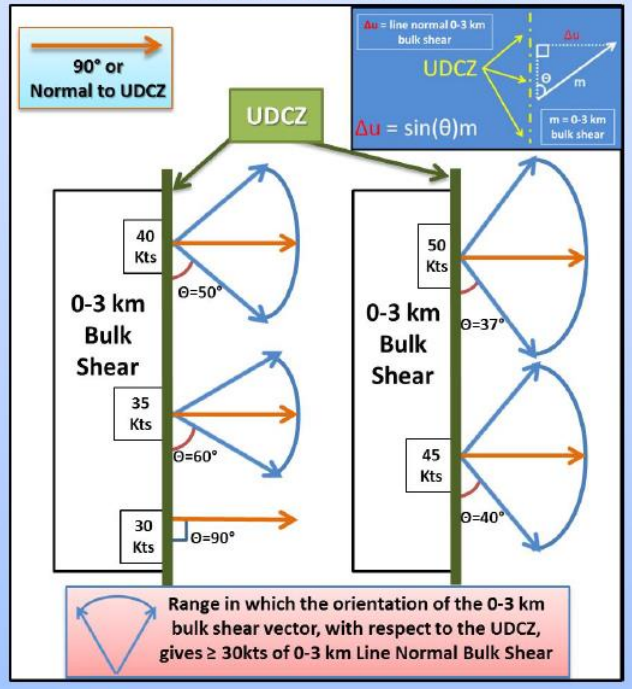
NOTE: 0.5° SRM and V plots can often reveal developing line surges and bows before the classic "concave" reflectivity signature appears.

When all three (A, B, and C) ingredients are co-located in a QLCS, there is an increased likelihood for mesovortex genesis and intensification, along with increased tornado potential.

B – Find Line Normal 0-3 km Bulk Shear ≥ 30 Knots

1. Find 0-3 km bulk shear just ahead of the QLCS (must be ≥ 30 knots for ingredient to be fulfilled)
2. Use equation below to determine line normal bulk shear values ≥ 30 knots with respect to the orientation of the shear vector to the UDCZ

TIP: Watch bowing segments of the line…as the bow becomes more pronounced it often changes the orientation of the UDCZ. This is especially the case for the northern portion of the bowing segment.



Courtesy of Michael Mathews & Jason Schaumann - NOAA/NWS

Operational Quick References

1. Descending RIJ/ Reflectivity Drop

- Noticeable decrease in reflectivity in trailing stratiform region. May include enhanced surge along UDCZ.

2. Entry/Inflection Point

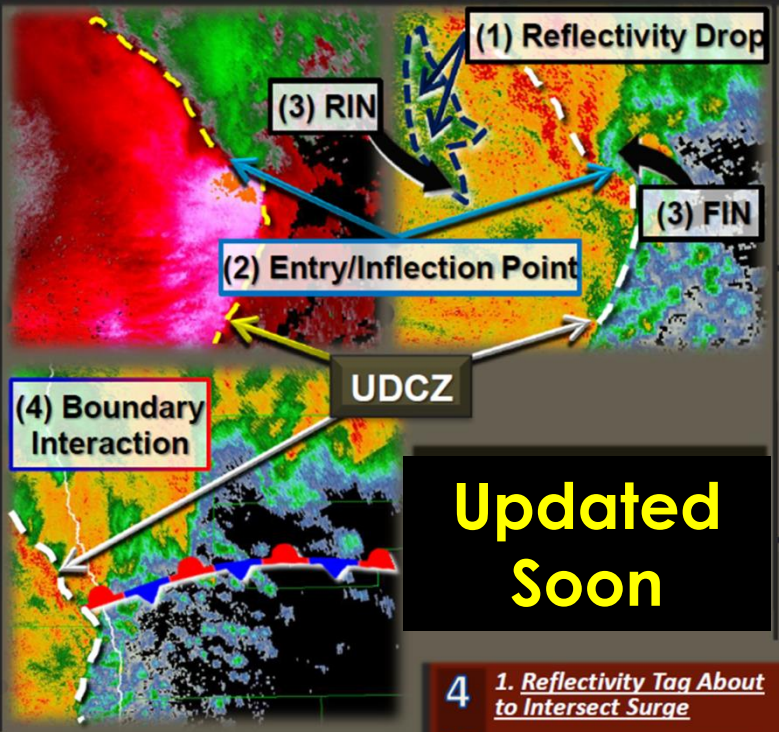
- Located where the UDCZ curls from the leading edge back into the precip.

3. Paired Front & Rear Inflow Notch (FIN/RIN)

- FIN on front & often northern side of surge. RIN location is typically directly behind FIN, but depends on trajectory of the RIJ/outflow.

4. Boundary Interaction

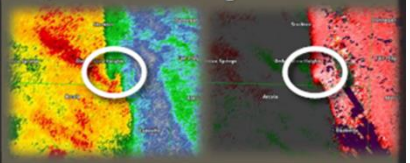
- Synoptic front or convective outflow ingested by surge. Front is typically stationary.



Updated Soon

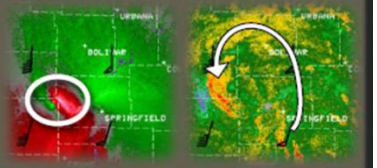
5. Front Reflectivity Nub

- May be variation of coupled FIN/RIN and local surge.



6. * Contracting Bookend Vortex w/ Increasing Rotational Velocity

- Low level Vr ≥ 25 kts.



7. Tight & Strong Mesovortex (no example)

- Low level Vr ≥ 25 kts.

8. * TDS (no example)

Increasing numbers of confidence builders present in conjunction with the three ingredients should increase confidence in issuing a Tornado Warning*.

Nudgers are secondary, and should add confidence in issuing a TOR when confidence builders and the three ingredients are present.

** Three ingredients not necessary to issue a TOR with a contracting bookend vortex (#6) or TDS (#8).*

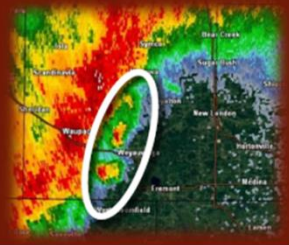
4 NUDGERS

1. Reflectivity Tag About to Intersect Surge

2. 0-3 km ML CAPE ≥ 40 J/kg

3. Reflectivity Spiking Up Near Surge

- Often ahead of line & may only be viewable at higher slices.



4. History of TDS's

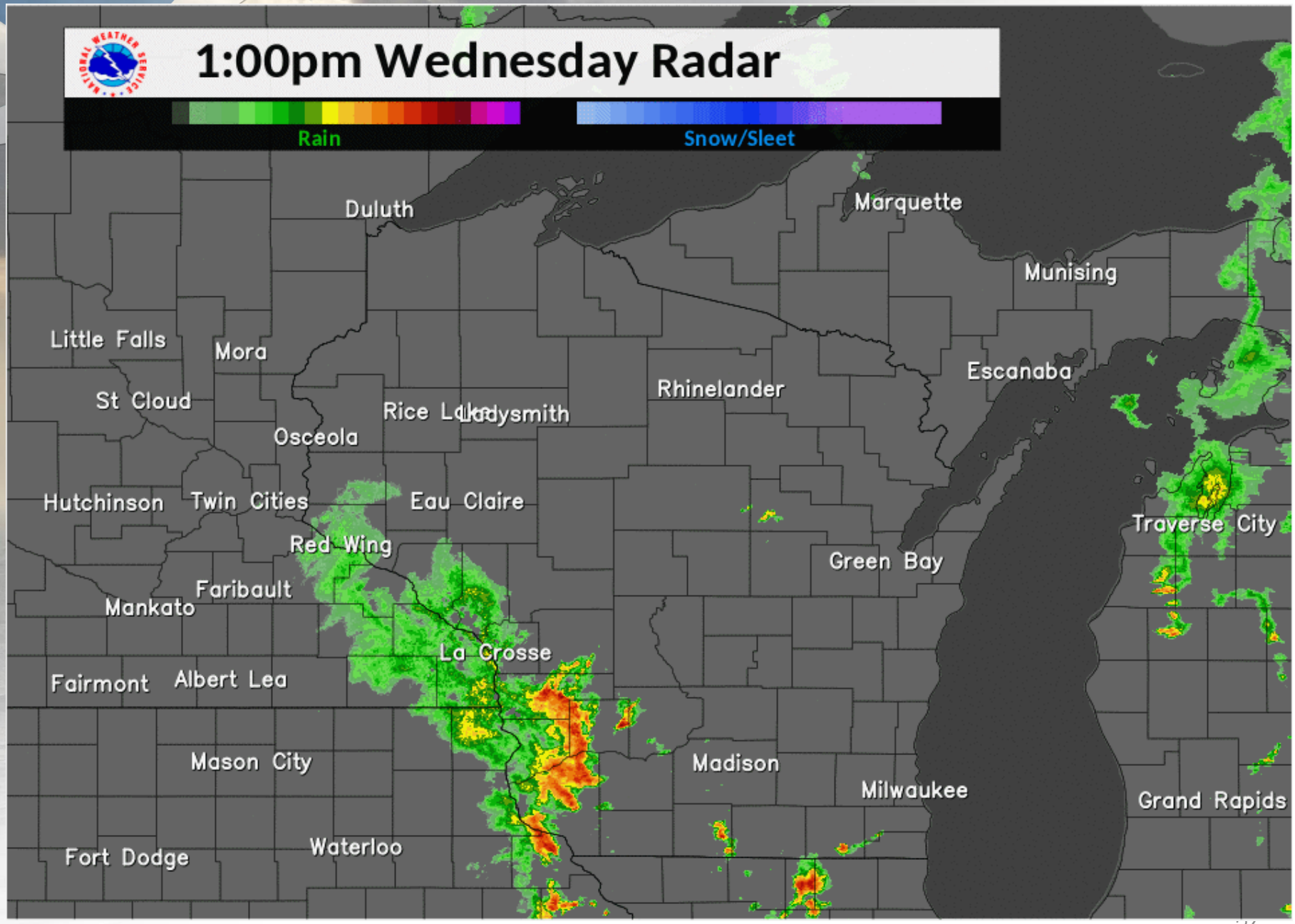
Courtesy of Michael Mathews & Jason Schaumann - NOAA/NWS

14 June 2017 Tornadic QLCS

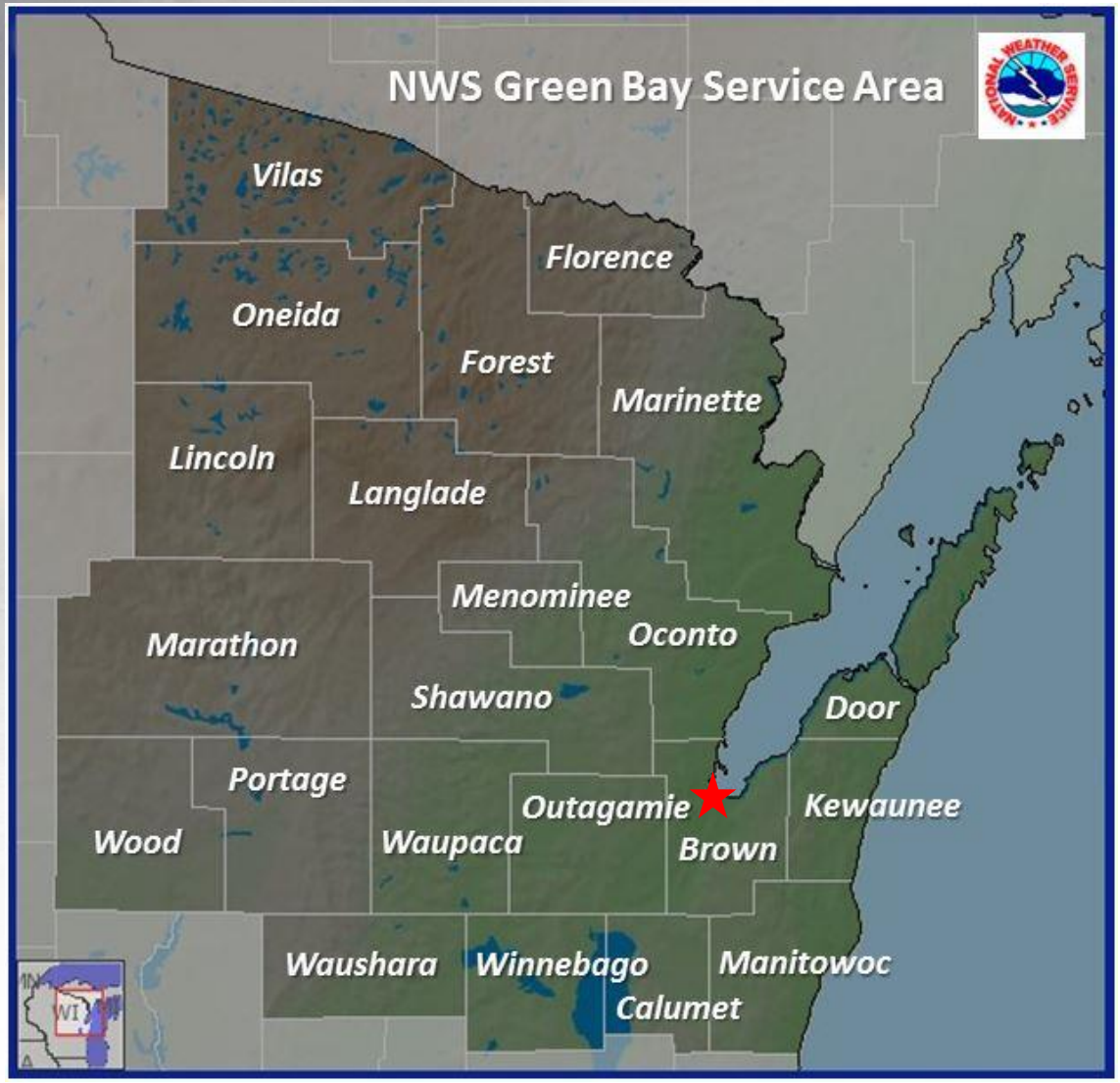
- ✓ Event Overview
- ✓ Warning Challenges
- ✓ What Happened

An Historic Event For Northeast Wisconsin

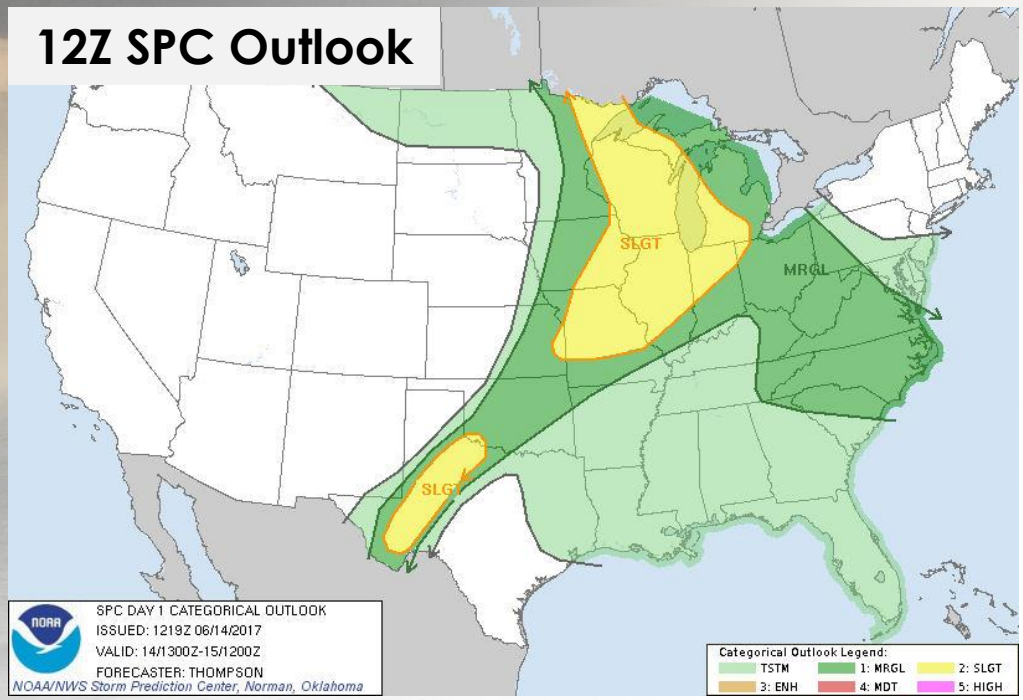
# TOR	Month	Date	Year	EF	Comments
10	**June**	**14**	**2017**	**1**	**QLCS** (late afternoon)
10	April	10	2011	3	Classic Supercells
7	June	4	2005	0	Mini Supercells
7	July	16	1997	2	Supercells
6	August	7	2013	2	**QLCS** (early morning)

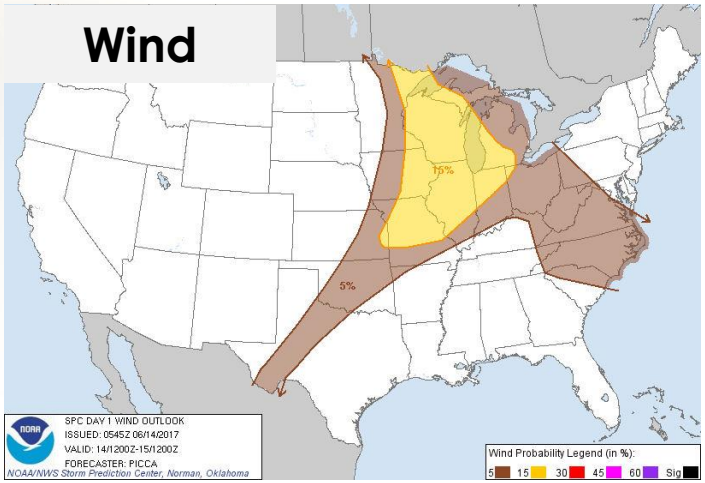

1:00pm Wednesday Radar
Rain
Snow/Sleet
Duluth
Marquette
Munising
Little Falls
Mora
St Cloud
Rice Lake
Ladysmith
Rhinelander
Escanaba
Osceola
Hutchinson
Twin Cities
Eau Claire
Red Wing
Traverse City
Green Bay
Faribault
Mankato
La Crosse
Fairmont
Albert Lea
Mason City
Madison
Milwaukee
Grand Rapids
Waterloo
Fort Dodge

