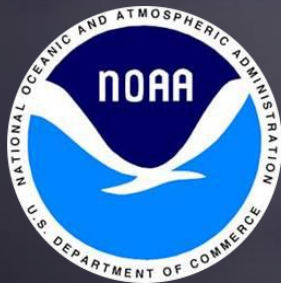


Assessing the utility of normalized rotation in detecting tornado development in the Allegheny Front

*Northeast Regional Operational Workshop XVII
3 November 2016*

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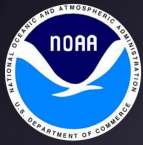


Outline



- Motivation/methodology
- Definition
- Individual cases
 - Discrete supercell
 - QLCS
 - Single cell
- Overall results
- Conclusions
- Final thoughts

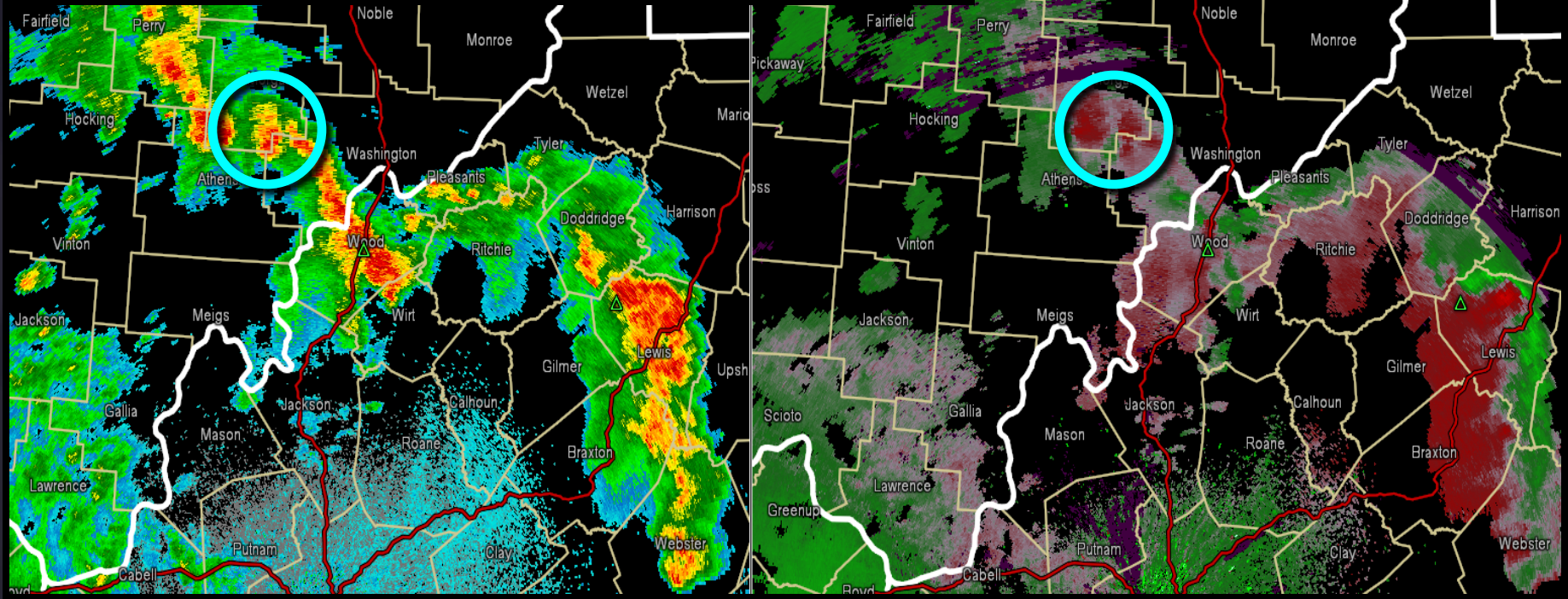
Two tornadoes near Dodge City, KS – 25 May 2016



Motivation



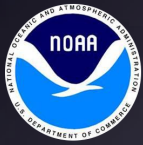
Washington County, OH tornadic storm – 20 June 2015



Problem: numerous operational challenges

- Many non-supercell and supercell variant modes
- Atypical Z/V radar patterns
- Complex terrain

Bottom line: **improve tornado detection by using NROT with radar & environmental analysis**



Methodology



Domain: JKL, RLX, PBZ CWAs/WSR-88Ds

- Used SPC's SVRGIS page for events
- Events occurring 2006-2015 within 80 nm of radar site

Sampling strategy:

- Five consecutive volume scans [t-4 to t=0 (closest to t-genesis)]
- Three lowest slices per scan
- 0.5° SAILS scans not used

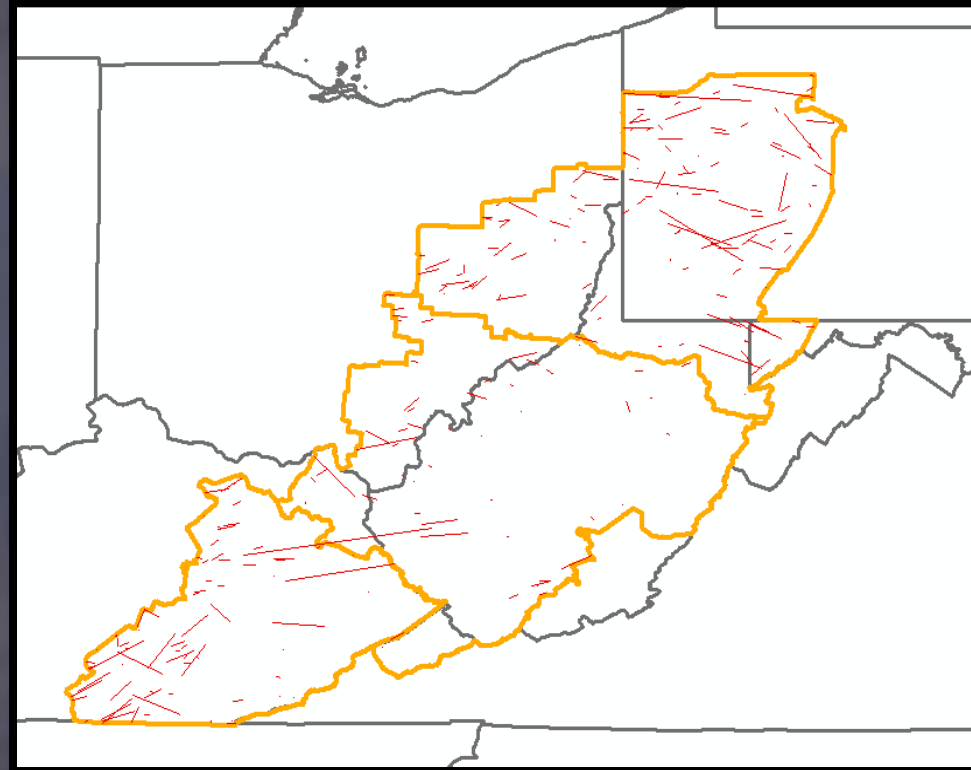
GR2Analyst:

- Calculated max NROT values per scan
- All radar data from NCEI (NCDC) archive

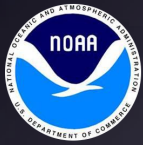
Data analysis:

- Stratified events by storm mode (loose, 3-tier classification scheme)
- Basic statistical analysis

Total cases used: 37



Domain with all historical tornado tracks. From SPC SVRGIS



Definition



NROT stands for Normalized ROTation. This is a fairly complex derived product that tries to find areas of rotation in dealiased BV (BVD). It does the following:

1) At each BVD bin, AE applies a 2d filter that simultaneously fits a second order surface to, and takes the azimuthal gradient of, the 5x5 surrounding bins. If not enough data is available, it tries with a 3x3 set of bins. This is very similar to the LLS algorithm in Smith/Elmore:

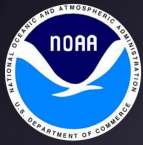
2) After step #1, AE has true ROT. Due to various physical factors (beam width vs fixed-size physical phenomena, etc), the significance of the value of true ROT varies with range. So, AE divides true ROT by the piecewise-linear curve given in the Algorithms->MDA Settings dialog box to remove this range-dependency.

The result is NROT, with a range of -5 to +5. Anything above 1.0 is significant and values above 2.5 are extreme.



**Very similar to NSSL
Rotation tracks in
AWIPSII**

Sources: GR2AE NROT product description,
Mike Ekster (WFO GYX)

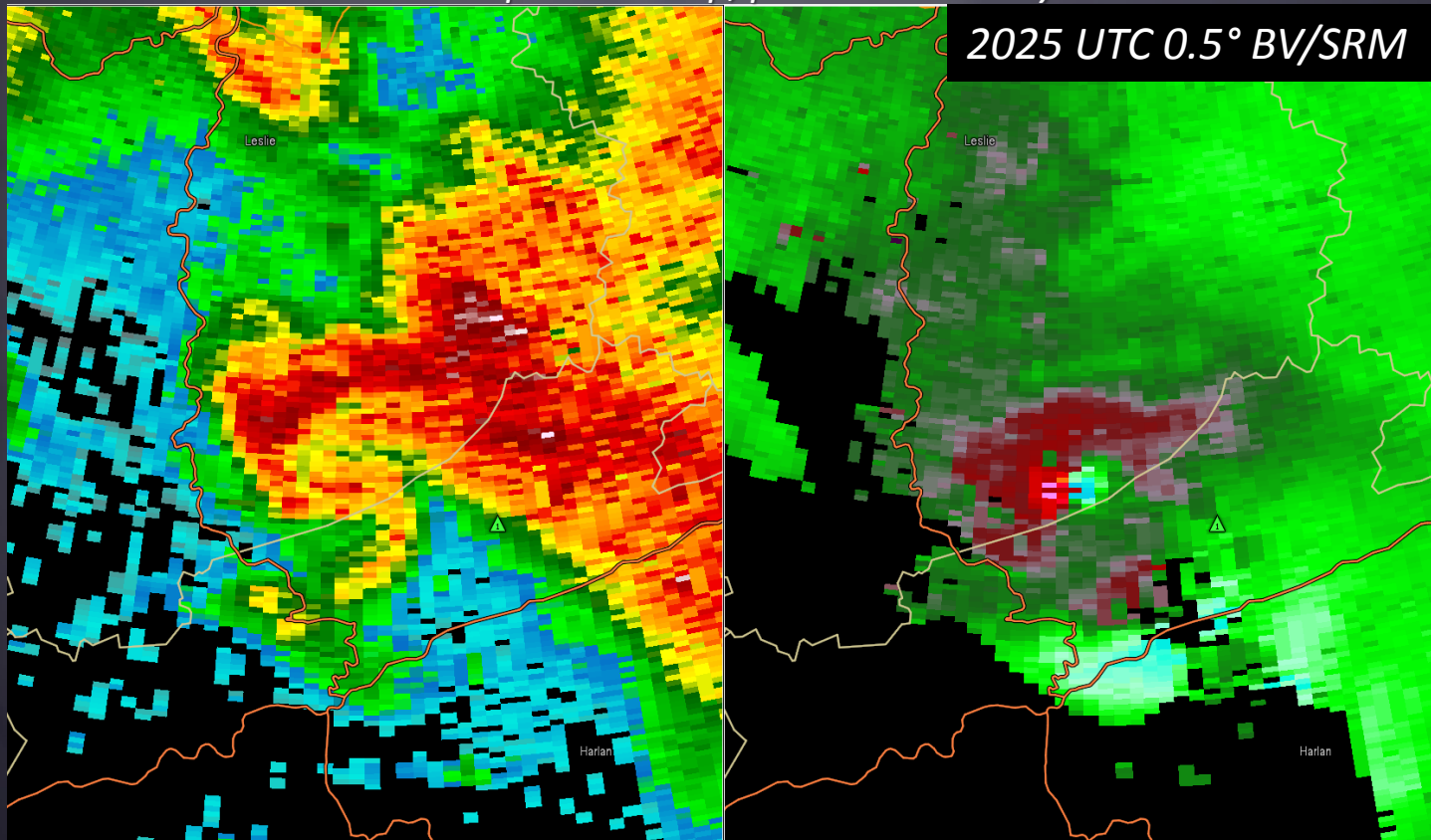


Case 1: Supercell



- 27 July 2015 - Leslie Co., KY
- 36.6 nm from KJKL (touchdown)
- Motion: 315° 30 kts
- Magnitude: EF-1
- Length: 2 miles
- Width: 900 yards