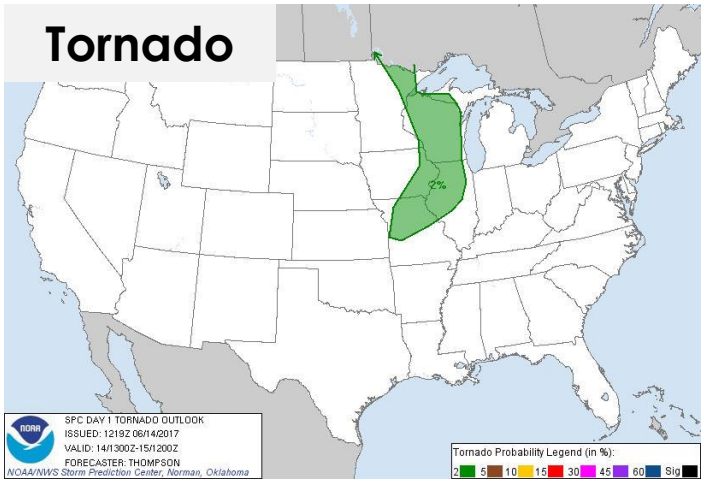
GRB County Warning Area



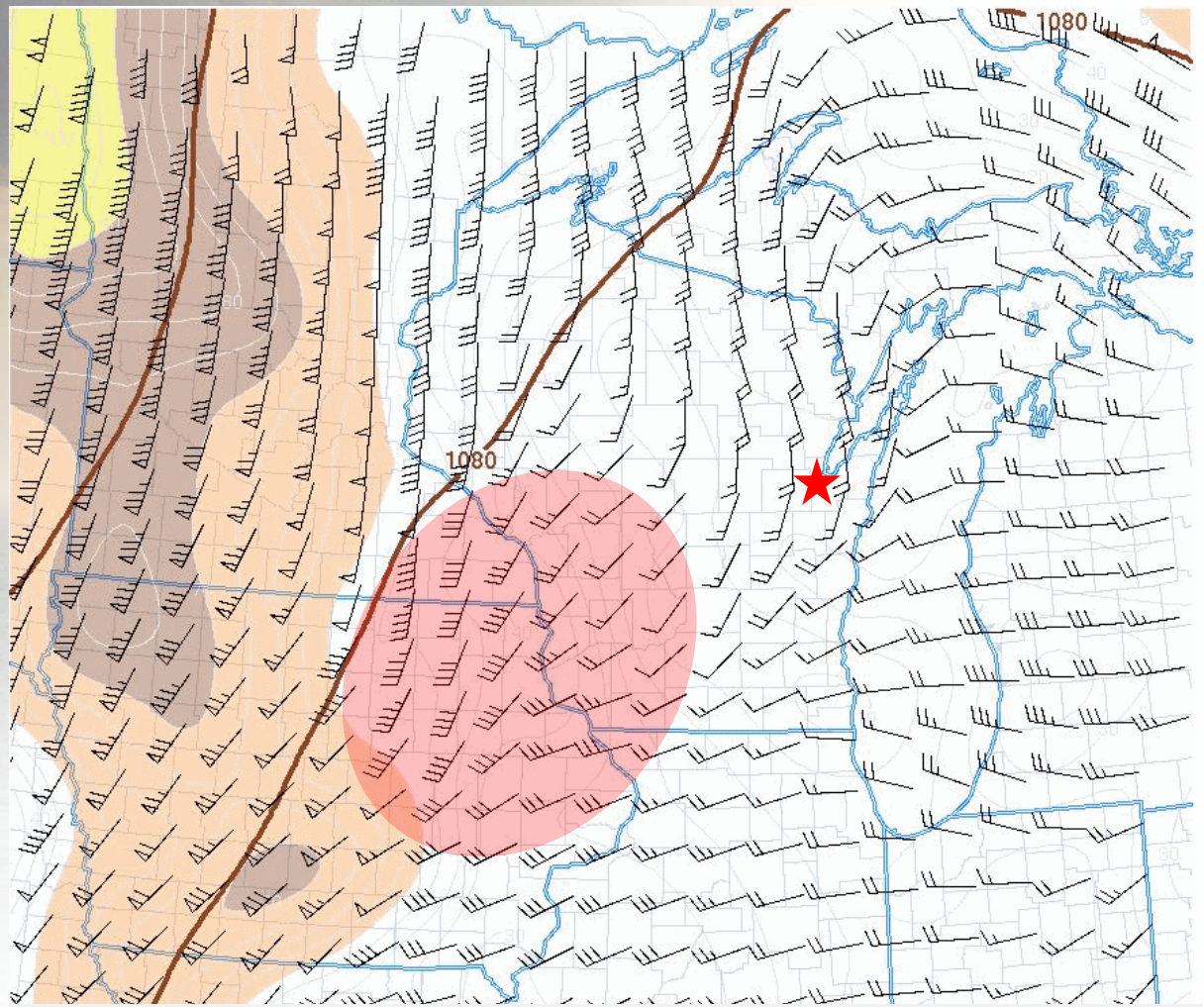
Early Morning Expectations





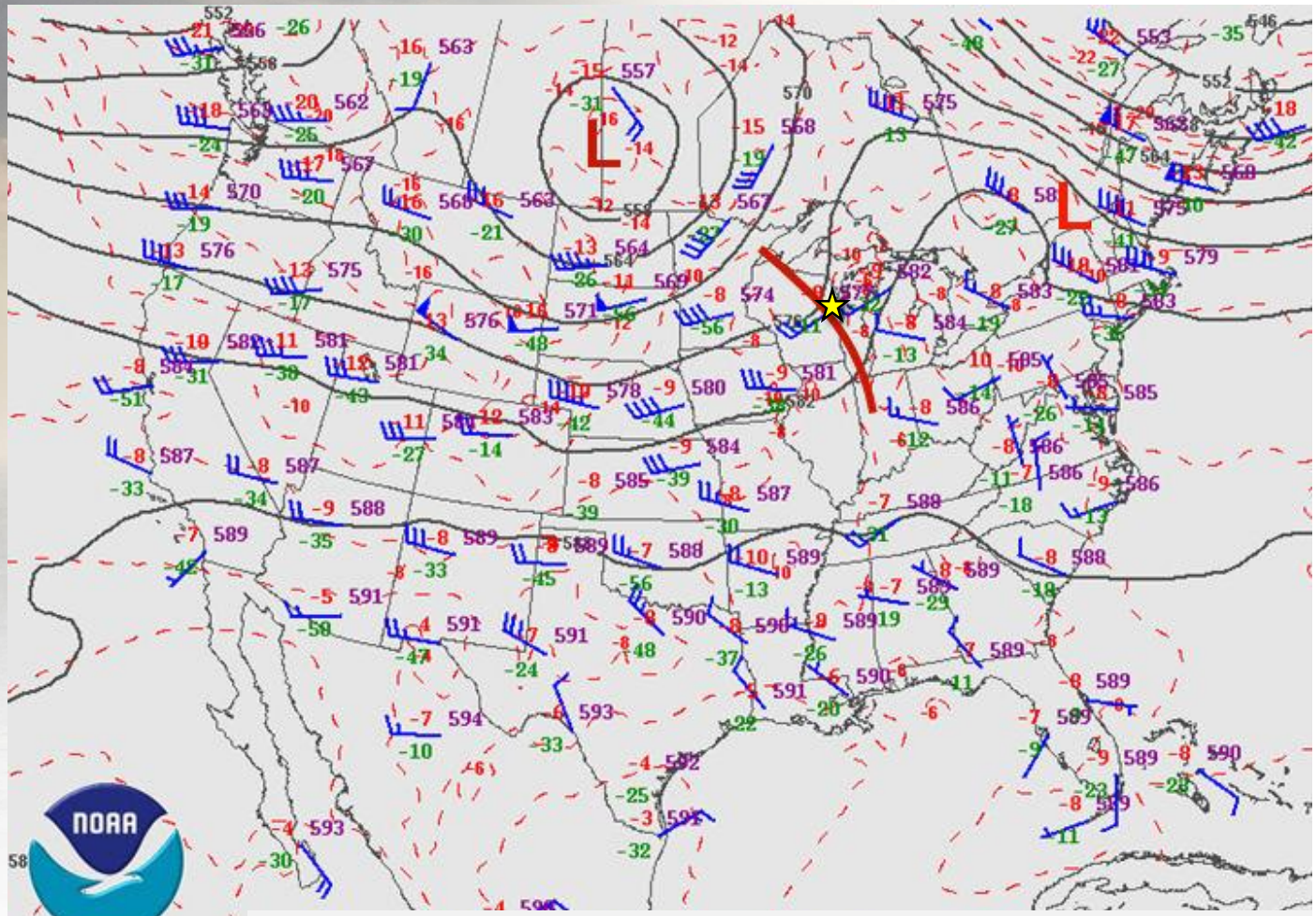


Synoptic Setting



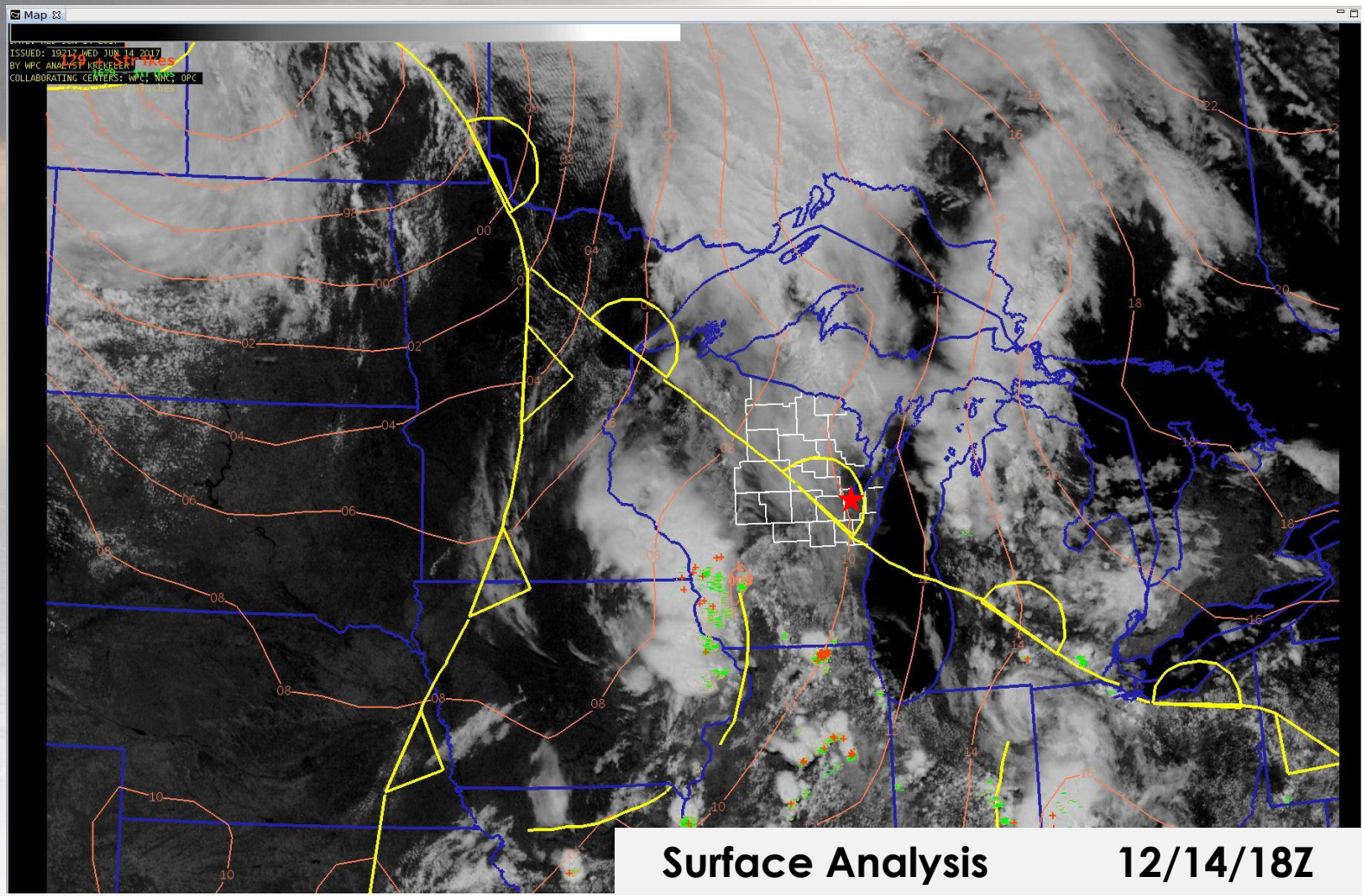
250 mb 12-18Z

Synoptic Setting

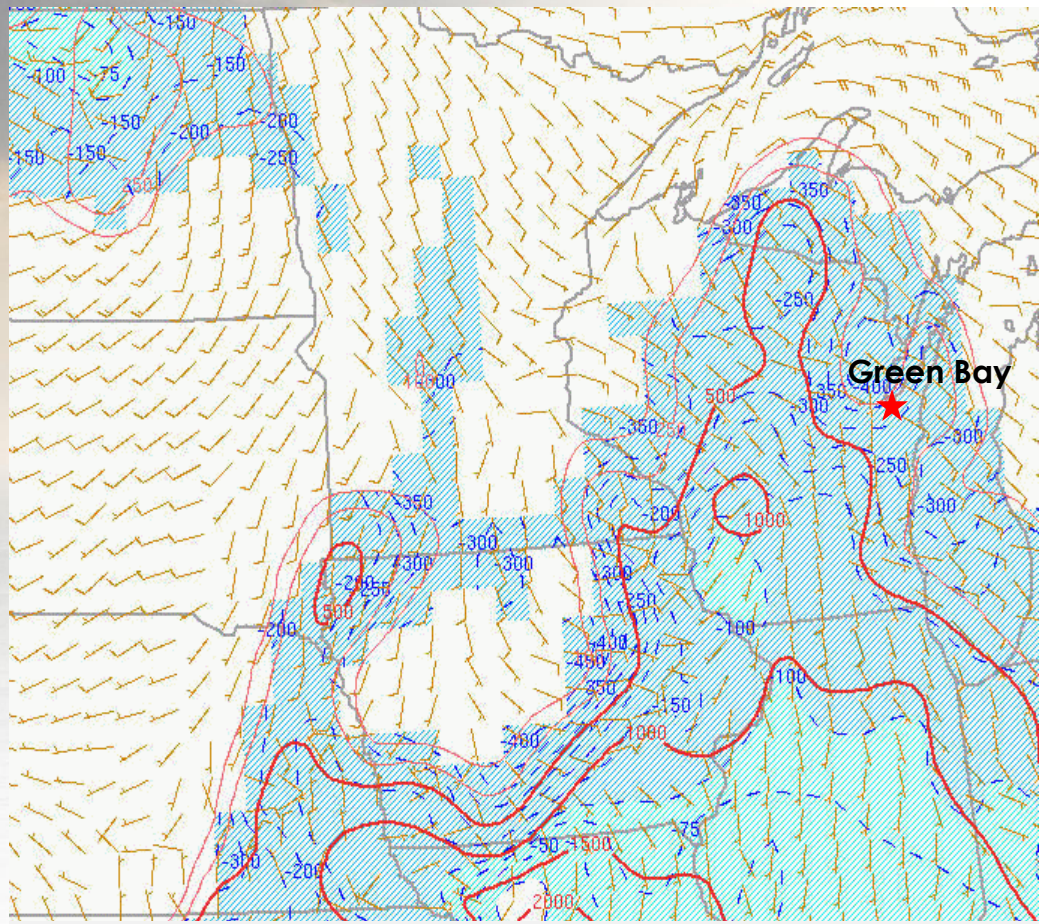


500 mb Analysis 12Z/00Z

Synoptic Setting

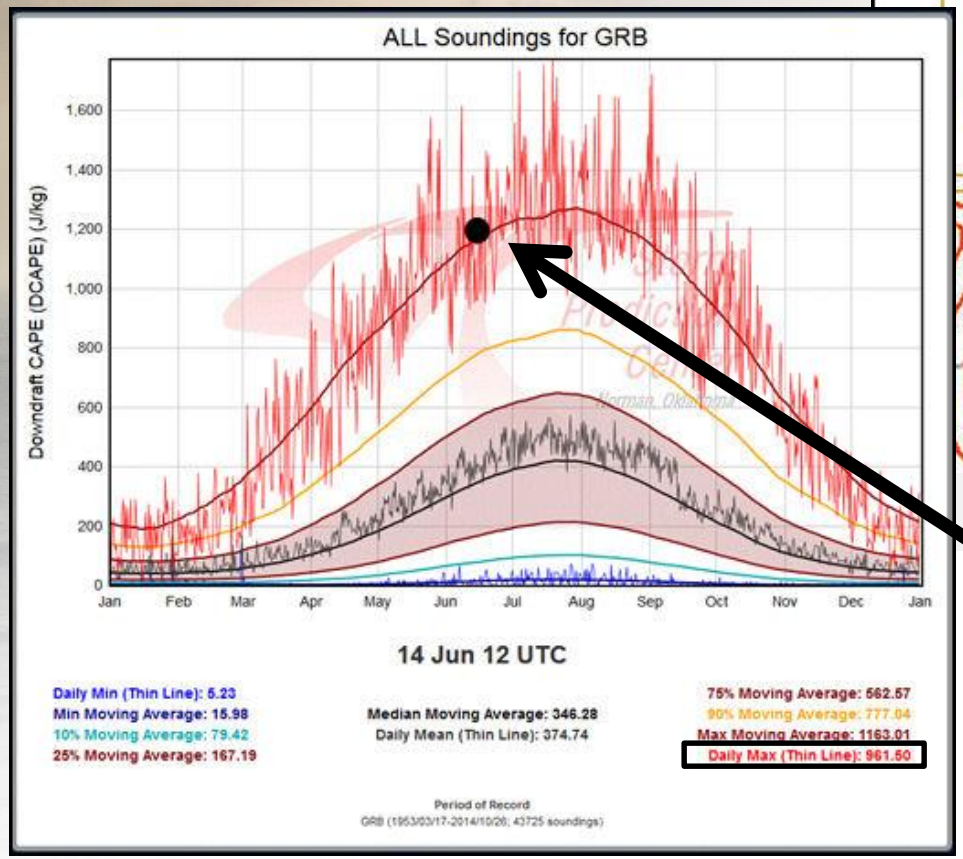


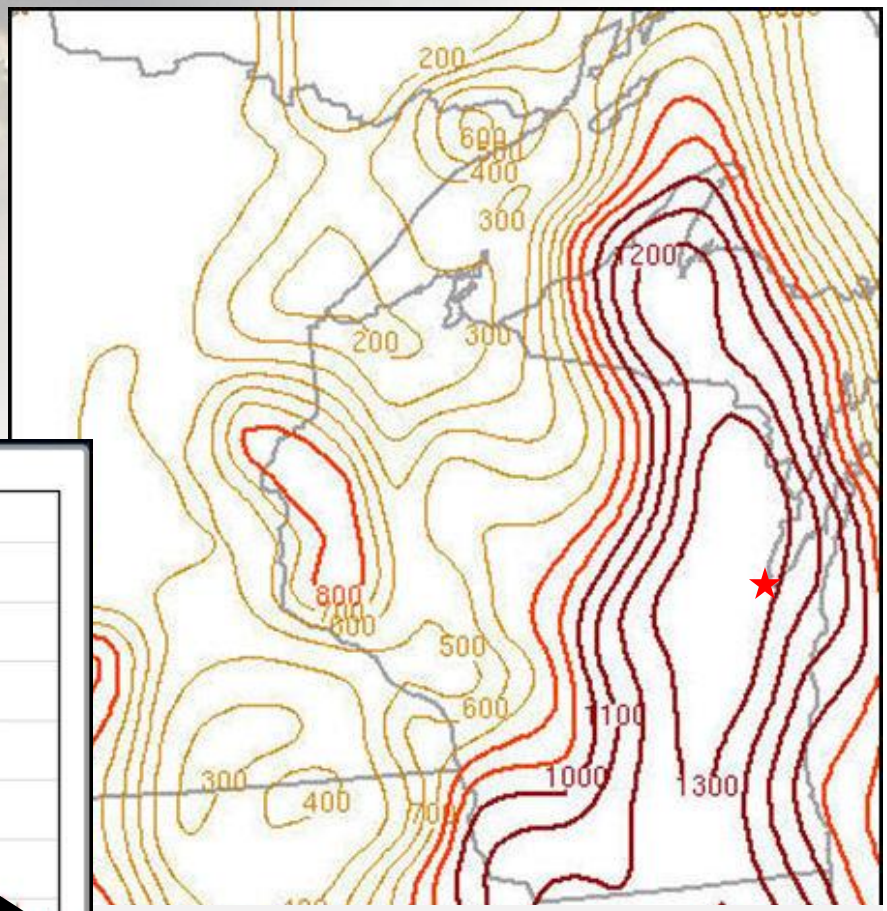
Synoptic Setting



MLCAPE & MLCIN (shaded) **12-18Z**

Synoptic Setting



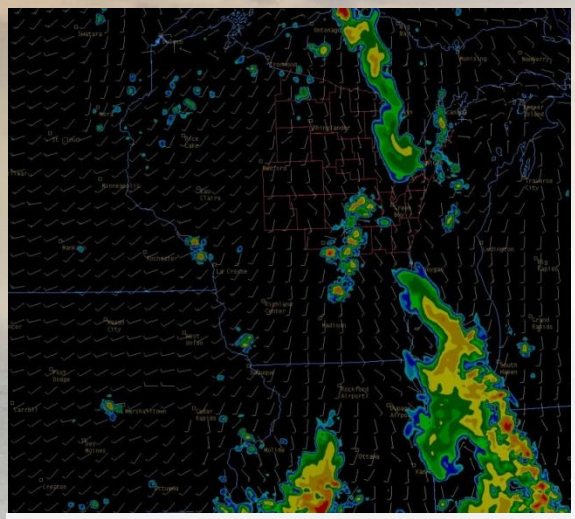


Downdraft CAPE 17Z

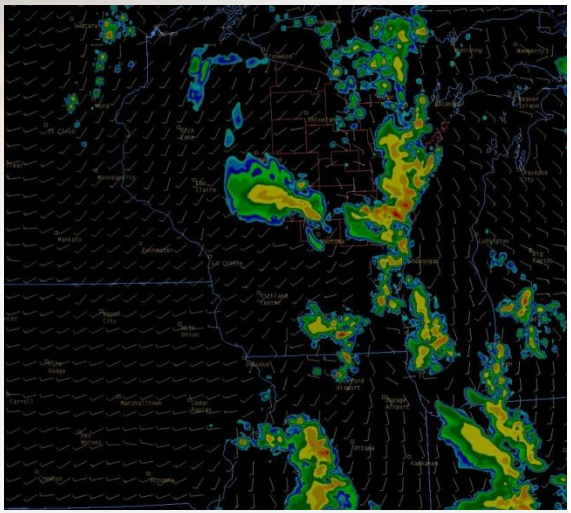
Green Bay Value
1200 J/kg

Synoptic Setting

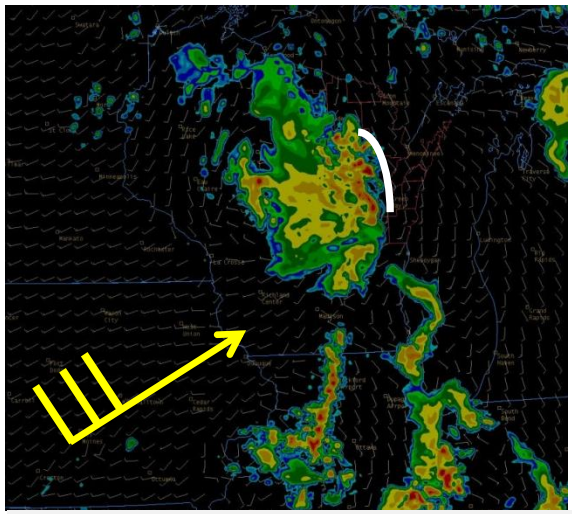
Consecutive HRRR forecasts all **valid at 21 UTC**