Storm must possess deep, persistent mesocyclone

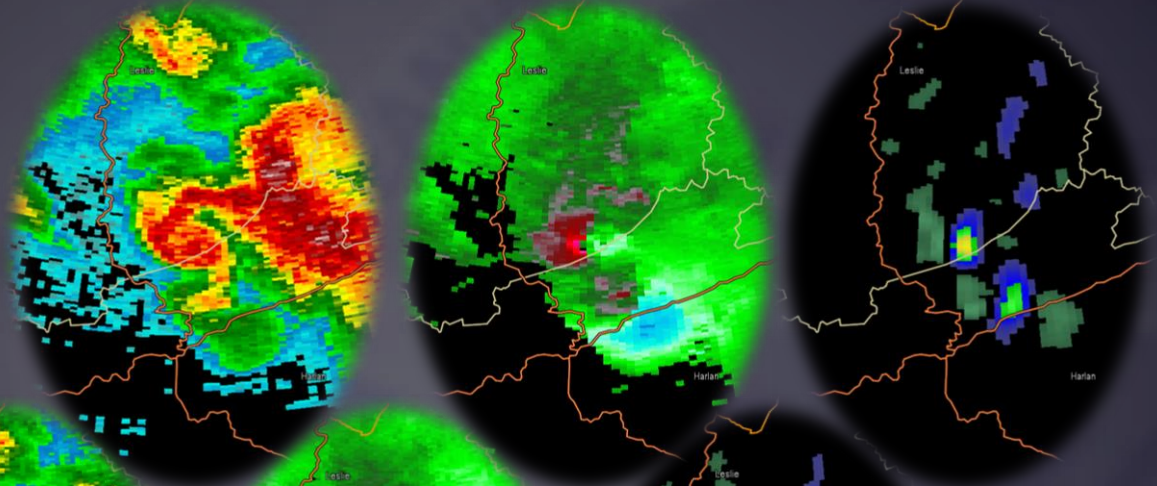




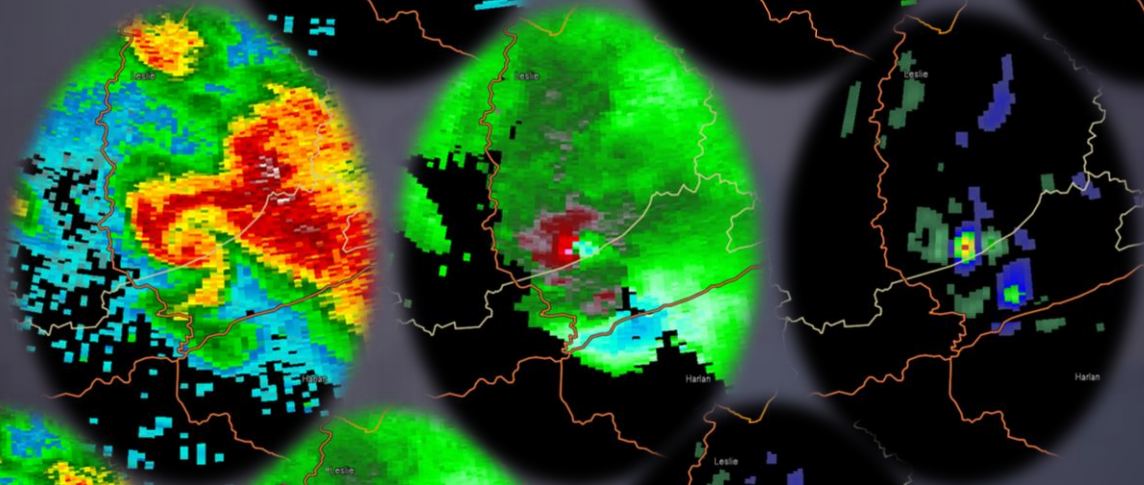
Case 1: Supercell



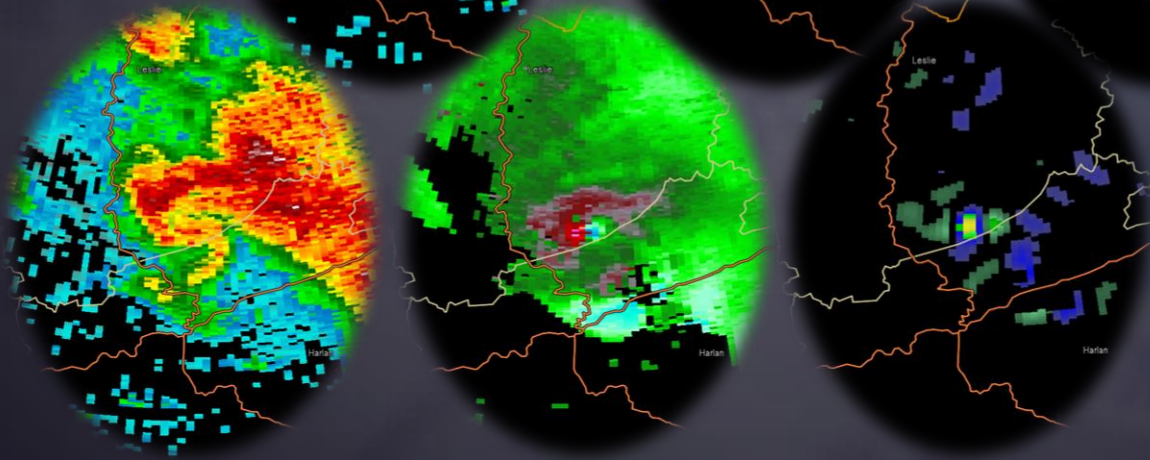
**t=0
(2025 UTC)**



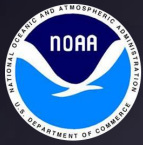
1.4°



0.9°



0.5°



Case 1: Supercell



Max NROT value noted in parentheses

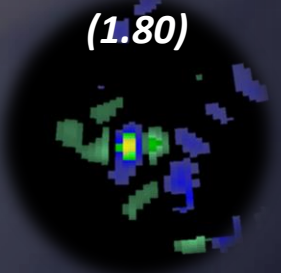
1.4°



0.9°



0.5°



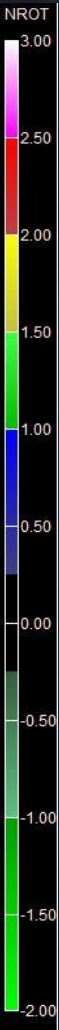
t-4

t-3

t-2

t-1

t=0



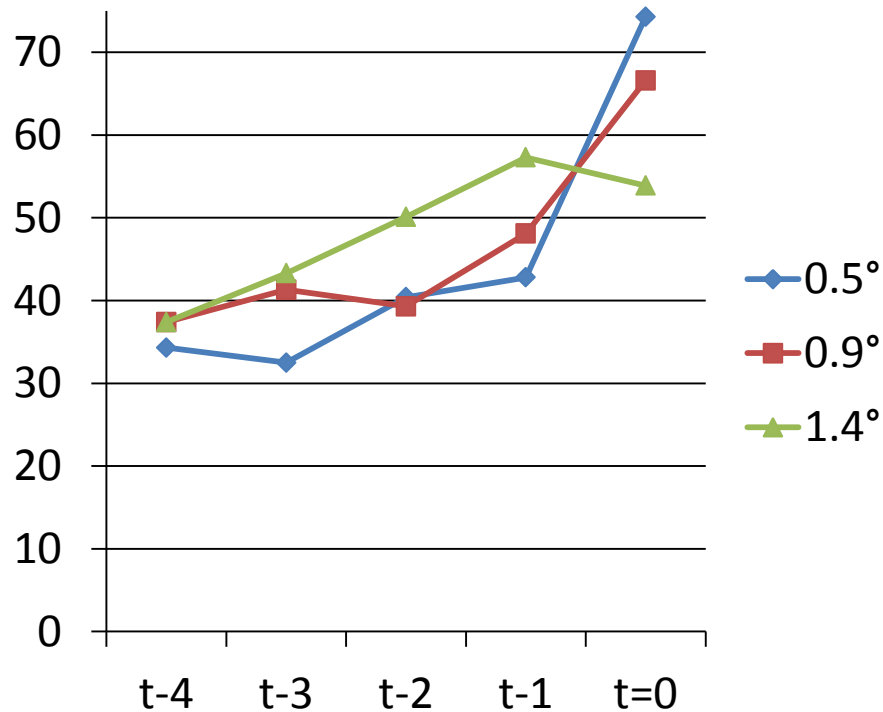
..... ~22 min



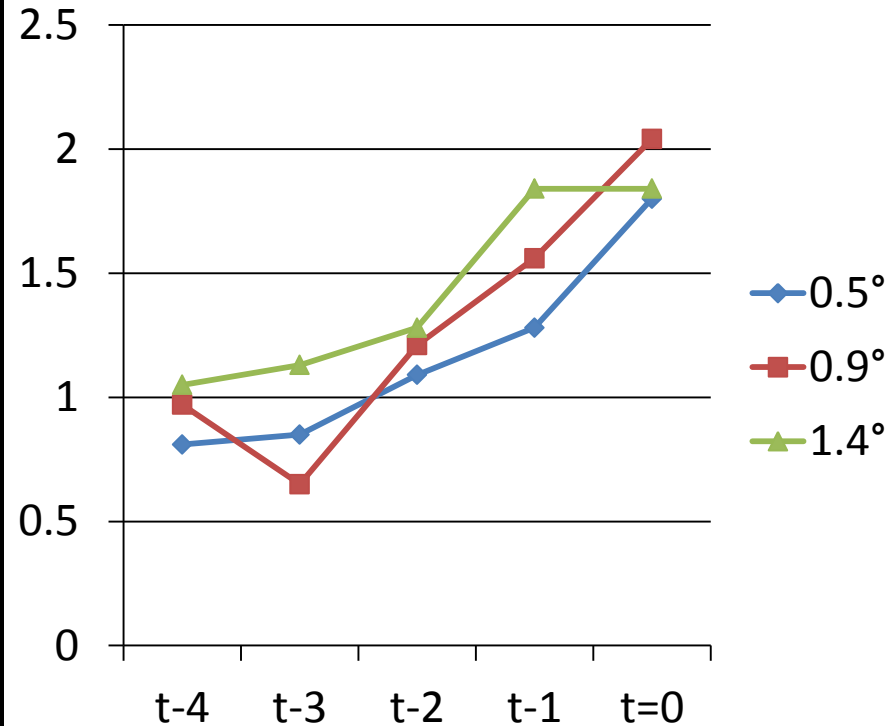
Case 1: Supercell



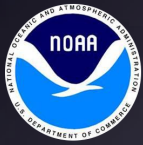
Max Vr (kts)



Max NROT



Max Vr calculated as (max outbound SRM + max inbound SRM)/2

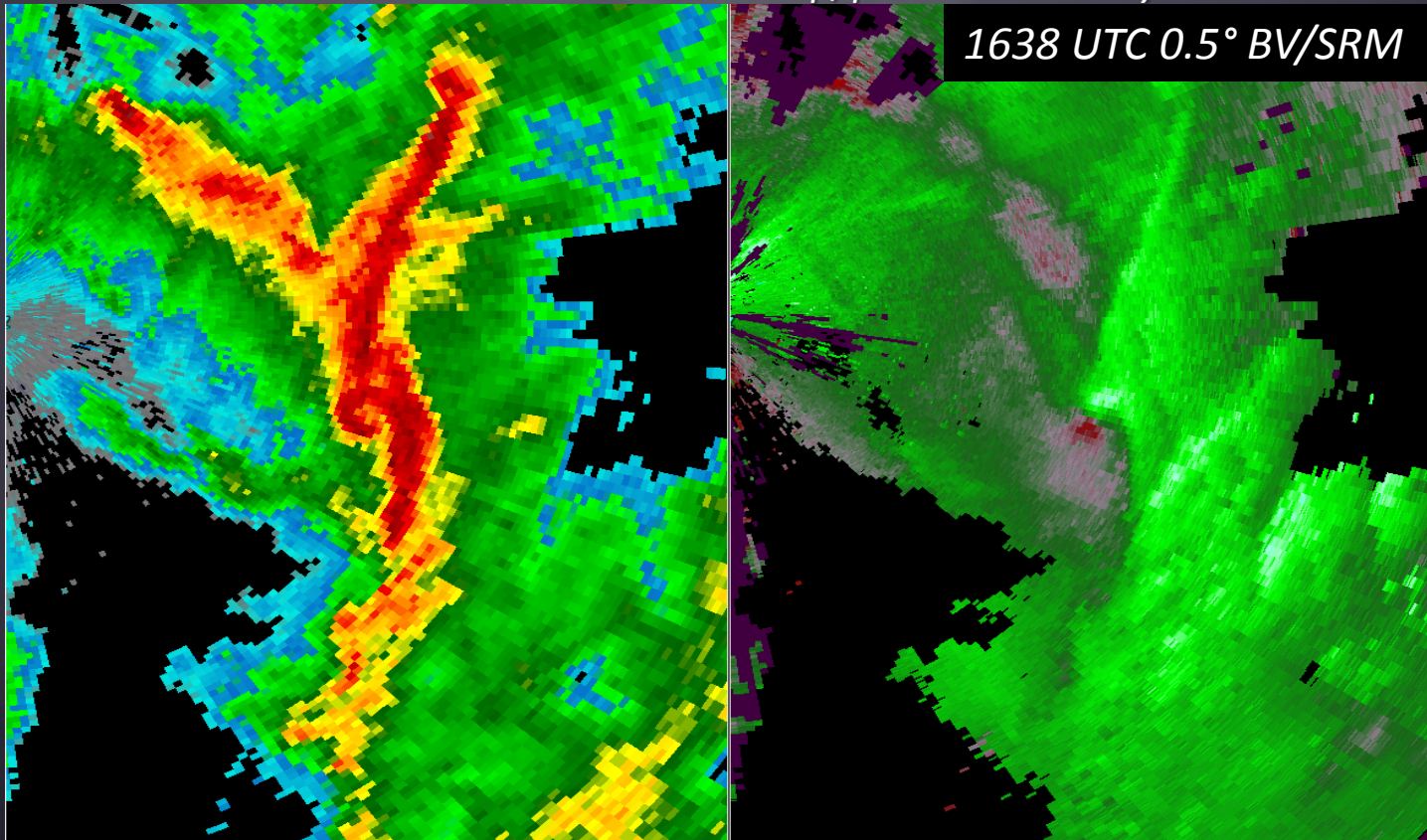


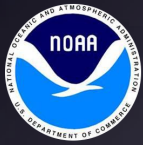
Case 2: QLCS



- 1 December 2006 - Westmoreland Co., PA
- 33.8 nm from KPBZ (touchdown)
- Motion: 237° 60 kts
- Magnitude: F-1
- Length: 8.87 miles
- Width: 50 yards