12Z Run

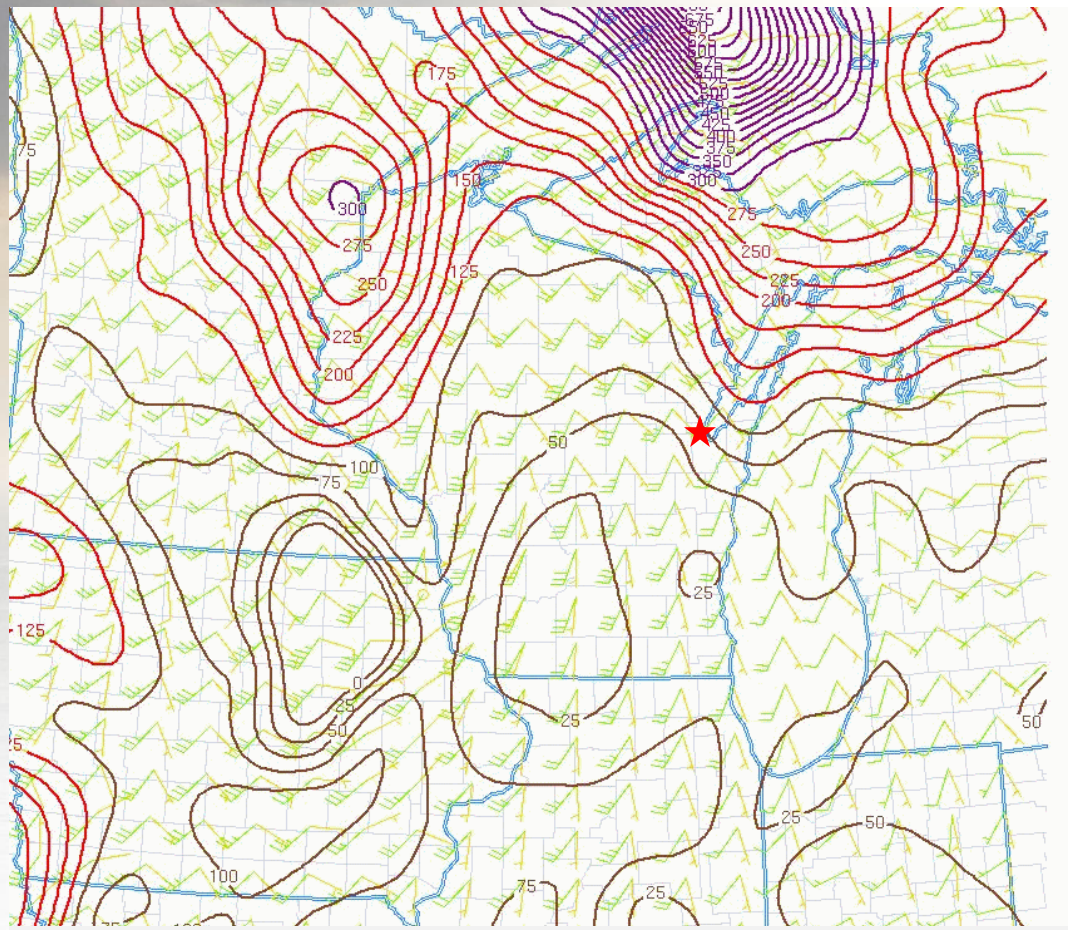


15Z Run



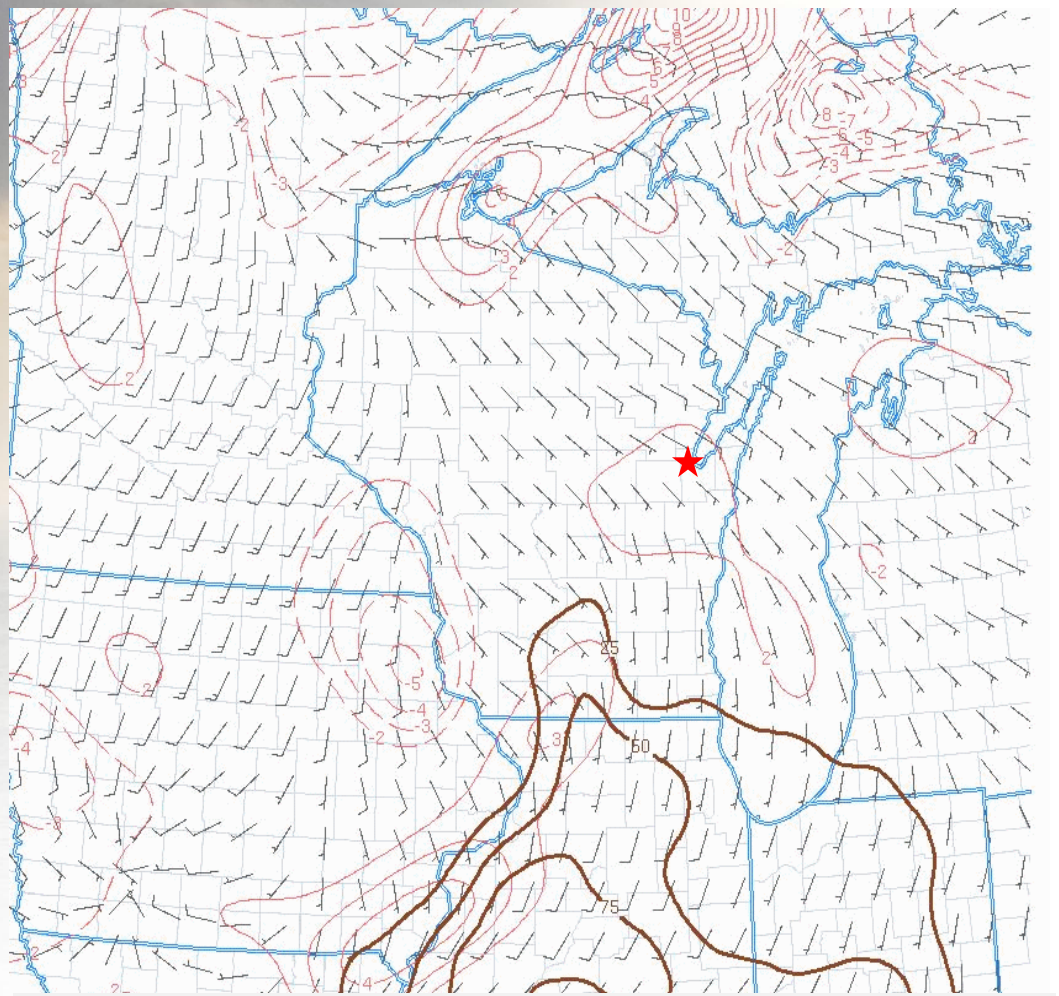
18Z Run

Tornado Potential



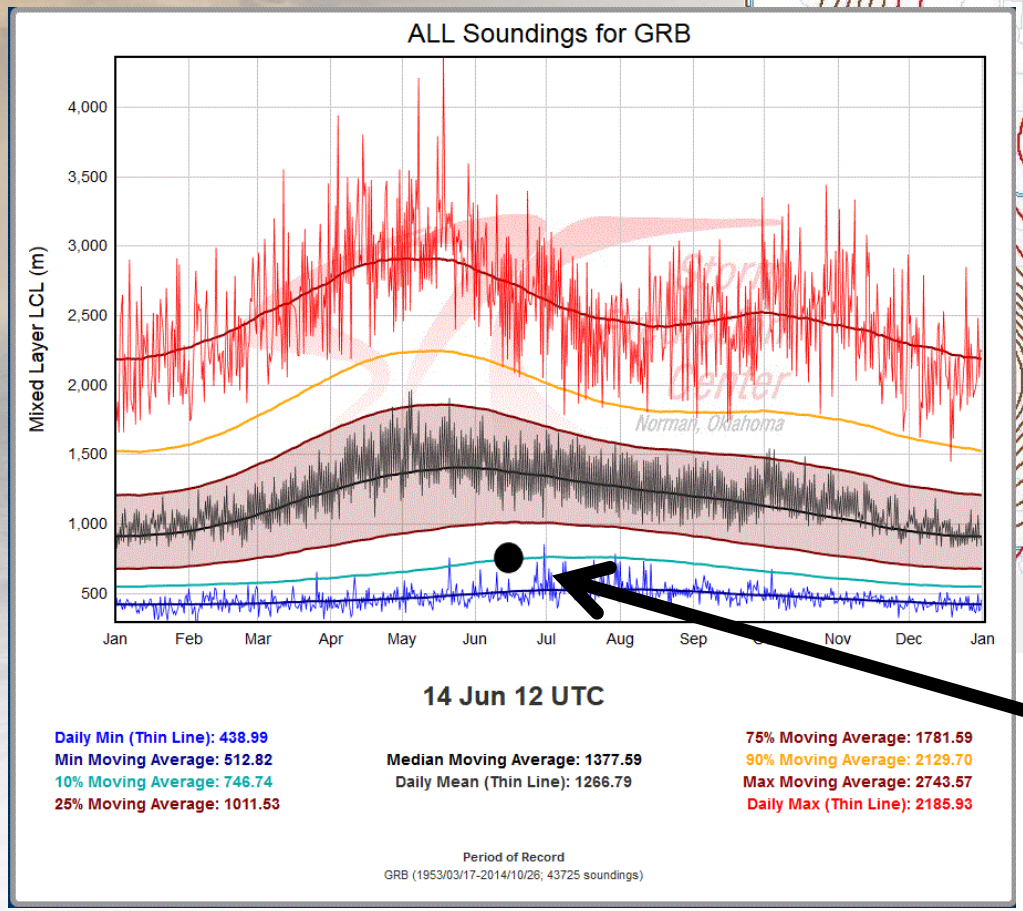
0-3 km Storm Relative Helicity 12-17Z

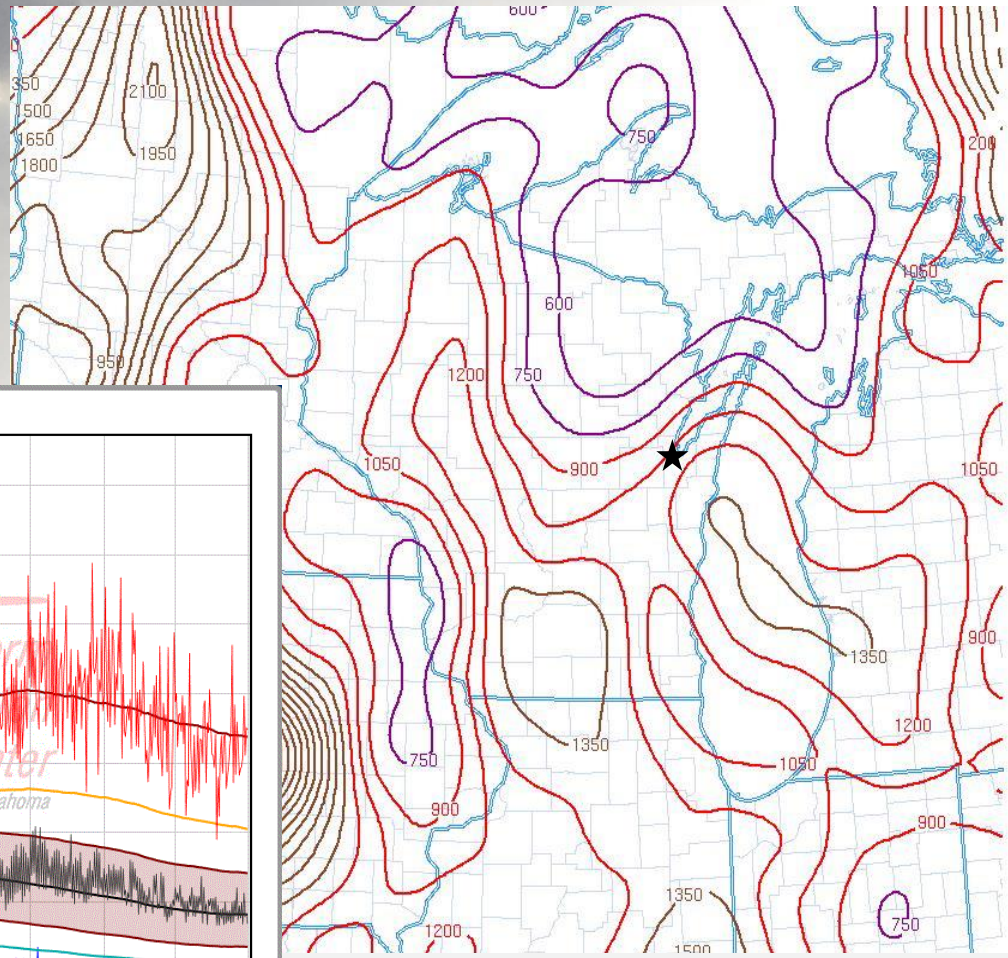
Tornado Potential



0-3 km CAPE **15-19Z**

Tornado Potential





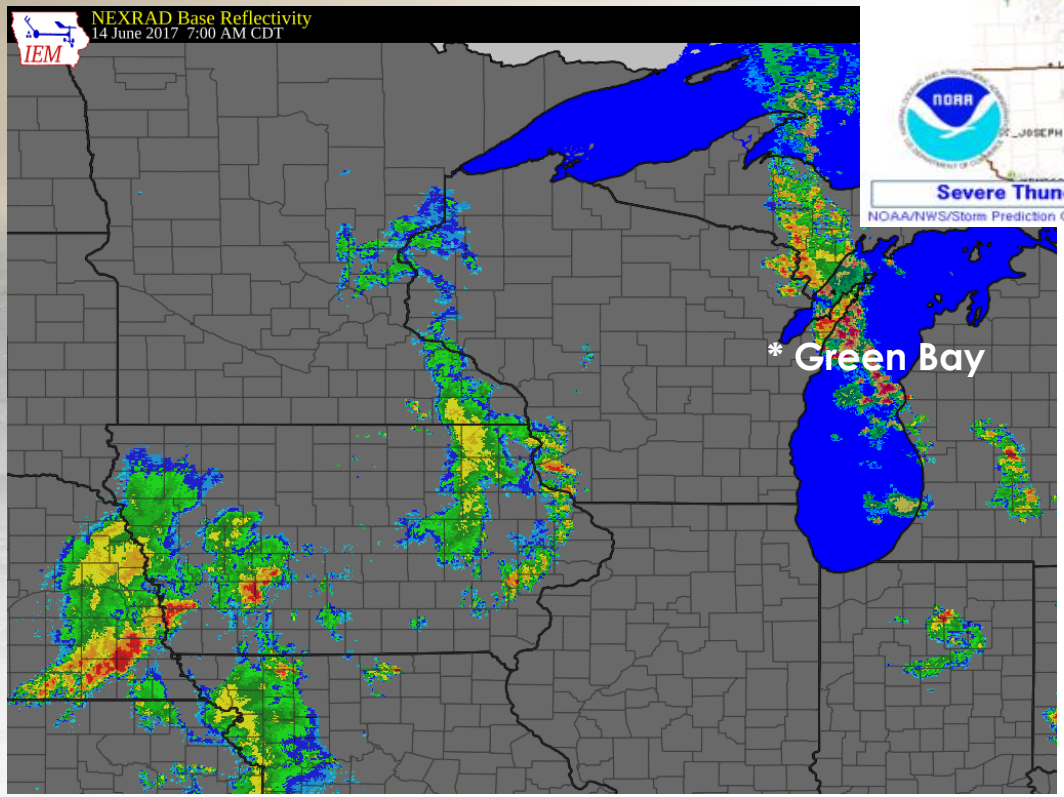
LCL Heights 18Z

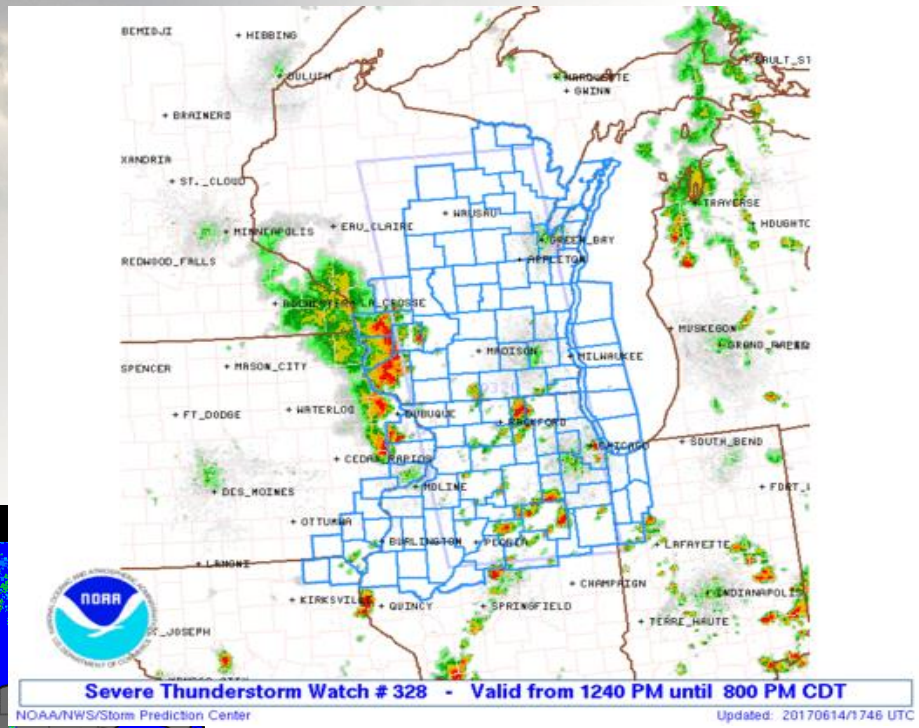
Green Bay Value
750 m

Synoptic Summary

- ✓ **RRQ of upper-level jet** and approaching **shortwave** disturbance provided large-scale ascent and destabilization to support organized convection
- ✓ Rapid destabilization associated with approaching **warm front**, MLCAPES 1500 -2000 J/Kg with No SBCIN by afternoon
- ✓ DCAPE favorable for enhanced downdraft potential
- ✓ **Low-level** (0-3 km) SRH, (0-3) MLCAPE and low LCL heights enhanced stretching potential
- ✓ **BOTTOM LINE: Environment became increasingly supportive of tornadoes during the morning**

Expectations Going Into the Afternoon



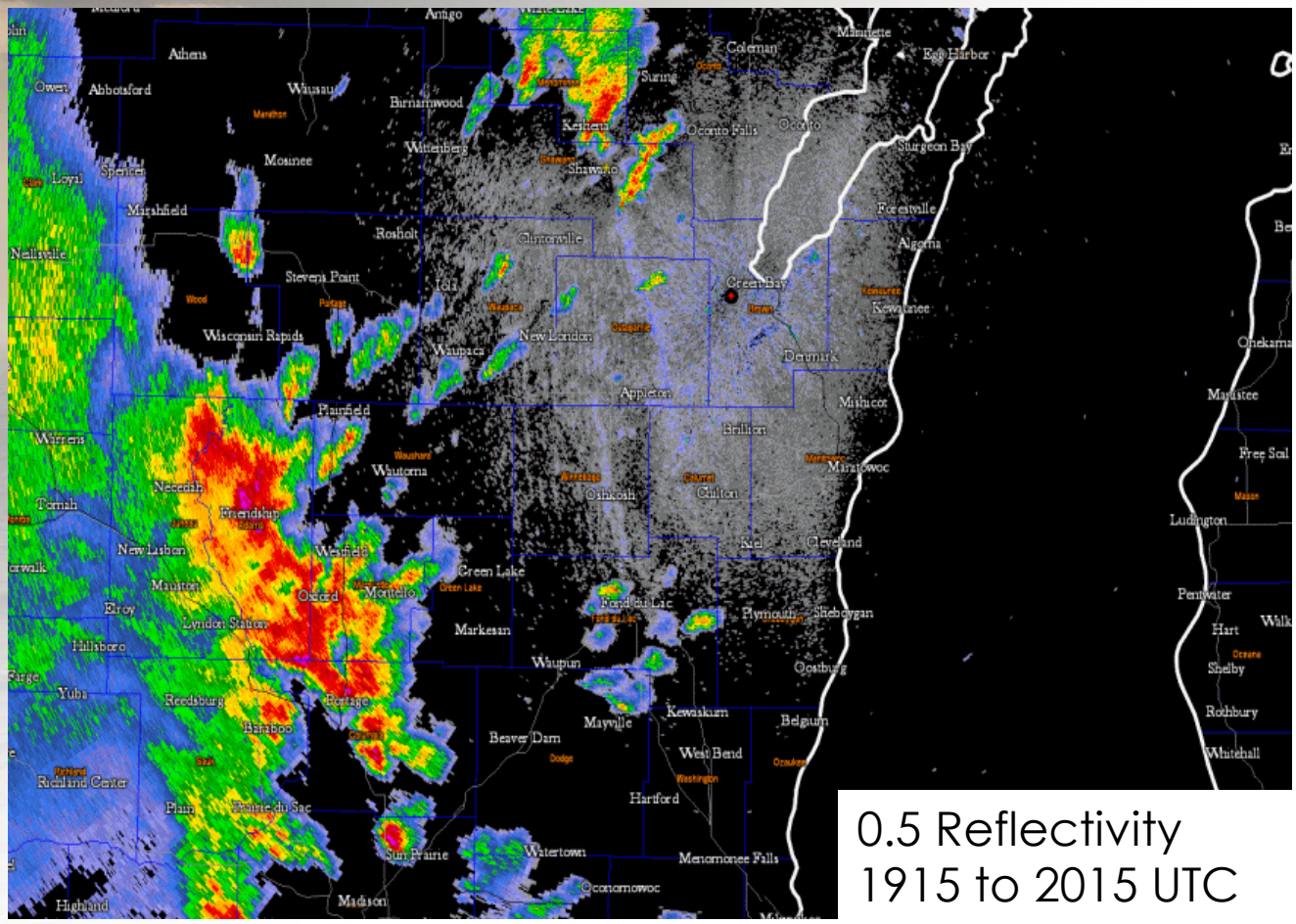


MCD issued at 1206 PM

Watch issued at 1240 PM

Warning Decisions and Challenges

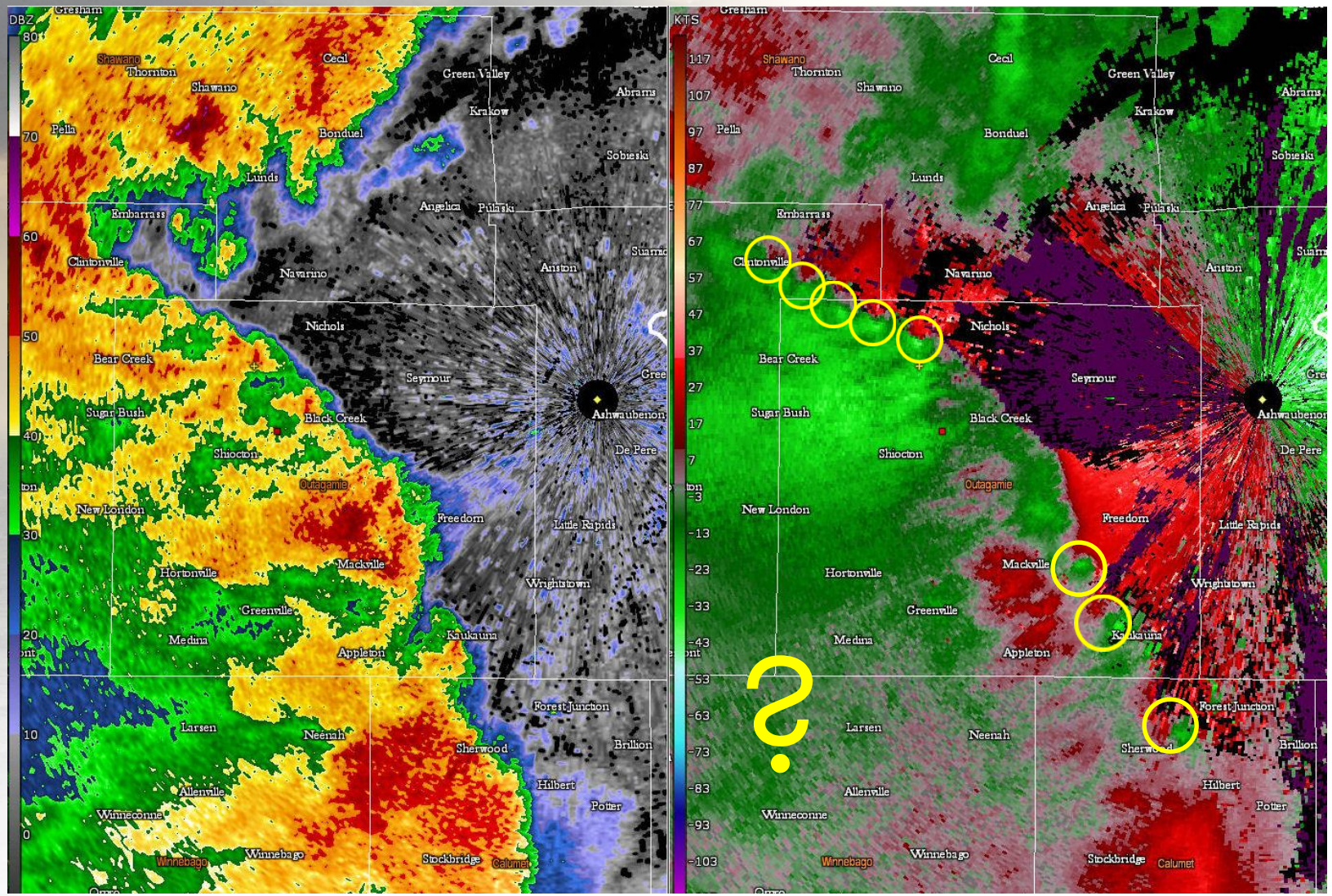
Initial strategy was to issue Severe Thunderstorm Warnings and leverage the Tornado Possible Tag



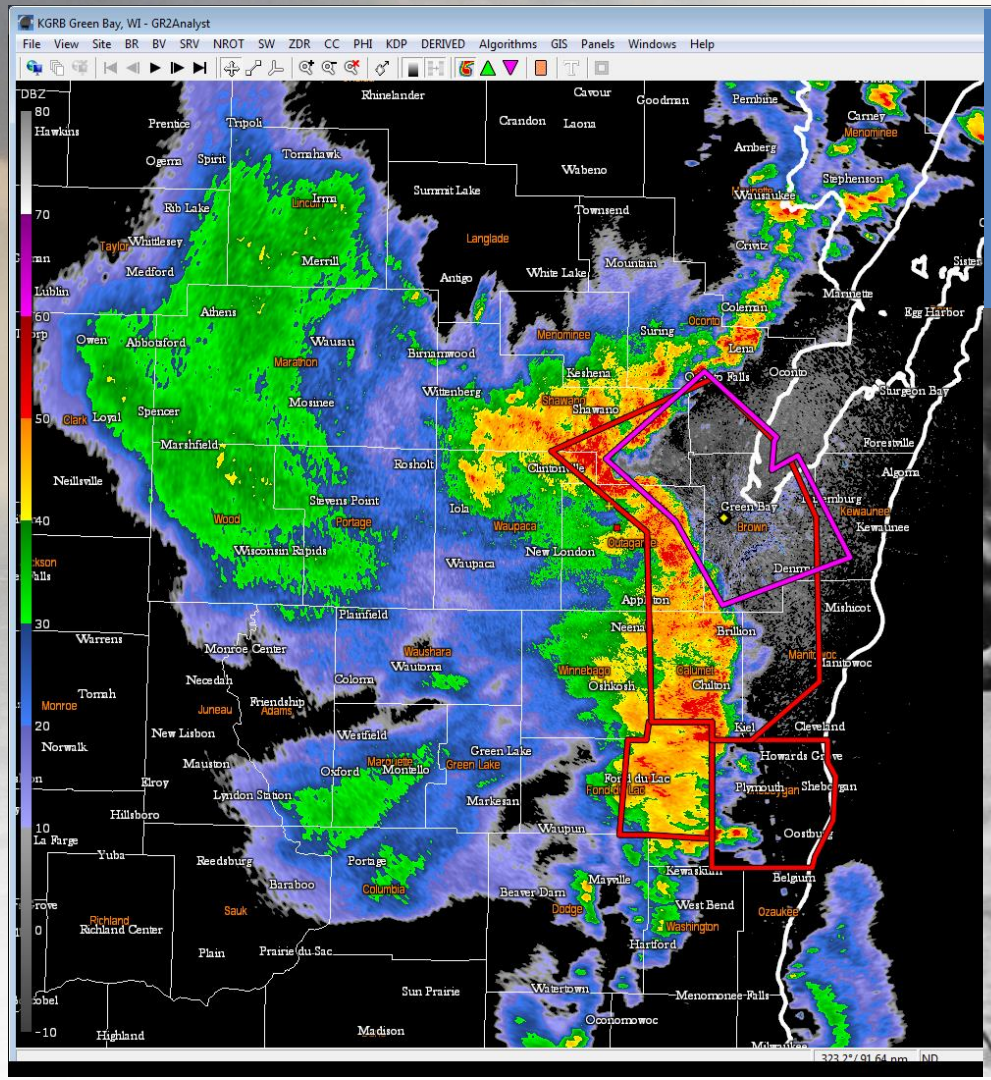
0.5 Reflectivity
1915 to 2015 UTC

- As storms approached the forecast area, expected threat was damaging winds.
- A small tornado threat was also possible particularly where the QLCS interacted with upstream broken line of discrete cells.
- Initial strategy was to leverage the **Tornado Possible Tag** for any weak circulations that may develop.

Warning Decisions and Challenges

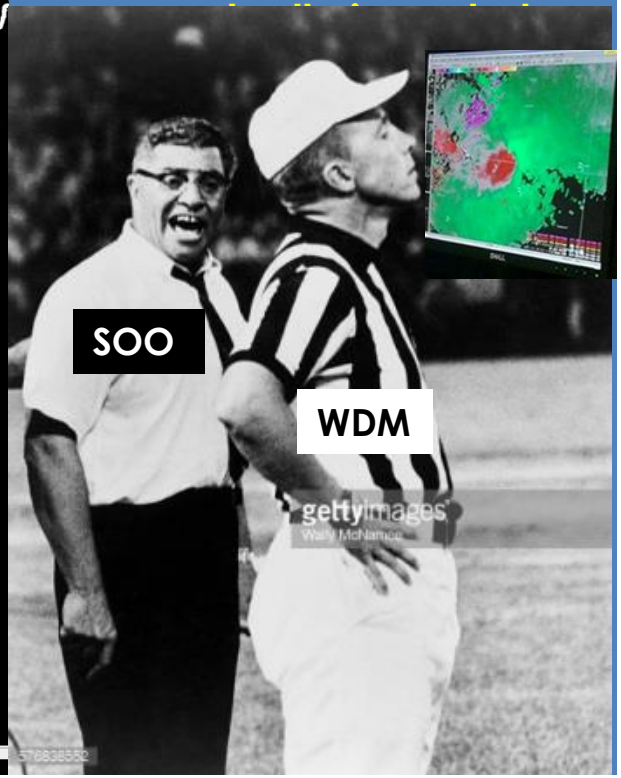


Warning Decisions and Challenges

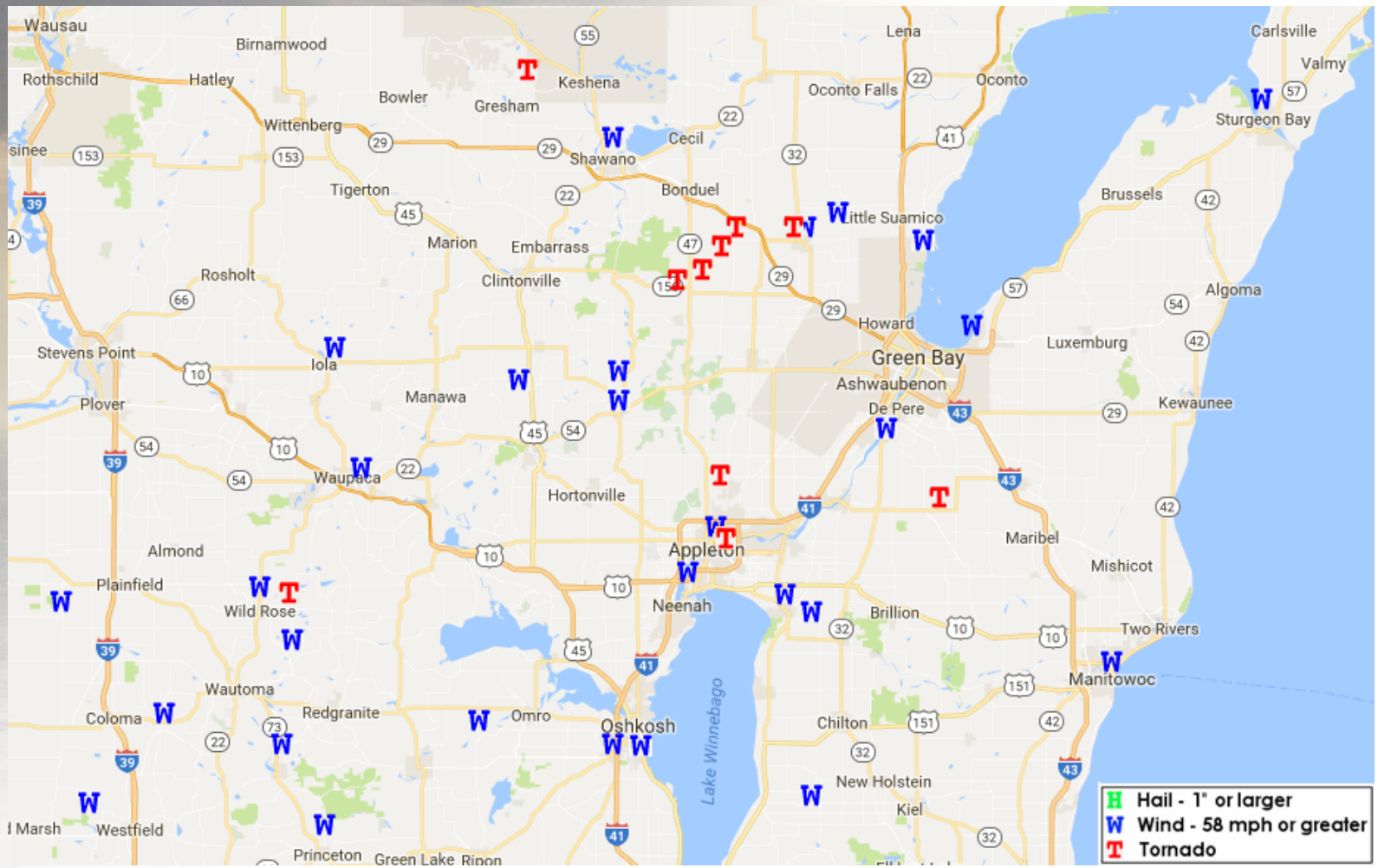


Warning operations debated how to best handle the tornado threat.

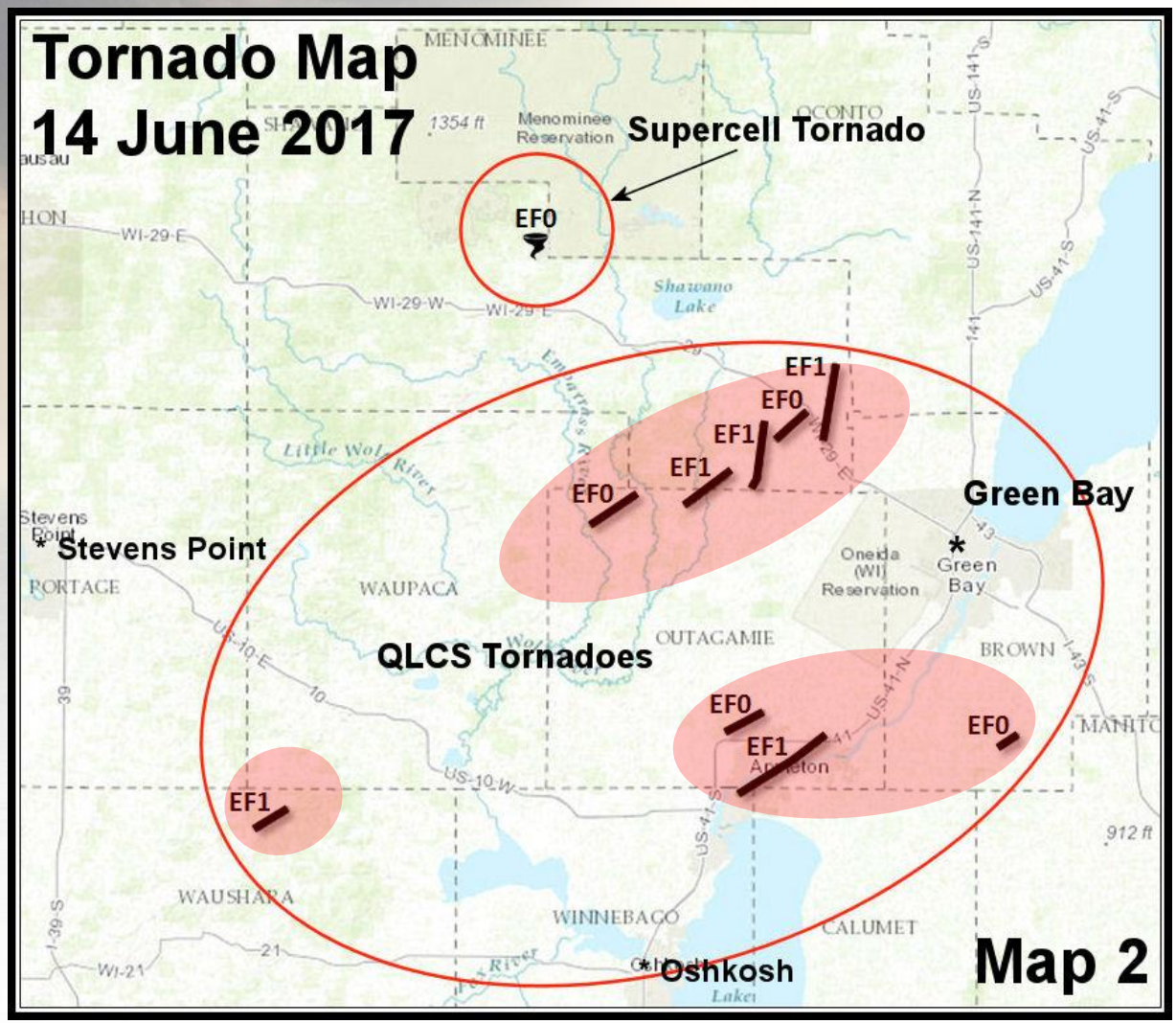
"Large" tornado Warning



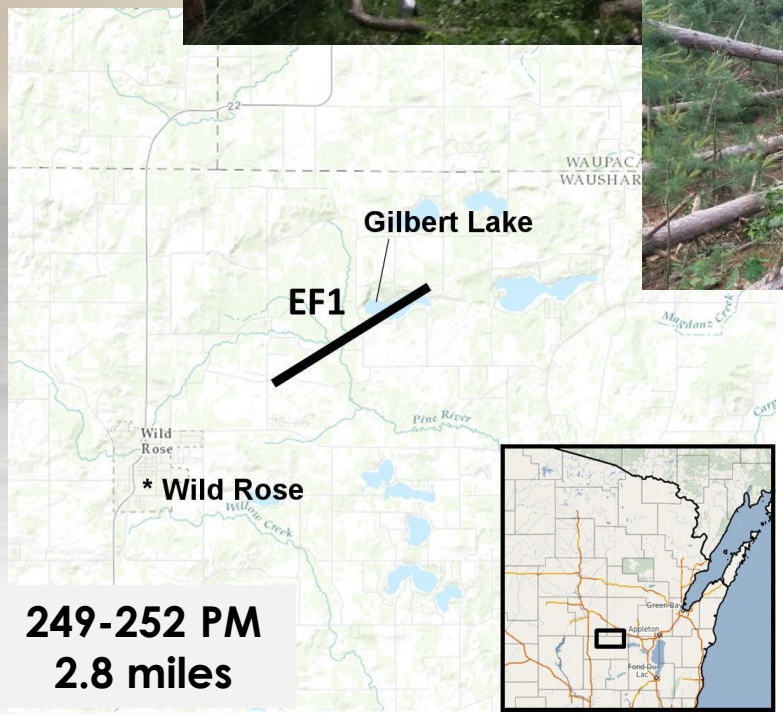
What Happened?