Linear convective bands with no deep, persistent mesocyclone

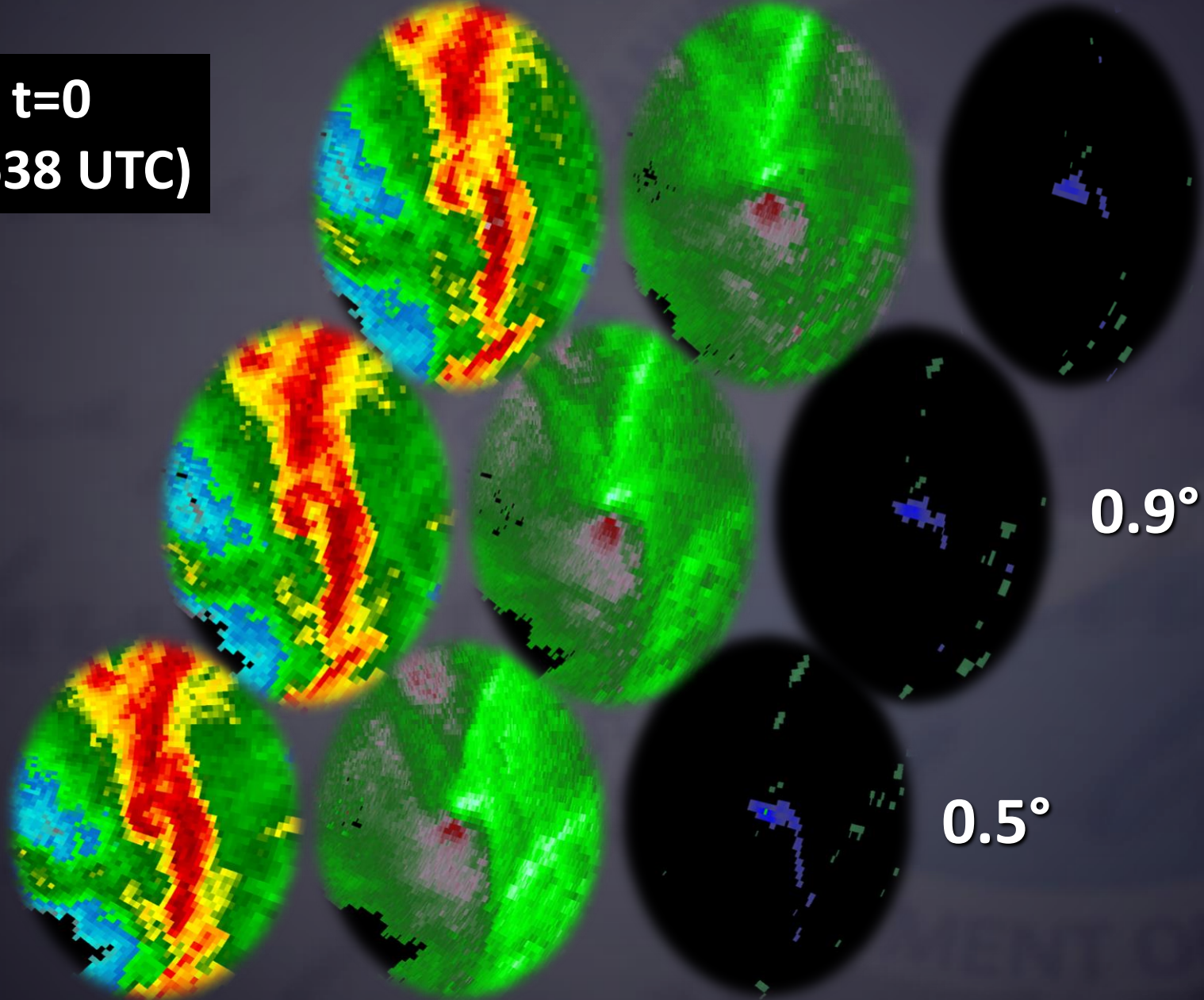




Case 2: QLCS



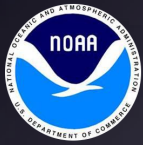
**t=0
(1638 UTC)**



1.4°

0.9°

0.5°



Case 2: QLCS



Max NROT value noted in parentheses

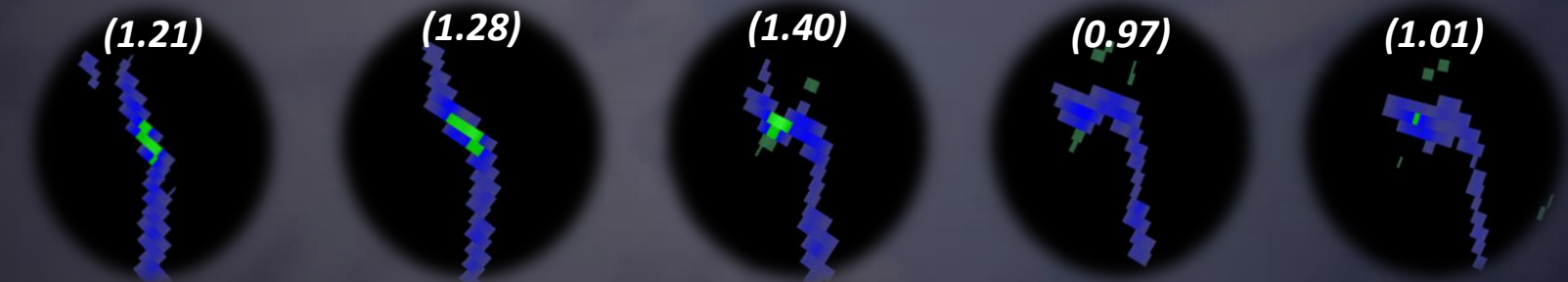
1.4°



0.9°



0.5°



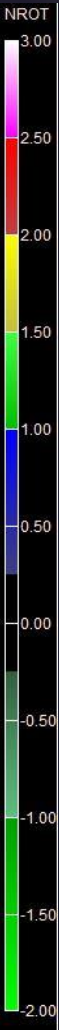
t-4

t-3

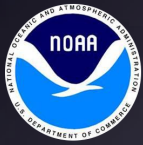
t-2

t-1

t=0



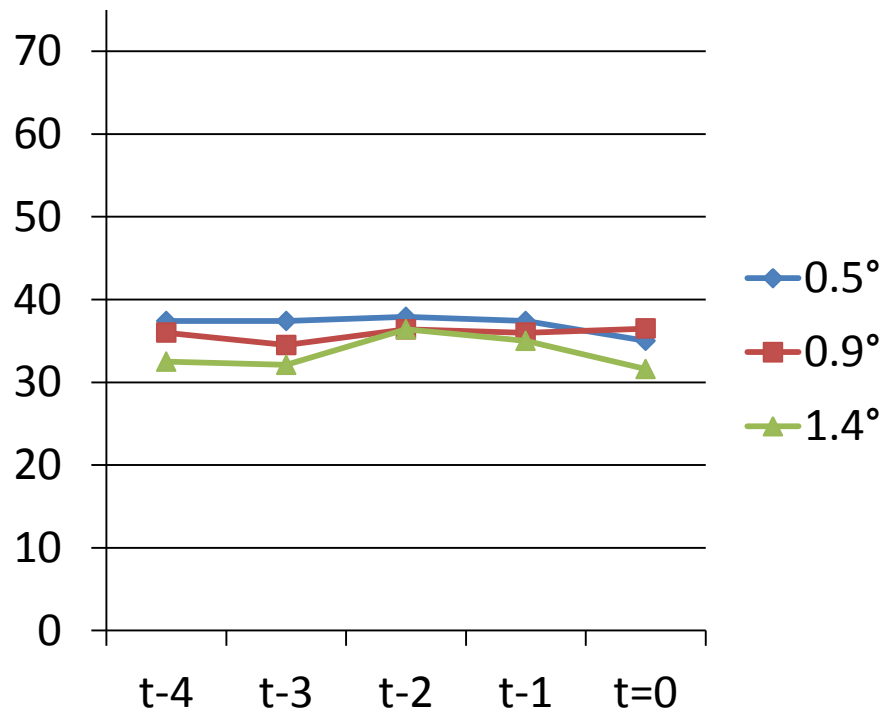
~17 min



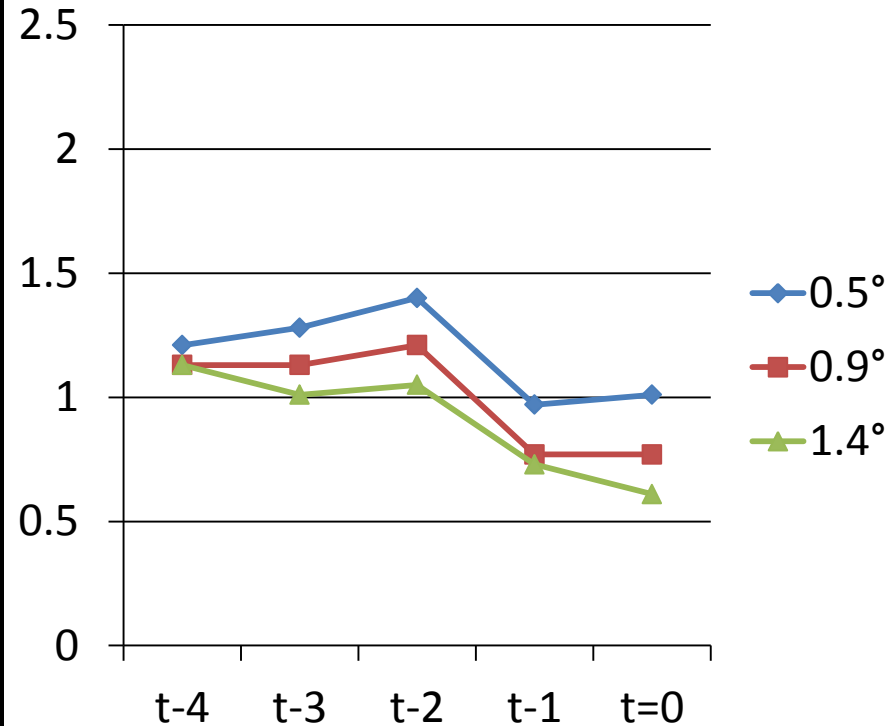
Case 2: QLCS



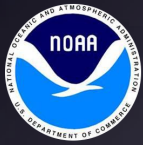
Max Vr (kts)



Max NROT



Max Vr calculated as (max outbound SRM + max inbound SRM)/2

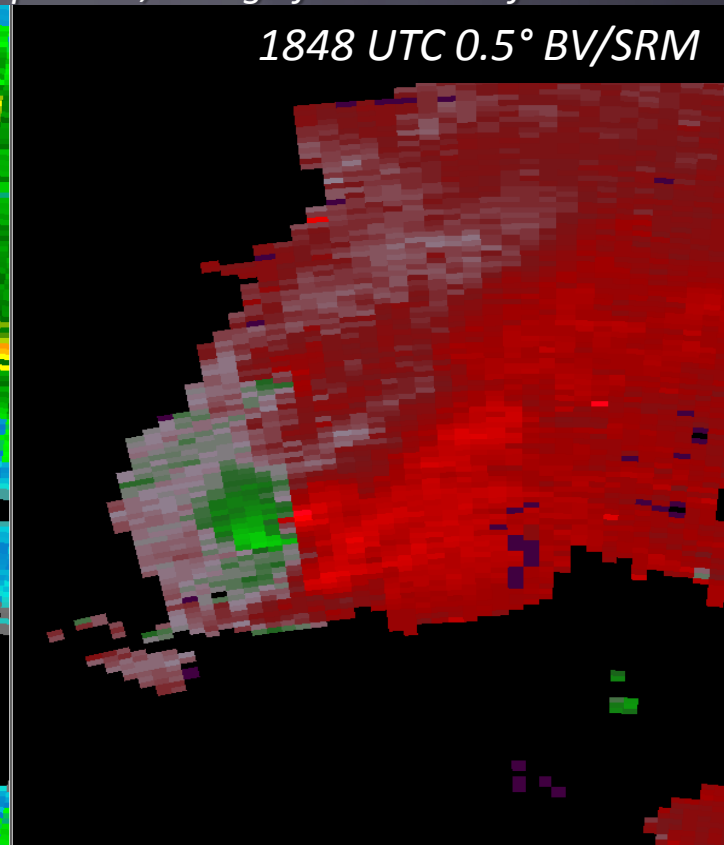
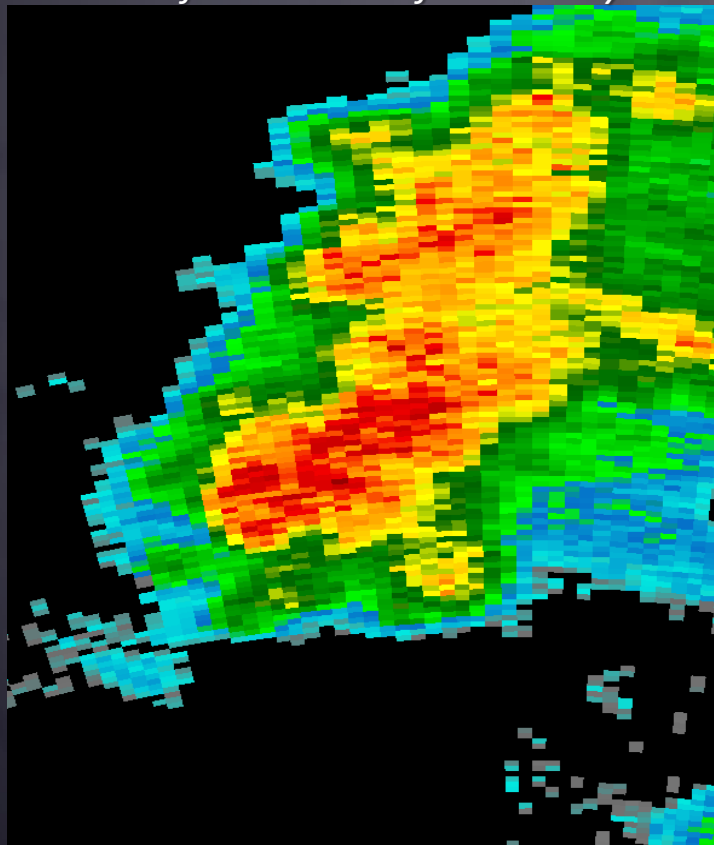