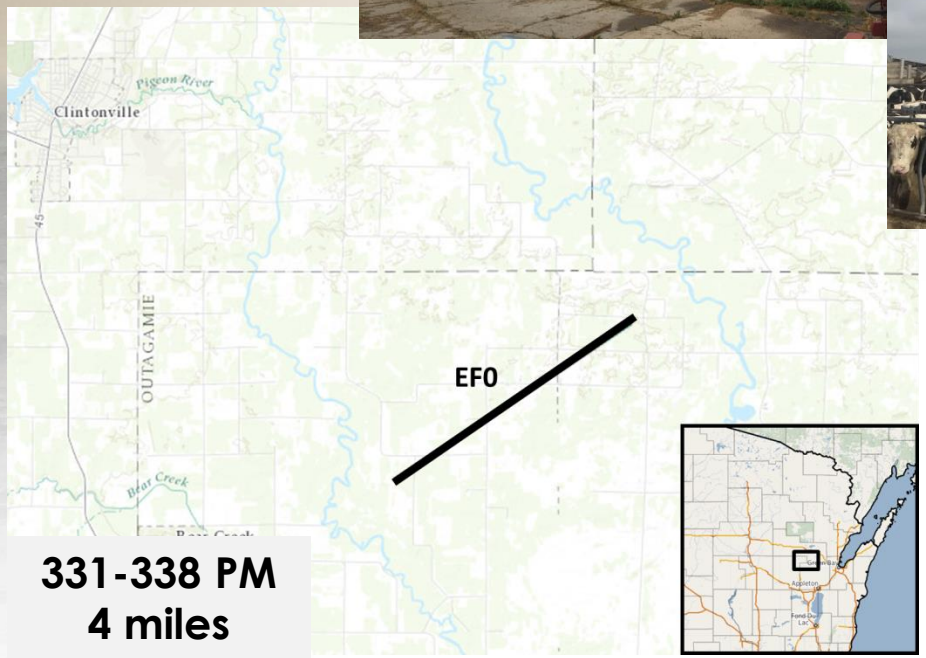
The Tornadoes



The Tornadoes – **Gilbert Lake**



The Tornadoes – **Bear Creek**

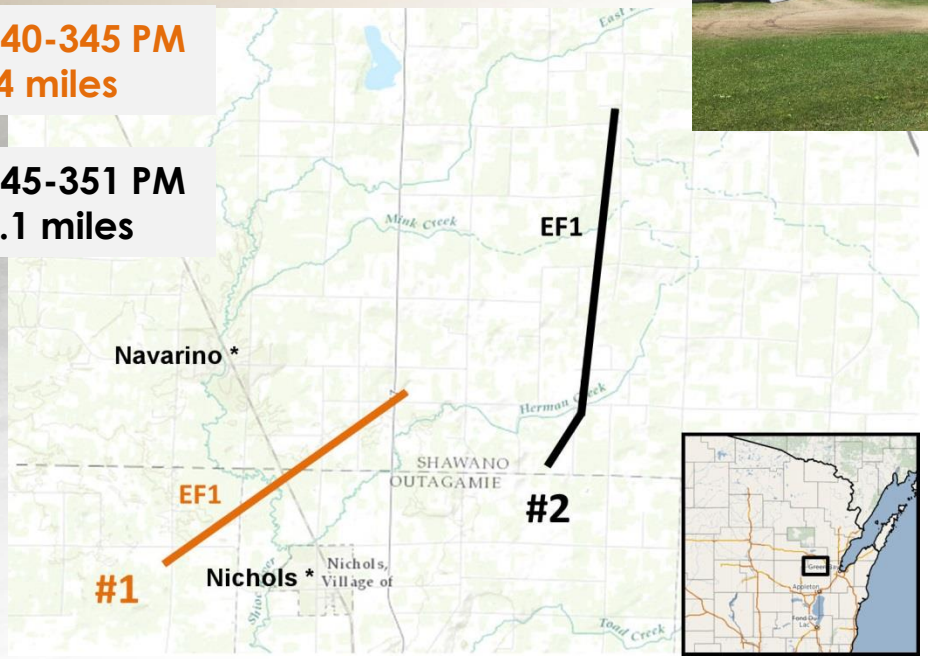


331-338 PM
4 miles

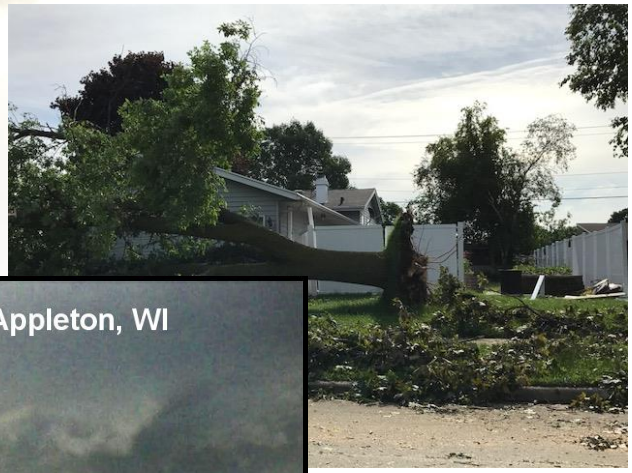
The Tornadoes – **Nichols/Navarino**

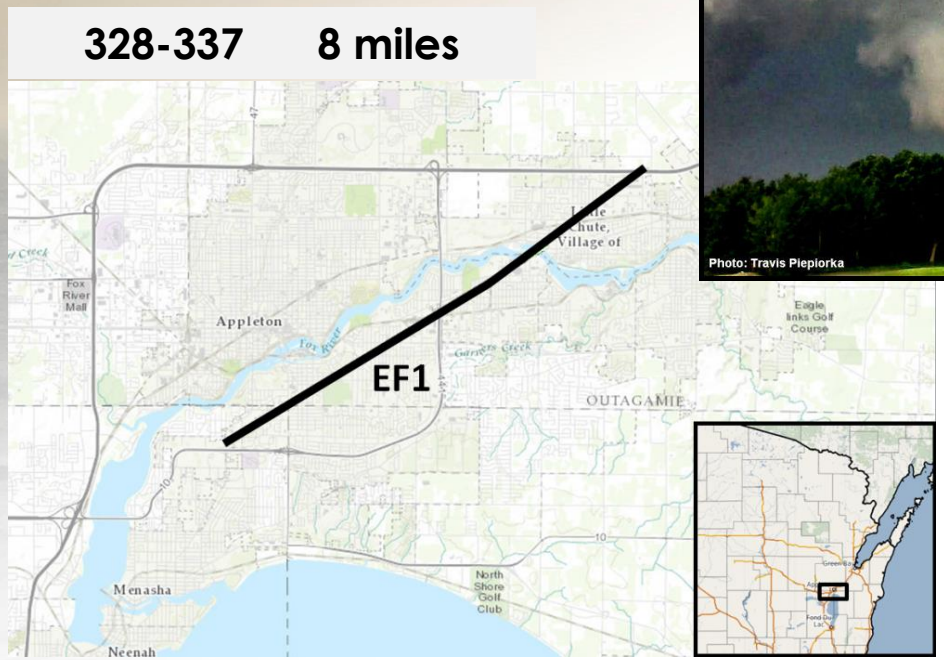
#1 340-345 PM
4 miles

#2 345-351 PM
5.1 miles



The Tornadoes – **Appleton/Kimberly**





Application of the QLCS Mesovortex Warning System The 14 June 2017 Tornadic QLCS over Northeast Wisconsin

Part I – Questions?

Kira Benz, Timm Uhlmann, and Gene Brusky
National Weather Service Green Bay

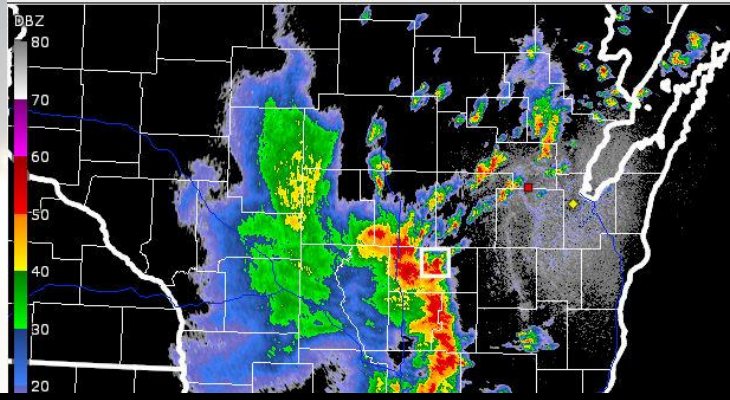
26th Great Lakes Operational Meteorology Workshop
May 1-3, 2018
Cleveland, Ohio

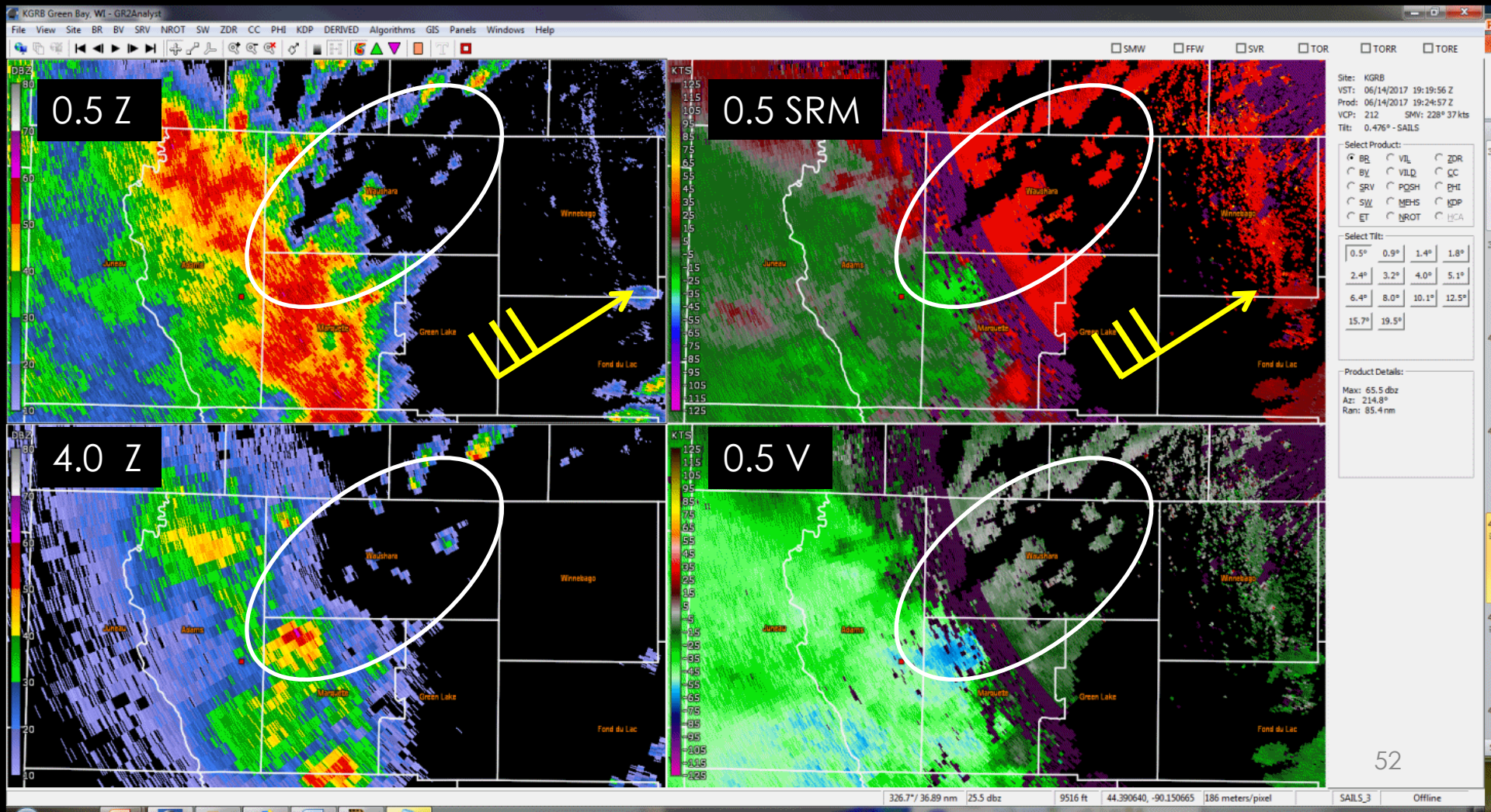
Part II: Application of the QLCS Mesovortex Warning System

Recall Four Primary Steps

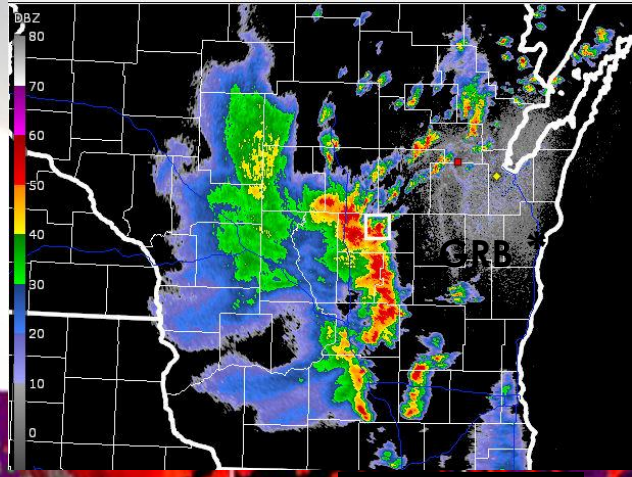
1. Three Ingredients method (Schaumann and Przybylinski, 2012)
   - ✓ Used to anticipate mesovortex genesis over next 30-45 minutes
2. Identify presence of confidence builders and nudgers indicating increased likelihood for tornadoes
3. Determine number and quality of confidence builders and nudgers
   - ✓ Dictates warning type
4. Construct a "smart" polygon
   - ✓ Capture mesovortex genesis region over next 30-45 minutes

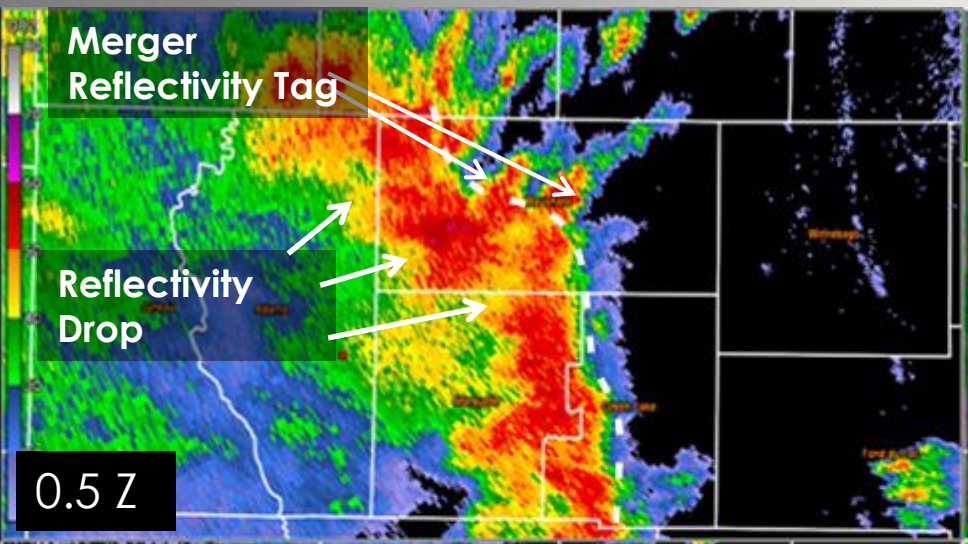
Example 1
Waushara County

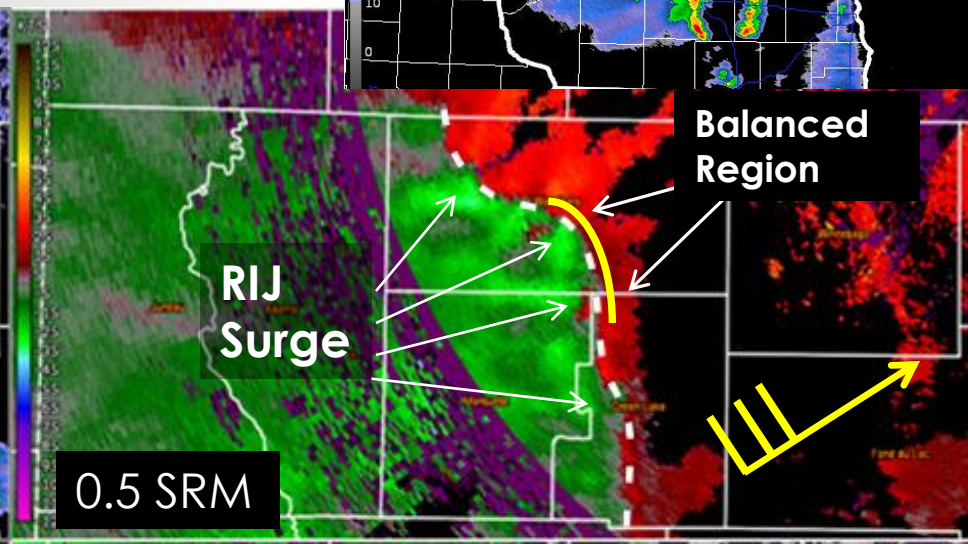


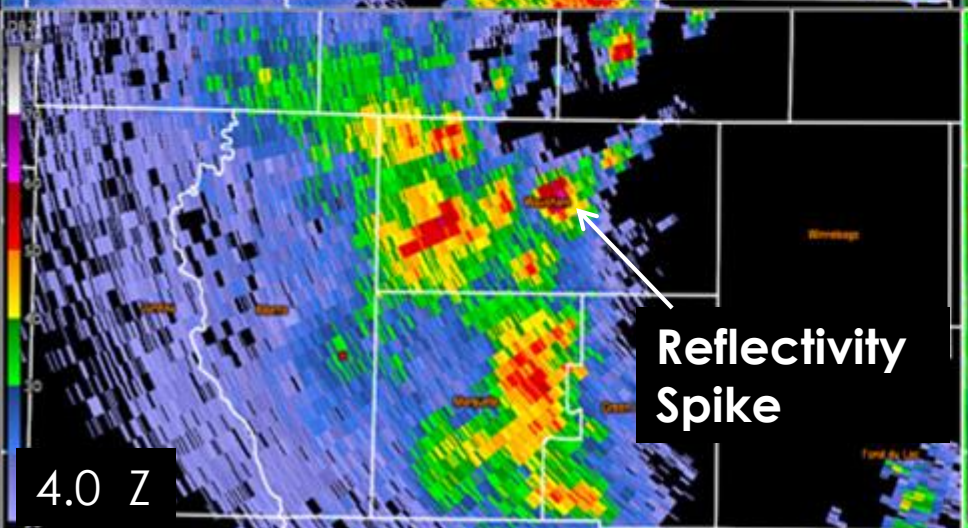


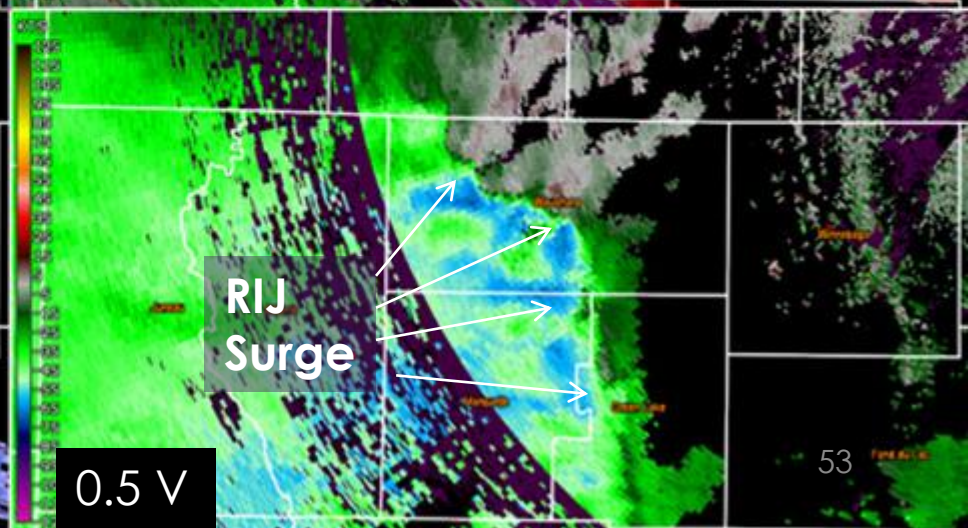
- RIJ/Surge
- Reflectivity Drop
- Merger
- Enhanced Reflectivity Spike Near Surge



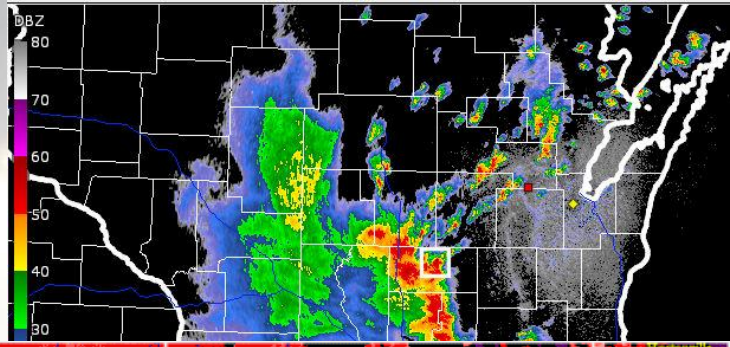


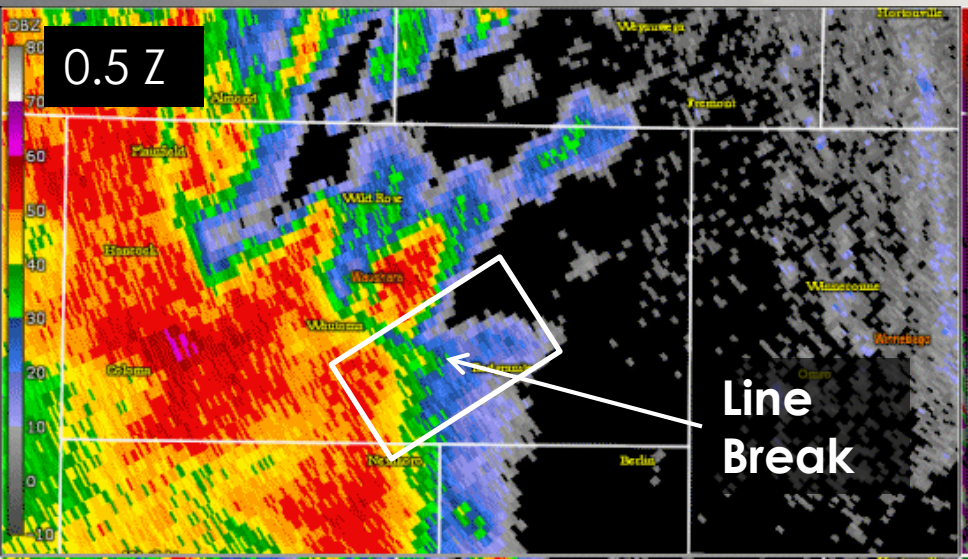


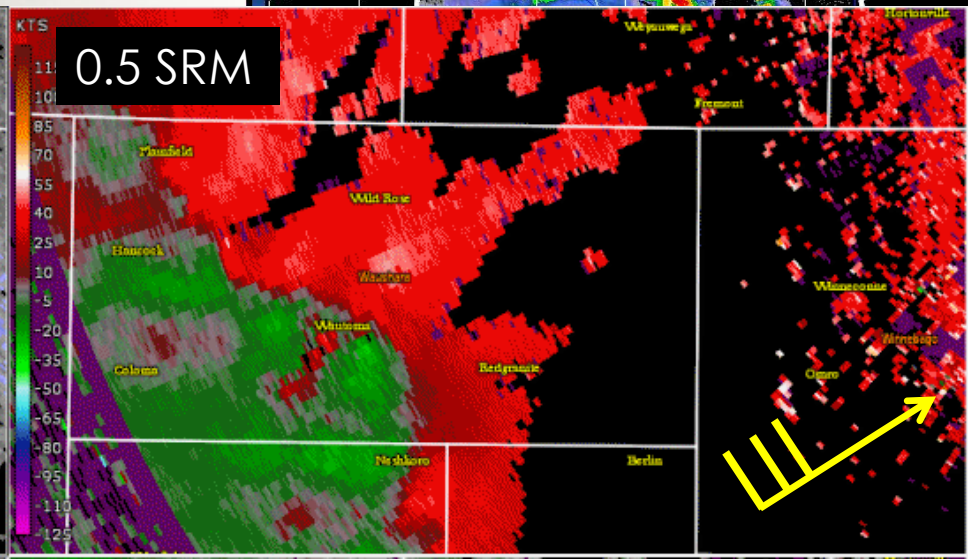


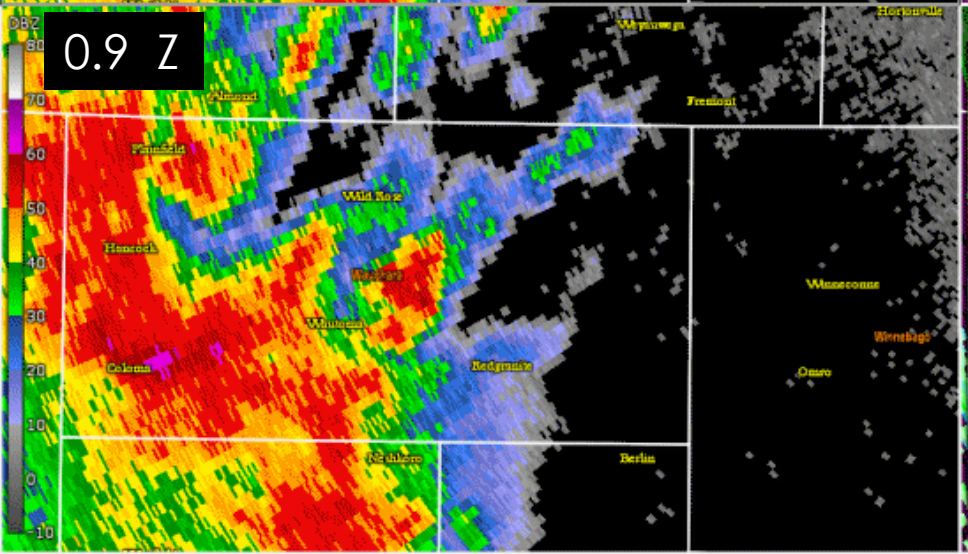


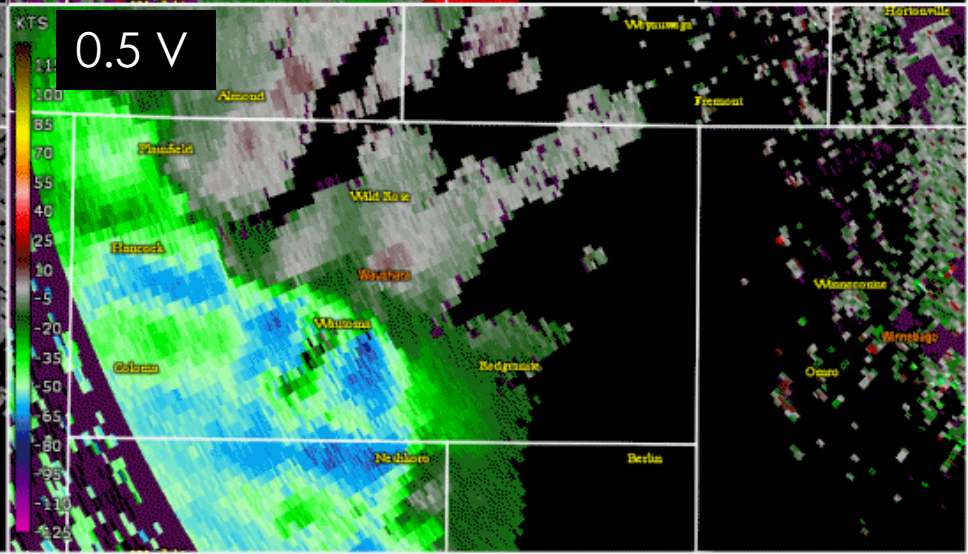
- RIJ/Surge
- Merger / Reflectivity Tag
- Reflectivity Drop
- Enhanced Reflectivity Spike Near Surge
- Line Break











QLCS Mesovortex Warning System

Step 3: Determine number & quality of confidence builders & nudgers

3 Ingredients Met in Most Situations
✓ Descending RIJ/Reflectivity Drop
✓ Enhanced Surge
✓ Line Break
UDCZ entry/inflection point
Paired front/rear inflow notch
Boundary ingestion
Front reflectivity nub
Contracting bookend vortex with $V_r \geq 25$ kt *
Tight/strong mesovortex with $V_r \geq 25$ kt
Confirmed tornado/Tornadic debris signature (TDS)

?

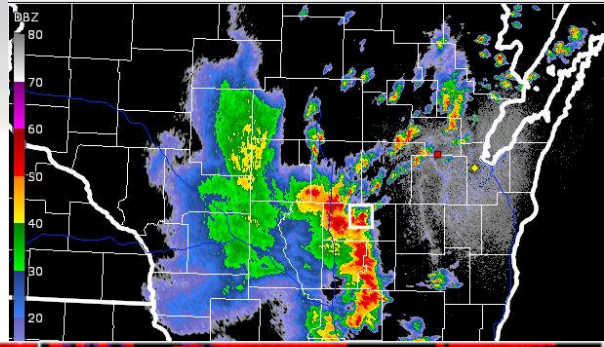
3 Ingredients Met in Most Situations
✓ Reflectivity tag intersecting a surge
✓ 0 to 3 km MLCAPE $\geq$ 40 J/kg
✓ Cell merger / Reflectivity spike near surge

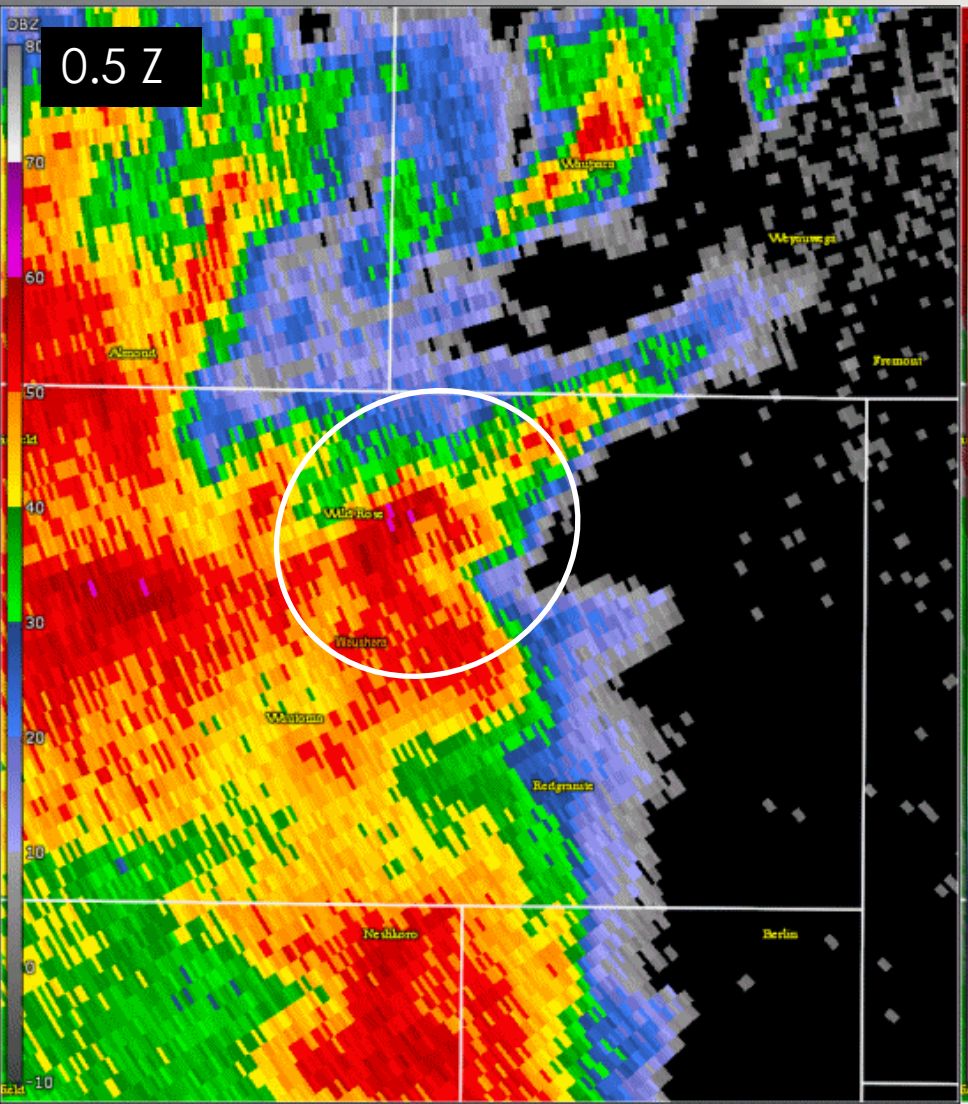
1-3: Severe with tornado possible tag
4 or more: **Tornado Warning?**

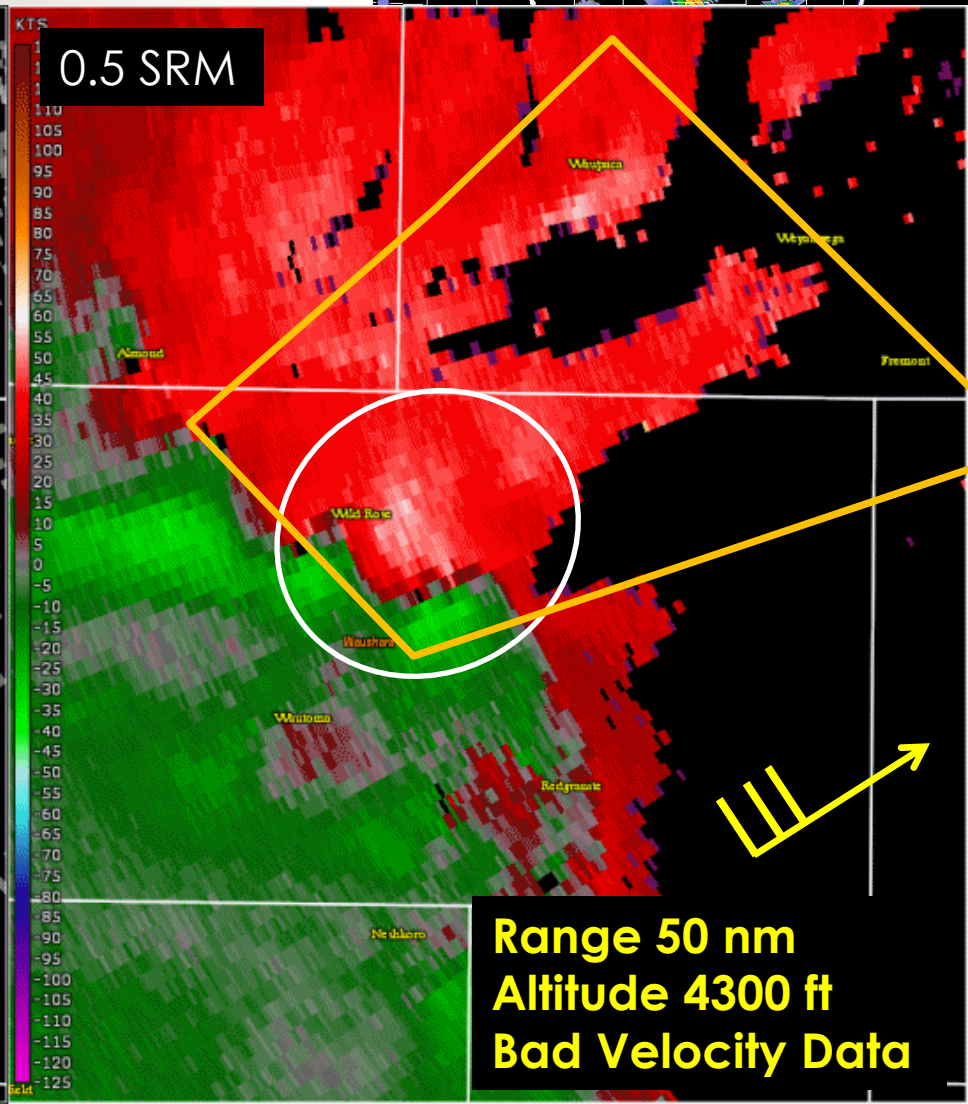
Assess quality/persistence

No magic numbers or magic combinations!

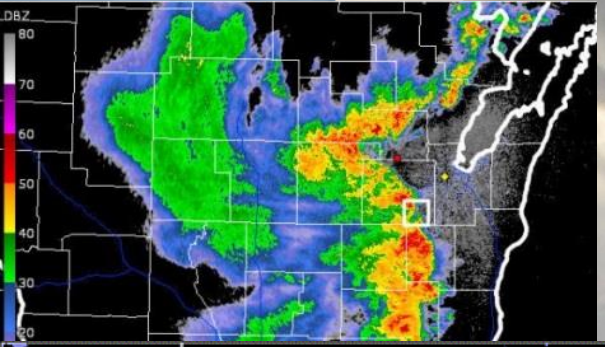
Step 4: Smart Polygon

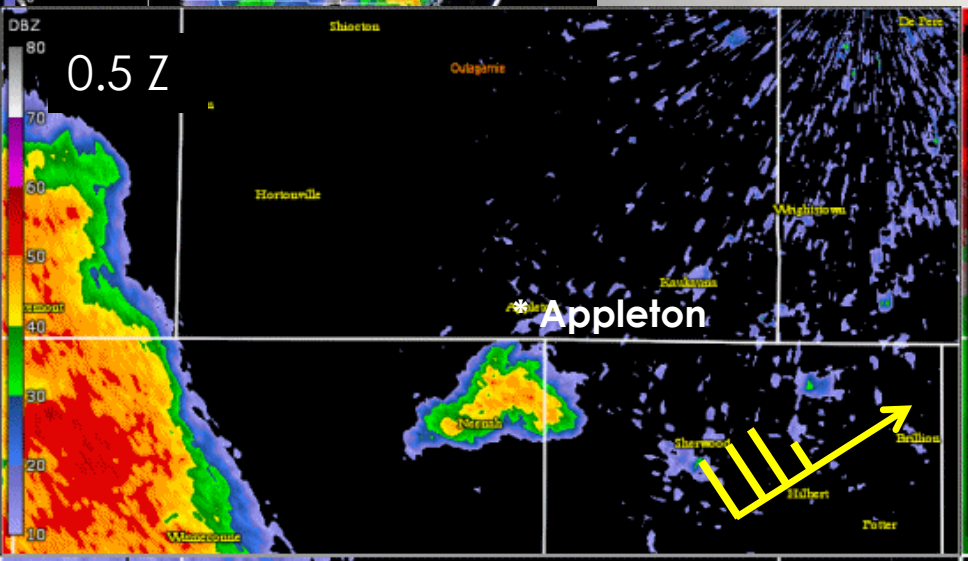


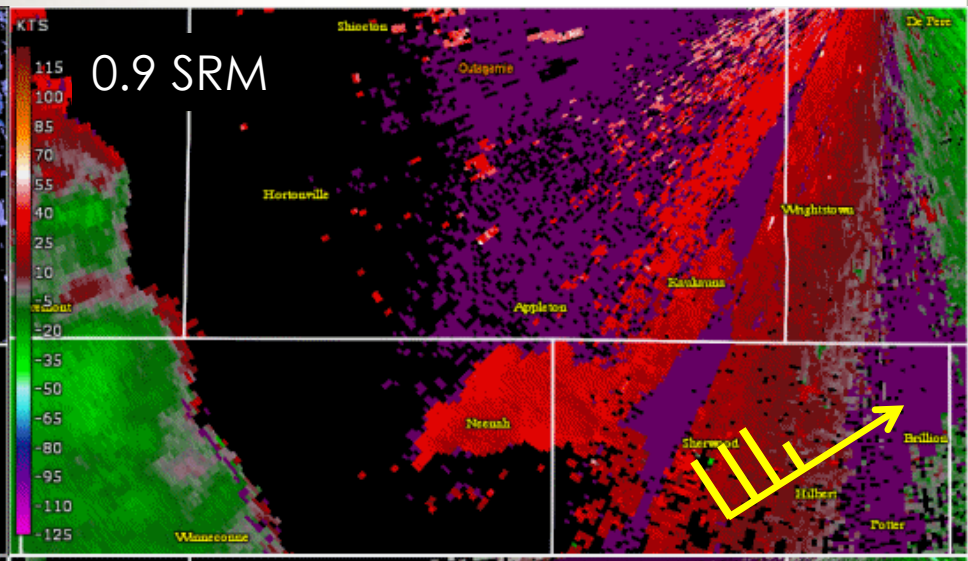


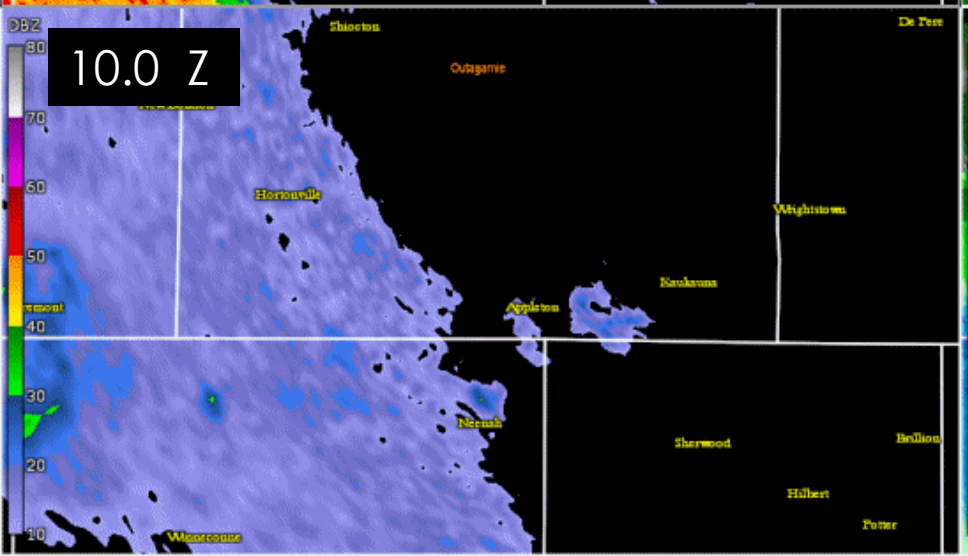


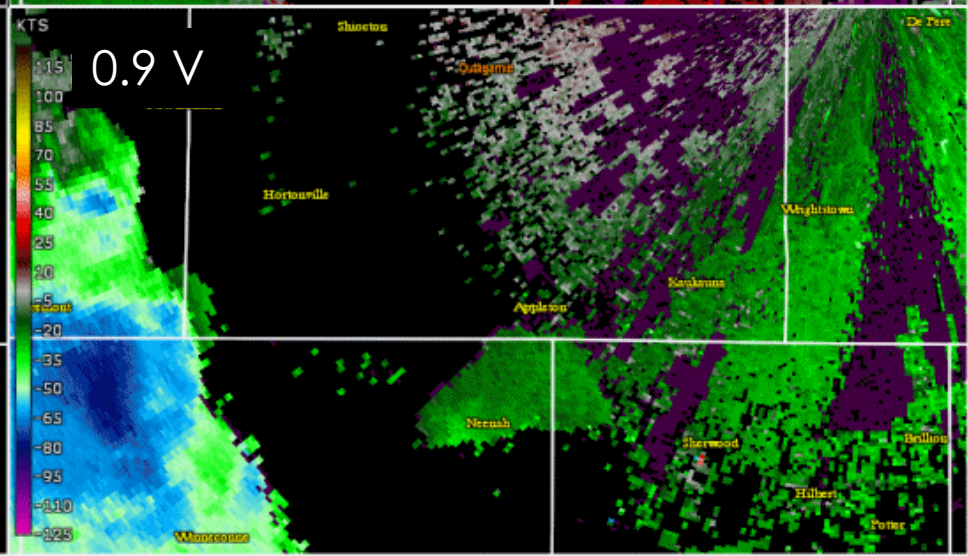
Example 2
Appleton/Mackville











- Reflectivity Nub
- Line Break

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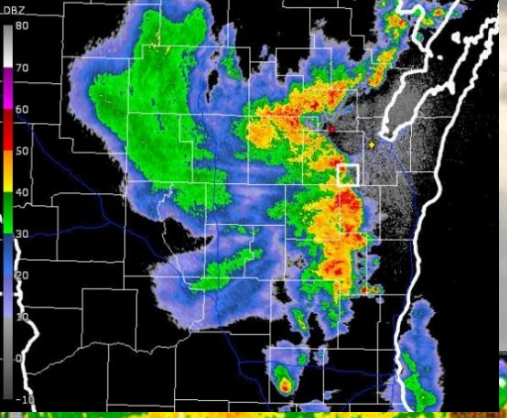

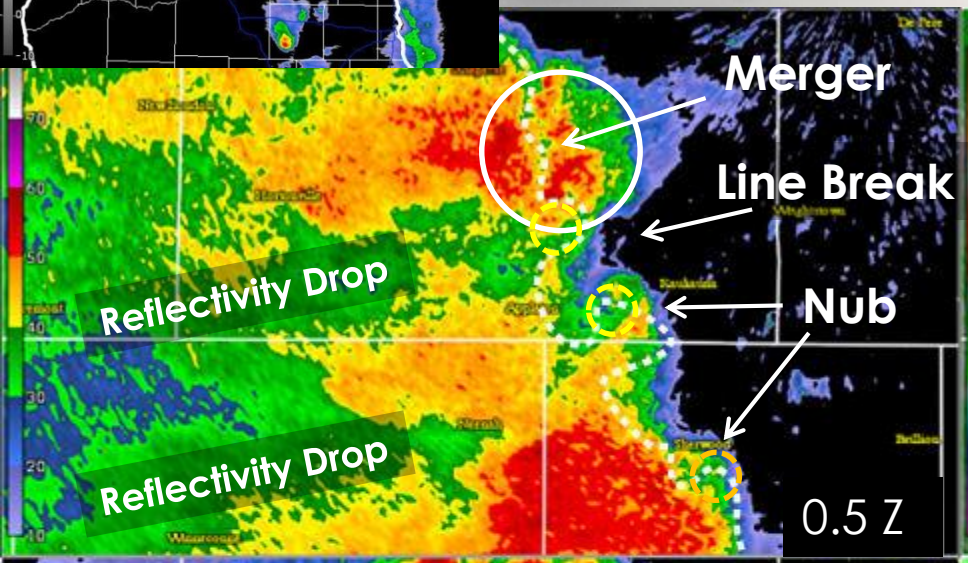

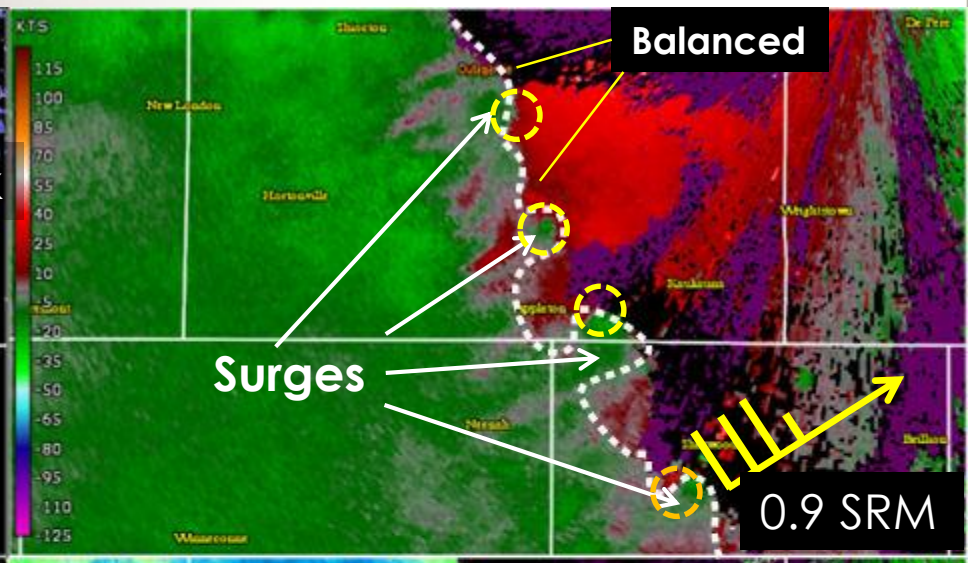

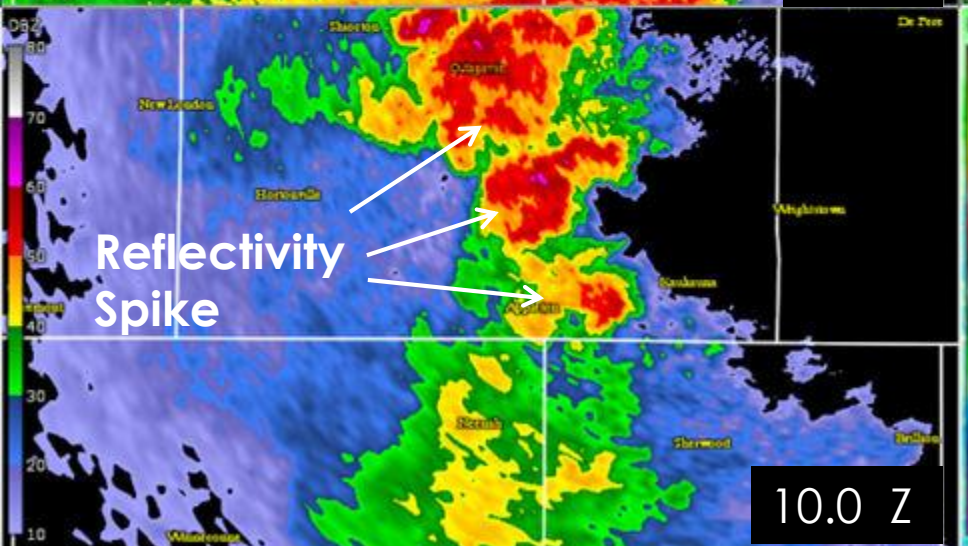

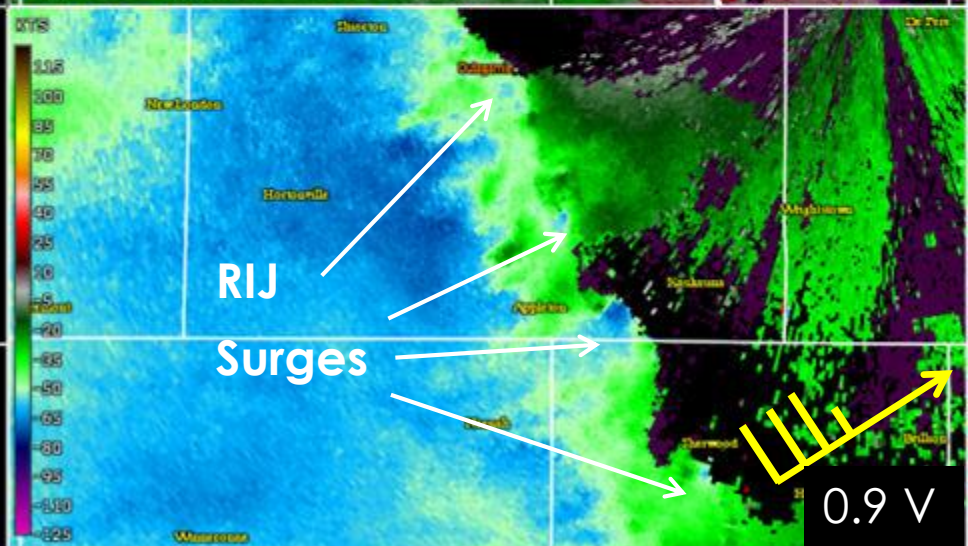

QLCS Mesovortex Warning System

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? Contracting bookend vortex with $V_r \geq 25$ kt *
Tight/strong mesovortex with $V_r \geq 25$ kt
Confirmed tornado/Tornadic debris signature (TDS)

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Reflectivity tag intersecting a surge
✓ 0 to 3 km MLCAPE ≥ 40 J/kg
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1-3: Severe with tornado possible tag
4 or more: **Tornado Warning**