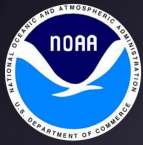
Case 3: Single Cell



- 8 July 2014 - Mercer Co., PA
- 40.8 nm from KPBZ (touchdown)
- Motion: 244° 34 kts
- Magnitude: EF-1
- Length: 2.46 miles
- Width: 150 yards

Classified as other if no mesocyclone present, no significant linear features

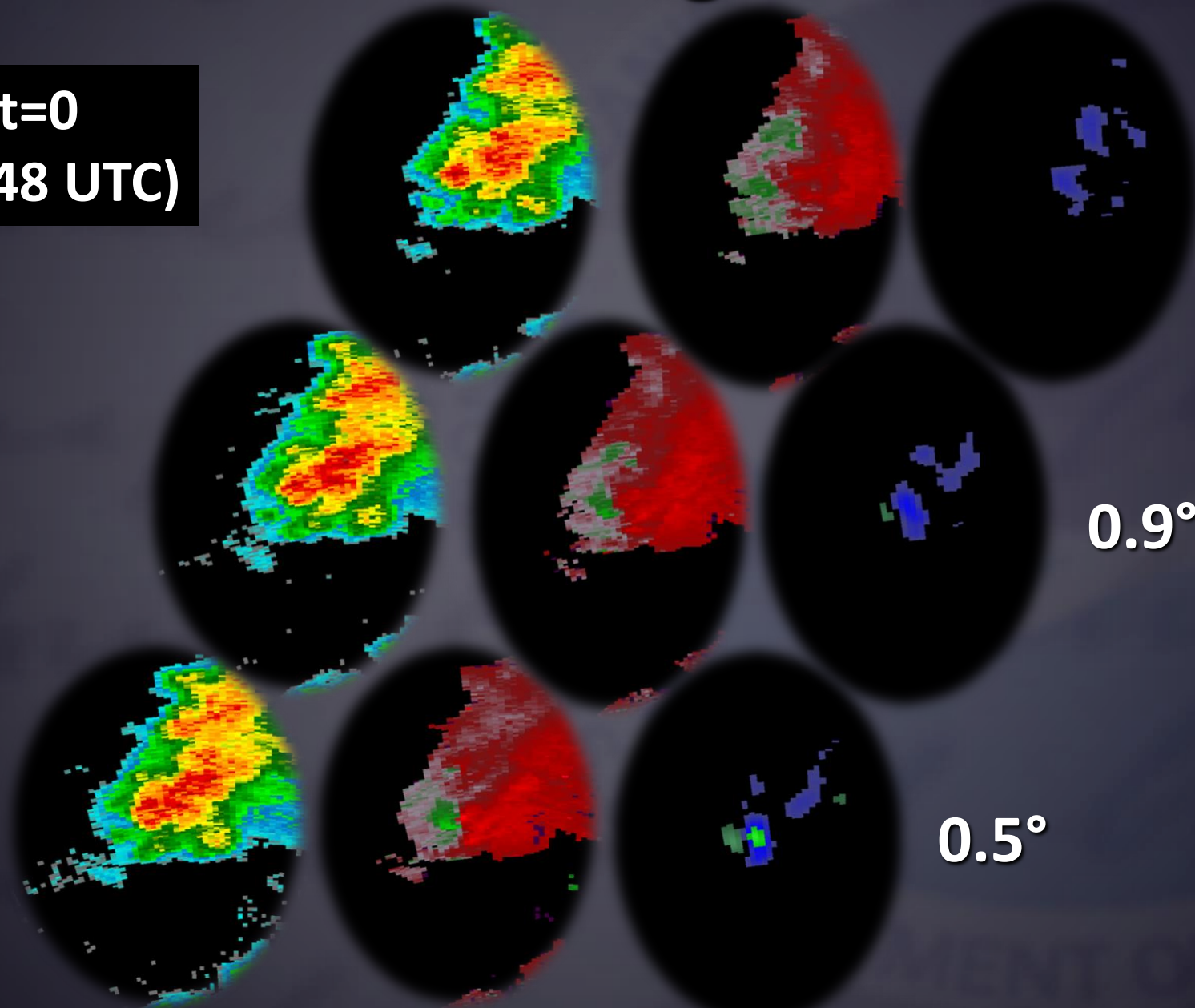




Case 3: Single Cell



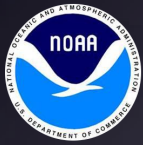
t=0
(1848 UTC)



1.4°

0.9°

0.5°



Case 3: Single Cell



Max NROT value noted in parentheses

1.4°



0.9°



0.5°



t-4

t-3

t-2

t-1

t=0

~21 min

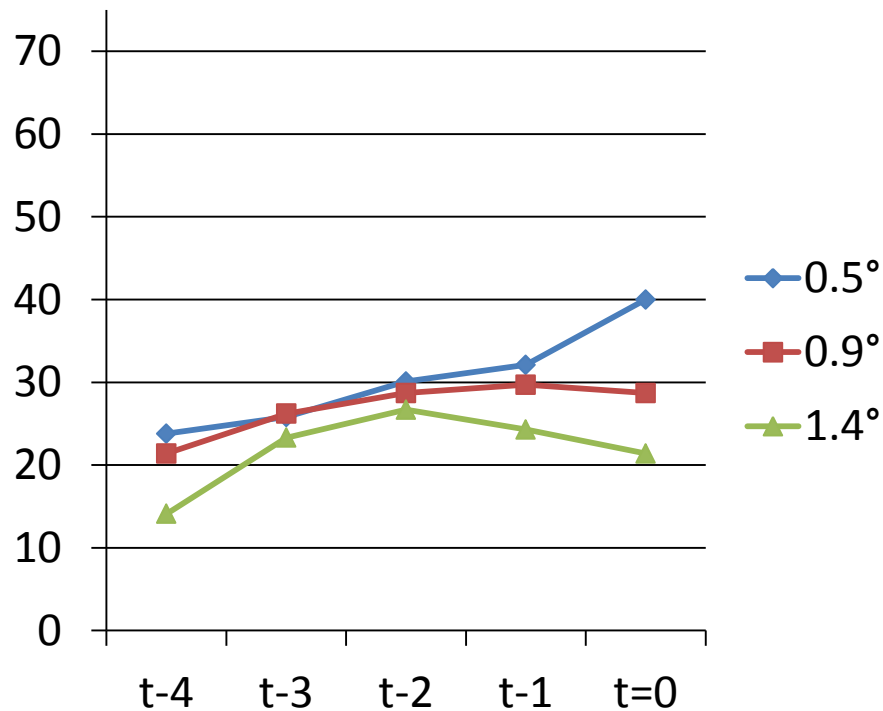




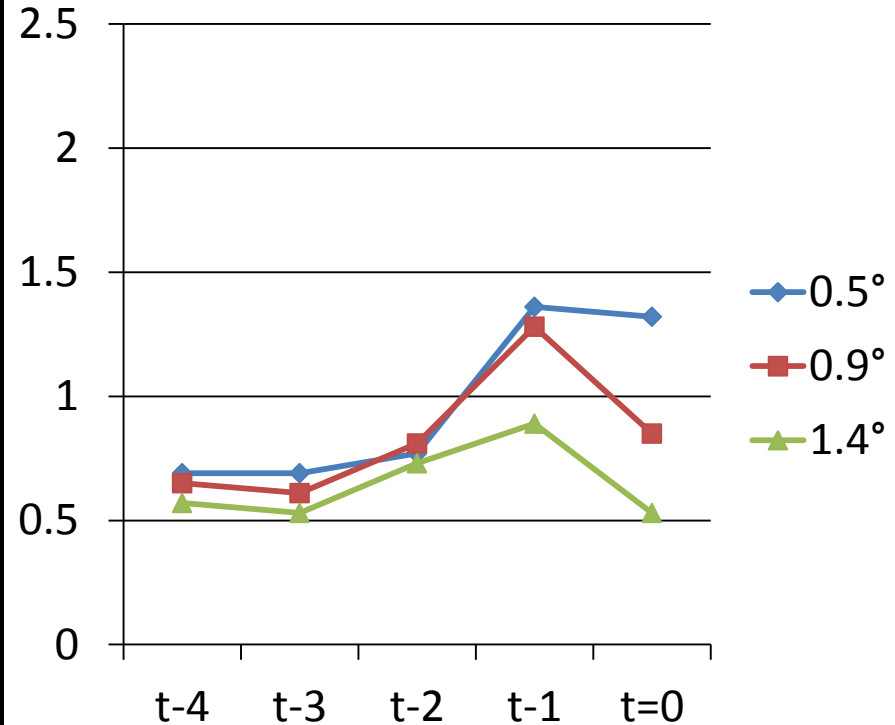
Case 3: Single Cell



Max Vr (kts)



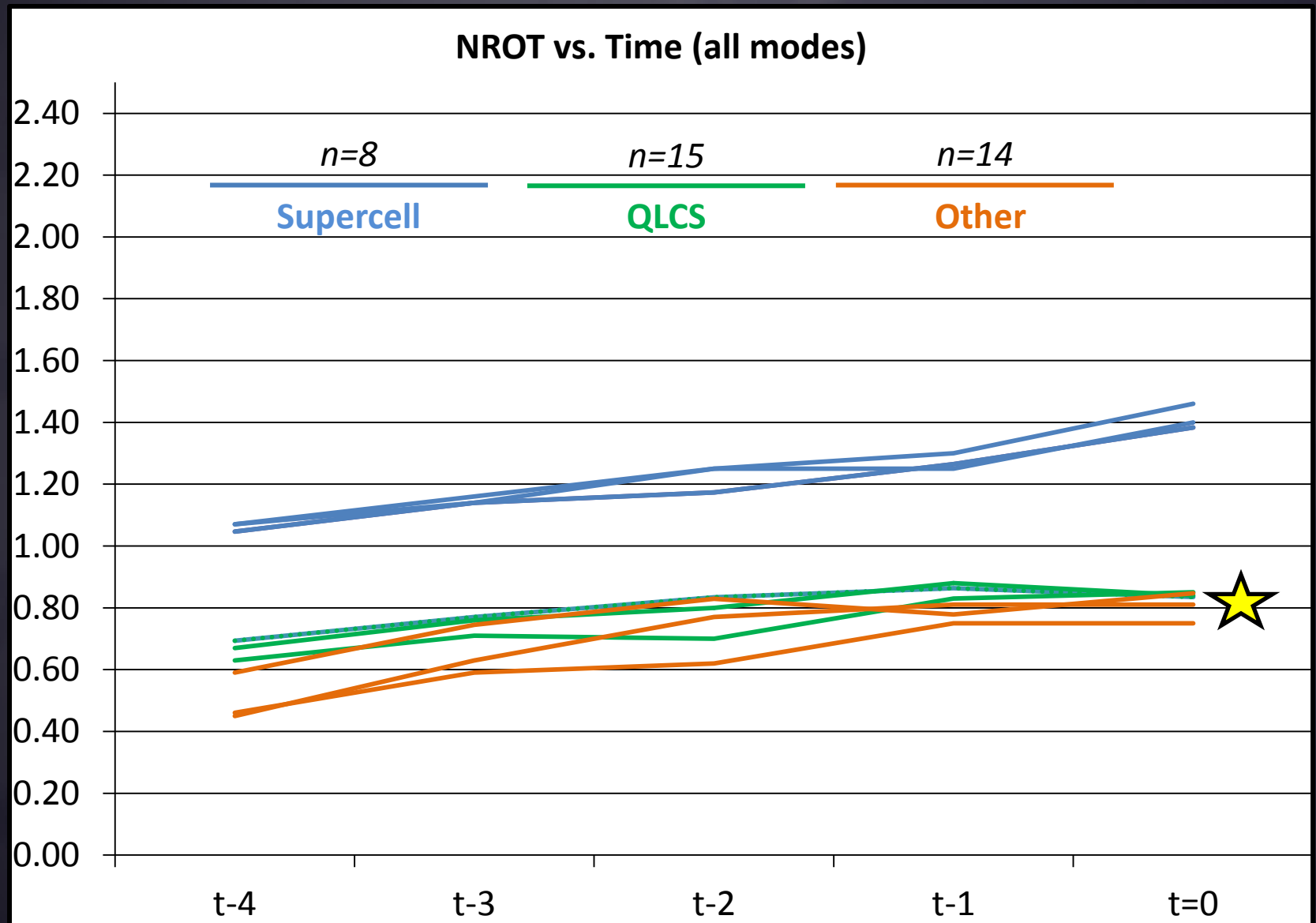
Max NROT



Max Vr calculated as (max outbound SRM + max inbound SRM)/2



Overall Results (all modes)





Conclusions



PRELIMINARY!

- Better correlation with *positive* NROT values
- Look at upper/lower bounds and **TRENDS**
- Better skill for supercells?
- Null cases?
- Good first step, more in depth study needed
- Other studies → **significance of values ≥ 0.8** ★



Final Thoughts



Is there utility in using NROT for tornado prediction?

Yes. Need to assess how much and best applications

- *Refine current data, add new data (statistical significance)*
- *Build conceptual understanding of NROT and its application*
- *Re-work with MRMS low-level rotation tracks*

Finally:

- *Develop training and guides to help forecasters*
- *Hands on familiarization via W2B/GR2AE simulations*
- *Full introduction to ops*

Only one of many tools. Still must use radar, env. data for decision-making!



Questions



Tornado near Abbott, NM – 7 June 2014