Assess quality/persistence

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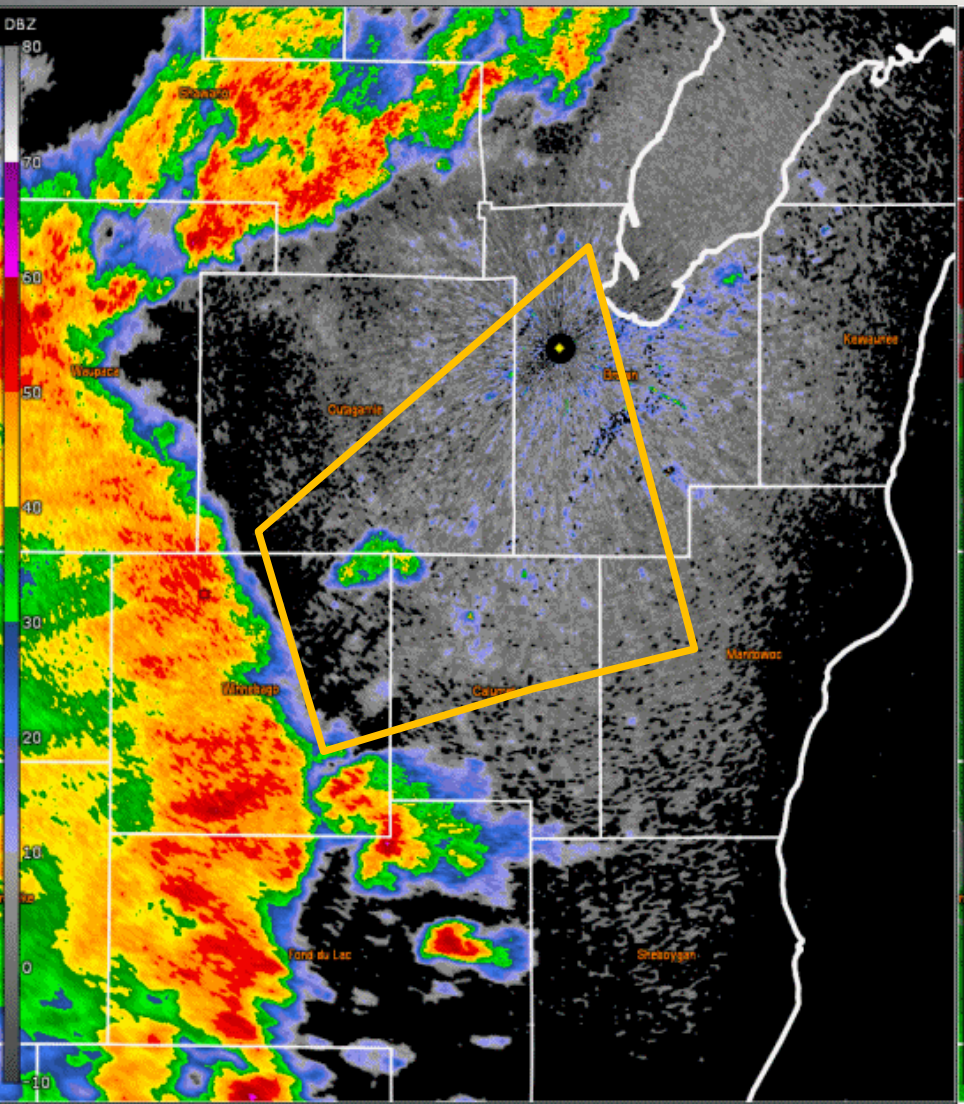
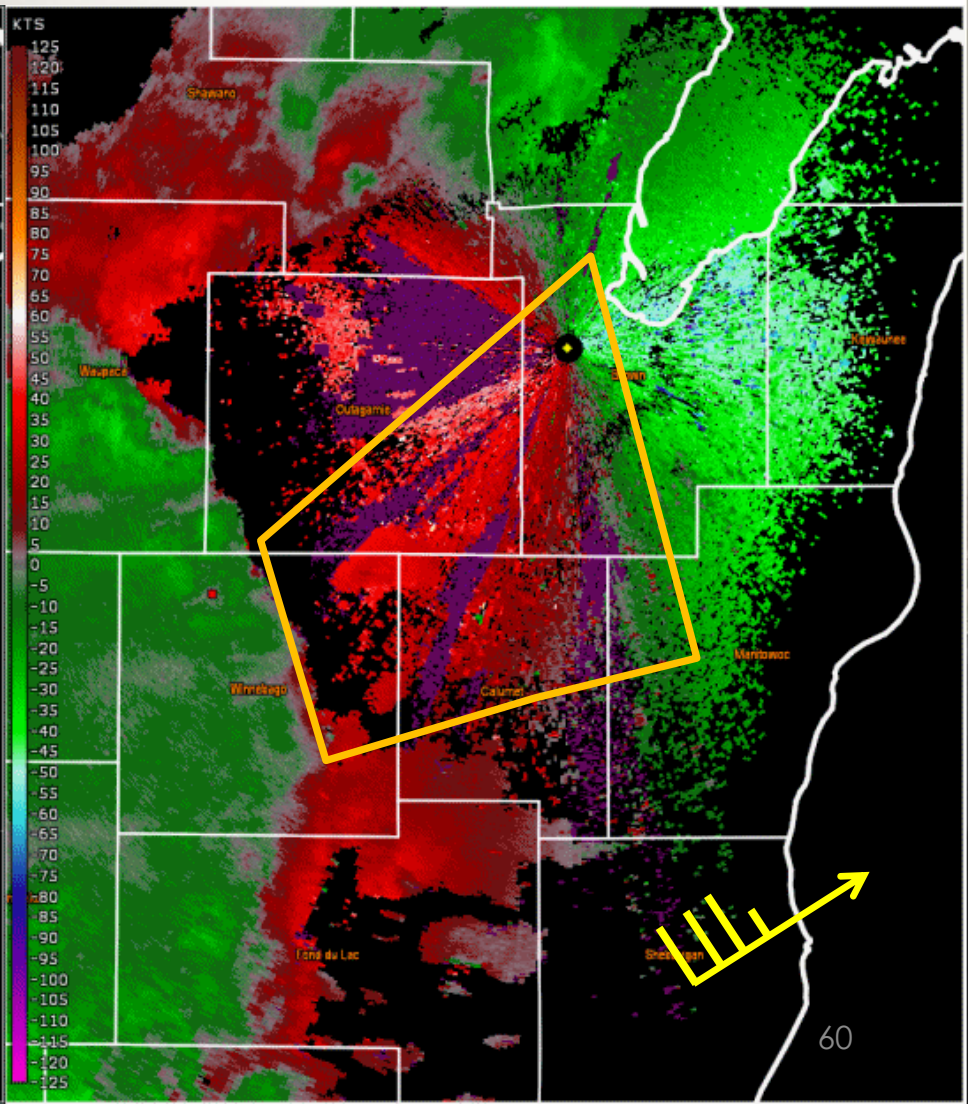
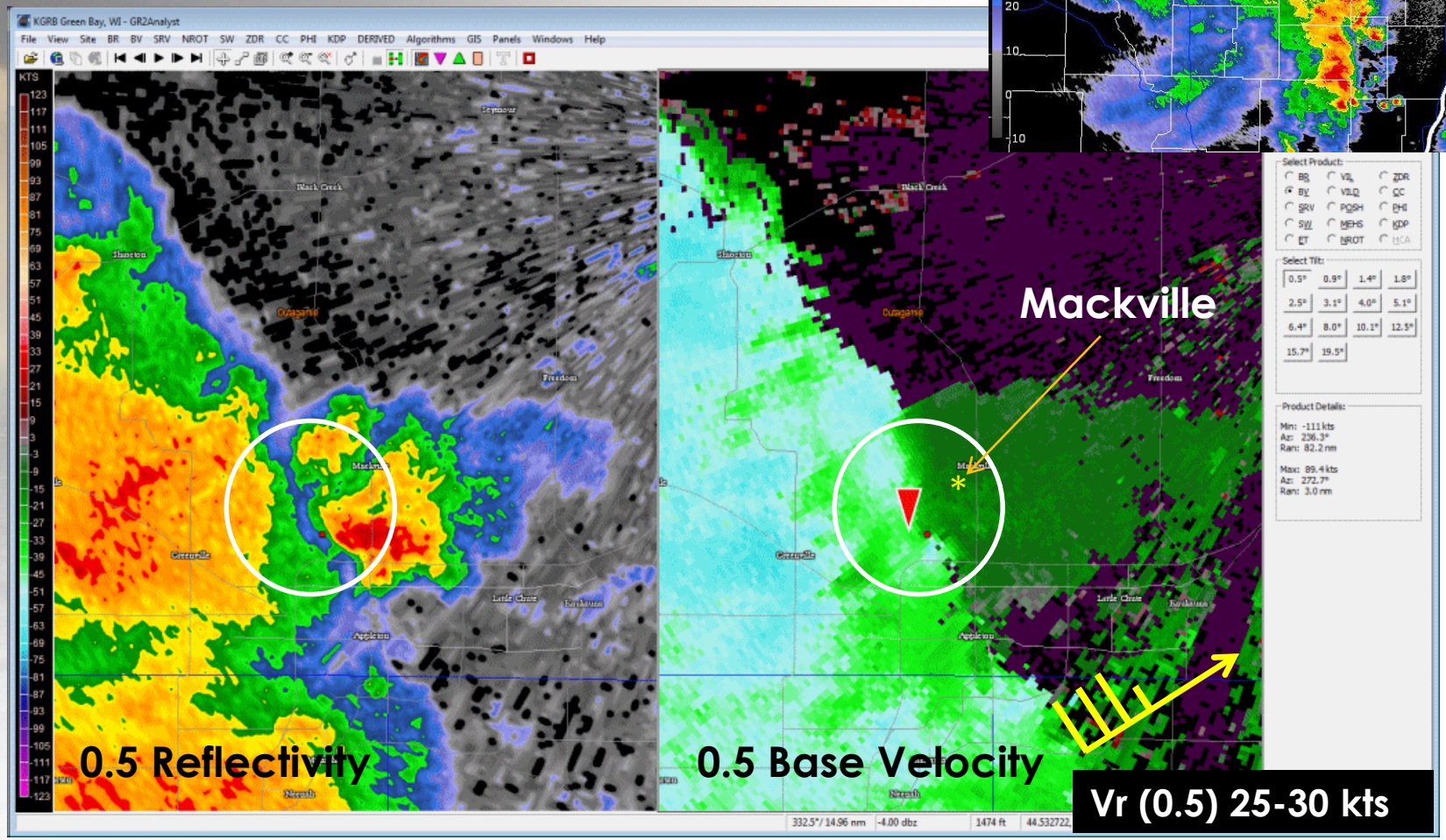
Step 4 – Smart Polygon



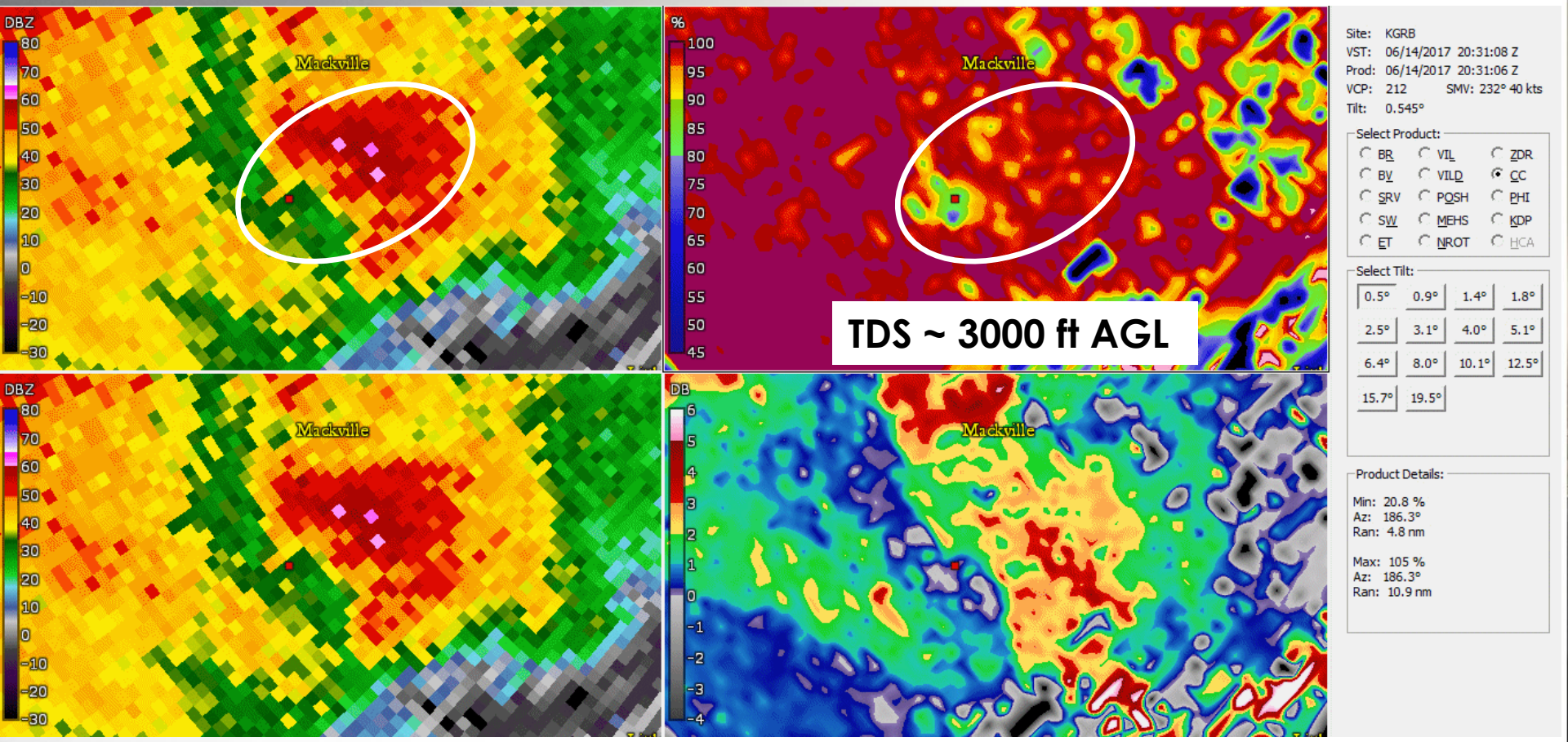


Example 2
Mackville (EF0)

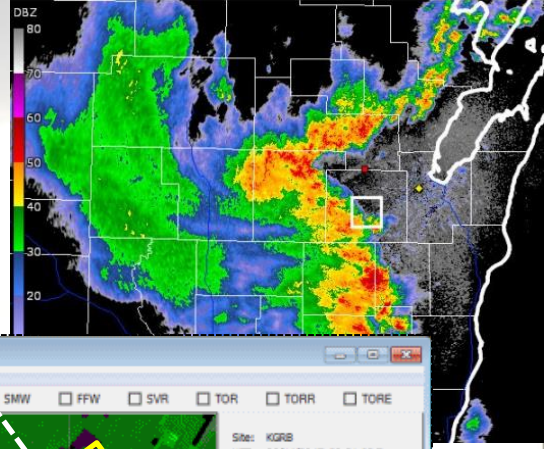


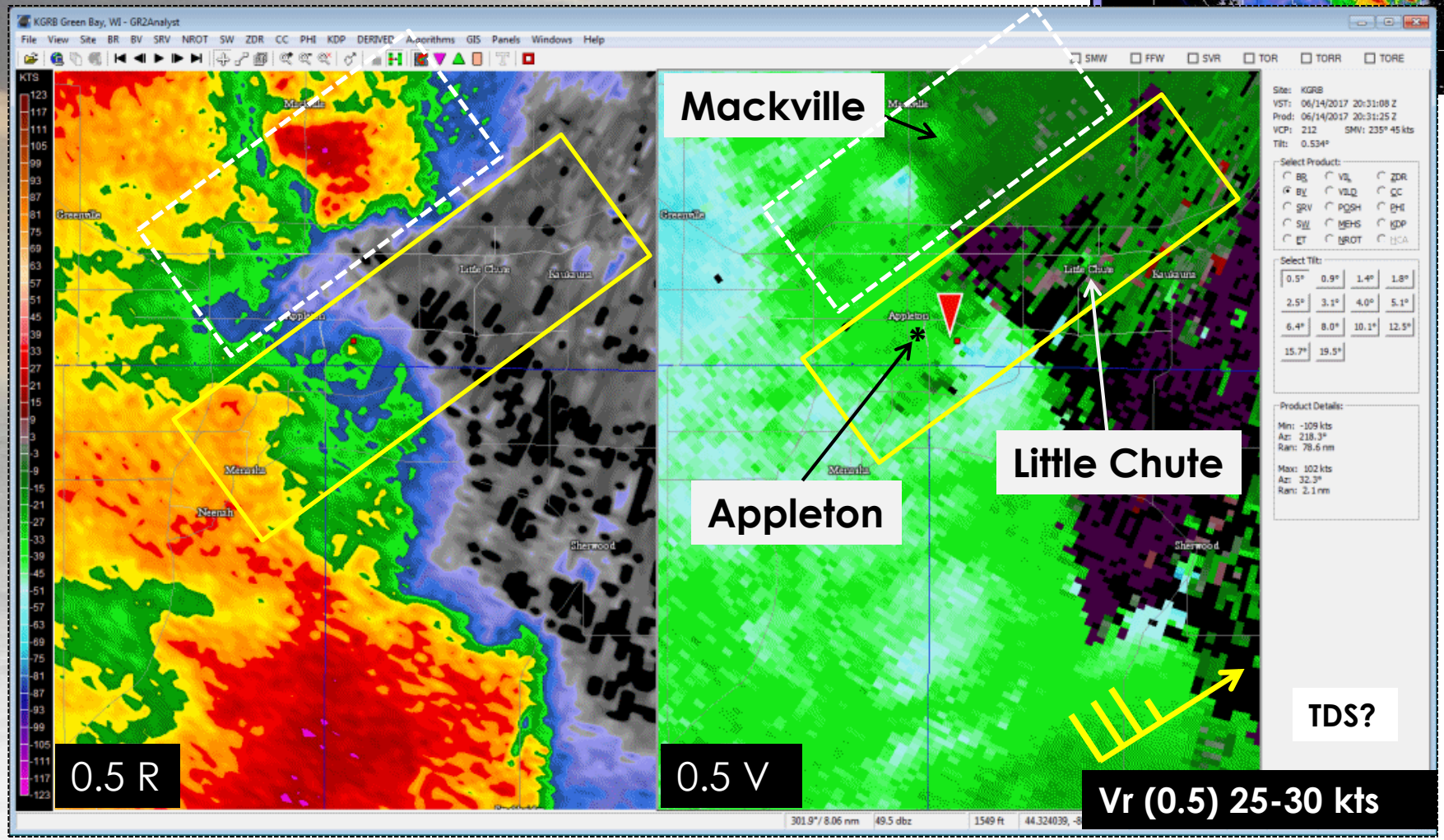
TDS Signature - Mackville

0.5, 0.9,1.4 (all-tilts)

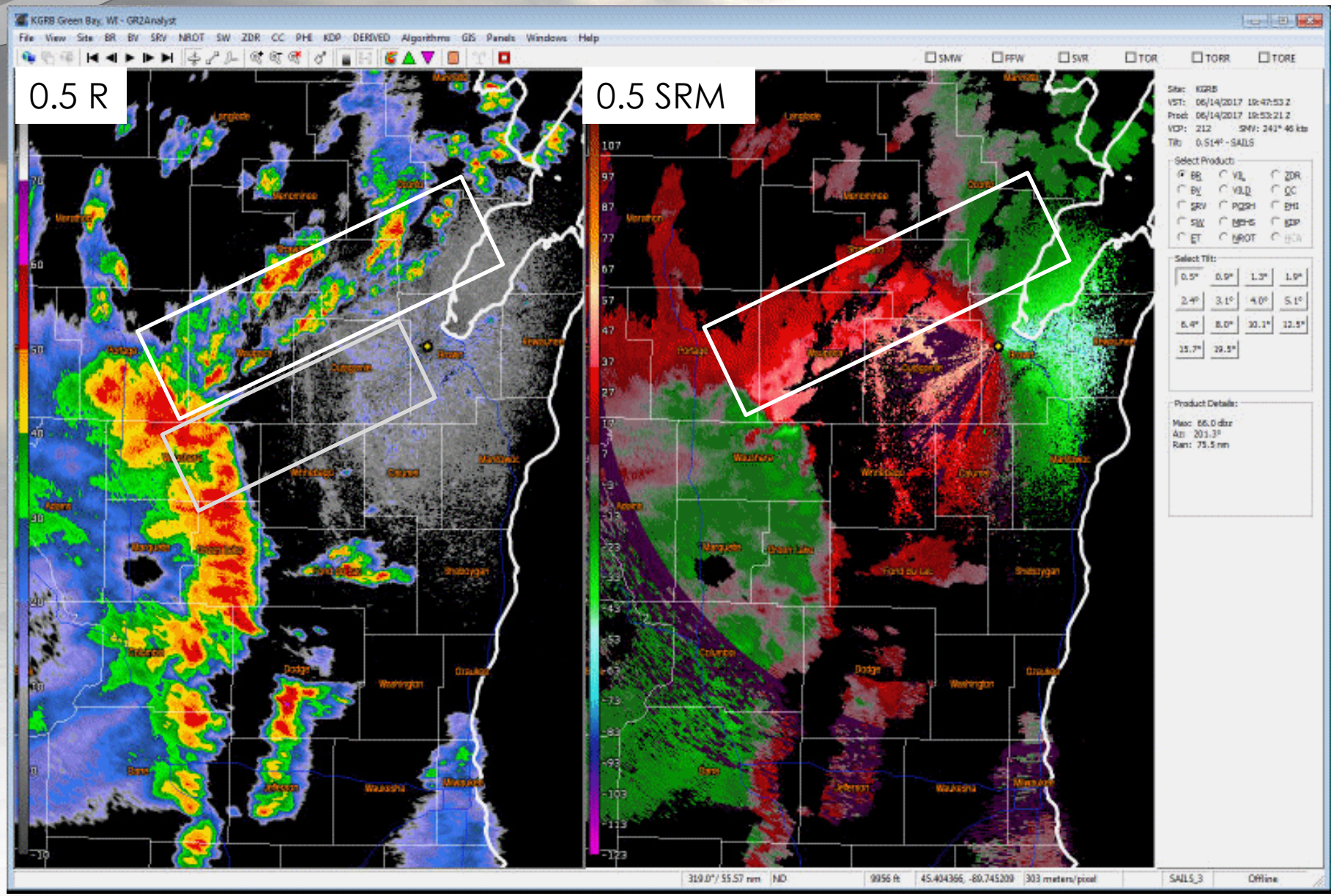


Example 2B
Appleton/Little Chute

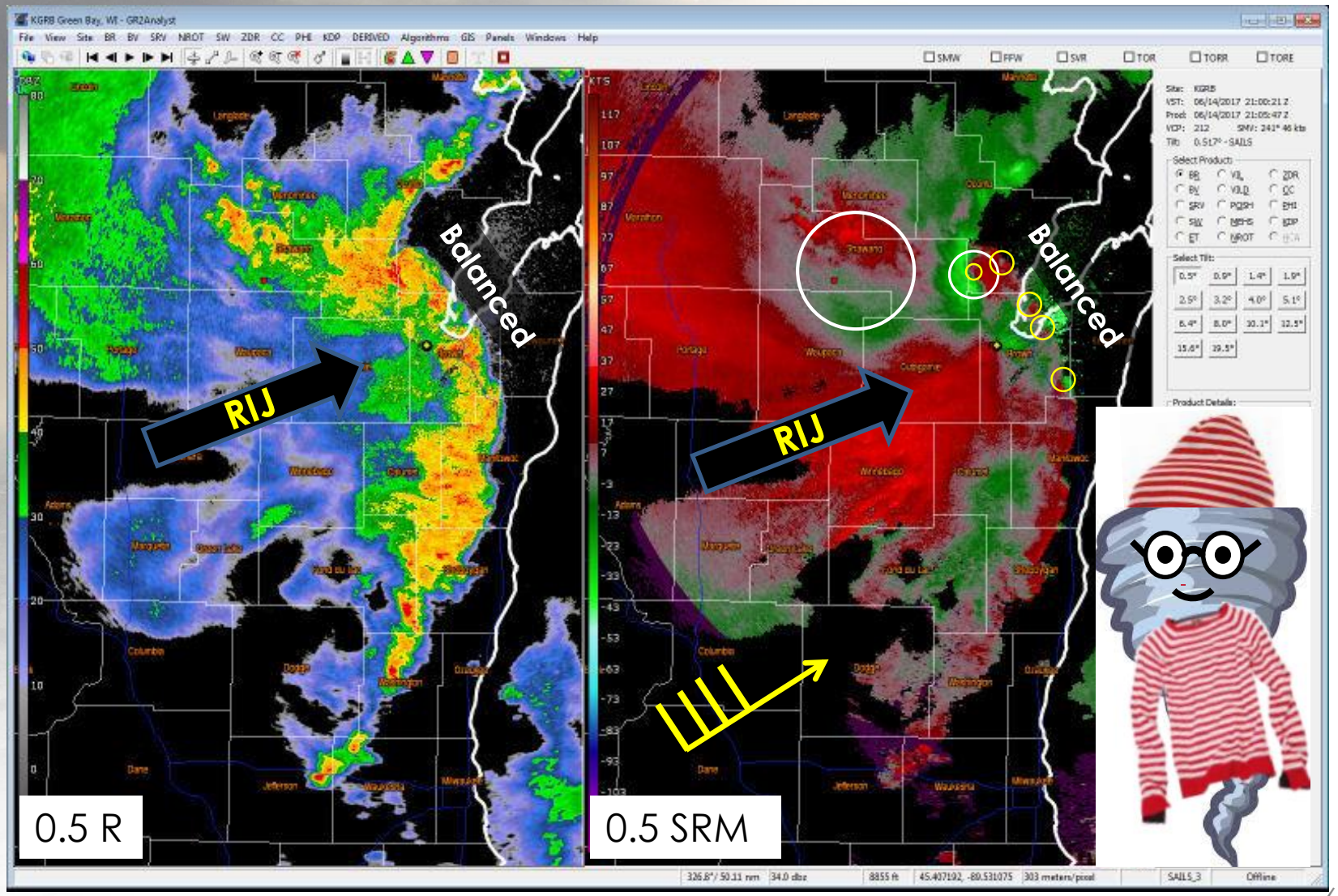




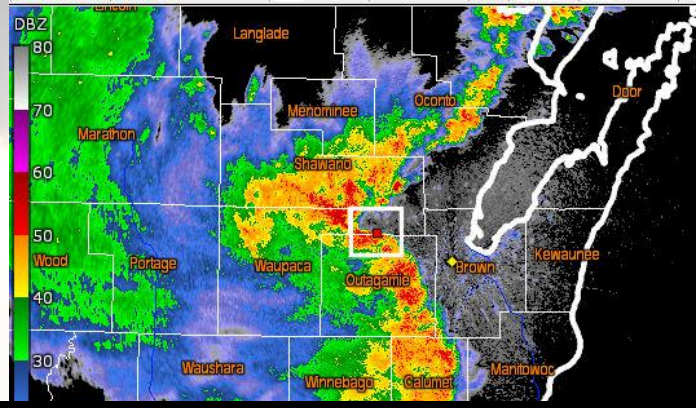
Northern Portion of the QLCS

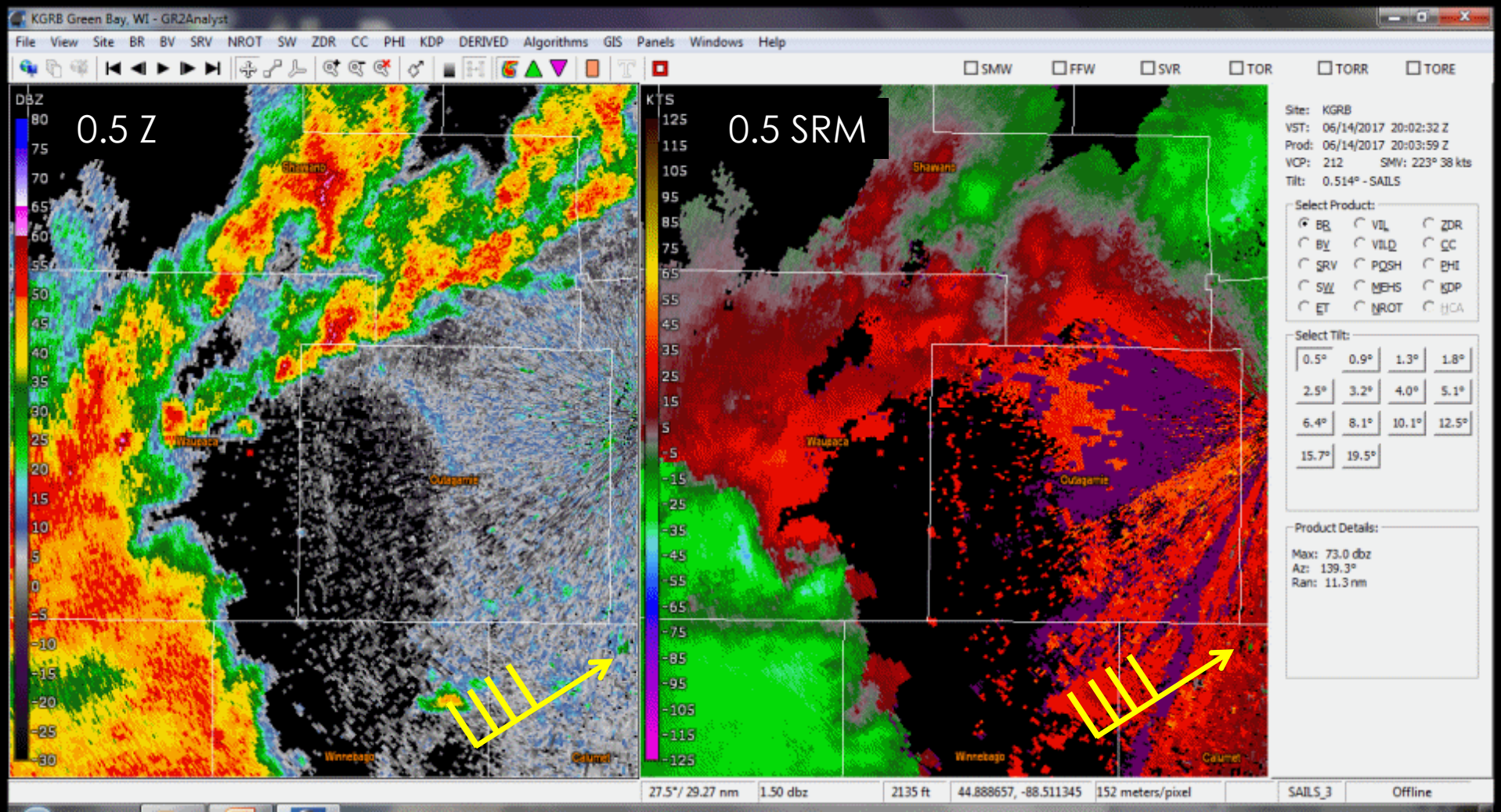


Where's Waldo?



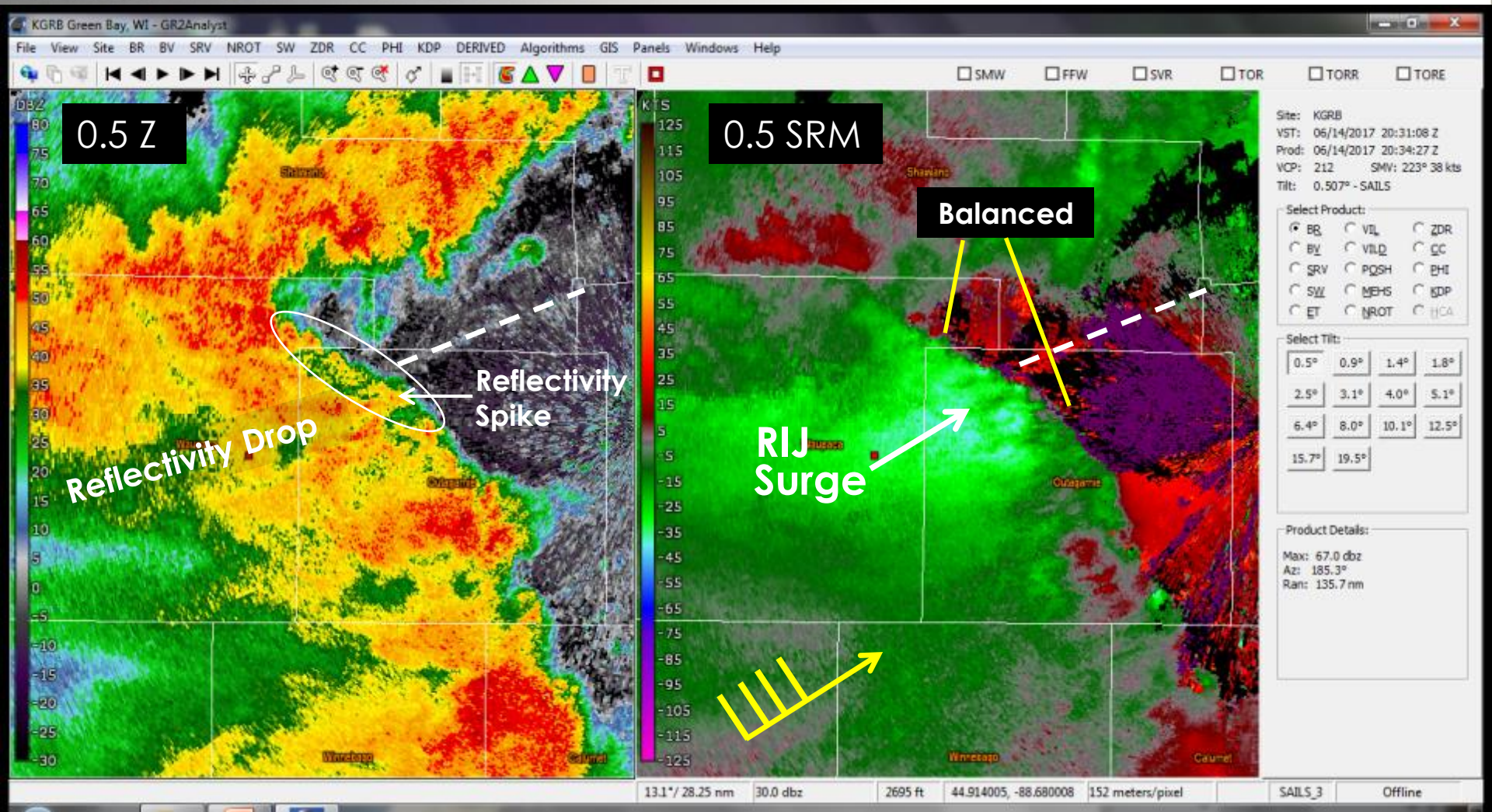
Example 3
Bear Creek / Nichols





Example 3
Bear Creek /Nichols

- RIJ/Surge
- Reflectivity Drop
- Surge along Boundary
- Spike In Reflectivity



QLCS Mesovortex Warning System

Step 3: Determine number & quality of confidence builders & nudgers

3 Ingredients Met in Most Situations
✓ Descending RIJ/Reflectivity Drop
✓ Enhanced Surge
Line Break
UDCZ entry/inflection point
Paired front/rear inflow notch
✓ Boundary ingestion
Front reflectivity nub
Contracting bookend vortex with $V_r \geq 25$ kt *
? Tight/strong mesovortex with $V_r \geq 25$ kt
Confirmed tornado/Tornadic debris signature (TDS)

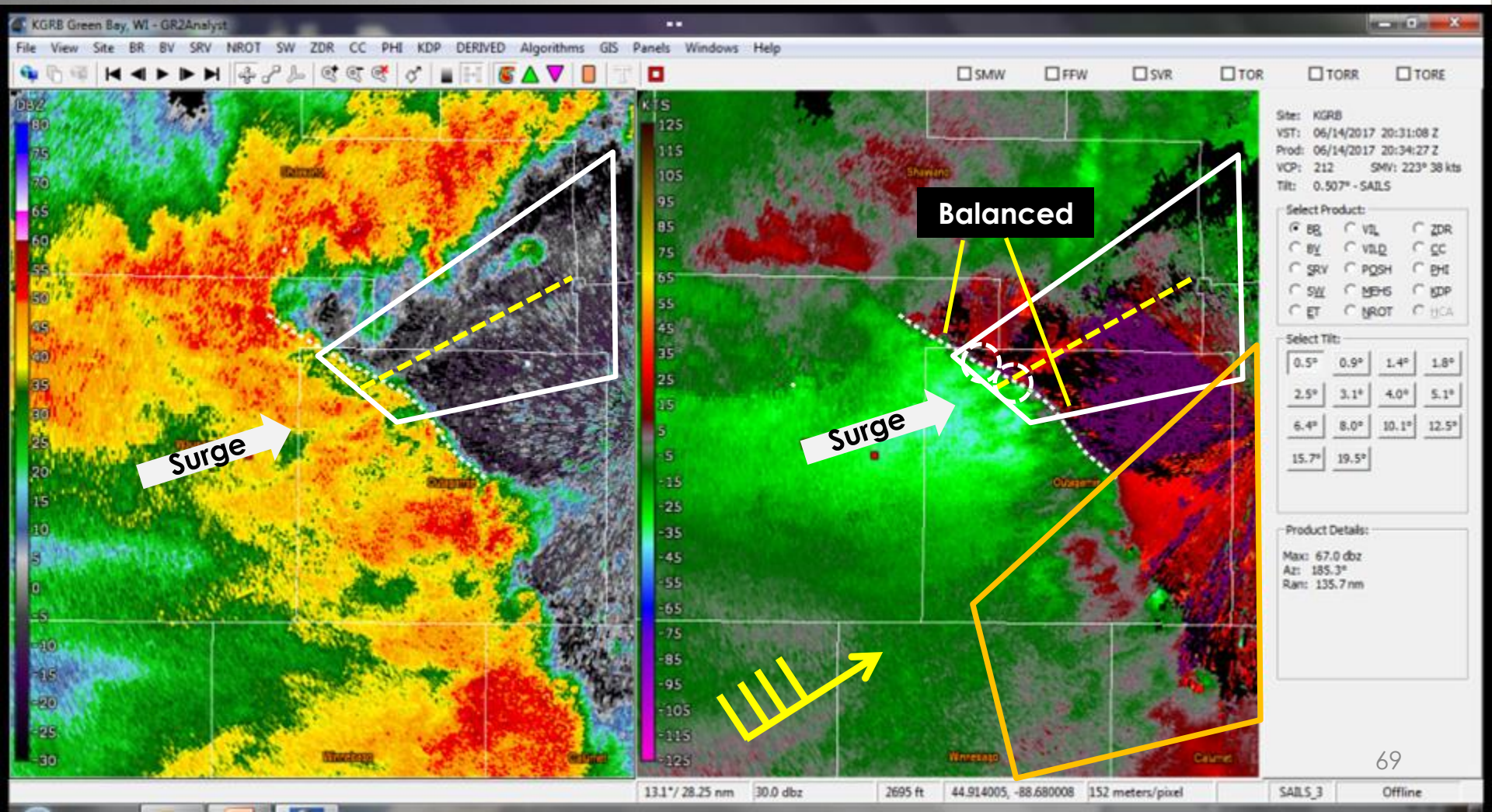
3 Ingredients Met in Most Situations
✓ Reflectivity tag intersecting a surge
✓ 0 to 3 km MLCAPE $\geq$ 40 J/kg
✓ Cell merger / Reflectivity spike near surge

1-3: Severe with tornado possible tag
4 or more: **Tornado Warning?**

Assess quality/persistence

No magic numbers or magic combinations!

Step 4 – Smart Polygon

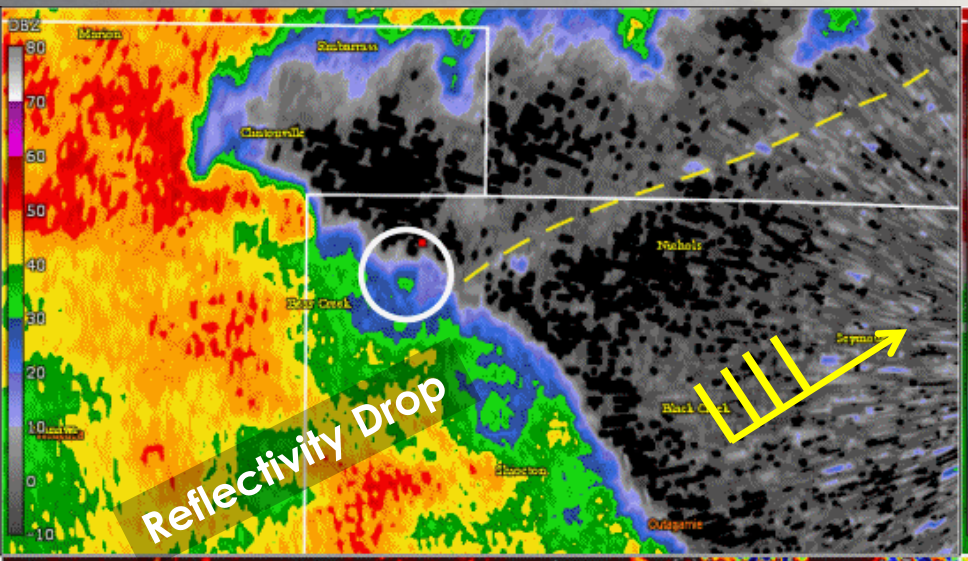


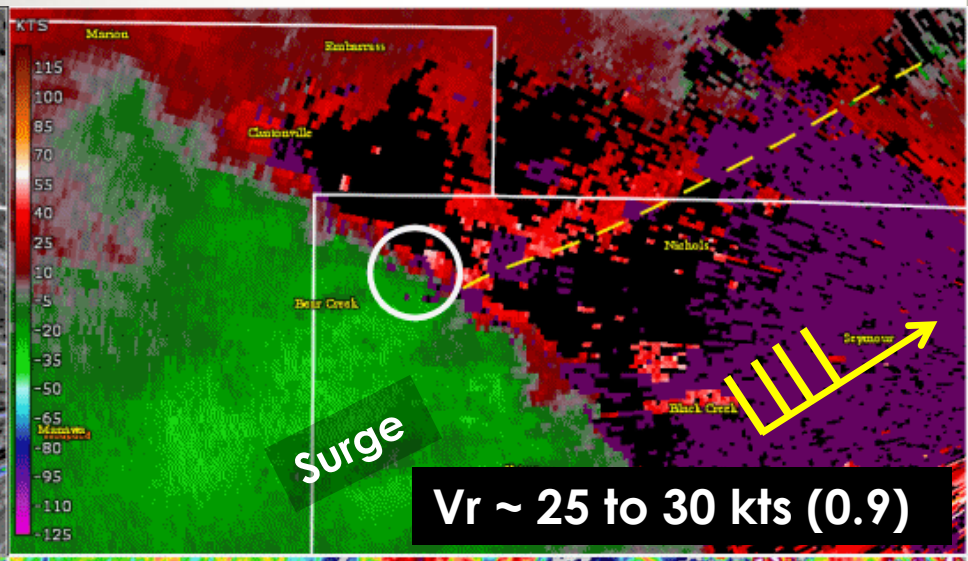
Example 3
Bear Creek /Nichols

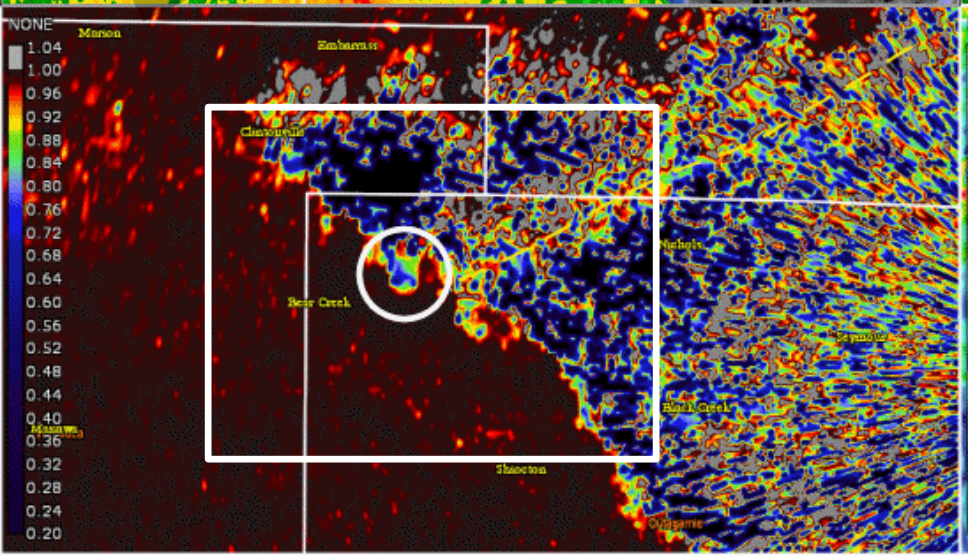
TDS ???

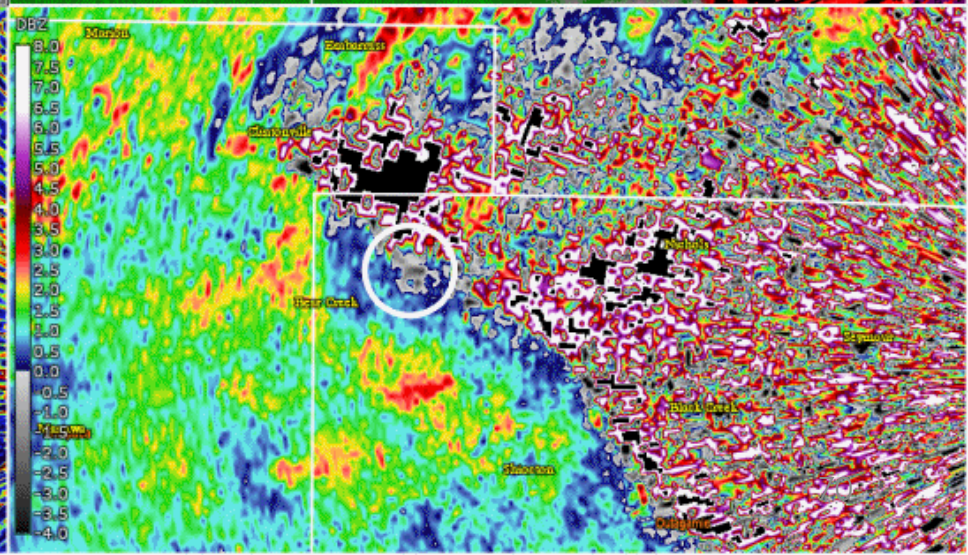
All-tilts Animation

0.5, 0.9, 1.3, 1.8



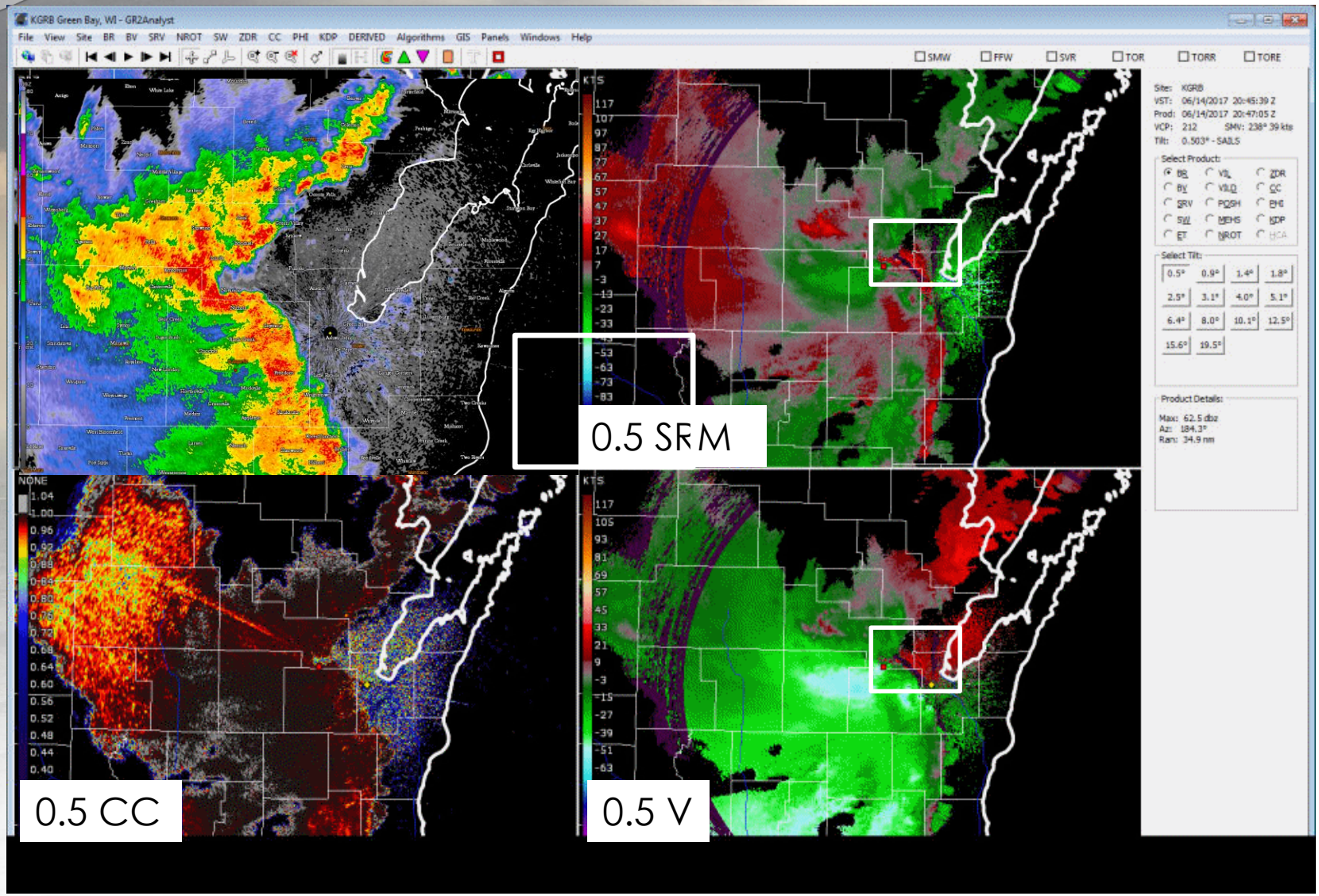






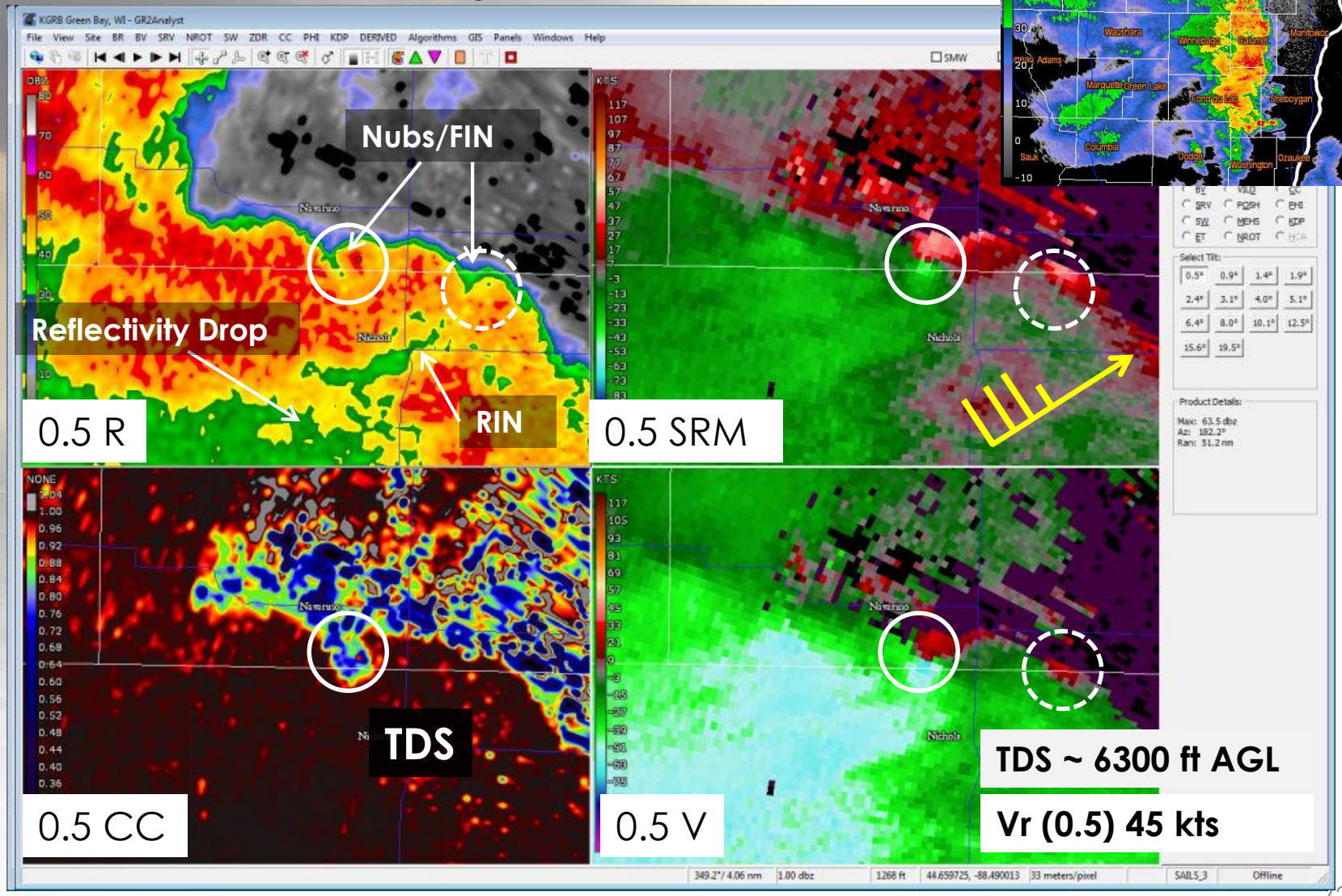
Example 4 - Contracting Bookend Vortex

Nichols, Navarino, Angelica, Pulaski



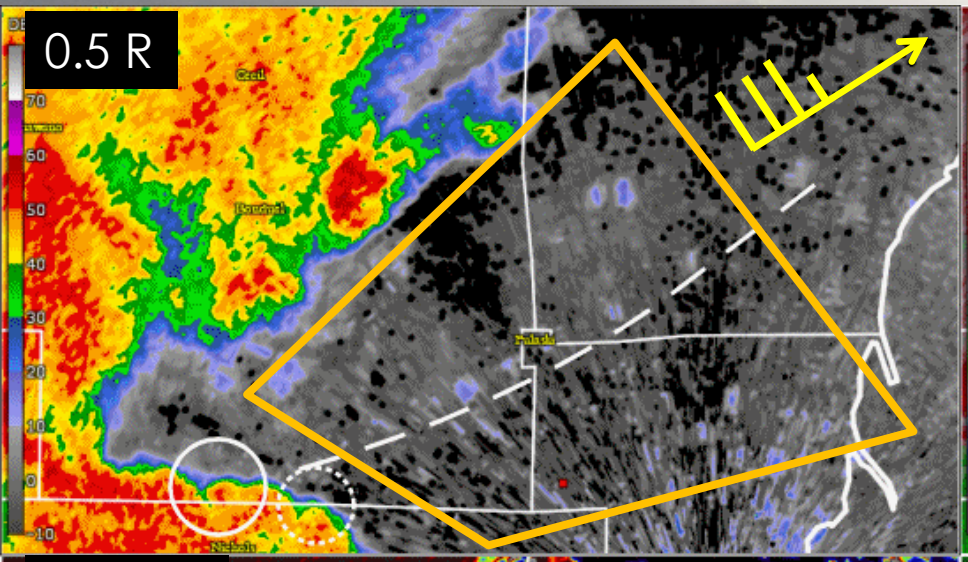
Example 4
Contracting Bookend Vortex

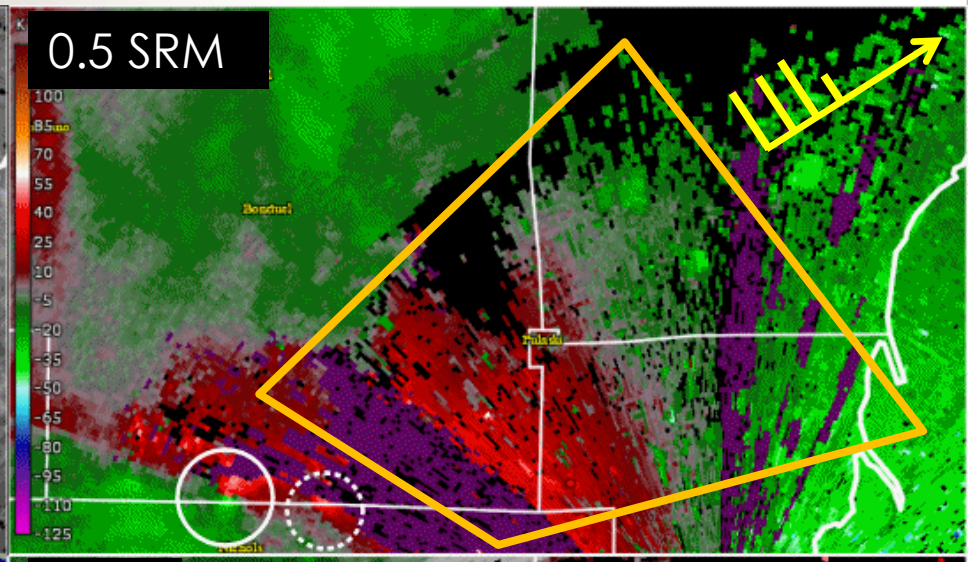
Nichols, Navarino, Angelica, Pulaski

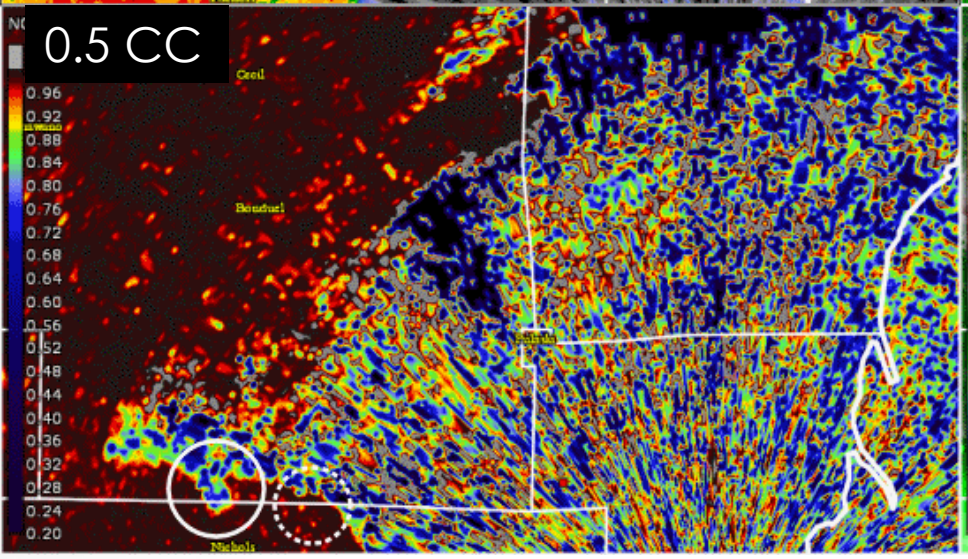


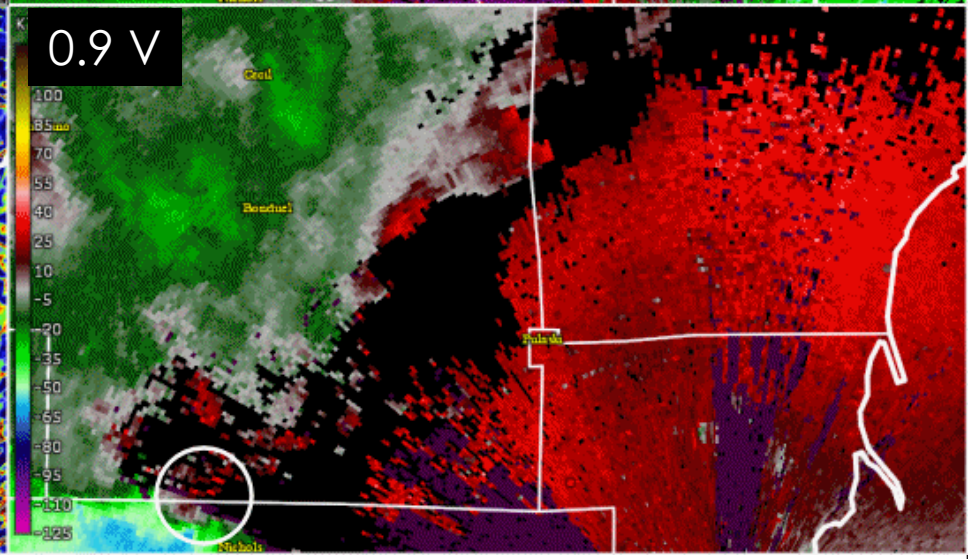
- Contracting Vortex
- Boundary?
- Surge
- Reflectivity Nubs
- Paired RIN/FIN
- TDS

Smart Polygon





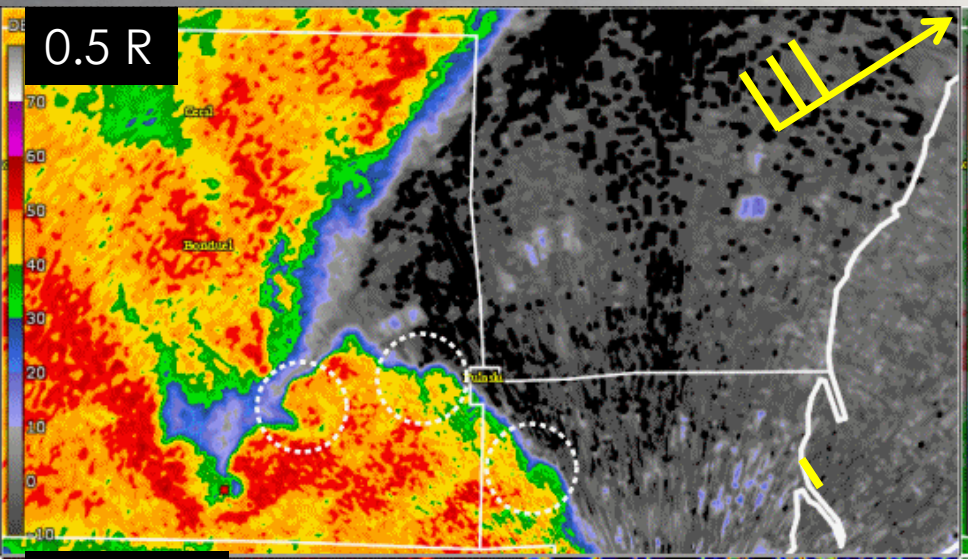


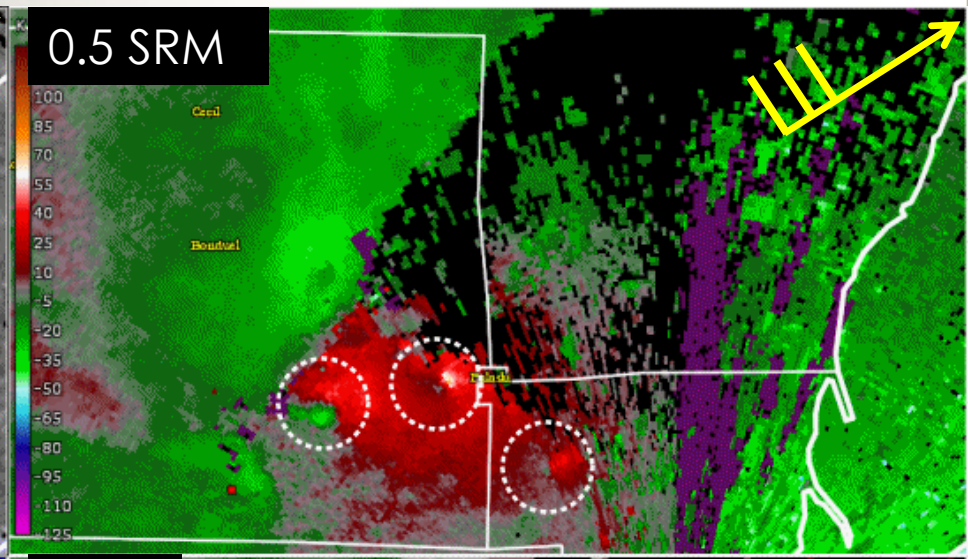


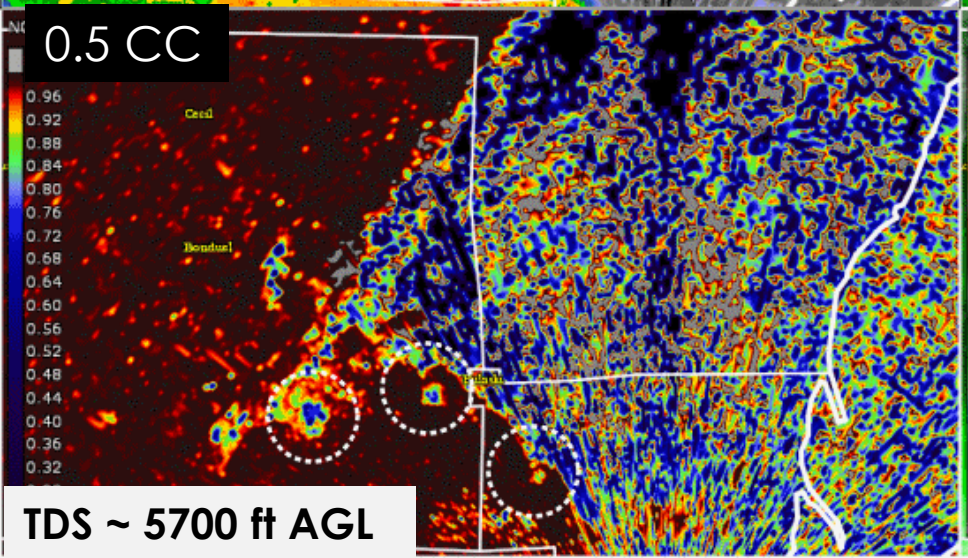
- Surge
- Reflectivity drop
- Reflectivity Nubs
- TDS
- 0-3km CAPE ~ 40 J/Kg

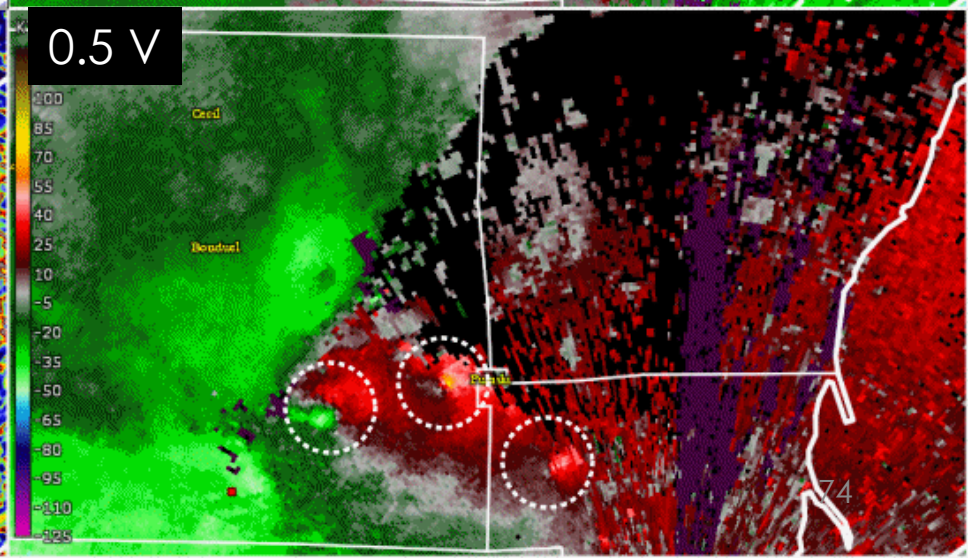
Contracting Bookend Vortex

Don't Give Up On It Too Soon!



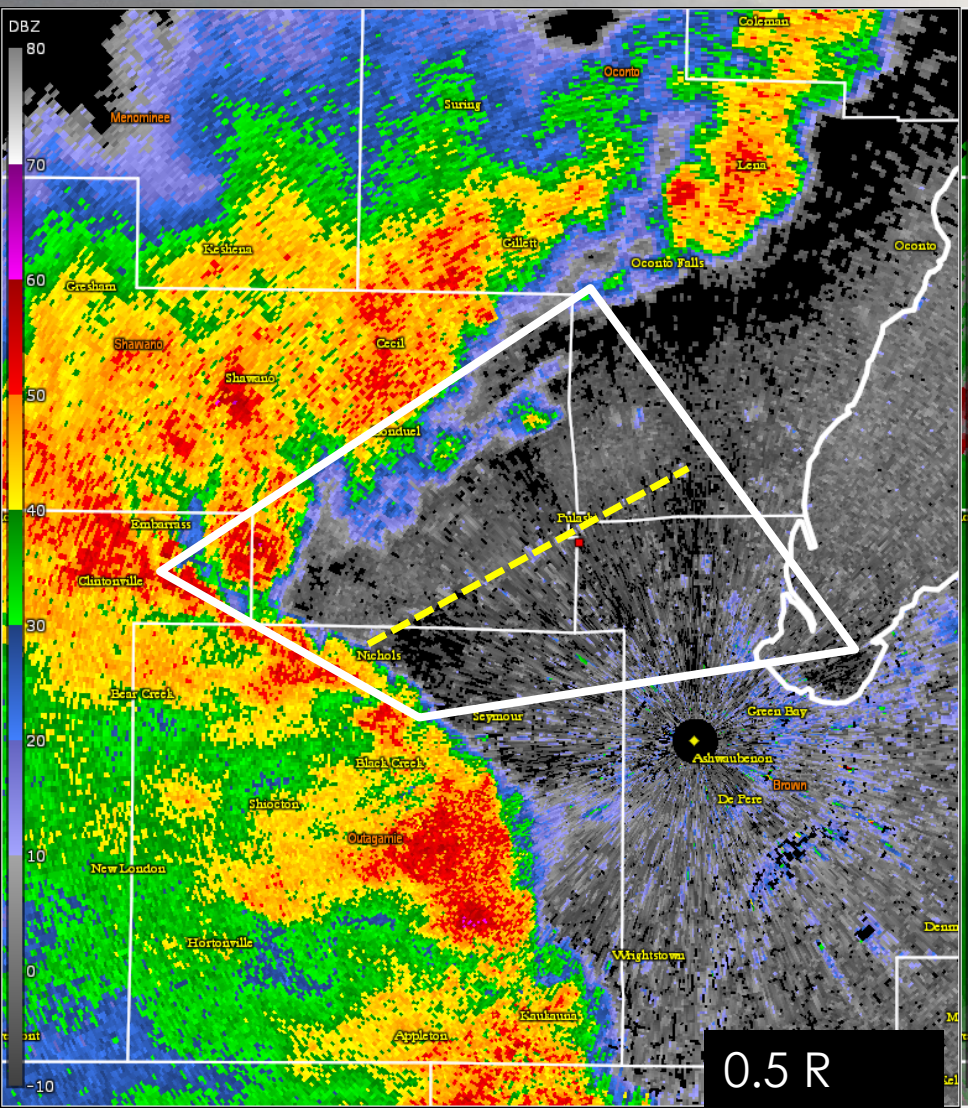


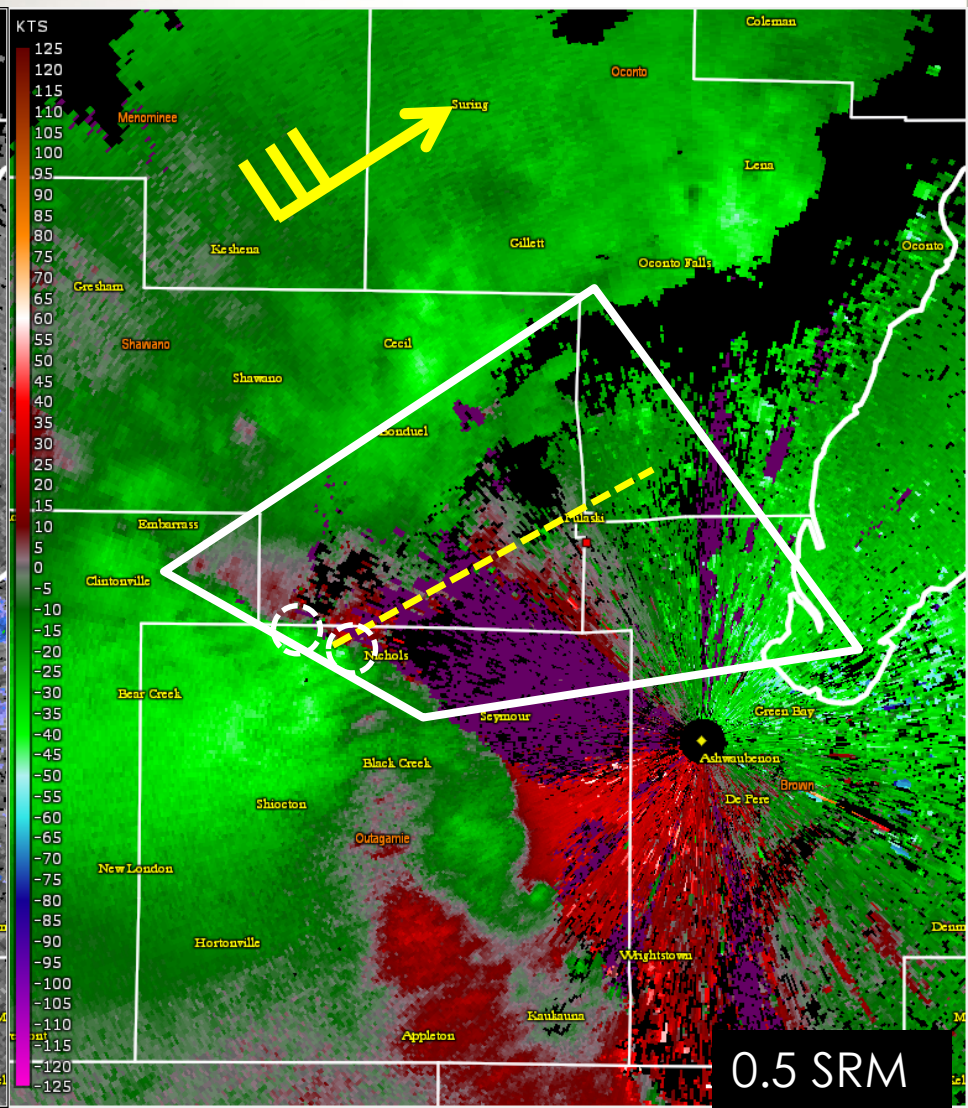




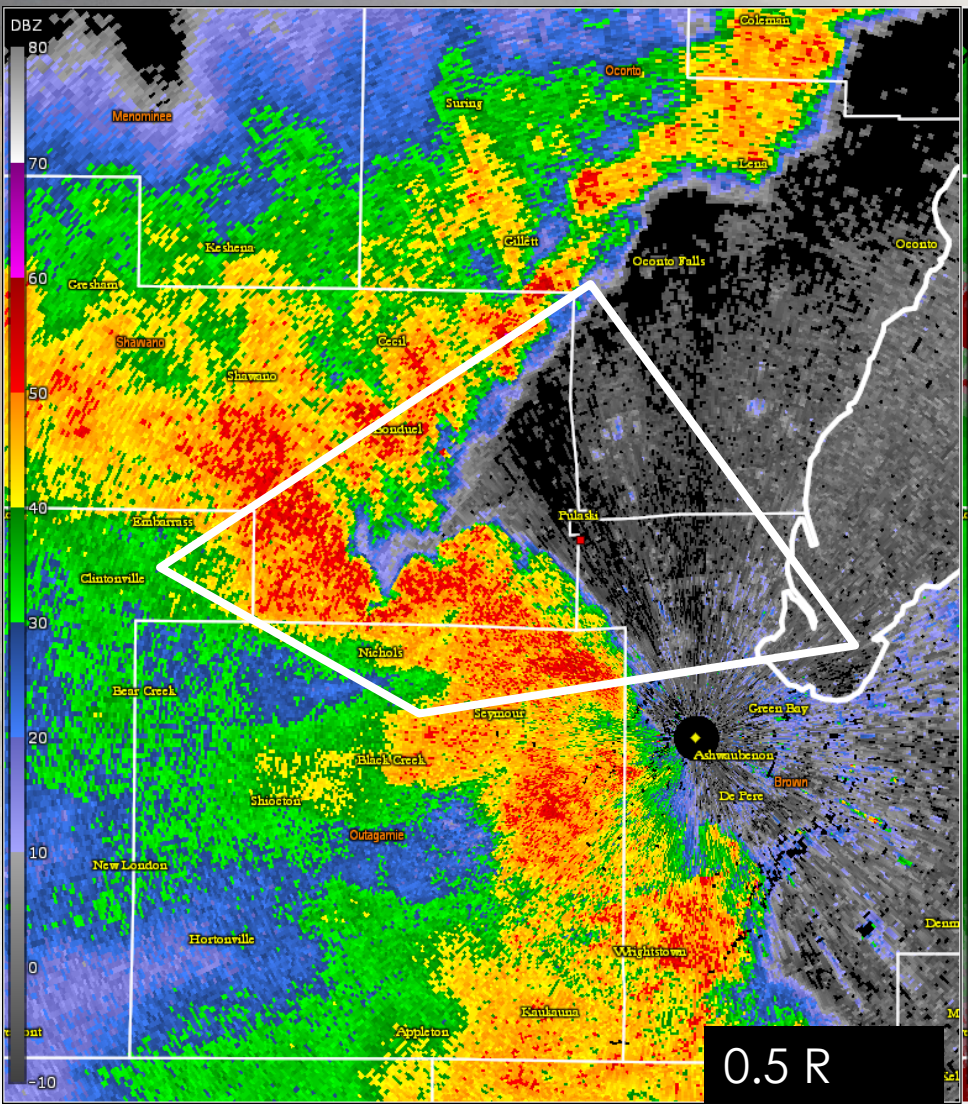
TDS ~ 5700 ft AGL

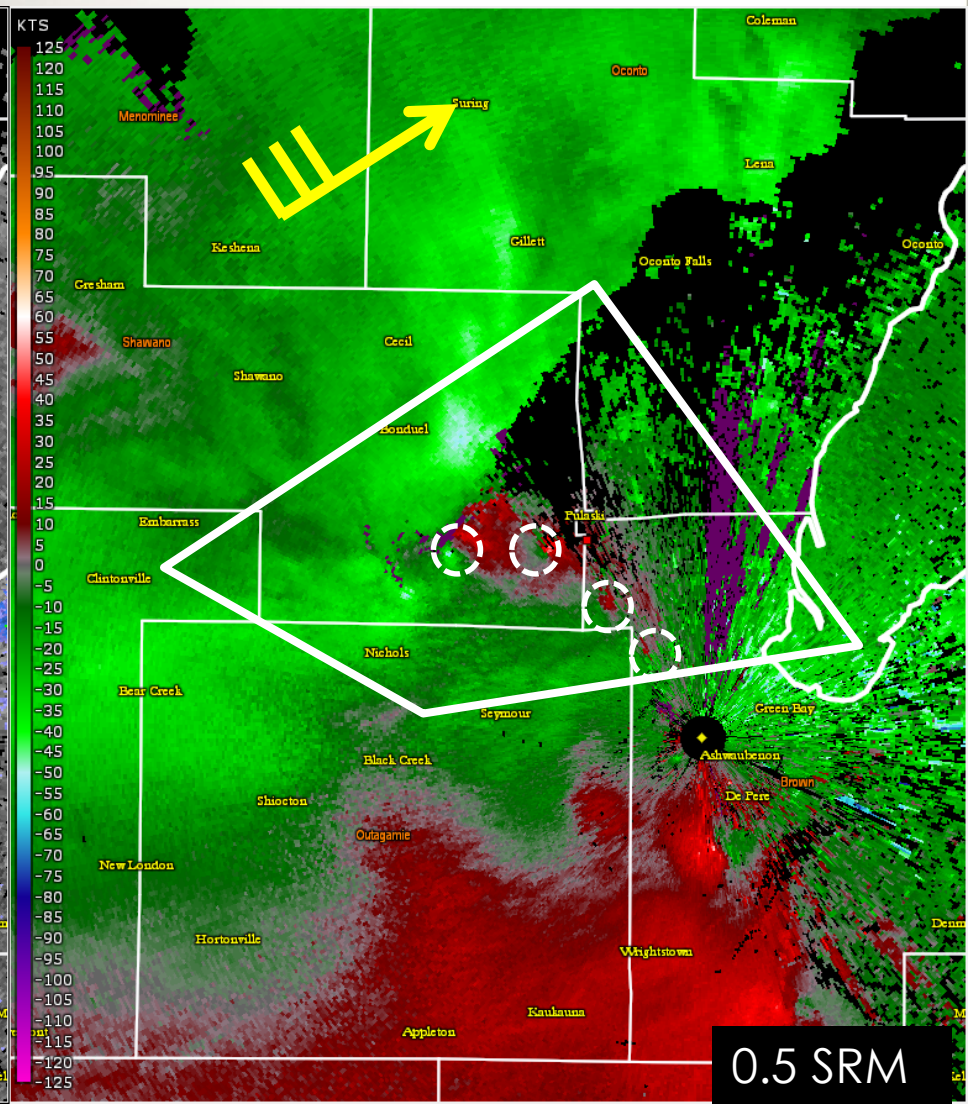
Bookend Vortex
Smart Polygons



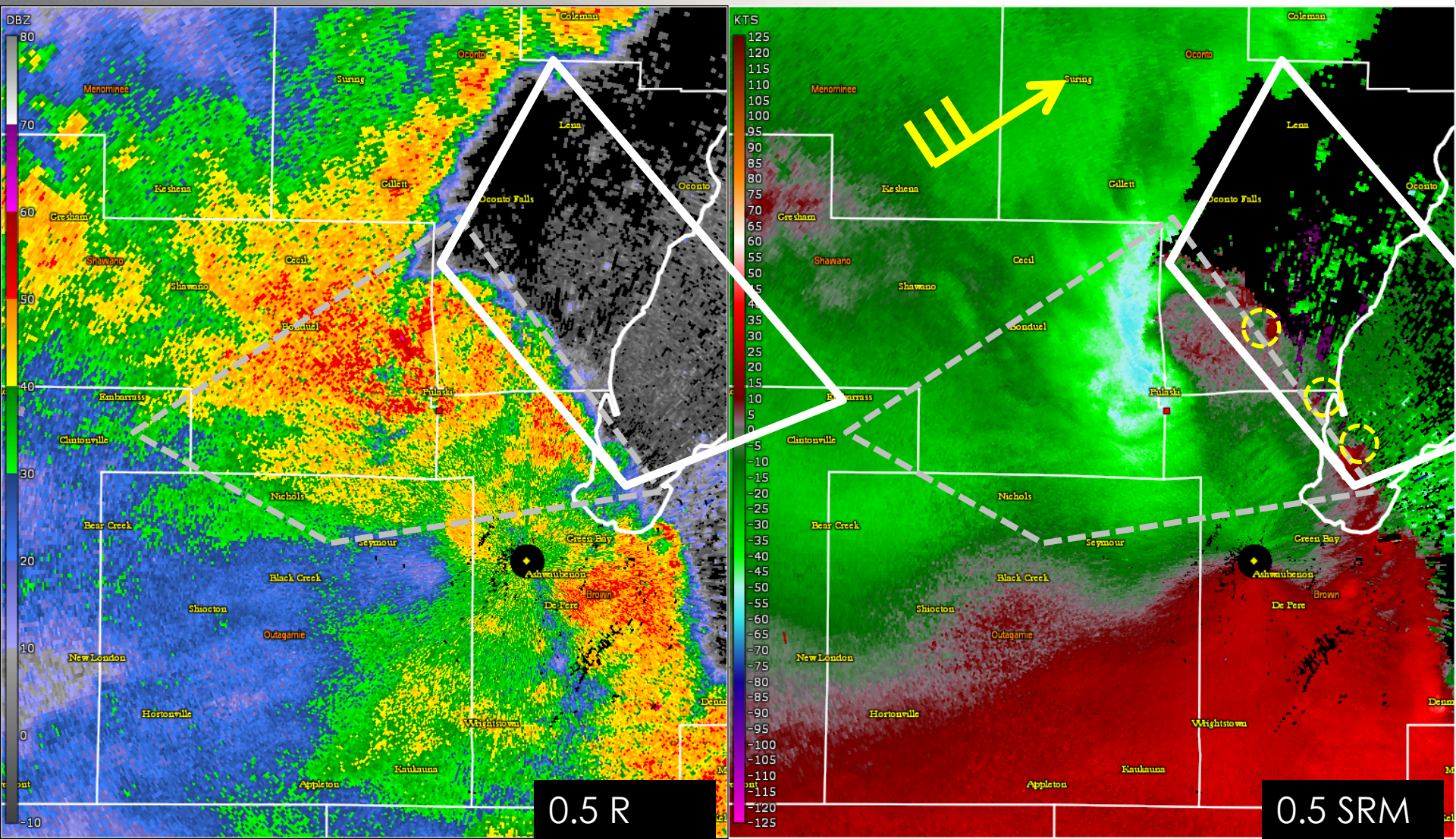


Bookend Vortex
Smart Polygons





Bookend Vortex
Smart Polygons



Takeaways

QLCS Mesovortex Warning System:

- ✓ Provides more objective and organized method for anticipating MV genesis using a 4-step process.
- ✓ Provides methodology for warning for QLCS MVs even before MVs develop.
- ✓ Confidence builders and nudgers can provide more confidence to warn for QLCS tornadoes
- ✓ Application of the QLCS mesovortex warning system in this case may have provided greater tornado warning lead time.

Takeaways

- Relatively high 0-3 km CAPE and low LCL heights favored stretching and tornadic mesovortex potential.
- **Cell mergers** contributed to tornadic MV genesis in this event likely as a result of weak convective inhibition and environment favorable for stretching.
- **Thunderstorm outflow** played significant role in tornadic MV genesis and may have played a role in development of contracting bookend vortex.
- Strongest tornadic MV of the event appeared to have occurred as surge interacted with thunderstorm outflow.
- Several tornadic MVs were observed along surging (balanced?) portion of contracting bookend vortex.

Acknowledgments

- Jason Schaumann (SOO SGF)
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  - Fred Glass (Lead Forecaster LSX)
  - Aaron Johnson (SOO DDC)
  - Jason Schaumann (Lead Forecaster SGF)
  - John Stoppkotte (SOO LBF)

Application of the QLCS Mesovortex Warning System The 14 June 2017 Tornadic QLCS over Northeast Wisconsin

Kira Benz, Timm Uhlmann and Gene Brusky
National Weather Service Green Bay

26th Great Lakes Operational Meteorology Workshop
May 1-3, 2018
Cleveland, Ohio

Thank You!

Photo by: Phil Kurimski